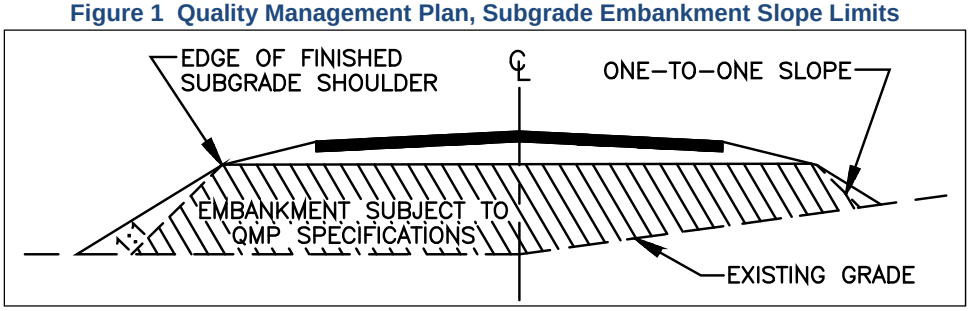
Materials sampling and testing methods and documentation procedures prescribed in chapter 8 of the CMM are mobilized into the contract by standard spec 106.3.4.1 and standard spec 106.3.4.3.1.

8-32.1 Quality Management Plan Description

Quality Control (QC) includes all activities in the subgrade construction including process control inspection, sampling, testing, recording, and adjustments in the process. QC for the project will be understood to cover all subgrade construction on the mainline within the limits of the assumed one-to-one slopes extending outward and downward from the outer limits of the finished subgrade shoulder lines (see Figure 1). This will include all embankment fills, backfill of excavations below subgrade (EBS), structure or utility backfill, and the recompaction of the subgrade in cut areas.

The individual performing all the QC activities must be certified by HTCP, and have the Grading Technician I certification. An individual holding a Nuclear Density Gauge Operator certification will perform all moisture density testing. Fill materials placed outside the assumed slopes of the mainline project including side roads, frontage roads, and driveways will not apply to the Quality Management Plan (QMP). Fills outside the mainline will be placed in accordance with standard spec 207.3.6.1.

Figure 1 Quality Management Plan, Subgrade Embankment Slope Limits



The contract parties (contractor and engineer) will agree on the portions of subgrade work on the project to be included under the QMP. This agreement should be reached and documented at the project preconstruction conference. Questions regarding QMP work on the project should be either resolved at this conference, or the mechanics will be in-place to resolve issues before the work begins.

8-32.2 Contract Quality Control Plan

The contractor is required by the QMP subgrade special provision to provide the engineer with a written QC plan. The plan is to explain how the contractor proposes to control the equipment, materials, and processes to ensure the specified product is obtained. The contractor will be expected to respond to failing tests through increased testing, modification of the operation, or other appropriate action. All pertinent items in standard spec 205 and standard spec 207 will be covered in the plan but tailored to meet specific needs of the project. Construction of subgrade will not begin until the engineer accepts the plan.

The contractor will agree to consider appropriate changes to the QC plan as requested by the engineer in order to ensure proper quality. Mutually agreed subsequent amendments then become part of the plan.

8-32.3 Pre-Startup Activities

8-32.3.1 Soil Source Study

The contractor will conduct a soil source study before the beginning of grading operations. The soil source study will identify and test the significant soil types that will be used as fill material on the project. The maximum density and corresponding optimum moisture level will be determined for each soil type. A site-specific family of Proctor curves will be developed from the completed soil source study to be used in determining the compaction compliance on the project.

To perform the soil source study, the contractor will review the soil borings and geotechnical report prepared by the department for the project. The contractor's QC personnel will determine, based on the project's soil borings and any additional soil explorations performed by the contractor, which significant soil types from the cut areas or borrow sources should be sampled for laboratory testing. Consultation with the department's geotechnical section and/or the region material section in determining which soils to include in the soil source study is recommended.

The contractor will perform test pit excavations to obtain representative samples of the soil types for laboratory testing, using the geotechnical report as a guide in locating the significant soil types. An expanded exploration plan of test pit excavations by the contractor is encouraged to identify any soil types that were not encountered in the department's soil borings.

Due to the limitations of the backhoe excavation equipment, the contractor is only required to perform the initial soil source study in the top 15' of the deep cut and borrow areas. The initial soil source study must be completed and approved by the engineer before any site grading. The contractor is required to expand the soil source study in those deep cut and borrow areas (greater than 15') as those areas become accessible during the site grading. The laboratory testing for any additional soil types encountered during site grading must be completed and approved by the engineer before placement of that fill material. The contractor is encouraged to closely monitor the cut and borrow areas for changes in soil types, to prevent any delays due to laboratory testing.

The contractor will obtain a sufficient amount of material for each specified soil type to split into two laboratory samples of approximately 50 lbs. each. The material will be split by quartering or with a riffle splitter similar to the method described in CMM 8-60. Each sample will be labeled by the contractor with the contract number, date sampled, sample number, and location.

The department's samples must be promptly delivered to the department at:

Mr. Tom Brokaw
3502 Kinsman Blvd
Madison, Wisconsin 53704

or to other locations as directed by the engineer for possible quality assurance testing.

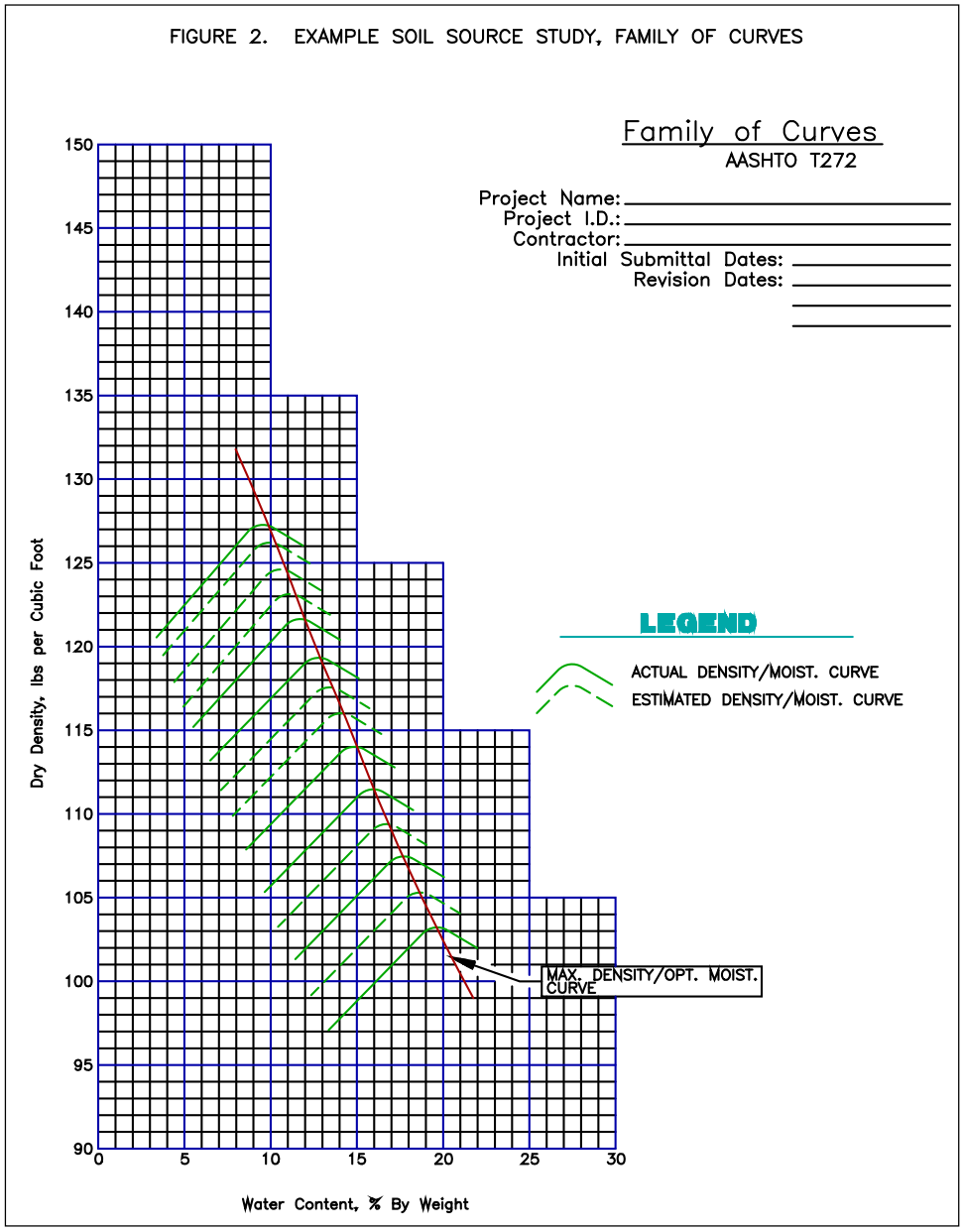
If the samples are sent to 3502 Kinsman Blvd. in Madison, it's recommended to you contact Mr. Brokaw at 608-246-7934 in advance to assist in scheduling priorities. The department will complete the quality assurance comparison tests on the soil source study samples within seven working days after the department has received the samples.

The contractor will also retain a sealed, jar size sample (8 oz minimum) of each soil type selected, at its natural moisture content, for use in identifying the soil types during the site grading.

The contractor will perform a moisture-density (Proctor) curve and characterization tests as listed in the special provision for each soil type. A site-specific family of Proctor curves will be developed from the completed soil source study and be submitted to the engineer for review and approval. An example of a family of Proctor curves is illustrated in Figure 2. The soil source study submittal will also include the natural moisture content of each soil type selected for the study. Those natural water contents that exceed the moisture control limit for the project will be identified as materials that will likely require drying during placement.

Use department form WS2071, Soil Moisture/Density, to determine the moisture-density relation of soil (AASHTO Designation T 99).

Figure 2 Example Soil Source Study, Family of Curves



8-32.4 Excavations Below Subgrade

Excavations below subgrade (EBS) due to poor soil conditions will be determined by the engineer, with assistance from the contractor's QC personnel. The contractor will notify the engineer for direction if unstable subgrade soil conditions are encountered.

With the soils evaluation associated with the soil source study and the monitoring of the grading operations, the contractor's QC personnel will have an intimate knowledge of the site's soil conditions. This specific site soil knowledge should be a benefit in predicting and identifying areas of the site that may require EBS. The contractor's QC personnel should work closely with the engineer in identifying potential subgrade problems so as to expedite any correction of the subgrade soils that may be required.

Excavations below subgrade will be backfilled in accordance with the special provision unless otherwise directed by the engineer.

8-32.4.1 Guidelines Predicting EBS Areas

Excavation Below Subgrade (EBS) should be anticipated if one or more of the following conditions are present:

- Normal groundwater levels are 3 feet or less from the surface.
- Soils have a silty “B” horizon (layer below the topsoil).

- Normal topsoil depths exceed 12 inches.
- Natural soil moisture levels are above the plastic limit and are approaching the liquid limit.
- Soils are of relatively recent alluvial origin.
- The existing roadway was constructed before 1940.
- Extensive filling has occurred in the general area (urban areas).
- The existing roadway shows signs of distress such as patches, cracks, allegatored surface, localized rutting, or subsidence.
- Pedological soils descriptions or on-site investigations indicate the presence of silt pockets or layers, wet sand layers, or highly variable soil conditions.
- The finished subgrade is within 2 feet of the original ground surface.

8-32.5 Field Density/Moisture Control Testing

The contractor's QC personnel must perform subgrade construction monitoring, testing, and field sampling to ensure compliance with the provision. The QC personnel must be on site during all grading operations performed under the QMP grading plan. The QC personnel must test for density and moisture of subgrade fill construction, where specified, within the established limits of the QMP. Monitoring of the subgrade construction should include documentation of the contractor's procedures for subgrade preparation and embankment fills. Testing and sampling of the subgrade materials must be performed in accordance with the procedures and at the frequencies stated in the special provisions.

8-32.5.1 Field Density/Moisture Testing

Fill placed during subgrade construction must be tested for density and moisture, where specified, using a nuclear density/moisture gauge in accordance with AASHTO T 310.

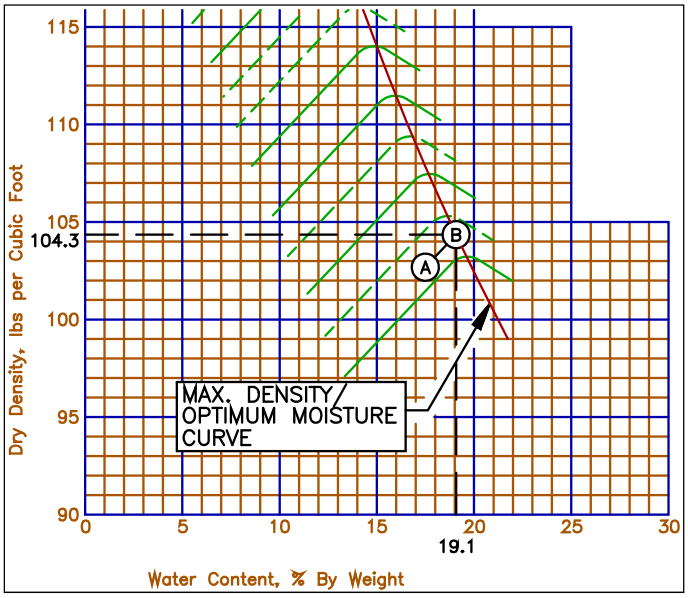
To determine the percent compaction and the percent of optimum moisture, the fill material from each field density/moisture test should be related to one of the specific soil types identified in the soil source study. Textural identification of the specific fill material for each test will be the primary method of estimating which maximum density curve from the soil source study to use in determining the percent compaction and percent of optimum moisture. A detailed description of the textural identification procedure is presented in ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

To aid in the visual and textural identification, a sample must be retained, at its natural moisture content, of each of the soil types included in the soil source study. The QC personnel can then refer to this library of soil samples when selecting the appropriate maximum density-optimum moisture curve.

As a check in determining the correct soil type, the QC personnel is required to obtain a representative sample of the fill material at every third randomly selected field density test location. This sample must be tested in accordance with AASHTO Designation T 99 and T 272, Family of Curves - One-Point Method, Method A or C (one-point Proctor test). The one-point Proctor test result will be compared to the curves developed in the soils source study to determine the maximum density and optimum moisture applicable to the field density test. The appendix for AASHTO Designation T 272 will be used as a guide in this determination.

Figure 3 illustrates how to select the maximum density and optimum moisture using the family of curves and the one-point Proctor value. The one-point Proctor test results will be recorded on the Nuclear Soil Testing Record (see example on Figure 4). The results of the one-point Proctor test should be used to determine the percent compaction and percent of optimum moisture for the field test from which the one-point Proctor sample was retained. The contractor should retain a split sample of the material selected for the one-point Proctor test for 14 days for quality assurance comparison testing, unless released sooner by the engineer.

Figure 3 Plotting the One-Point Test Result



Example 1

Point A is a plot of the One-Point Proctor test results (102.7 lb./cf. dry density at 17.5% moisture). A line is drawn parallel to the nearest Proctor curve from point A to the Maximum Density/Optimum Moisture curve (Point B). The coordinates of point B (104.3 lb./cf. dry density and 19.1% moisture content) are the maximum dry density and the optimum moisture used for determining the percent compaction of the field density test represented by the One-Point Proctor test.

The contractor may conduct additional testing at any time to supplement the specified work. The specific frequencies represent the minimum testing for the project. However, it should be understood that only test results from randomly selected locations can be used for computing running average values for control charts. Therefore, test results generated by testing at the discretion of the contractor, while recommended and considered meaningful, will be for the contractor's information and process control use only.

The QC personnel should document the test data and locations for all randomly selected tests. The documentation will include the nuclear density/moisture meter test readings, test locations, and test elevations. Elevations are to be accurate to + 0.5 feet based on hand level readings taken from grade stakes.

Department form WS4601, Nuclear Soil Testing Record, can be downloaded and used for the test documentation and may be reproduced, as needed. Figure 4 is an example of the field density/moisture test data documentation.

Figure 4 Example Field Density/Moisture Test Documentation

NUCLEAR SOILS DENSITY TESTING RECORDS Wisconsin Department of Transportation

WS4601

Project ID. 7091-06-72		Road Name Oregon-Evansville		Project Engineer B. Smith	
Contractor Excavators, Inc		County Dane		Region 1	Hwy. No.
Operator J. Doe		Set No.	Density Standard	Moisture Standard	Date 07/02/08
Test No.	1	2	3	4	5
Grading Area	2	2	2	2	2
Station	359+32	360+21	360+93	359+10	360+72
Offset	25' LT	20' LT	6' LT	38' LT	31' LT
Depth Below Subgrade	3.5'	3.0'	1.0'	2.0'	Ø
Test Position **B.S. or D.T. Depth ,4",6"or 8"**					
Required % of Maxium Density					
Contact Reading **Density Count**	3463	3286	3457	3361	3301
Air Gap Reading	5062	5078	5069	5071	5063
Wet Density (P.C.F.) **Total Density**	121.8	123.7	114.8	119.1	120.4
Moisture Count	127.0	200.5	185.5	250.0	263.5
Moisture (P.C.F.) **(b) Total Water**	17.6	16.9	15.5	19.5	20.1
Bulk Dry **(c) Dry Density**	104.2	106.8	99.3	99.6	100.3
% Moisture 100 x b / c	16.9	15.8	18.6	19.6	20.0
% Maxium Density 100 x c / d	93.5	95.8	94.2	95.5	95.2
Soils Classification	Br. Silty Clay	Br. Silty Clay	Br. Silty Clay	Br. Silty Clay	Br. Silty Clay
Proctor Number Pit Number					
Maximum Density (d) of Proctor	111.5	111.5	105.4	104.3	105.4
Proctor Optium Moisture	16.0	16.0	18.7	19.1	18.7
% R-4 Material					
Test Remarks					

8-32.5.2 Random Testing Selection

The QC plan special provision specification requires the contractor to perform "randomly selected tests" on subgrade fill soils for field density and moisture.

The use of a random testing practice is specified with the intention of eliminating bias in the sample selection process and, thus, increasing the representative state of samples. Greater reliability is assigned to test results from this process and the "strength of data" is improved for statistical purposes.

The method to be used for selecting random test locations is ASTM D3665, Standard Practice for Random Sampling of Construction Materials. Random numbers may be selected by following the instruction of Section 5 of ASTM D3665 or by using a calculator with a random number generator.

The contractor QC personnel should do the selection of random testing locations. In order to fully ensure that the selection of test locations is random, only those who need the information, such as QC personnel, should be notified. The operator will not be advised in advance as to when tests are to be taken. The effectiveness of process control sampling is completely reliant on unbiased testing. Collusion between the QC personnel or QA personnel and compactor operator, in this regard, may be cause for decertification of technicians.

The QC personnel should discuss the anticipated fill placement schedule with the contractor's grading foreman on a daily basis. The QC personnel and QA personnel need to know the general grading area(s) in which the contractor intends to fill and the anticipated rate of fill placement based on the number of scraper or trucks hauling and the length of the haul. Based on the anticipated rate of fill placement the QC personnel will

determine at what approximate time periods during the day random field density/moisture tests will be required. The QC personnel may have to make adjustments to the testing schedule during the day if the contractor's production rate changes. Therefore, the QC personnel should document the load counts during the mid-day lunch break and at the end of the day to determine if the production rate is as anticipated. If the load counts indicate a significant change in the production rate the QC personnel must adjust the testing frequency accordingly.

Example 2

Based on the number of scrapers and the length of the haul the contractor anticipates placing approximately 1000 CY per hour with a total of 10,000 CY for the day. With the test frequency set at one test per every 3000 CY the QC personnel will be required to perform a test approximately every three hours during the day with a total of three tests for the day. The additional yardage could be included in the following day's production, or handled by conducting a fourth test for the day.

To determine the specific test location the QC personnel will determine the general location of the active fill area at the time the test is being performed. Depending on the filling operations at that time the active fill area may only be a portion of the general grading area.

Example 3

The individual segment area in which the contractor has been placing fill for the day extends from approximately station 347+50 to station 356+30. However, for the previous several hours of grading the fill placement and compaction has been concentrated in only a portion of the general fill area because the contractor is allowing the fill in the remaining portion to dry.

When the QC personnel selects the test location only the active fill portion of the grading area should be used in determining the random location. The active portion of the grading at this time is from Sta. 353+75 to Sta. 356+30 and the width of the fill from finished shoulder slope to shoulder slope is 74 feet.

Total fill length = 255' (Sta. 353+75 to Sta. 356+30)

Total fill width = 74' (shoulder slope to shoulder slope)

Dimension/Fill Area		Random Number		Random Location Measurements
255' (length)	x	0.272	=	69' (length)
74' (width)	x	0.519	=	38' (width)

Therefore, the dimensions for the location of the random test are 69' from the fill area's starting station (Sta. 353+75 plus 69') or Sta. 354+44 and 38' left from the right shoulder slope line.

The QC personnel may use some discretion in determining the exact location to place the nuclear meter for the test, due to surface conditions at the test location. However, the test will be performed within a three-foot radius of the calculated random location.

8-32.5.3 Grading Areas

Grading areas are defined as portions of the project in which fill placement and compaction procedures are unique and/or independent of another. Therefore, due to their isolation or unique procedures the quality control documentation for these areas should also be evaluated independent for each area.

Example 4

The contractor decides to split the grading crew and place and compact fill in two isolated portions of the site. The two grading operations are independent of each other. The quality control documentation for these two grading areas should also be independent of each other.

If the QC documentation is not separated a potential exists in which poor compaction procedures and low test results in one of the grading areas can be offset by exceptional test results in the other area.

The designation of a grading area is determined by the QC personnel but will be subject to review and acceptance by the engineer. As grading areas are designated, the QC personnel will assign an identification number to the grading area and document the approximate location of the area. The grading area identification number will be used for all test documentation. Figure 5 is an example of the grading area designation documentation. Department form WS2073, Grading Area Designations Sheet, is used for documenting the grading areas.

Figure 5 Example Grading Area Designation

Sheet 1 of 1

WS2073 Grading Area Designations

Project I.D.: 7091-06-72		Project Name: Oregon - Evansville		
Contractor: Excavators, Inc.				J. Doe
I.D. No.	**Stations**	**Elevations**	**Dates Filled**	**Remarks**
1L*	357+00 → 372+50	11.5' → 6.0'	6/27 → 7/03	Lower fill zone
2U	355+00 → 378+70	6.0' → 0	6/30 → 7/10	Upper fill zone
3U	381+25 → 385+10	4.5' → 0	7/8 → 7/10	
4U	371+32 → 371+40	5.5' → 0	7/8	
* "L" indicates Lower Zone fill; "U" indicates Upper Zone fill.				

8-32.5.4 Control Chart

Control charts are defined as graphs to reflect variability of a characteristic over a period of time on individual segments. Standardized control charts must be maintained by the contractor QC staff at the field laboratory.

If the contractor is placing fill in separate distinct grading areas for the project he/she must provide separate control charts for each grading area for the project work. Individual test results obtained by the contractor must be recorded on the control charts as soon as possible on the same day as the tests are run. The engineer (QA staff) will post results of assurance tests on the same QC charts as soon as data is available.

Control charts must be maintained and kept current for the following items:

- Field density tests.
- Field moisture tests.

Control charts contain pertinent identification information as well as the plotted data. In addition to the individual test points of the contractor and engineer, a moving average of the last four (4) QC data points must be plotted.

Control charts include both control and warning limits. The areas between the control and warning limits are the warning bands.

Two different parameters will be plotted on the control charts for subgrade testing, each having different control criteria. The control chart for field density will have a lower warning limit and a lower control limit for the moving average values, plus a second lower control limit for individual test points. However, there is no upper warning

or upper control limits for the field density tests.

The criteria for field density control limits may be different for each project, depending on where in the embankment the tests were performed. Density tests for the fill placed in the top six feet of a fill will be based on criteria established for upper-zone fills unless otherwise specified. Density tests performed at depths greater than six feet will be based on the criteria established for lower-zone fills unless otherwise specified. Refer to the special provisions for the specific criteria and zone definitions. The test data must be recorded on separate control charts for fill placed in upper-zones and lower-zones, if there is a change in criteria.

Figure 6 is an example of calculations for the moving averages for both the percent compaction and moisture content test results. It is used for calculating the moving averages. Department form WS2076, Moving Average Calculation, can be downloaded to perform the control chart plotting.

Figure 7 is an example of the field density control chart based on upper-zone criteria. Department form WS2079, Field Density Control Chart, can be downloaded to perform the control chart plotting for either upper-zone or lower-zone criteria.

The control chart for field moisture will have both upper and lower control limits with no warning limits. Refer to the special provisions for the specific moisture criteria.

Figure 8 is an example of the field moisture control chart. Department form WS2078, Field Moisture Control Chart, can be downloaded to perform control chart plotting.

The following color-coding will be used to draw control charts and plot data as outlined in the special provision specifications.

- Contractor individual data (QC) — Black
- Contractor moving average of four (4) — Red
- Engineer individual assurance data (QA) — Blue
- Warning limits — Dash green
- Control limits — Dash Red

Other legends may be used, with approval of the engineer, but one legend system will be adhered to for a contract. If an alternate legend is used the system should be defined on the control chart sheets.

Figure 6 Example, Moving Average Calculation Sheet for Field Density and Moisture, Form WS2076

Date	Grading Area	Test	% Comp.	Ave. (4)	% of Opt. Moist.	Ave. (4)
7/7/93	3	1	92.3	---	108.3	---
	3	2	95.6	---	105.3	---
	3	3	95.1	---	105.7	---
	3	4	96.0	94.8	103.6	105.7
	3	5	97.1	96.0	95.1	102.4
	3	6	94.3	95.6	92.2	99.2
7/8/93	3	7	94.7	95.5	93.5	96.1
	3	8	96.1	95.6	99.0	95.0
	3	9	95.5	95.2	92.1	94.2
	3	10	95.0	95.3	93.0	94.4
7/9/93	3	11	96.2	95.7	102.4	96.6
	3	12	97.0	95.9	105.1	98.2

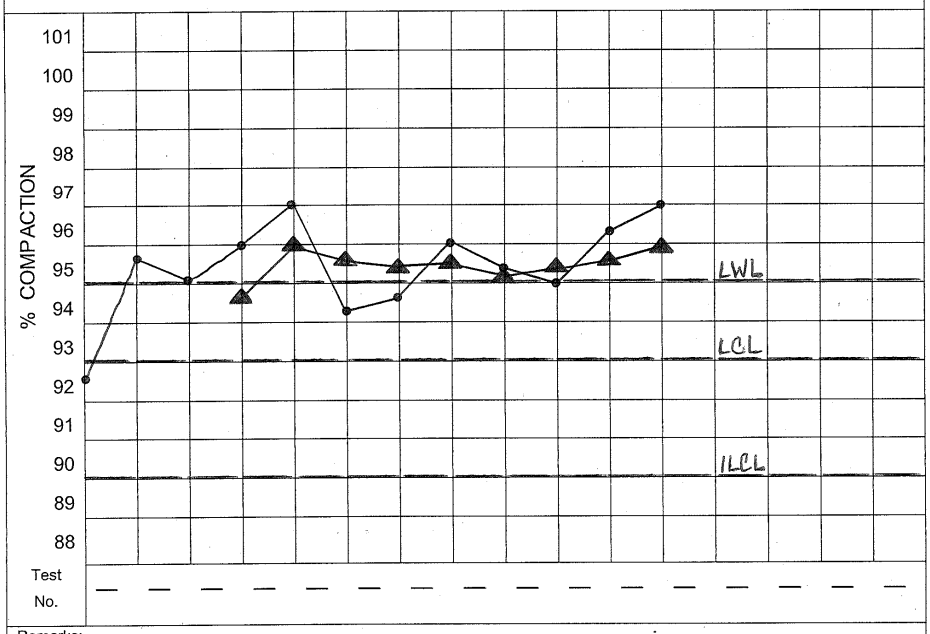
Figure 7 Example, Field Density Control Chart, Form WS2079

WS2079 Field Density Control Chart

Sheet 1 of 1

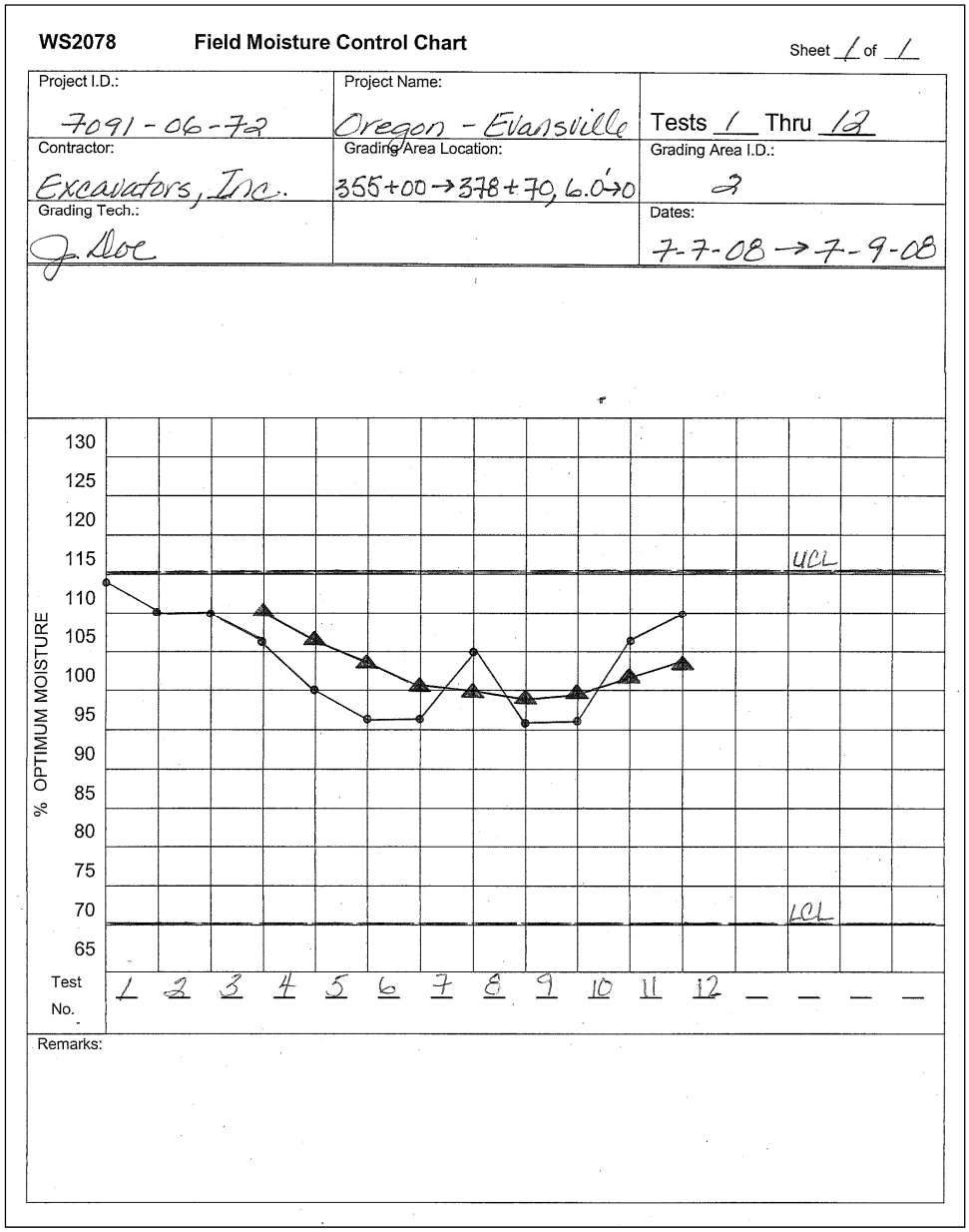
Project I.D.:	Project Name:	Tests 1 Thru 12
7091-06-72	Oregon - Evansville	
Contractor:	Grading Area Location:	Grading Area I.D.:
Excavators, Inc.	355+00→378+70, 6.0'→0	2
Grading Tech.:		Dates:
J. Doe		7-7-08 → 7-9-08

Criteria: Upper Zone ____ Lower Zone ____



Remarks:

Figure 8 Example, Field Moisture Control Chart, Form WS2078



8-32.6 Documentation

8-32.6.1 Records

The contractor must record observations, inspections, adjustments, and test results. Recording should be done in a timely manner, preferably upon occurrence of the activity. The records should be reported in a permanent field record book.

The records prepared by the QC personnel will be submitted to the project engineer on a daily basis and include the following:

- Nuclear soil testing records — WS2074
- Grading area designation sheets — WS2073
- Moving average calculation sheets — WS2076
- Field density and moisture control charts — WS2078 and WS2079
- Soil Moisture/Density — WS2071
- Field logbook for documentation of daily observations, inspections, and corrective action adjustments.

The records must be accurate and complete for all the work of the contract. The records should contain sufficient detail to sustain an audit, and clear enough to be read and understood. Emphasis should be placed on

neatness. Computation records should be clear, precise, accurate, and complete. Computations should be initialed and checked. The records should also include all significant conversations with various project personnel, meeting notes, and accounts of all disputes and subsequent decisions.

Records of adjustments, if required, should be provided to the engineer on a daily basis. When the project is complete, the total records of the contractor for the work need to be furnished to the engineer in a neat and organized manner. These records will become part of the final project records and it's to be assumed by those preparing them that they must withstand any review or analysis in future years.

8-32.7 Corrective Action

When the moving average trend for any of the control chart values is towards the warning limits for density or toward the control limit for moisture the contractor will consider corrective action (refer to Figure 9, Example A). Corrective action must always be documented. The corrective action undertaken may be to increase the testing rate, change compaction procedures or equipment, inspect field or laboratory equipment, dry or water the fill material, increase compaction effort, change materials, or combinations of these actions. In addition to documenting corrective actions, resulting effects of the corrective actions should be recorded.

When the field density moving average for the control chart value exceeds the warning limits the contractor must notify the engineer (refer to Figure 9, Example B). This should be done immediately, as soon as the value is determined. When a second consecutive moving average value for density exceeds the warning limits (refer to Figure 9, Example C) the contractor and engineer need to discuss a course of corrective action. The contractor will perform the corrective measures.

Figure 9 demonstrates the three density control chart patterns presented in the preceding two paragraphs. The appropriate action to be taken by the contractor is indicated on each chart.

In the foregoing examples illustrated in Figure 9 the data trends from the start are toward the warning limit. The prudent contractor and QC staff will be watching the data trend and making decisions to alter the trend, hopefully before the conditions in either Example B or C occur. The contractor will want to take action as soon as the data confirms something is not right.

Process quality control is the responsibility of the contractor. It is important that the contractor attend to controlling the process when warranted, or it could result in excessive delays due to repeated corrective actions.

In the previous Figure 9, Example C, there are a number of conditions that can result. One condition is that following the corrective action the field density may improve as evidenced by a new moving average point, after four random tests, which is not in the warning band. In this case, the contractor may continue production since the problem appears to be corrected (refer to Figure 10, Example A).

The second condition that can exist for Figure 9, Example C is that the corrective action does not improve the field density and the new moving average is still within the warning band (Figure 10, Example B). The continuation of fill placed within the warning band may have a cumulative effect on the stability and density of subsequent fill. Therefore, the fill represented by the third consecutive moving average point within the warning band is considered unacceptable. The contractor has to perform corrective action to bring the unacceptable subgrade fill material, after four additional re-tests, above the warning limit.

Two other scenarios would result in fill material being considered unacceptable:

1. If a moving average point falls outside the control limit.
2. If an individual test result falls below the individual control limit for density.

With regard to the moisture control chart, fill material would be considered unacceptable if the moving average point falls outside the control limits. Therefore, the contractor will perform corrective action to bring the unacceptable fill material, after four additional retests, within the moisture control limits.

Regardless of the corrective action selected for the unacceptable fill, re-tests of the unacceptable fill is required. The fill in this area will not be considered acceptable until the new moving average, calculated with the re-test, is no longer within the warning band or is within the control limits (Figure 10, Example C).

Should the contractor encounter a situation that he/she is unable to get fill material within control limits in a timely manner, consideration should be given to various alternatives. If the subgrade is obviously defective and inferior, the contractor should divert the material to other destinations, if possible. If the contractor is repeatedly reworking the material and performing numerous tests off the record (non-random samples) in an effort to bring the material within the control limits with no favorable results, the engineer should be advised of this condition and a proposal should be offered to the engineer for corrective action. In all cases, obviously defective subgrade (example: subgrade soil with a moisture content exceeding the control limit) must not be incorporated into the work. The engineer may refer to standard spec 106.5 for unacceptable material.

8-32.8 Quality Assurance Aspects for the Contractor

While the contractor and QC staff is not responsible for QA on the project they should be aware of how QA operations affect them.

8-32.8.1 Testing

The engineer QA staff must conduct testing on the split samples of the material selected for the soil source study. Testing will be at a minimum of ten percent of tests required of the contractor with a minimum of one sample to include each test listed in the Soil Source Study. The engineer may test as many of the samples as he/she determines necessary for the QA work. The engineer will be encouraged to select the most recent sample first and then select others, if needed to supplement QA information. Results should be provided to the contractor for comparison to the QC results as soon as possible after selecting the sample for test.

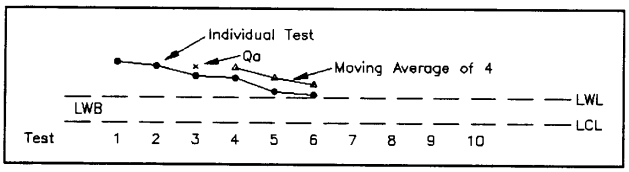
QA tests for field density/moisture must be from the exact location (nuclear source position) as the contractor and the one-point-proctor split samples will be tested at a minimum of ten percent of the tests required of the contractor.

The engineer will be permitted access to all areas of the project work including the QC laboratory. This is necessary for the engineer to conduct inspections and observations of operations as outlined in the specifications. If the engineer finds deficiencies in the contractor's process control he/she will notify the contractor verbally and in writing. The contractor should correct the deficiencies in a manner suitable to the engineer.

8-32.8.2 Testing Precision

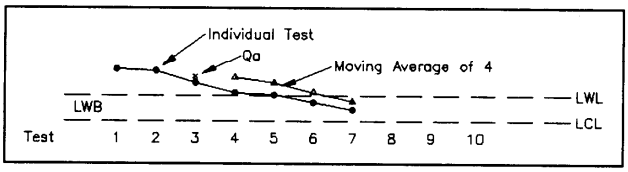
The special provision outlines allowable differences between engineer and contractor test results for the laboratory and field tests. The contractor should be aware of these differences and the importance that QC test results be comparable to QA data. Furthermore, the contractor should be aware that if testing differences exceed the allowable figures, the engineer must investigate the reason immediately. The contractor should want to make every effort to ensure their operations, equipment, and procedures are correct.

Figure 9 Density Control Chart Trends and Corrective Actions



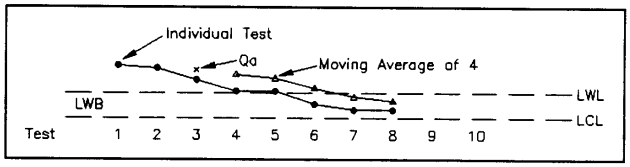
EXAMPLE A: Moving average trend is towards lower warning limit.

ACTION: The Contractor shall consider corrective action. This should happen as early as the 4th individual point and definitely by the 5th. Document action, if any taken.



EXAMPLE B: Moving average value exceeds the lower warning limit.

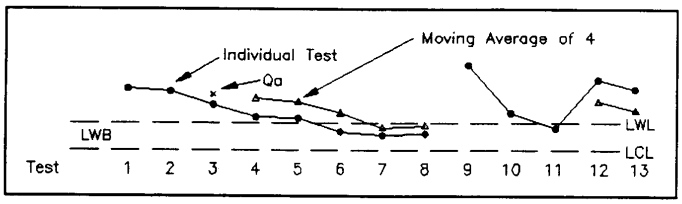
ACTION: The Contractor shall notify the Engineer when the first moving average point is obtained which exceeds the LWL (point 7). Document correction action, if any taken.



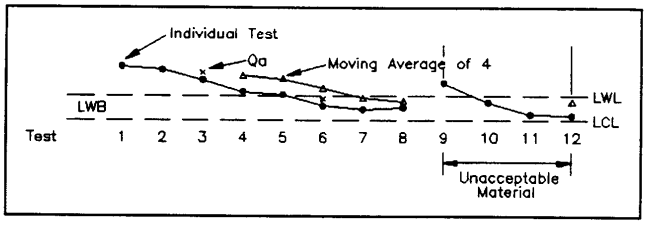
EXAMPLE C: A second consecutive moving average value exceeds the lower warning limit.

ACTION: The Contractor and Engineer shall discuss a course of corrective action when the 2nd consecutive moving average point (point 8) exceeds the lower warning limit. Document the corrective action taken.

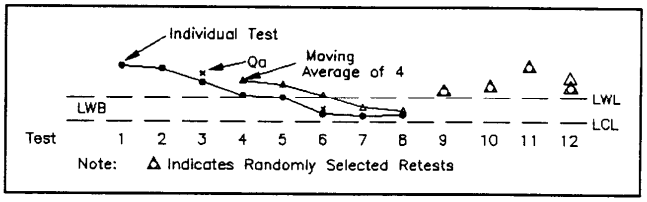
Figure 10 Conditions Resulting from Figure 9, Example C



EXAMPLE A: The Contractor notifies the Engineer at test 7. At test 8 the Contractor and Engineer discuss an action to take. At test 9 the new moving average of 4 random tests begins. At test 12 a new moving average is established, if this moving average is above the warning limit and the Contractor continues fill placement with the problem, seemingly, resolved.



EXAMPLE B: The Contractor notified the Engineer at test 7. At test 8, the Contractor and Engineer discuss an action to take. At test 12 the new moving average is still within the warning band and the material represented is unacceptable and will require correction before subsequent fill placement.



EXAMPLE C: The Contractor performs additional corrective actions on the unacceptable material (test 9-12). A re-test of the corrected material is used in calculating the new moving average for point 12. The new moving average is now above the warning limit and the Contractor continues fill placement.