

Section 2.3 EARTHWORK OPERATIONS

2.3.1 PURPOSE

This section describes the project Earthwork Operations, provides a written procedure for the assembly and use of the Earthwork Records System, and provides guidance for Florida Department of Transportation (Department) responsibilities related to earthwork materials.

2.3.2 SCOPE

The principal users of this document include District Materials and Research Offices (DMRO), District Construction Offices (DCO), Resident Construction Offices (RCO), Operations Centers, the State Materials Office (SMO), and the State Construction Office.

2.3.3 AUTHORITY

Sections 20.23(3)(a) and 334.048(3), Florida Statutes

2.3.4 SOURCES OF EARTHWORK MATERIAL

This section is guidance for those Districts involved in evaluating pits and stockpiles of material prior to construction.

Department specifications require contractors to use suitable excavated material or authorized borrow material to prepare subgrades and foundations. Department specifications also require the contractor to construct embankments in compliance with the Department Design Standards.

The Department and the contractor must perform sufficient material sampling and testing to assure compliance with Department Standard Specifications for Road and Bridge Construction. Ultimately, it is the in-place materials at the project that must meet Department requirements. Thus, any sampling of material before final placement is designed to reduce the contractor's risk of incurring transportation and placement costs for material that may ultimately fail the in-place requirements. As a result, pit sampling of material should be considered an "as requested" partnering activity.

If the Project Administrator (PA) requests the DMRO to sample a pit or stockpile material, a DMRO representative will visit the pit and acquire representative samples of the materials likely to be used on the project. The

DMRO will test the material and report the results in the Department's database.

If the material fails, the contractor or the PA may request the DMRO representative to return to the pit for another sampling event. When taking the samples, the DMRO representative will offer to perform a split sample with the contractor. If split, half of the sample will be given to the contractor for their testing and the remaining half would be tested by the Department's resolution laboratory.

The resolution laboratory will test the resolution sample and the results will be reported in the Department's database. If the Resolution laboratory result does not match the contractor's result, then the DMRO may inspect the contractor's laboratory.

2.3.5 EARTHWORK RECORDS SYSTEM

The SMO Earthwork Operations Unit is responsible for the Earthwork Records System (ERS) procedure. The ERS is composed of two books, ***Contractor Quality Control Density Record Book (Form No. 675-020-27)*** and ***Verification Density Record Book (Form No. 675-020-28)***, for recording and storing density tests, proctor sample data, material depth, as well as gauge comparison and calibration records. The ERS may also consist of other forms mentioned in section 2.3.11 of this chapter.

2.3.5.1 INSTRUCTIONS

Construction contracts with roadway earthwork items shall have an ERS. The Earthwork Records System shall be assembled, available for use, and contain all pertinent information. Each contract shall have both a quality control section with numbered pages and a verification record. For convenience, a completely assembled ERS may be temporarily separated by roadway, structure, staged construction, multiple numbered projects, or among density inspectors. Any deviation to the instructions specified in the ERS shall be approved by the DMRE.

2.3.5.2 EARTHWORK RECORDS SYSTEM PREPARATION

Prior to earthwork construction commencing, properly trained Department project inspection personnel shall, when necessary, guide the contractor in preparation and organization of the Earthwork Records System. All Earthwork Records System graphs shall be computer-plotted and page numbered. The ERS plot program can be downloaded from the State

Construction Office website. The ***Pipe Backfill Code Sheet (Form No. 675-020-05)*** and ***Embankment, Subgrade, and Base Code Sheet (Form No. 675-020-06)*** are available from the Department's Forms, Policies, and Procedures website.

2.3.5.3 PLOTS

Regular roadway earthwork construction consists of either embankment, subgrade, base, or any individual or multiple combinations of these three types. The Density Report sheets should have computer plotted graphs for the sections with embankment. The length of the plots should be such that test locations can be identified adequately. The computer-plotted graphs shall accurately illustrate the required testing (the first to the last lift placed). The Pavement Plot sheet may be used for sections with no embankment. This Pavement Plot sheet is part of the ***Contractor Quality Control Density Record System (Form No. 675-020-27)***. A different bar chart is required for each base or subgrade layer, whether using embankment plot sheets, or pavement plot sheets. Any subsequent changes or re-plots that reflect a change from the plan cross-sections shall have a detailed note written on appropriate pages. Verification plots may be used at the option of the PA.

All drainage structures and connecting pipe should be accounted for inside and outside the 1:2 (Vertical:Horizontal) slope. A plot is required for all drainage structures that require testing.

LOTs, as defined in section 120 of the ***Department Standard Specifications for Road and Bridge Construction***, that are shorter than 500 feet may be used for plotting sections of Mechanically Stabilized Earth (MSE) wall construction.

Documentation of contractor's construction phasing should be clearly identified on the plot page(s). Vertical and/or horizontal lines should be inserted to clearly differentiate between multiple construction phases.

2.3.5.4 EXCAVATION OF UNSUITABLE MATERIALS

All computer-plotted embankment graphs shall be corrected for excavation of unsuitable materials. The anticipated depth of excavation may be coded as an undercut depth on the ***Embankment, Subgrade, and Base Code Sheet (Form No. 675-020-06)*** to provide a blank space for hand corrections. If the graph is re-plotted, make an appropriate note to identify deviation from the plans.

2.3.6 RESPONSIBILITIES OF PERSONNEL

2.3.6.1 CONSTRUCTION ENGINEERING AND INSPECTION (CEI)

The Department or Consultant CEI Inspector shall:

- 1) Ensure accurate sampling and testing per the Contract Documents.
- 2) Ensure recording of results in ERS.
- 3) Provide assistance and expertise in ERS use.
- 4) Perform Quality Assurance (QA) review of project data, including the Contractor's Quality Control and Verification for procedural errors and accurate certifiable test records on a minimum weekly basis. See Appendix A at the end of this chapter for guidance regarding proper project data review.
 - a. The QA review should be performed by supervisors or specially designated QA personnel responsible for entering test results.
- 5) Work with the contractor when evaluating new sources of material.

2.3.6.2 INDEPENDENT ASSURANCE (IA) PERSONNEL

The IA Density Inspector shall:

- 1) Monitor and support the project roadway earthwork Density Inspectors.
- 2) Perform systems-based IA in accordance with **Materials Manual Section 5.5 - Independent Assurance Program**.
- 3) Oversee the equipment comparison during the Initial Equipment Comparison and as needed during the project.
- 4) Review the ERS for accuracy and completeness.
- 5) Report deficiencies to the PA verbally (if possible), along with a written summary.
- 6) Issue **Density Inspection Report (Form No. 675-020-23)** or **Qualification Performance Report (Form No. 675-000-01)** when appropriate.
- 7) Initial the right hand margin of the ERS Sheets to indicate what has been reviewed.

2.3.7 EARTHWORK INSPECTION-IN-DEPTH (IID)

On selected projects, a State Materials Office IID Team may inspect the ERS and observe the density and moisture testing activities of personnel responsible for project acceptance. They shall also observe District Materials personnel

responsible for IA. The IID Team shall determine the degree of compliance with established standards and issue an inspection report.

2.3.8 ASSESSMENT OF DEFECTIVE MATERIALS

When the requirements of the Materials Acceptance Program are not met as specified in the Department Standard Specifications for Road and Bridge Construction, the District Materials and Research Engineer (DMRE) will determine the process that must be followed to resolve the deficiencies. Based on the information available to the Department, the DMRE may recommend a Disposition of Defective Materials (DDM) using the ***Disposition of Defective Material (Form No. 700-011-01)*** or remove and replace materials option without a DDM. The contractor may request the material remain in-place and propose the use of an Engineering Analysis Report (EAR) to evaluate the failing material. Typically, an EAR is used for missing test results or improperly tested material. When DMRO personnel receive the EAR request, they will review the information regarding the failure and make one of the following recommendations:

- 1) Remove and replace the material without an EAR
- 2) Leave the material in place without an EAR
- 3) Concur with EAR scope

When an EAR is authorized, DMRO personnel must ensure that the appropriate characteristics are evaluated to determine the disposition of the defective material. In some instances, it may be appropriate for DMRO personnel to recommend that additional or alternative tests be performed.

When reviewing the EAR scope, the following must be considered: The firm conducting the EAR must have a representative onsite during field operations to supervise any investigations. However, when agreed upon by the DMRE, a Department representative may oversee the investigation plan developed by the EAR firm and may take temporary possession of any samples until the EAR firm can retrieve them. The contractor should not take possession of any samples. The laboratory performing the testing must be AASHTO Materials Reference Laboratory (AMRL) or Construction Materials Engineering Council (CMEC) accredited. Alternatively, the EAR firm can use another accredited laboratory (not the contractor's laboratory or other laboratory performing QC work for the contractor or that specific contract), provided those test results are signed and sealed by the Professional Engineer (P.E.) in charge of the laboratory or in charge of the technician performing the testing. The final EAR must be signed and sealed by the P.E. of the specialty firm that performed the engineering analysis.

The following guidelines should be used when reviewing a proposed EAR scope based on a particular failure, to determine if any areas require removal and replacement.

- 1) **Missing Density:** Evaluate sections where density tests are missing. While the Department requires earthwork construction to be tested in accordance with the frequency and horizontal length specified in standard specification, it may not be feasible to excavate and obtain missing density tests once successive layers are built. The DMRO should take this into account and evaluate the options provided by the contractor to best determine a way to verify density.
- 2) **Erroneous Test Results:** When percent compaction is incorrect because of calculation errors or incorrect data, the correct percent compaction must be determined. LOTs where densities are determined to be failing or the percent compaction cannot be determined will be treated the same as missing densities.

2.3.9 CERTIFICATION OF PROJECT EARTHWORK RECORDS SYSTEM

At the completion of the project, the QC Manager will submit the earthwork records to the PA. If requested, the PA will send a copy to the DMRE for review. The QC Manager or PA shall resolve all deficiencies to the satisfaction of the DMRE. Upon satisfactory completion of work, the PA will complete the **Materials Statement** in Appendix A of Section 5.4 of the Materials Manual. For full federal oversight projects, the PA will forward the Materials Statement to the State Materials Office Certification section, at 5007 NE 39th Avenue, Gainesville, FL 32609, for project certification.

2.3.10 TRAINING

An ERS training class can be provided upon request to SMO. The training includes information concerning the ERS assembly, computer coding to generate earthwork graphs, and the proper use of the completed ERS. Requests for training should be processed through the District Construction Training Administrator. Additional information is available from the State Construction Training Manager.

2.3.11 FORMS

The following forms are available from the Department's Forms Library on the Internet at the following webpage:

<http://www.fdot.gov/procedures/forms.shtm>

These non-automated forms should be printed as needed.

ITEM	FORM NO.
Qualification Performance Report	675-000-01
Pipe Backfill Code Sheet	675-020-05
Embankment, Subgrade, and Base Code Sheet	675-020-06
Density Inspection Report	675-020-23
Contractor Quality Control Density Record System	675-020-27
Verification Earthwork Density Record System	675-020-28
Disposition of Defective Material	700-011-01

APPENDIX A MATERIALS GUIDELIST

ONGOING EARTHWORK CONSTRUCTION

- 1) Is constructed earthwork tested, approved, and accurately documented in the ERS?
- 2) Have quality control (QC) and verification (VT) samples been taken at the appropriate frequency and do they accurately reflect the construction to date?
- 3) Have QC and VT density tests been taken at the appropriate frequency and do they accurately reflect the construction to date?
- 4) Are Independent Verification density test performed for any QC dry density result of 105% or greater than the required density?
- 5) Have noted deficiencies been corrected?
- 6) Is there a written notification for any reduced frequency testing or use of existing rock?
- 7) Are shipping tickets and certifications collected when materials arrive on site?

EARTHWORK RECORDS SYSTEM

- 1) Nuclear Gauge and Initial Equipment Compare Log in data:
 - a. Are the initial equipment comparisons entered?
 - b. Has the comparison been performed and logged if any new gauges are brought to the project?
 - i. Have the calibration records been placed in the ERS?
- 2) Summary of Proctors
 - a. Are QC and VT Proctors properly logged?
 - b. Can the frequency and location of subgrade and base proctor samples be determined from the log book?
 - i. Do the sample numbers meet the requirements in the ERS?
 - c. Are the verification Limerock Bearing Ratio (LBR) samples labeled with a number that corresponds to the location (LOT No.) where the material was sampled for testing?
 - d. If resolution testing is required for LBR test results:
 - i. Is there a concern with the variability of laboratory test results? If yes, was the resolution sample taken within 10 feet of the original verification sample?
 - ii. Is there a concern with the material consistency in the stabilizing operation? If yes, was the resolution sample taken at a random location within the LOT?
 - iii. Is independent verification (IV) sampling increased for:
 1. LBR results frequently falling below the requirements

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2. Material variability which may be indicated by varying densities or varying soil classifications
- 3) Roadway Density Tests
 - a. Plot Sheets
 - i. Are all base, subgrade, curb pads and shoulders plotted with correct thicknesses on jobs that have embankment?
 - ii. Do the elevations match the plans?
 - iii. Did QC personnel initial each plot sheet in the QC logbook verifying plan elevations before data entry on that particular page?
 - iv. Are the plot sheets numbered?
 - v. Are the lifts numbered on the side of the plot sheet?
 - vi. If actual embankment differs from the plans or there is de-mucking or subsoil excavation, have corrections been made to show the change?
 - vii. Is the water table plotted and dated (multiple water tables)?
 - viii. Is the ▼ symbol used to denote the water table and are multiple tables dated?
 - ix. Are lines drawn to clearly delineate phasing?
 - b. Roadway Density Sheets
 - i. Is all header information filled out correctly?
 - ii. Are headings used to identify construction type (embankment, subgrade, base, etc.)?
 - iii. Does the page number match the plot sheet with a letter to designate additional pages?
 - iv. Is initial production LOT noted in the ERS?
 - v. Are all completed LOTs tested and verified?
 - vi. Did embankment testing begin with the first lift not affected by water?
 - vii. Is engineer's approval letter filed if backfill is under wet condition?
 - viii. Are lifts affected by water denoted on the graph and density report sheet?
 - ix. Has a test section been taken and verified if compacting 12 inch thick lifts of AASHTO Soil Class A-1, plastic materials or A-2-4 materials with greater than 15 % fines?
 - x. Is the last lift of completed embankment been constructed and tested a maximum 6 inch compacted thickness?
 - xi. Is test data filled out correctly and completely?
 - xii. Is there a verification density test for any QC density greater than 105%?
 - xiii. Have all failing density tests been properly accounted?
 - xiv. Are lifts constructed but not tested because of reduced frequency documented?

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- 4) Retaining Wall Systems
- a. Are project personnel using the same proctor and acceptance requirements for density?
 - b. Is there a density test for each density requirement for each lift of material?
 - c. Is embankment between the Reinforced Wall backfill considered compacted in one operation?
 - d. Are there any spread footings in the wall backfill?
 - e. Are metallic soil reinforcement being used at the wall?
- 5) Pipe and Drainage Structures
- a. Plot Sheets
 - i. Are structure and pipe run plots representative of the plans?
 - ii. Have elevations been checked and verified?
 - iii. Are lifts numbered and verified to be correct?
 - iv. Are density tests plotted in the correct location on the plot sheet?
 - v. Is the ▼ symbol used to denote the water table and are multiple tables dated?
 - vi. Are lines drawn to clearly delineate phasing?
 - b. Density Record
 - i. Is all header information filled out correctly?
 - ii. Do page numbers correspond to the referenced plot sheet?
 - iii. Is test data filled out correctly and completely?
 - iv. Is there documentation when structure and pipe are compacted in the same operation?
 - v. Are the graphs hand corrected or re-plotted when there is over-excavation or excavation of unsuitable material?
 - vi. Is there a verification test for pipe (and structures if compacted separately) on each first lift not affected by water?
 - vii. Are lifts affected by water denoted on the graph and density report sheet?
 - viii. Are both sides of the pipe tested on the first lift?
 - ix. Is the same effort of compaction on successive lifts occurring on both sides of the pipe?
 - 1. If not, are density tests taken on both sides of the pipe?
 - x. Is maximum compacted thickness kept to 6 inches in the cover zone?
 - xi. Has a test section been tested and verified for any thick lift construction outside the cover zone?
 - xii. Do lines clearly delineate phasing and the transition from pipe backfill to embankment testing?

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- xiii. Are lifts constructed but not tested because of reduced frequency documented?
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- 6) Does the LOT Index reflect the density testing to date?
 - a. Are special provisions and/or special requirements documented on the LOT index sheet and on other sheets where necessary?

 - 7) Mixing and Base Depth
 - a. Are mixing depths for subgrade recorded?
 - i. Are any measurements outside of the tolerance?
 - 1. If too deep did the inspectors dig down and test the bottom 12 inches?
 - 2. If too shallow did contractor remix the material?

 - b. Is depth of base recorded?
 - i. Are the QC measurement verified to be correct?