Tennessee Valley Authority	WBN INSTRUCTION Title BACKFILL	WBN-CPI-8.1.8-C-101 Rev. 0 Page 1 of 44 ☒ Quality Related ☐ Nonquality Related
	INTERIM TRANSFER (See Revision Log)	Effective Date: 02/15/89

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REVISION LOG

Revision No.	Description of Revision	Reason or Justification
0	Initial issue. Interim transfer of MAI-22, without change, to the Nuclear Procedures System as a Construction Process Instruction. This action supersedes MAI-22.	To establish Nuclear Procedures System Manuals for NC site instructions in accordance with WBN-GCI-4.4.9-01.

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1.0 PURPOSE

This Instruction specifies the methods and guidelines for placement, inspection, and documentation of all permanent Earthfill and Granular Fill at Watts Bar Nuclear Plant (WBN) (other than final six inches of topsoil) within the scope of this Instruction.

2.0 SCOPE

This Instruction applies to all permanent (QA and Non-QA) Backfill Operations on Transferred Areas/Items and within 50 feet of transferred structures. Work performed SHALL be inspected by Site Quality Assurance (SQA) for QA Areas and by a Certified Inspector for Non-QA areas.

3.0 REFERENCES

3.1 Source Documents

3.1.1 NQAM, Part I, Section 1.7

3.1.2 TVA General Construction Specification G-9, "Rolled Earthfill for Dams and Power Plants"

3.1.3 TVA General Construction Specification T-1, "Site Development, Highway, Railroad, and Bridge Construction"

3.2 Other Documents

3.2.1 AI-1.8, "Plant Housekeeping"

3.2.2 AI-9.8, "Drilling, Chipping, and Excavation"

3.2.3 ASTM C33, "Standard Specification for Concrete Aggregates"

3.2.4 ASTM-C136, "Sieve Analysis of Fine and Coarse Aggregate"

3.2.5 ASTM D422, "Standard Method for Particle Size Analysis of Soils"

3.2.6 ASTM D698, "Moisture-Density Relations of Soils Using 5.5-lb Rammer and 12-Inch Drop"

3.2.7 ASTM D1556, "Density of Soil in Place by Sand-Cone Method"

3.2.8 ASTM D1558, "Moisture-Penetration Resistance Relations of Fine-Grained Soils"

3.2.9 ASTM D2167, "Density of Soil in Place by the Rubber-Balloon Method"

3.2 Other Document, continued

3.2.10 ASTM D2216, "Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures"

3.2.11 ASTM D2487, "Classification of Soils for Engineering Purposes"

3.2.12 ASTM D2488, "Description and Identification of Soils (Visual-Manual Procedure)"

3.2.13 ASTM D2922, "Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)"

3.2.14 ASTM D3017, "Moisture content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)"

3.2.15 ASTM D4253, "Maximum Index Density of Soils Using a Vibratory Table"

3.2.16 ASTM D4254, "Minimum Index Density of Soils and Calculation of Relative Density"

3.2.17 HCI-M15, "Excavations"

3.2.18 Memorandum to Guenter Wadewitz from W. H. Childres dated 1/13/84, SUBJECT: WBNP - TESTING OF 1032 CRUSHED STONE FROM TEN MILE STONE COMPANY (SME 840113001)

3.2.19 Memorandum to John Stiner from W. H. Childres dated 10/16/84, SUBJECT: WBNP - TESTING OF 1032 CRUSHED STONE FROM RHEA COUNTY QUARRY (SME 841016012)

3.2.20 Memorandum to T. B. Northern from R. O. Lane dated 2/21/79, SUBJECT: WBNP - MANUFACTURED SAND FROM TEN MILE STONE COMPANY (SME 790221003)

3.2.21 Memorandum to Jerry Cofield from R. O. Lane dated 11/15/76, SUBJECT: WBNP - MINIMUM-MAXIMUM DENSITY TESTING (761116H0677)

3.2.22 Report CEB-76-15: "Watts Bar Nuclear Plant Instructions for Backfilling After Construction of Yard Conduits and Piping"

3.2.23 TVA Division of Nuclear Quality Assurance (DNQA) Quality Control Procedure WBN-QCP-2.01, "Earthfill and Backfill Placement, Inspection, and Documentation"

3.2.24 TVA Division of Nuclear Quality Assurance (DNQA) WBN-QCP-2.06, "Granular Fill Placement, Inspection, and Documentation"

3.2.25 TVA Drawings:

10A805-1 & 2	10W335
10B805-1 & 2	10W336
10N210	10W337
10W332-3	

4.0 GENERAL

4.1 Definitions

4.1.1 Backfill--Material that is used for refilling excavations around structures and that cannot be placed until the structure reaches a required degree of completion; and material used for refilling open excavations when the use of the excavation is completed.

4.1.2 Certified Inspector--An Individual in SQA or Modifications/ Mechanical Maintenance Engineering who has been certified as a Soils/Backfill Inspector by Singleton Materials Lab.

4.1.3 Clearing and Grubbing--The removal of trees and brush and their stumps from a work area.

4.1.4 Crushed Stone--Well-graded crushed stone suitable for backfill or that complies with the provisions of Specification T-1.

4.1.5 Cutoff--A provision made in an excavation or fill, or beneath such areas, for the purpose of reducing seepage of water within the area.

4.1.6 Degree of Compaction--The ratio of the dry density of a compacted soil to its maximum dry density as accomplished in the laboratory by standard methods, expressed as a percentage.

4.1.7 Earth--Natural clay, silt, sand, and small gravel materials and mixtures of them that can be dug by equipment without blasting.

4.1.8 Friable--Easily crumbled.

4.1.9 Granular Fill/Rockfill--A fill constructed of rock pieces, compacted by dumping (large rock) or by rolling in layers with heavy equipment. (Rockfill is generally 6-inch or larger rock, where granular fill is generally less than 6 inches.) (REFER TO crushed stone.)

4.1.10 Hold Point--A requirement for independent Quality Control (QC) verification or witnessing of conformance to Acceptance Criteria at specific in-process points before the work activity may continue.

4.1.11 Penetrometer--A device to measure the Comparative Density of fine-grained soils in terms of the force required to press a slender steel rod into the soil at a given rate.

4.1.12 Relative Density--For cohesionless soils, the ratio of:

(1) The difference between the void ratio of the soil in its loosest state and its present void ratio

4.1 Definitions, continued

TO:

(2) The difference between its void ratio in its loosest and densest states.

4.1.13 Riprap--A layer of rock pieces placed on an earth slope, normally to protect the earth slope from erosion by the impact of flowing water or waves.

4.1.14 Rolled Earthfill--Selected earth materials placed in successive layers rolled with multiple passes of heavy equipment to bond the material together and compact them into a stable mass.

4.1.15 Sand--Material which is generally smaller the the No. 4 sieve and similar to Section 4 of ASTM C33.

4.1.16 Slope Indication--The angle from Horizontal of an excavated or constructed slope, expressed as the Vertical Offset of the slope on the Horizontal Offset (e.g., 1 on 3, one Vertical on three Horizontal; 3 on 1, three Vertical on one Horizontal).

4.1.17 Soils Classification System--A system for classifying soils for engineering purposes based on laboratory determination of particle-size characteristics, liquid limit, and plasticity index. (ASTM Standard D2487)

4.1.18 Stripping--The removal of undesirable earth materials from the surface of a work area in preparation for placing fill or excavating fill materials.

4.2 Prerequisites

NOTE:

Steps preceded by # require documentation in data package.

4.2.1 A Drilling, Chipping, and Excavating Release SHALL be initiated prior to excavating any area, as applicable. (REFER TO AI-9.8.)

#4.2.2 Only DNE approved fill material SHALL be used on the project. These SHALL be obtained from approved earth borrow areas and/or approved quarries. Qualification testing SHALL be provided by the Central Laboratories (Singleton Materials Laboratory - SME).

4.2.3 TVA General Construction Specification G-9 is the basis for items not covered in this Instruction. DNE drawings SHALL take precedence if conflicts should arise.

4.2 Prerequisites, continued

4.2.4 SQA coverage is required during performance of this Instruction in a QA area. Each Hold Point in a Non-QA area SHALL be verified by a Certified Inspector.

4.2.5 Lines and grades SHALL be provided when necessary for:

- Bottom of excavation;
- Bottom of structure, pipe, etc., that is to be placed;
- Final finished grade (contours).

4.2.6 Housekeeping signoff per AI-1.8 SHALL be Controlled by the Work Generating Document (WGD).

#4.2.7 The Modifications Concrete/Soils Coordinator SHALL be notified (verbally) on the day of the intent to backfill. Minimum information supplied to the Coordinator at that time SHALL include:

- Workplan/MR Number (WGD);
- Item Description;

AND

- Engineer's Name/Phone Number.

The Coordinator will assign a Placement Number which SHALL be placed on both Data Sheets A and B.

4.3 Precautions

#4.3.1 The slope indication SHALL be within the following requirements and dangerously loose or eroded material or overhang on the sides SHALL be removed prior to working in the excavated area. (REFER TO HCI-M15.) Vertical sides should NOT be higher than approximately 4 feet. Above the Vertical sides, the earth should be laid back on a one-to-one slope or flatter, depending on the depth of excavation and type of materials encountered. The foreman SHALL record acceptance on Data Sheet A.

4.3.2 Backfill operations are to be suspended for a minimum of one day if concrete operations have been conducted within the area where vibration from the tampers/rollers will affect set and bond. Distance SHALL be determined on a case-by-case basis by the Inspector.

4.3.3 All movement of earth hauling, spreading, and compacting equipment SHALL cease prior to and during a Density Test (e.g., Sand Cone, Rubber Balloon).

5.0 INSTRUCTIONS

5.1 Preliminary Work

5.1.1 Foreman to inspect area for safety per Section 4.3.1.

QC HOLD POINT

5.1.2 REMOVE all muck, sod, roots, brush, construction debris or other unsuitable materials from fill area. (REFER TO Sections 6.1.3 and 6.4.7.)

5.1.3 REMOVE all free water.

QC HOLD POINT

5.1.4 PROVIDE standpipes as required by Inspector. (REFER TO 6.1.13.)

5.2 Earthfill/Granular Fill

QC HOLD POINT

5.2.1 OBTAIN earth from a DNE approved area and granular fill from a DNE approved source. (REFER TO 4.2.2.)

QC HOLD POINT

5.2.2 Preplacement Checks

A. REMOVE foreign matter (from all fill material) and all stones larger than one-half the thickness of the compacted layer (for earthfill). (REFER TO 6.1.3, 6.3.5.)

QC HOLD POINT

B. SCARIFY the surface of the substrate prior to fill placement to allow proper bonding. (REFER TO 6.3.7 and 6.4.7.)

5.2.3 Placement/Layer Thickness

A. No permanent fill SHALL be deposited at any time except in the presence of an authorized QC Inspector for QA areas or a Certified Inspector for non-QA areas.

QC HOLD POINT

B. SPREAD the fill materials in uniform layers of such thickness as will permit the required compaction. COMPACT with appropriate equipment. (REFER TO 6.3.9, 6.3.10, and 6.4.9 thru 6.4.15.)

5.2 Earthfill/Granular Fill, continued

QC HOLD POINT

C. ADD water to increase moisture, or HARROW to allow drying to obtain acceptable moisture content. (REFER TO 6.3.13 and 6.4.19.)

D. For earthfill, SCARIFY between each successive lift to allow proper bonding. (REFER TO 6.3.7.)

QC HOLD POINT

E. SEAL OFF earthfill surface at end of each working day or in the event of inclement weather. (REFER TO 6.3.13.)

F. BRING fill up to within 6 inches of final "Topsoil" grade.

QC HOLD POINT

#G. PLACE final 6 inches of organic topsoil. CLEAN and SEED final area. Final Density Test, if required, may be done following placement of topsoil. In the event Granular Fill, concrete, etc., is to be placed over the fill, Final Density Tests SHALL be performed, if required, prior to this operation.

6.0 INSPECTIONS AND ACCEPTANCE CRITERIA

6.1 General - Earthfill/Granular Fill

6.1.1 Work SHALL be conducted per the drawings and G-9. Any changes SHALL be made with the joint agreement of the Division of Nuclear Engineering (DNE) Representative and the Responsible Engineer.

6.1.2 All materials and work SHALL be subject to rigid inspection. Fill operations SHALL be done only in the presence of the Authorized Inspectors.

A. For fill in QA areas, QC Inspectors are to be continually present.

B. For all other areas, a Certified Inspector SHALL follow the Backfill operations. Continual presence of the Certified Inspector will NOT be required, however, the Certified Inspector SHALL maintain strict control of all operations.

6.1 Earthfill/Granular Fill, continued

C. The QC Inspectors for QA Fill and the Certified Inspector for Non-QA Fills have the responsibility and the authority to suspend fill operations whenever, in their judgment, the weather or the in-place material (substrate) conditions are not proper for compaction of the Earthfill or Granular Fill.

#6.1.3 Muck, sod, roots, brush, construction debris, or other unsuitable materials SHALL NOT be allowed to be included in the fill material or in the area to be filled.

#6.1.4 Environmental Conditions

A. Material SHALL NOT be placed at WBN when either the material or the surface on which the material is to be placed is frozen, NOR SHALL any snow or ice be buried in the fill.

B. Earthfill and Granular Fill operations SHALL be suspended in freezing weather, in rainy weather, when rain has made the earth in borrow areas too wet for proper drying for compaction on the fill. It SHALL also be suspended in weather so hot and dry that proper earth and granular moisture for compaction on the fill cannot be maintained in borrow areas and during hauling and spreading.

NOTE:

1075 Crushed Stone (Spec T-1) may be placed within any environmental conditions UNLESS otherwise noted if it is within the criteria of 6.1.3, 6.1.4, and 6.1.5.A.

C. The activities SHALL be performed in a manner that will minimize degradation of local air quality, fugitive dust emissions, erosion of land areas, and pollution of streams. Holding or Settling Ponds SHALL be constructed if necessary to control erosion and stream pollution.

6.1.5 Work areas of fill placing SHALL be limited in size to areas on which fill can be spread and compaction completed before a planned suspension of fill placing or a suspension because of inclement weather.

6.1.6 All areas to be filled and borrow areas SHALL, at the proper time, be cleared of both trees and brush and have stumps and roots grubbed out. Cleared and grubbed areas SHALL be maintained free of vegctation growth throughout the progress of the work.

6.1 Earthfill/Granular Fill, continued

6.1.7 After clearing and grubbing borrow areas and areas of excavation, all materials which are not suitable for fill SHALL be excavated and removed. Organic topsoil SHALL be stripped to such a depth that will remove all roots. After clearing and grubbing foundation areas, all materials which are not suitable SHALL be excavated and removed.

6.1.8 Topsoil suitable for dressing of slopes and other areas that are to be grassed SHALL be stockpiled and saved for that use. Other stripped materials SHALL be disposed of in an approved area and in a manner that will not detract from the finished appearance of the project.

6.1.9 UNLESS otherwise indicated on the drawings, excavation SHALL continue to a depth that will obtain a foundation that will support heavy earthmoving equipment without rutting into the ground and without heaving the ground so as to reduce its stability. A smaller confined area SHALL only require a foundation suitable to support smaller rollers, tampers, etc., without any pumping action. Compaction of the foundation SHALL be accomplished so that end results meet the required compaction. This SHALL be to the satisfaction of the Inspector if the foundation material is different from the fill.

6.1.10 Final cleanup prior to placing fill materials SHALL be accomplished with handtools. Any stones or loose rock that will impede the compacting action of the equipment SHALL be removed.

6.1.11 If there is shale exposed on the rock foundation that, in the opinion of the Project Geologist, will be subject to air slaking or damage by freezing, such shale SHALL either be removed or left with a protective cover of 12 inches of undisturbed material or kept flooded with water until final cleanup. The final excavation SHALL then be done as a continuous operation in nonfreezing weather, followed without delay by placement of Earthfill materials. Alternatively, if directed by the DNE Engineer, the shale may be covered with protective concrete.

6.1.12 Backfilling of confined areas, such as test pits and excavations around structures, SHALL normally be done with the same materials as will be used in the overlying or surrounding fill and with the same requirements for preparation of surfaces and to the same Compaction Requirements as specified for the fill.

6.1 Earthfill/Granular Fill, continued

#6.1.13 Springs

A. Whenever there is flowing water or seepage on the prepared foundation, provisions SHALL be made to control the water so that it will NOT interfere with Earthfill or Granular Fill placing and will NOT become a later problem. All springs SHALL be brought to the attention of the DNE Engineer. The DNE Engineer may require that a spring be cut off with a program of grouting.

B. If a spring is permitted to remain, the following SHALL be used as a guide. The locations and treatment of all springs SHALL be recorded to be shown on the drawings. Springs SHALL be covered with graded crushed rock, such as 1075 (Spec T-1) or if severe enough, surge, THEN 1075. The rock SHALL then be surrounded by approved filter material, such as 1032 (Spec T-1). A standpipe SHALL be placed at the low end, and the standpipe SHALL be extended as the fill rises until the water level in the standpipe stabilizes. Pumping SHALL be utilized if necessary to keep water from overflowing the standpipe onto the fill. The standpipe SHALL be plugged at the bottom with concrete and the standpipe filled with concrete or if water is removed from the standpipe, filled with tamped earth. The standpipe SHALL be cut off about two feet or more below the finished surface UNLESS permitted by DNE to remain.

6.1.14 No fill material SHALL be placed until the foundation has been properly prepared and approved. Work areas SHALL be large enough to permit effective equipment use. There SHALL be no free water on the foundation when Earthfill or Granular Fill is placed upon it.

NOTE:

Just before placing fill on earth or rock surface, the surface SHALL be moistened but there SHALL be no standing water.

6.1.15 Modifications of requirements may be made by the DNE Engineer based on additional information obtained during the progress of the work.

6.1.16 Confined holes such as test pits and excavation around structures, SHALL, whenever possible, be backfilled to the level of the surrounding ground before fill placing begins around them. Compaction SHALL normally be done with power tampers.

6.1 Earthfill/Granular Fill, continued

A. Backfill SHALL be brought up as evenly as possible around structures.

B. Unless otherwise specified, when backfilling will cover parts of the structures or complete structures or items like conduits, piping, or cable tunnels, the backfilling SHALL be continued to cover such structures or items to a depth of at least 12 inches before operating large vibratory or tamping rollers over them.

NOTE:

Drawings for the project may have additional restrictions on the methods of compacting backfill around and over structures.

6.1.17 It is imperative that a tight contact be obtained between the foundation and the fill placed upon it to achieve strength at the contact and to impede the passage of water. On earth foundations, this is to be accomplished by stripping the foundation to sound soil and conditioning the soil surface so it will bond with the fill. On rock foundations, it is to be accomplished by removal of earth and unsound rock materials and treatment of the rock surface to eliminate features that will interfere with fill compaction.

#6.1.18 Excavating and hauling equipment SHALL be capable of excavating and delivering fill materials in proper condition and in adequate quantity for the performance of the work.

A. The distribution of fill materials by the hauling equipment SHALL be such as to avoid lenses, pockets, streaks, or layers of materials differing substantially from adjacent material. Hauling equipment SHALL be capable of depositing materials in windrows on the fill surface. The equipment SHALL preferably be of the bottom dump type except for Granular Fill. IF dump trucks are used (required for Granular Fill), they SHALL be operated by spilling the material from the moving trucks to distribute it in windrows, NOT by dumping in piles to be redistributed by the spreading equipment. Successive loads SHALL be deposited in adjacent windrows. Loads SHALL NOT track each other on the fill, tending to make ruts and cause laminations or uneven compaction in the fill. Ruts and compacted wheel tracks SHALL be eliminated by scarifying and rerolling before placing fill over them.

6.1 Earthfill/Granular Fill, continued

B. In restricted areas, such as backfilling around structures where it is impracticable to distribute fill material from moving equipment, the material may be dumped from trucks in piles and distributed by the spreading equipment. Earthfill piles SHALL be spread promptly after dumping. Dumping and spreading SHALL generally proceed from one end of the fill placement. IF it is necessary to dump simultaneously in separate piles, the piles SHALL be spaced well apart, THEN the material spread to cover the space between piles.

C. High-speed traffic of hauling equipment on the compacted fill surface tends to cause shear cracking and lamination of the fill, especially near the bottom of approach ramps and where hauling paths turn. Every effort SHALL be made to prevent this damage to the fill by:

1. Limiting equipment speed;

2. Avoiding the use of down ramps directly to the fill;

3. Providing several traffic paths to, on, and from the fill;

4. Making equipment turning radius on the fill as large as possible;

AND

5. Maintaining a layer of at least eight inches of loose fill material on critical areas of the fill surface. Such loose fill materials SHALL be removed and reworked with proper roller compaction or removed and wasted.

6.1.19 Excavation, hauling, placing, and compaction of fill materials SHALL be performed as a planned program to accomplish the work in an orderly fashion.

6.1.20 Haul roads and ramps built within the fill area SHALL be removed UNLESS otherwise directed by the DNE Engineer. To be permitted to remain, they must be built with the same requirements for compaction, slopes, and surface preparation as for the rolled fill and must have an alignment satisfactory to the DNE Engineer.

6.1.21 Drainage or pumping SHALL be provided in such a way as to prevent standing pools of water and to keep water from seeping into the contact between the fill and the abutment or structure. Provisions must be made to intercept or collect and conduct rainfall runoff away from abutments. Any saturated earth SHALL be removed before placing additional fill in the

area. Low places in which rainfall can accumulate without acceptable means of removal SHALL NOT be permitted. At the edges of the fill, provisions SHALL be made to collect water and conduct it away so that it does NOT cause erosion. "Crowning" of the fill will help alleviate low points or pools.

#6.1.22 All quantities, including fill in trenches and backfill in pits and around structures, regardless of the source of materials, SHALL be measured in the fill after compaction, as cubic yards placed.

6.2 Specific Requirements/Information

#6.2.1 The Responsible Engineer SHALL fill out the top portion of Data Sheet A down to Part I and SHALL sign the appropriate space. For the placement number(s), REFER TO Section 4.2.7. Sample Numbers SHALL be supplied by SQA following testing. (The absence of the Sample Numbers and Placement Numbers SHALL NOT delay the Responsible Engineer from signing the appropriate space.) The Description, Location, and Reference Drawings should be sufficient for the data sheet to stand on its own.

#6.2.2 The "Type" SHALL be determined and checked by the Responsible Engineer. If granular fill, SPECIFY 1032, 1075, etc. If rockfill, SPECIFY surge or riprap. If other, SPECIFY manufactured sand, etc. "Material Source" SHALL specify area or supplier, such as Borrow Area 16, Ten Mile quarry, Rhea County Quarry, etc.

#6.2.3 The Criteria SHALL be specified using one or more of the following examples and SHALL be listed by the Responsible Engineer:

A. Drawing--10N210 Classifications and Boundaries of Types A, B, and C Fill

B. CER-76-15--REFER TO Appendix F of this Instruction. LIST the appropriate section.

C. Other--Drawings such as 17A302-4 and 5, FCRs, etc.

D. Required Density and Moisture Content (Earthfill)--As addressed in the criteria specified in 6.2.3.A, B, and C above.

#6.2.4 Overall beginning and overall ending elevations SHALL be the bottom of initial excavation and the top of final fill when the job is complete.

NOTE:

Each data sheet may represent only a portion of the entire fill. (The applicable portion will be listed by the Inspector in Part II "Data" of Data Sheet A.)

6.3 Earthfill

6.3.1 The borrow area SHALL be graded to provide free drainage at all times. Additional drainage by ditching SHALL be done when useful in reducing excess water content of the soils. When portions of the borrow area are plowed or materials are spread in the borrow area for drying or for addition of water, the volume of soil so handled should NOT be more than can be hauled to the fill area, placed, and compacted before the next planned suspension of earth operations, whether a shift suspension or longer or before a suspension because of inclement weather.

6.3.2 Stockpiling of Earthfill materials is generally undesirable because of double handling and difficulty in controlling soil moisture content. If stockpiling must be done, it SHALL be done in an approved area and in such a manner as will, as far as possible, prevent moisture changes in the soil. The surface of the pile and the surrounding ground SHALL be graded to permit free drainage away from the pile. The surface of the pile SHALL be sealed with rubber-tired equipment or smooth-drum rollers and should be protected against erosion.

#6.3.3 The Craft Foreman is to verify that the geometry of the area to be filled is acceptable per Section 4.3.1 for safety purposes. This SHALL be recorded on Data Sheet A.

#6.3.4 VERIFY that the fill material is from a DNE-approved borrow area (Section 4.2.2).

#6.3.5 VERIFY that fill material does NOT contain foreign material per Section 6.1.3 and that all stones in the fill material that are large enough to impede the compacting action of the roller have been removed. As far as feasible, stones SHALL be removed for the fill material at their source to avoid their rehandling on the fill. In general, stones left in the fill SHALL be limited in largest dimension to one-half the thickness of the compacted layer. No stone larger than six inches in largest dimension SHALL be allowed to remain in any of the fill compacted by rolling. Any such discovered in the rolling SHALL be dug out and the hole filled with compacted earth. Stones within the acceptable limits remaining in the fill SHALL be separated by several inches of earth.

#6.3.6 VERIFY that the environmental conditions are per Section 6.1.4.

#6.3.7 VERIFY that the preplacement substrate conditions are acceptable per Sections 6.1.4.A, 6.1.6 through 6.1.18, 6.1.20, and 6.1.21. Also VERIFY that the surface of any previously placed layer of fill has no materials on it that will interfere with roller compaction and SHALL have no standing water. If

6.3 Earthfill, continued

the surface is too smooth for proper bonding with the fill to be placed upon it, it SHALL be scarified to a minimum depth of three inches and rerolled. If the surface material has more or less moisture than the proper compaction moisture, the surface SHALL be scarified and harrowed for drying or for the addition of water, working the soil to achieve uniform moisture and rerolled.

6.3.8 Surface depressions SHALL be filled with compacted earth to the extent necessary to obtain a sufficiently smooth surface to permit unimpeded operation of the rollers. Compaction of fill in depressions SHALL be done with power tampers or with rubber-tired equipment.

#6.3.9 Fill materials SHALL be spread in uniform layers of such thickness as will permit the required compaction. UNLESS otherwise directed, spreading SHALL be done with crawler-type bulldozers whose tracks assist in breaking up friable materials and blending them with the finer soils. Spreading SHALL closely follow dumping and SHALL be so conducted as to blend the materials deposited by dumping. VERIFY also that placement is per Section 6.1.18.

#6.3.10 Compaction of rolled earthfill SHALL, whenever possible, be done with tamping rollers (e.g., sheepsfoot type).

A. A systematic procedure for rolling earthfill SHALL be laid out and followed throughout the course of the work. In general, all fill to be compacted with rollers SHALL be spread in layers of loose thickness to achieve a compacted layer thickness of approximately six inches (REFER TO 6.3.10.D). The rollers SHALL pass over all parts of every layer of fill as many times as is determined necessary to break up lumps and to accomplish the required compaction. Rolling SHALL closely follow spreading. Dumping SHALL NOT be allowed in areas where rollers and spreaders are operating. Rollers operating in any area SHALL follow the same route. If rollers of different foot design or foot spacing are used, they SHALL be placed alternately in the line of rollers. No rollers SHALL be operated at a speed of more than five miles per hour.

B. Rolling SHALL be done in a direction parallel to the length of the fill except as required for turnaround and adjacent to faces of rock abutments, ledges, and embedded structures. Adjacent to such features, rolling SHALL be done parallel to them, operating the rollers as closely as possible to them. The fill in the strip immediately against such features SHALL be compacted with hand-operated power tampers or heavy rubber-tired equipment.

6.3 Earthfill, continued

C. Compaction against the sides of earth trenches SHALL be done by having a bulldozer or grader operated parallel to the earth abutment face on every one or two layers of uncompacted, fill so that the blade of the machine cuts into the earth abutment face about 12 inches. The cut material SHALL be spread on the uncompacted fill and the rollers operated to compact the fill against the cut face, the rollers finally overlapping the original earth, breaking down and compacting the edge of the blade cut. If the blade cuts present smooth surfaces, the surfaces SHALL be scarified before spreading fill upon or against them in order to achieve bond of the fill with the in situ earth.

#D. The rollers and tampers SHALL meet the requirements of G-9. The loose layer thickness SHALL be as follows to achieve the appropriate compaction:

1. When power tampers (e.g., Air Tamp, Wacker) are used, each layer placed is up to approximately three inches thick before compaction.

2. When small tamping rollers (e.g., Bomag, Vibromax) are used, each layer placed is up to approximately six inches thick before compaction (four inches if in a confined area).

3. When standard sheepsfoot rollers are used, each layer placed is up to approximately eight inches thick before compaction.

4. Backfill of all holes in confined areas SHALL be brought evenly around any structure or as specified on design drawings.

5. Backfill in confined areas is to be compacted with power tampers or other small tamping compactors. The compactor density SHALL equal or exceed that required for adjacent or overlying portions, whichever is greater.

6.3.11 The measure of earthfill compaction SHALL be by the determination of the density and moisture content of the compacted fill. Test requirements are given in Section 6.6.1. If at any time the required compaction cannot be obtained with established procedures, the DNE Engineer SHALL be notified so that improved procedures can be determined. Any materials placed that do NOT meet compaction requirements may require removal and rework or replacement per the Inspector.

6.3 Earthfill, continued

A. The degree of fill compaction required and the allowable limits on soil moisture content when required to achieve both proper compaction and strength in the compacted fill will be specified on the drawings and SHALL NOT be changed without the written approval of the DNE Engineer. Control Values will be established by the DNE Engineer from tests made by Singleton Materials Lab (SME) on all soils to be used for fill, on the soils in the major materials sources (borrow areas) by preconstruction sampling and testing, and on soils from supplementary or alternate borrow areas by sampling and testing during the course of the work.

B. SME will prepare compaction curves (moisture-density curves and moisture-penetrometer charts) for all soil classes, further divided as appropriate into subclasses, which SHALL be used by the Inspectors of fill placing, for control, and testing of fill compaction.

#6.3.12 A penetrometer should be used by the Inspectors on the fill to maintain a continual check on the compaction of all parts of the fill, supplementing the tests specified in Section 6.6.1. For determination of dry density and moisture content, the penetrometer SHALL be correlated with the proctor tests specified in Section 6.6.1.

#6.3.13 The moisture content of earthfill materials is critical to their proper compaction. The moisture content of the soils SHALL, as far as possible, be controlled in the borrow area, with only final moisture conditioning as the soil is spread and rolled on the fill.

A. To correct moisture content and to achieve uniform moisture distribution in the soil, the soil should be worked in the borrow area and on the fill by plowing and/or continual harrowing, permitting evaporation of excess water to dry the soil, or before and during the process, adding water to increase the moisture content. When addition of large quantities of water is necessary to moisten the soil properly, approximately three-fourths of the estimated amount of water should be applied in the borrow area and one-fourth on the fill.

B. All soils SHALL be checked for moisture content as placed on the fill. Final drying or addition of water SHALL be accomplished during harrowing of the soil after spreading. Harrowing SHALL obtain uniform moisture distribution throughout the depth of the soil layer. Any fault in moisture content disclosed during the rolling operations on any layer SHALL be remedied before the next layer is spread.

6.3.14 If drying cracks tend to develop in the compacted fill surface, such cracking SHALL be avoided by periodic sprinkling with water. Any developed cracks SHALL be eliminated by ripping up and reworking at least the top layer of fill to the extent directed by the Inspector.

6.3.15 Before the suspension of fill placing in normal operations and when fill placing is to be suspended because of inclement weather or improper soil condition, the top surface of the fill SHALL be sealed against penetration of water by a planned procedure of blading with a grader or approved equal and rolling with smooth-drum or rubber-tired equipment, obtaining complete coverage over the surface. Fill placing and compaction SHALL be planned so that the entire top layer of fill SHALL have received the required compaction before sealing. Fill areas SHALL be "crowned" to permit good drainage and avoid saturation.

6.4 Granular Fill/Rockfill

6.4.1 All Granular Fill material SHALL meet the criteria of Spec T-1 and/or ASTM C33 for requirements, durability, gradation, etc., UNLESS otherwise noted on the drawings.

6.4.2 All Rockfill Material SHALL be sound, tough, dense, durable, resistant to the action of frost, and free of dirt and debris. Rock particles having their longest dimension more than four times the thickness SHALL be discarded or broken to acceptable pieces.

#6.4.3 The craft foreman SHALL VERIFY that the geometry of the area to be filled is acceptable per Section 4.3.1 for safety purposes. This SHALL be recorded on Data Sheet A.

#6.4.4 VERIFY that the material being placed is from the correct stockpile or is delivered under an approved contract.

NOTE:

A Certificate of Conformance from the vendor, stating that the Granular Fill material supplied will meet the specification SHALL be required prior to the award of the contract. In addition, the DNE Geologist SHALL inspect the quarry and approve the rock formation in coordination with the DNE Engineer prior to the award of the contract. Testing by SQA for gradation SHALL be performed before shipment and periodically during shipment to ensure compliance with the contract, Spec T-1, and ASTM C33.

#6.4.5 VERIFY that fill material does NOT contain foreign material per Section 6.1.3.

6.4 Granular Fill/Rockfill, continued

#6.4.6 VERIFY that the environmental conditions are per 6.1.4.

#6.4.7 VERIFY that the preplacement surface conditions are acceptable per Sections 6.1.4(A), 6.1.6 through 6.1.18, 6.1.20 and 6.1.21.

6.4.8 Surface depressions SHALL be filled with compacted Granular Fill to the extent necessary to obtain a sufficiently smooth surface to permit unimpeded operation of the rollers. This compaction SHALL be performed with hand-operated power tampers.

#6.4.9 VERIFY that placement of fill is per Section 6.1.18 with the use of dump trucks. (Bottom dump-type loaders are NOT acceptable due to the crushing (fracturing) and subsequent increase in fines.) A systematic procedure for rolling Granular Fill SHALL be laid out and followed throughout the course of the work. In general, all fill to be compacted with rollers SHALL be spread in layers of loose thickness to achieve a compacted layer thickness of approximately six inches (REFER TO 6.4.12 and 6.4.14). The rollers SHALL pass over all parts of every layer of fill as many times as is determined necessary to achieve the required compaction without causing fracturing of the fill. Rolling SHALL closely follow spreading. Dumping SHALL NOT be allowed in areas where rollers and spreaders are operating. Rollers operating in any area SHALL follow the same route. No rollers SHALL be operated at a speed of more than five miles per hour.

CAUTION:

PARTICLE BREAKDOWN OF THE COARSE GRANULAR FILL DUE TO OVERCOMPACTION COULD RESULT IN POST COMPACTION FILL GRADATIONS FINER THAN THE SPECIFIED LIMITS. TO REDUCE THE PROBABILITY OF EXCESSIVE PARTICLE BREAKDOWN, THE GRANULAR FILL SHALL NOT BE COMPACTED ANY MORE THAN IS REQUIRED TO ACHIEVE THE SPECIFIED RELATIVE DENSITY.

#6.4.10 Rolling SHALL be done in a direction parallel to the length of the fill except as required for turnaround and adjacent to faces of rock abutments, ledges, and embedded structures. Adjacent to such features, rolling SHALL be done parallel to them, operating the rollers as close as possible to them. The fill in the strip immediately against such features SHALL be compacted with hand-operated power tampers or heavy rubber-tired equipment.

#6.4.11 Rollers used for compaction of Granular Fill SHALL be vibratory type with smooth drums to prevent fracturing of the larger particles.

6.4 Granular Fill/Rockfill, continued

#6.4.12 Backfills of all holes in confined areas are in layers that do not exceed three inches of properly moistened loose materials. The backfill is brought up evenly around any structure or as specified on DNE drawings. These areas are compacted with small rolling machines or hand-tamping equipment until the density is equal to that required.

#6.4.13 UNLESS otherwise noted, fill is compacted to a depth of at least 12 inches over structures before larger rollers are allowed to operate.

#6.4.14 In unconfined areas, when large smooth drum vibratory rollers are used and there is sufficient cover over underground features, each layer of loose thickness is to be such as to achieve a compacted layer thickness of approximately six inches.

#6.4.15 Except where noted on DNE drawings or instructions, the layer thickness designated in this section is subject to change by agreement between the Responsible Engineer and DNE.

6.4.16 The measure of granular compaction SHALL be by the determination of the relative density and moisture content of the compacted fill. Test requirements are given in Section 6.6.1. IF at any time the required relative density cannot be obtained with established procedures, the DNE Engineer SHALL be notified so that improved procedures can be determined.

6.4.17 The degree of granular fill compaction required to achieve both proper relative density and strength in the compacted fill will be specified on the DNE drawings and SHALL NOT be changed without the written approval of the DNE Engineer. Control values will be established by the DNE Engineer from tests made by SME on the compacted fill by sampling and testing during the course of the work.

6.4.18 SME will prepare Maximum/Minimum Index Dry Density Graphs which will be used by the Inspectors for fill placing, control, and testing of fill relative density.

#6.4.19 The moisture content of Granular Fill materials is critical to their proper compaction. The moisture content SHALL be controlled at the fill site after Granular Fill is spread and immediately prior to compaction.

6.4.20 All granular fill SHALL be checked for moisture content as placed on the fill. Any fault in moisture content disclosed during the rolling operations on any layer SHALL be remedied before the next layer is spread.

6.4 Granular Fill/Rockfill, continued

6.4.21 Riprap

A. The embankment faces of ponds or lake will normally be protected against damage from wave action by rock riprap and where not riprapped, against erosion from rainfall by grass or other approved vegetative ground cover. When other types of slope protection are to be used, their requirements will be given on the drawings or in separate Construction Specifications for the project. Slope protection SHALL be applied at the locations and within the limits shown on the DNE drawings.

B. Riprap and Filter--The thickness of riprap and weight of riprap stones and the thickness of the filter(s) between the riprap and the earthfill will be shown on the DNE drawings. The materials SHALL conform to the requirements of other specifications referenced on DNE drawings.

C. Filter(s) and riprap SHALL be placed in Horizontal layers. Dumping of riprap stone from a higher level to fall down the face SHALL NOT be permitted. Riprap stones SHALL be dumped as nearly as practicable in final position. If necessary, the larger stones SHALL be worked to the outside face of the riprap to prevent the creation of pockets of smaller stone on the face. The smaller stones SHALL be well-distributed throughout the riprap and NOT allowed to segregate and create pockets of smaller stone. Bridging of larger stones over openings in the face or within the riprap SHALL be broken down. Large openings SHALL be filled by chinking or otherwise manipulating the stone.

6.5 Cleanup/Ground Cover

6.5.1 The backfilled areas are to be left in a clean and sightly condition. The area SHALL be cleaned up of all extraneous materials. Excavations, borrow areas, spoil areas, temporary construction roads, and other disturbed areas SHALL be restored to approximate natural conditions.

6.5.2 The areas SHALL be graded to permit natural drainage and edges of areas graded to blend with surrounding natural ground. The areas SHALL be revegetated with grass, trees, or other vegetation, UNLESS otherwise specified on the DNE drawings. Requirements for grassing (or other ground cover) and references to other specifications for the work will normally be given on DNE drawings showing the final grading and surface treatment of the general site area.

6.6 In-Process Tests

6.6.1 All Granular Fill and Earthfill materials SHALL be periodically tested by SQA-CQC as required by General Construction Specification G-9. The SQA-CQC will perform in-process tests and SHALL utilize Appendix A for soils and Appendixes B through E for Granular Fills for completing the appropriate tests.

A. Gradation of Granular Fill SHALL be performed by the Project Concrete Lab per ASTM D422.

B. The location of samples SHALL be distributed in both plan and elevation to obtain good representation throughout the area. If distinctly different materials are used in separate zones, sampling and test requirements SHALL apply to each of the zones.

C. The routine samples of the fill SHALL be taken regularly for Relative Density, Moisture Content, and Degree of Compaction. Sampling SHALL be done by the Sand-Cone or Rubber-Balloon Method for Earthfill (REFER TO 6.6.1.D). Samples SHALL be taken just below the top layer of compacted fill as soon as practicable after that layer is compacted. At least one sample SHALL be taken each day during Backfill Placement and at least one test on each 2,000 cubic yards of fill. PERFORM more frequent tests if specified by or if directed by the Responsible Engineer. Additional samples SHALL be taken in any areas where the Inspector suspects compaction does NOT meet the DNE drawing or CEB-76-15 requirements. Where tests show that the fill does NOT meet Compaction Requirements, the fill SHALL be reworked and SHALL be retested to verify the adequacy of the reworking and that the compaction is within the requirements.

D. The Nuclear Density and Moisture Gauge may be used in lieu of the Sand-Cone Method for 1032 Granular Fill. Sampling for sand fill may be performed using Sand-Cone, Rubber-Balloon, or Nuclear-Density and Moisture Gauge Methods.

E. Soil class determination on each Earthfill sample SHALL be made with a 1-Point Moisture-Density Proctor Test for correlation with the Compaction Curves prepared by SME (REFER TO Appendix A). SQA-CQC SHALL use the same type of specimen compaction equipment and procedures as were used by SME to prepare the Compaction Curves. The moisture content of the soil for the 1-Point Test SHALL be at or slightly below anticipated optimum, drying out some of the moisture if necessary.

6.6 In-Process, continued

F. To confirm correlating with SME Compaction Curves, at least once for each 50 routine tests on each soil type (e.g., CH, ML, SM, etc.) being used for fill, a 3-Point Moisture-Density Proctor Test SHALL be made on each soil type, with moisture contents 2 to 3 percent below, 2 to 3 percent above, and near optimum. IF less than 5,000 cubic yards of a soil type is being placed each month, at least one 3-Point Test SHALL be made each two months of earthfill operations. At any time difficulty is found in the correlation of the 1-Point Soil Class Determination with the 3-Point Test or in correlation of either with the SME Compaction Curves, companion samples of the soil SHALL be sent to SME for comparison testing and resolution of the Soil Class Determination. If tests show that the soils being used for fill are NOT represented in the SME Compaction Curves, SME SHALL make additional Laboratory Index Tests and Compaction Tests to establish new Compaction Curves and SHALL consult the Design Representative to determine if additional Soil Strength Tests are required.

NOTE:

Test frequency is based on the compacted volume of fill material. Samples are taken just below the top layer of compacted fill. Samples need not be taken the same day fill is placed but are taken as soon as practicable after the fill is compacted.

6.6.2 In-process test records by SQA-CQC SHALL be handled per QCP-2.01 and 2.06. In-process test records can be obtained from SQA/CQC. In-process test records for Modifications/ Maintenance are filed by Earthfill/Granular Fill Test Number as follows:

- NN XXXX Nuclear Density
- NS XXXX Sand Cone
- NR XXXX Rubber Balloon

7.0 DOCUMENTATION

7.1 Inspection SHALL be documented on Data Sheet A and can be used for two successive days on the same area.

7.2 Satisfactory completion of the work SHALL be designated by signing and dating of the appropriate blocks on Data Sheet A.

7.0 Documentation, continued

7.3 Unanticipated conditions encountered, including Field Change Request (FCR), SHALL be recorded in the REFERENCE and/or REMARKS Section of Data Sheet A.

7.4 Upon completion, Data Sheet A SHALL be attached to the Workplan or MR.

7.5 Data Sheet B (or a copy of Data Sheet A), along with a copy of the test results, SHALL be completed and returned to the Modifications Concrete/Soils Coordinator for adherence to requirements in G-9 within 5 Working Days (or End of Month, whichever is sooner) following each day of Backfill placement. This information will be forwarded to SQA by the Coordinator within the same time frame. Records will be forwarded monthly to DNE per Section 12.0 of G-9 by SQA for all permanent material

ATTACHMENTS/APPENDIXES

Data Sheet A - Backfill Data Sheet

Data Sheet B - Encoding Information

Appendix A - Earthfill Compaction Control Curves - Borrow Area 16

Appendix B - Relative Density Control Graph - Manufactured Sand (Ten Mile)

Appendix C - Relative Density Control Graph - Manufactured Sand (Rhea County)

Appendix D - Relative Density Control Graph - 1032 Crushed Stone (Ten Mile)

Appendix E - Relative Density Control Graph - 1032 Crushed Stone (Rhea County)

Appendix F - Report CEB-76-15

Data Sheet A
Page 1 of 3

BACKFILL DATA SHEET

Workplan/MR No. _____ (To be obtained from Modifications Concrete/Soils Coordinator on day of placement) (4.2.7)

Placement No(s). _____ _____
Day 1 Day 2

Sample No(s). _____

Description _____

_____

Location _____

Reference Drawings/Documents: _____

Type: F Earthfill; F Granular Fill (T-1 Sect.) _____;
(6.2.2) F Rockfill (Type) _____; F Other (Type)_____
Material Source(s) _____
Criteria: Drawing _____; CEB-76-15 Section _____;

.2.3) Other (e.g., 17A302-4 and 5) _____; Required Density _____
Overall beginning elevation _____ Overall finish Elevation _____

Above information supplied by _____/_____(6.2)
Responsible Engineer Date

I. PREPLACEMENT

(6.1.13 Spring Encountered F YES: F NO _____/_____
Inspector Date

If YES, DNE Notified: _____/_____
Responsible Engineer Date

4.3.1, 6.3.3, 6.4.3 Geometry Acceptable

DAY 1		DAY 2	
Craft Foreman	Date	Craft Foreman	Date

4.2.2, 6.3.4, 6.4.4 Fill Material from Approved Area

Inspector	Date	Inspector	Date

6.1.3, 6.3.5, 6.4.5 Fill Material is Clean

Inspector	Date	Inspector	Date

6.1.4, 6.3.6, 6.4.6 Environmental Conditions Acceptable

Inspector	Date	Inspector	Date

.3.7, 6.4.7 Surface Conditions Acceptable

Inspector	Date	Inspector	Date

Data Sheet A
Page 2 of 3

II. DATA		DAY 1	DAY 2
Fill Opened (Date & Time)			
Approximate stations	From		
	To		
Approximate Elevations	From		
	To		
(6.3.10, 6.3.10.D, 6.4.11, 6.4.12, 6.4.13) Compactors (brand/model)			
Compactor (weight)			
Passes per Lift (number)			
(6.3.10.D, 6.4.12, 6.4.14) Maximum Lift Thickness (in.)			
Penetrometer Readings (Soils) Acceptable (6.3.12)		/ Inspector Date	/ Inspector Date
(6.1.18, 6.3.9, 6.3.10, 6.4.9 - 6.4.15) Placement (spreading/rolling) Acceptable (Inspector Signature)			
Addition of Water-Drying Acceptable (Inspector Signature) (6.3.13, 6.4.19)			
Approximate Cubic Yards Placed (compacted quantity) (6.1.22)			
(6.3.13) Fill Closed and Sealed Off (Time)			
Representative Density Test Number(s)			

III. INSPECTION METHOD: F Sand Cone (NS); F Rubber Balloon (NR);
F Nuclear Density (NN)

DENSITY TEST NUMBER(S)	(NS) % COMPACTION	(NN OR NR) RELATIVE DENSITY %	MOISTURE CONTENT %	SOIL CLASS	(SOILS) PENETRATION RESISTANCE ON MOLD (PSI)	APPROX CUBIC YARDS REPRESENTED

5.2.3.G Above Results Acceptable: _____ / _____
QC Inspector Date

REMARKS: _____

Data Sheet A
Page 3 of 3

Results Reviewed by _____/_____†
Responsible Engineer Date

†Signature also implies cleanup acceptable per 6.5 (if final placement); Encoding Sheet (Data Sheet B) forwarded to Modifications Concrete/Soils within five working days; etc.

Data Sheet B
Page 1 of 1

ENCODING INFORMATION

Workplan # _____ ECN #_____ MR #_____

DESCRIPTION AND EXACT LOCATION	DATE PLACED	SAMPLE #	QUANTITY	MATERIAL USED AND SOURCE e.g., Ten Mile 1032, Borrow Area 16, etc.	REQUIRED DENSITY	PLACEMENT NO. †

†Obtained same day as placement from Modifications Concrete/Soils Coordinator. One number for each day of placement.

REMARKS _____

_____

_____

_____ / _____ / _____

(Print) Responsible Engineer Date Section

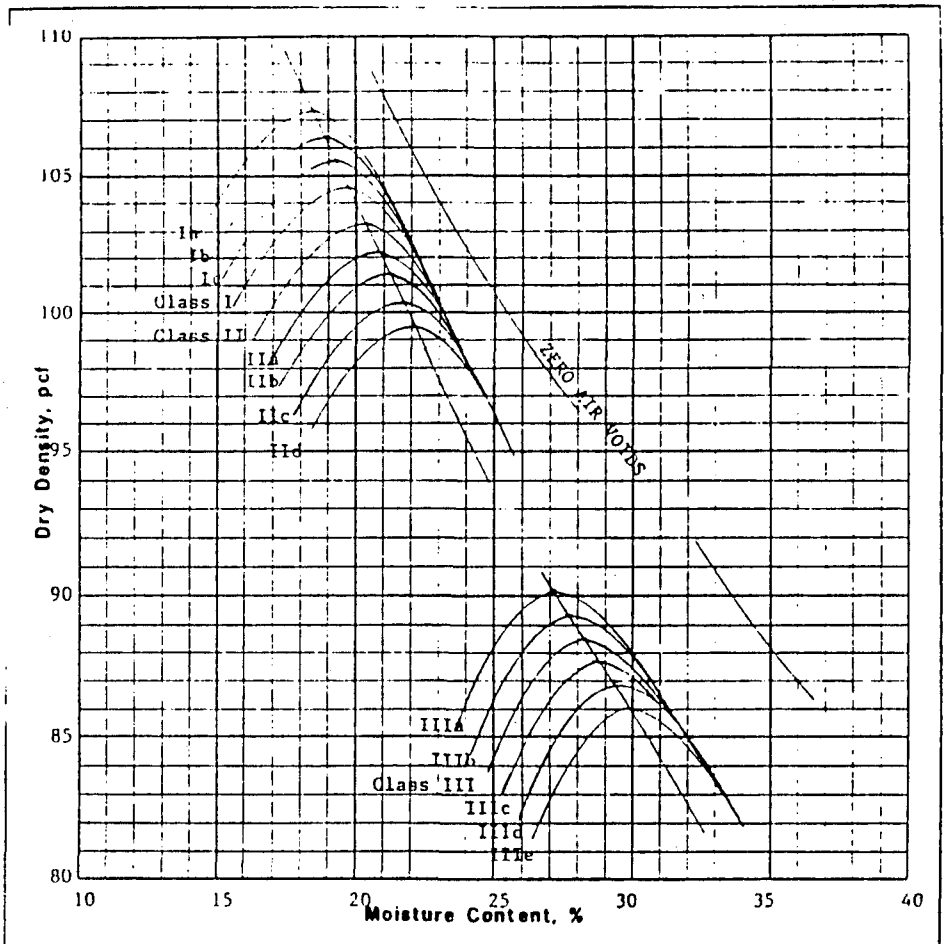
Form required for all permanent material.

RETURN to Modification Concrete/Soils Coordinator for administrative purposes (General Construction Specification Requirements) within five working days of each day of Backfill Operation, or end of month (whichever is sooner).

This form is NOT to remain with Workplan or MR.

Appendix A
Page 1 of 2

EARTHFILL COMPACTION CONTROL CURVES - BORROW AREA 16



Soil Class	Gravel %	Sand %	Silt %	Clay %	Specific Gravity	LL %	PI %	Optimum Moisture, %	Maximum Density, pcf
I-CL	0	27	37	36	2.70	36	13	19.8	104.5
II-ML	0	19	45	36	2.73	37	11	20.3	103.2
III-MH	0	16	28	56	2.78	60	13	28.2	88.5

Plus No. 4 Specific Gravity, S S D	--
Plus No. 4 Absorption, %	--

Remarks:

Project Watts Bar Nuclear Plant

Feature Borrow Area 16

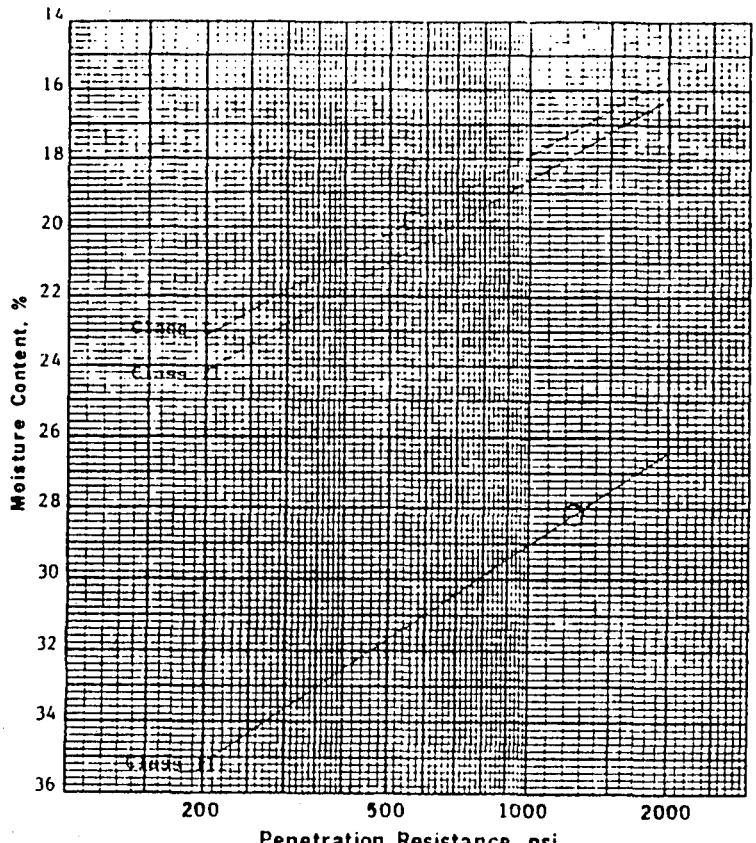
ASTM Designation D 698A

Date Tested

COMPACTION TEST (FAMILY OF CURVES)

Appendix A
Page 2 of 2

EARTHFILL COMPACTION CONTROL CURVES - BORROW AREA 16



Soil Class	Optimum Moisture, %	Maximum Density, pcf	Penetration Resistance, psi
I-CL	19.8	104.5	560
II-ML	20.3	103.2	620
III-MH	28.2	88.5	1250

Remarks:

○ Denotes Optimum Moisture

Project Watts Bar Nuclear Plant

Feature Borrow Area 16

ASTM Designation D 698A

Date Tested

MOISTURE - PENETRATION TEST

Tested by: CBE Reviewed by: JBe

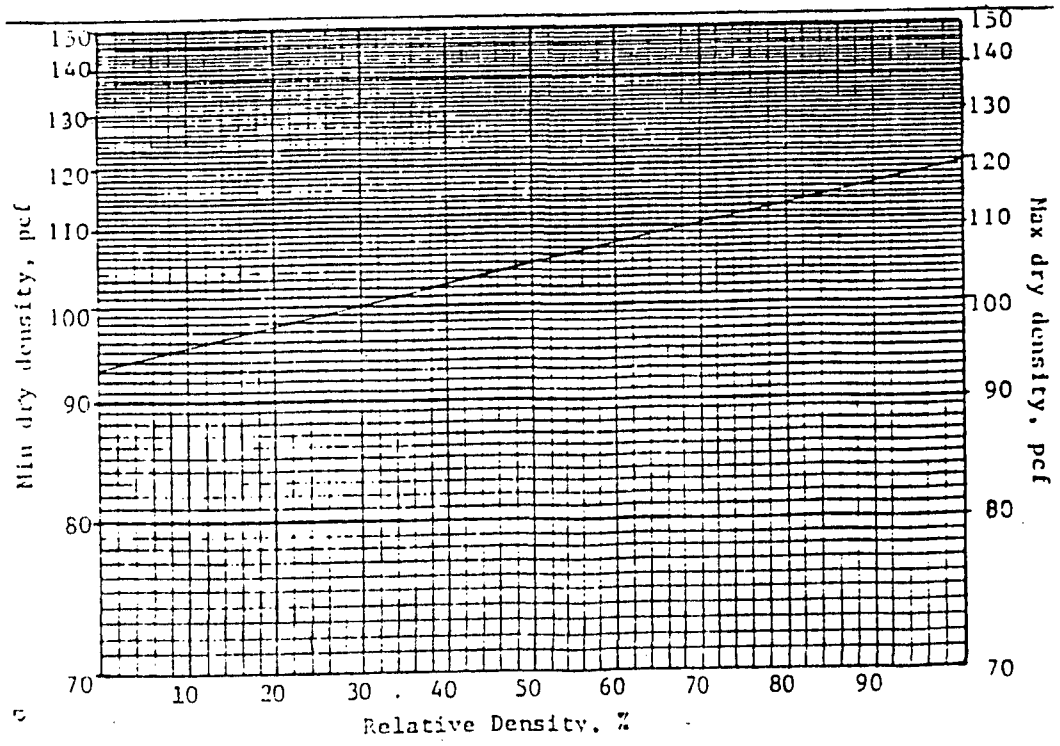
Apperdix B
Page 1 of 1

RELATIVE DENSITY CONTROL GRAPH – MANUFACTURED SAND (TEN MILE)

Part I - Relative Density Conversion

Reference Memo: SME 790221003
Approved Source: Ten Mile Stone Co. (Sand)
Effective Date: 2/21/79

ASTM D4253 Maximum Dry Density:	119.6	pcf
ASTM D4254 Minimum Dry Density:	93.1	pcf



w = Fill dry density
x = Maximum dry density
y = Minimum dry density
z = Relative density

Conversion Formula: $\frac{x}{w} \cdot \frac{w - y}{x - y} \cdot 100 = z$

Part II - Sieve Analysis

Sieve Size	Percent Passing	Specified Limits Minimum	Specified Limits Maximum
1/4"	100	-------	100
No. 4	100	95	100
No. 8	97	80	100
No. 16	72	50	85
No. 30	39	25	60
No. 50	17	10	30
No. 100	8	2	10
N/A	N/A	N/A	N/A

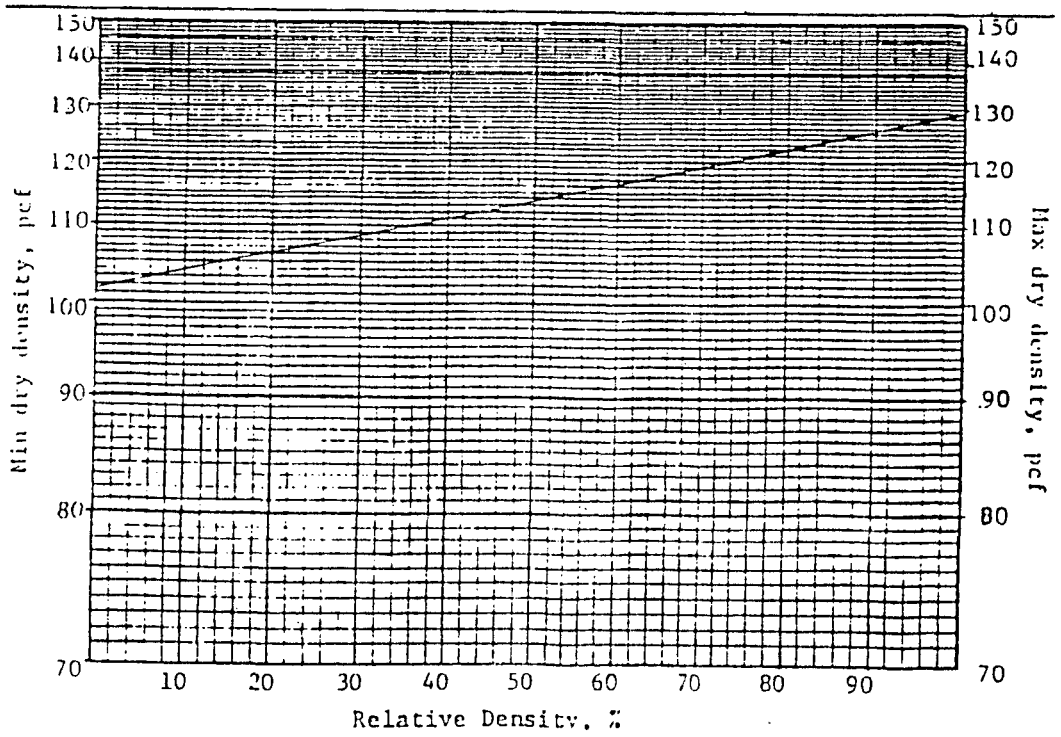
Appendix C
Page 1 of 1

RELATIVE DENSITY CONTROL GRAPH – MANUFACTURED SAND (RHEA COUNTY)

Part I - Relative Density Conversion

Reference Memo: 761116H0677
Approved Source: Rhea County Quarry (Sand)
Effective Date: 11/15/76

ASTM D4253 Maximum Dry Density:	129.0	pcf
ASTM D4254 Minimum Dry Density:	101.6	pcf



w = Fill dry density
x = Maximum dry density
y = Minimum dry density
z = Relative density

Conversion Formula: $\frac{x}{w} \cdot \frac{w - y}{x - y} \cdot 100 = z$

Part II - Sieve Analysis

Sieve Size	Percent Passing	Specified Limits	
		Minimum	Maximum
No. 4	99	95	100
No. 8	79	80	100
No. 16	56	50	85
No. 30	34	25	60
No. 50	14	10	30
No. 100	5	0	5
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A

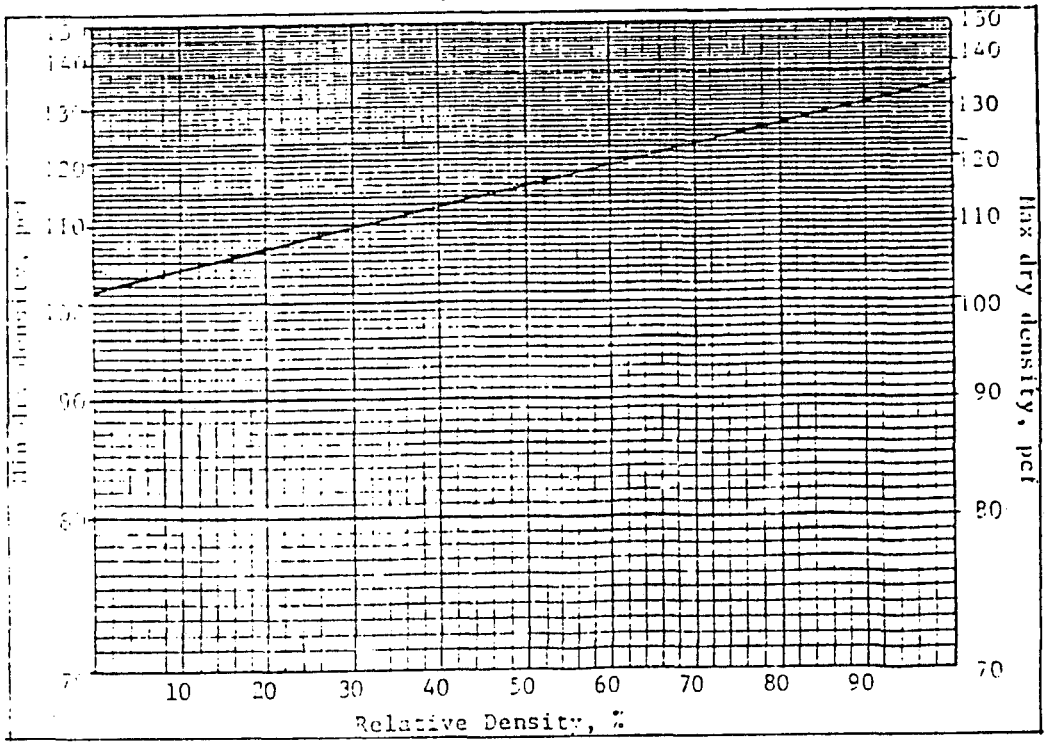
Appendix D
Page 1 of 1

RELATIVE DENSITY CONTROL GRAPH - 1032 CRUSHED STONE (TEN MILE)

Part I - Relative Density Conversion

Reference Memo: SME 840113001
Approved Source: Ten Mile Stone Co. (1032)
Effective Date: 1/13/84

ASTM D4253 Maximum Dry Density:	135.2	pcf
ASTM D4254 Minimum Dry Density:	102.3	pcf



w = Fill dry density
x = Maximum dry density
y = Minimum dry density
z = Relative density

Conversion Formula: $\frac{x}{w} \cdot \frac{w - y}{x - y} \cdot 100 = z$

Part II - Sieve Analysis

Sieve Size	Percent Passing	Specified Limits Minimum	Specified Limits Maximum
1-1/4"	100	-------	100
1"	100	95	100
3/4"	100	70	100
3/8"	75.3	50	85
No. 4	45.9	33	65
No. 10	34.0	20	45
No. 40	17.3	8	25
No. 200	9.8	0	10

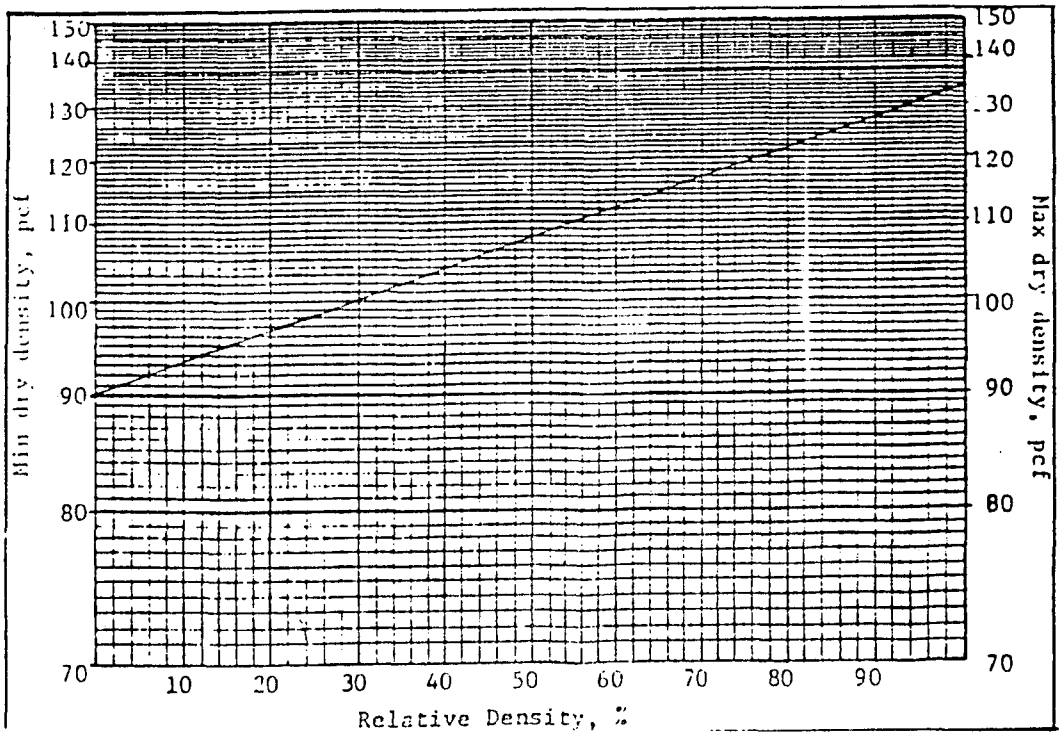
Appendix E
Page 1 of 1

RELATIVE DENSITY CONTROL GRAPH -- 1032 CRUSHED STONE (RHEA COUNTY)

Part I - Relative Density Conversion

Reference Memo: SME 841016012
Approved Source: Rhea County Quarry (1032)
Effective Date: 10/16/84

ASTM D4253 Maximum Dry Density:	133.6	pcf
ASTM D4254 Minimum Dry Density:	90.0	pcf



w = Fill dry density
x = Maximum dry density
y = Minimum dry density
z = Relative density

Conversion Formula: $\frac{x}{w} \cdot \frac{w - y}{x - y} \cdot 100 = z$

Part II - Sieve Analysis

Sieve Size	Percent Passing	Specified Limits	
		Minimum	Maximum
1-1/4"	100	------	100
1"	100	95	100
3/4"	95	70	100
3/8"	68	50	85
No. 4	46	33	65
No. 10	26	20	45
No. 40	12	8	25
No. 200	8	0	10

Appendix F
Page 1 of 6

TENNESSEE VALLEY AUTHORITY

DIVISION OF ENGINEERING DESIGN

CIVIL ENGINEERING BRANCH

WATTS BAR NUCLEAR PLANT

INSTRUCTIONS FOR BACKFILLING AFTER CONSTRUCTION OF YARD CONDUITS AND PIPING

REPORT CEB-76-15

DATE - ORIGINAL ISSUE JUNE 22, 1976

WATTS BAR NUCLEAR PLANT
INSTRUCTIONS FOR BACKFILLING AFTER CONSTRUCTION
OF YARD CONDUITS AND PIPING

1. Noncategory I subgrade Service Lines (REFER TO Note 1, Page 5)

A. Electrical Conduits and Conduit Banks

1. Construction trench through in-situ soil

a. Soil backfill

(1) Use of material excavated from trench

(a) Identify material with respect to a borrow class (use field soil tests to reasonably identify borrow class)

(b) Compact to type B compaction specification

(2) Use of material from borrow source

(a) Compact to type B compaction specification

b. 1032 Crushed stone as backfill

(1) Compact to 75-percent relative density

(2) REFER TO Note 2, Page 5

2. Construction trench through fill

a. Soil Backfill

(1) Compact material excavated from trench to compaction specificaton of the fill

b. 1032 Crushed stone as backfill

(1) Compact to 75-percent relative density

(2) See Note 2, Page 5

B. Mechanical Piping

1. Construction trench through in-situ soil

a. Soil backfill

(1) Use of material excavated from trench

(a) Identify material with respect to a borrow class (use field soil tests to reasonably identify borrow class)

(b) Compact to Type B compaction specification

(2) Use of material from borrow source

(a) Compact to Type B compaction specification

(3) REFER TO Note 3, Page 6

b. 1032 Crushed stone as backfill

(1) Compact to 75-percent relative density

(2) REFER TO Note 3, Page 6

(3) REFER TO Note 2, Page 5

2. Construction trench through fill

a. Soil Backfill

(1) Compact material excavated from trench to compaction specification of the fill

(2) REFER TO Note 3, Page 6

b. 1032 Crushed stone as backfill

(1) Compact to 75-percent relative density

(2) REFER TO Note 3, Page 6

(3) REFER TO Note 2, Page 5

II. Category I subgrade service lines

A. Electrical Conduits and Conduit Banks

1. Construction trench through in-situ soil

a. Soil Backfill

(1) Use of material excavated from trench

(a) Identify material with respect to borrow class

(b) Compact to Type A compaction specification

(2) Use of material from borrow source

(a) Compact to Type A compaction specification

b. 1032 Crushed stone as backfill

(1) Compact to average of 85-percent relative density with a minimum of 80-percent relative density for any one density test

(2) REFER TO Note 2, Page 5

2. Construction trench through fill

a. Soil backfill

(1) Compact material excavated from trench to Type A compaction specification

b. 1032 Crushed stone as backfill

(1) Compact to average of 85-percent relative density with a minimum of 80-percent relative density for any one density test

(2) REFER TO Note 2, Page 5

B. Mechanical Piping

1. Construction trench through in-situ soil

a. Soil backfill

(1) Use of material excavated from trench

(a) Identify excavated material with respect to borrow class

(b) Compact to Type A compaction specification

(2) Use of material from borrow source

(a) Compact to Type A compaction specification

(3) REFER TO Note 3, Page 6.

b. 1032 Crushed stone as backfill

(1) Compact to average of 85-percent relative density with a minimum of 80-percent relative density for any one density test

(2) REFER TO Note 2, Page 5

(3) REFER TO Note 3, Page 6

2. Construction trench through fill

a. Soil backfill

(1) Compact material excavated form trench to Type A compaction specification

(2) REFER TO Note 3, Page 6

b. 1032 Crushed stone as backfill

(1) Compact to average of 85-percent relative density with a minimum of 80-percent relative density for any one density test

(2) REFER TO Note 2, Page 5

(3) REFER TO Note 3, Page 6

NOTE 1:

The level of compaction specified in these instructions for the backfill is a minimum. If the drawings or construction specification used for construction required a higher compaction level, the backfill is to be compacted to the higher density.

NOTE 2:

At present the use of 1032 Crushed Stone as fill or backfill in areas where the stability of slopes has to be ensured is limited (REFER TO figure in memorandum dated June 22, 1976, from Pierrce to Killian, "Watts Bar Nuclear Plant - Yard Conduits and Piping - Backfilling During Construction," for location of these areas). Only the areas listed below that have been identified as areas requiring the assurance of the stability of slopes, are allowed to use 1032 as backfill or fill during construction.

Area B--The 1032 Crushed Stone is to be compacted to an average of 85-percent relative density, with a minimum of 80-percent for any one test. The outward slope of the fill is to be 3:1.

Area C--The 1032 Crushed Stone for the fill slopes around the Diesel Generator Building is to be compacted to an average of 85-percent relative density, with a minimum of 80-percent for any one test. The outward slope of the fill is to be 3:1.

In areas that are not identified as needing the assurance of slope stability, 1032 Crushed Stone can be used for fill or backfill.

NOTE 3:

Since mechanical piping frequently has a protective coating on its surface, the field is not to backfill around any piping without checking mechanical drawings for pipe surface protection requirements. Any soil with gravel is not to be used next to the surface of piping with pipe surface protection requirements.