

Chapter 3 Excavation and Embankment

2-300 General

2-300A Introduction

The general term “earthwork” encompasses the initial construction operations on a highway project. These operations include staking slopes; clearing and grubbing the natural ground; excavating earth, rock, and other materials; building embankments; disposing of unsuitable and excess materials; compacting in-place materials to proper density; and installing temporary pollution controls.

This work is to be accomplished as indicated on the plans, in accordance with the current *Standard Specifications* or special provisions, and as designated by the Engineer.

2-300B Definitions

Various terms are used in the chapter to designate areas pertinent to a construction project. The terms are defined below.

- *Highway Limits.* The boundaries of the whole right-of-way that is reserved for or secured by the Department for use in constructing the roadway and its appurtenances.
- *Taking Lines.* The highway limits.
- *Roadway Limits.* The limits of construction. These limits may differ from the highway limits, if there are portions of the right-of-way on which construction is not to take place.
- *Clearing Limits.* The boundaries of the area to be cleared and grubbed for the road construction.

Figure 2-3.1, on the next page, illustrates the terms.

2-301 Setting Slope Stakes

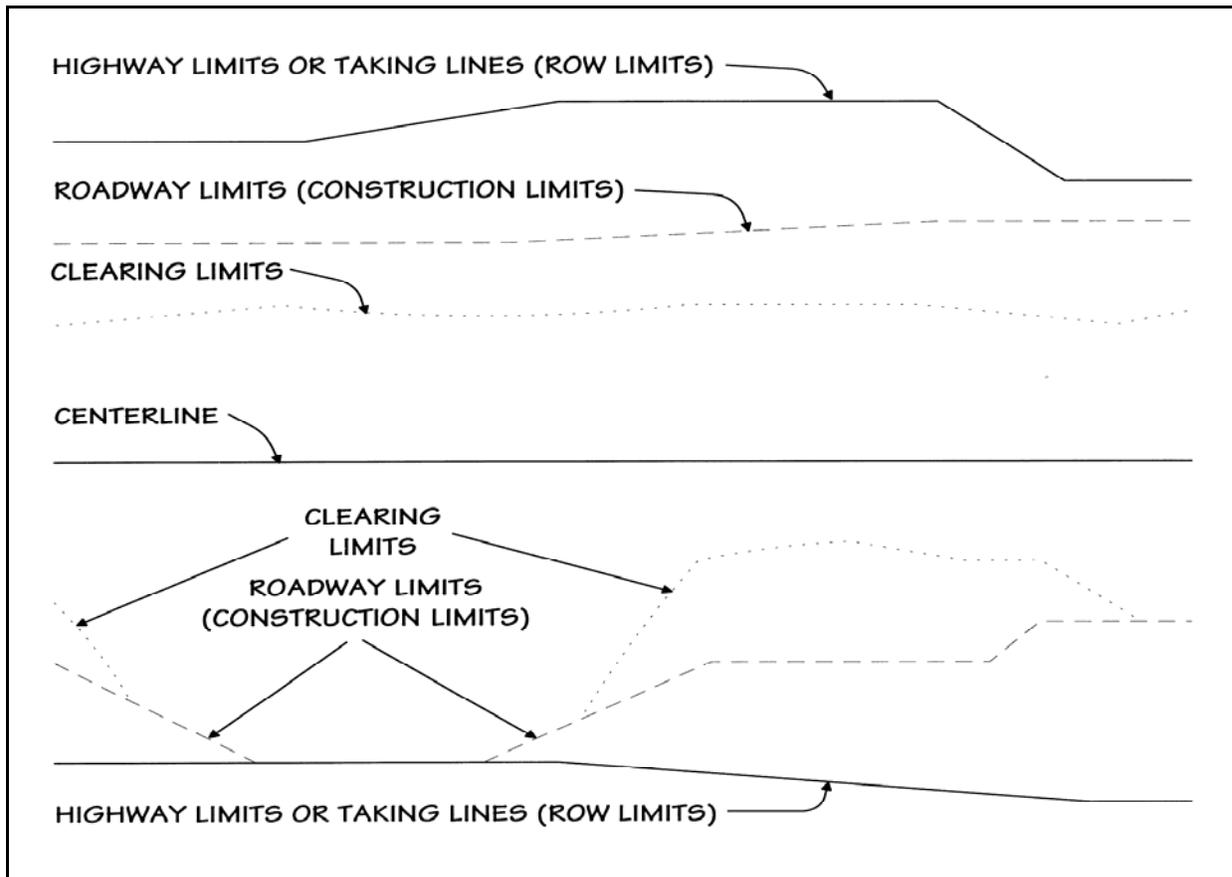
The Inspector must check the slope stakes set by the contractor to establish the grading extremities and to guide the grading work itself. Slope stakes must be set at the top of the slope in cuts and at the toe of slopes in fills, on both sides of the roadway opposite each offset stake. The stakes must be set in accordance with the cross-section template and the construction staking item. Slope stakes may also be used to guide the contractor during clearing and grubbing. Figure 2-3.2, contains additional information about setting slope stakes.

When the slope is designed with a roll at the top and toe, two stakes should be set on each side of the roadway, one to mark the intersection of the normal cut or fill with old ground and the other to determine the limit of the roll.

The Chief Inspector must check frequently as the work progresses to determine that slopes are constructed as designed. The Inspector may be assisted by a survey party in checking the development of the cut or fill if the assistance expedites the check and contributes to its accuracy. However, any assistance given the Inspector by a survey party does not relieve the contractor of responsibility for the proper grading of the entire project.

Figure 2-3.1

Illustration of Lines and Limits

**2-302 Clearing and Grubbing****2-302A Description**

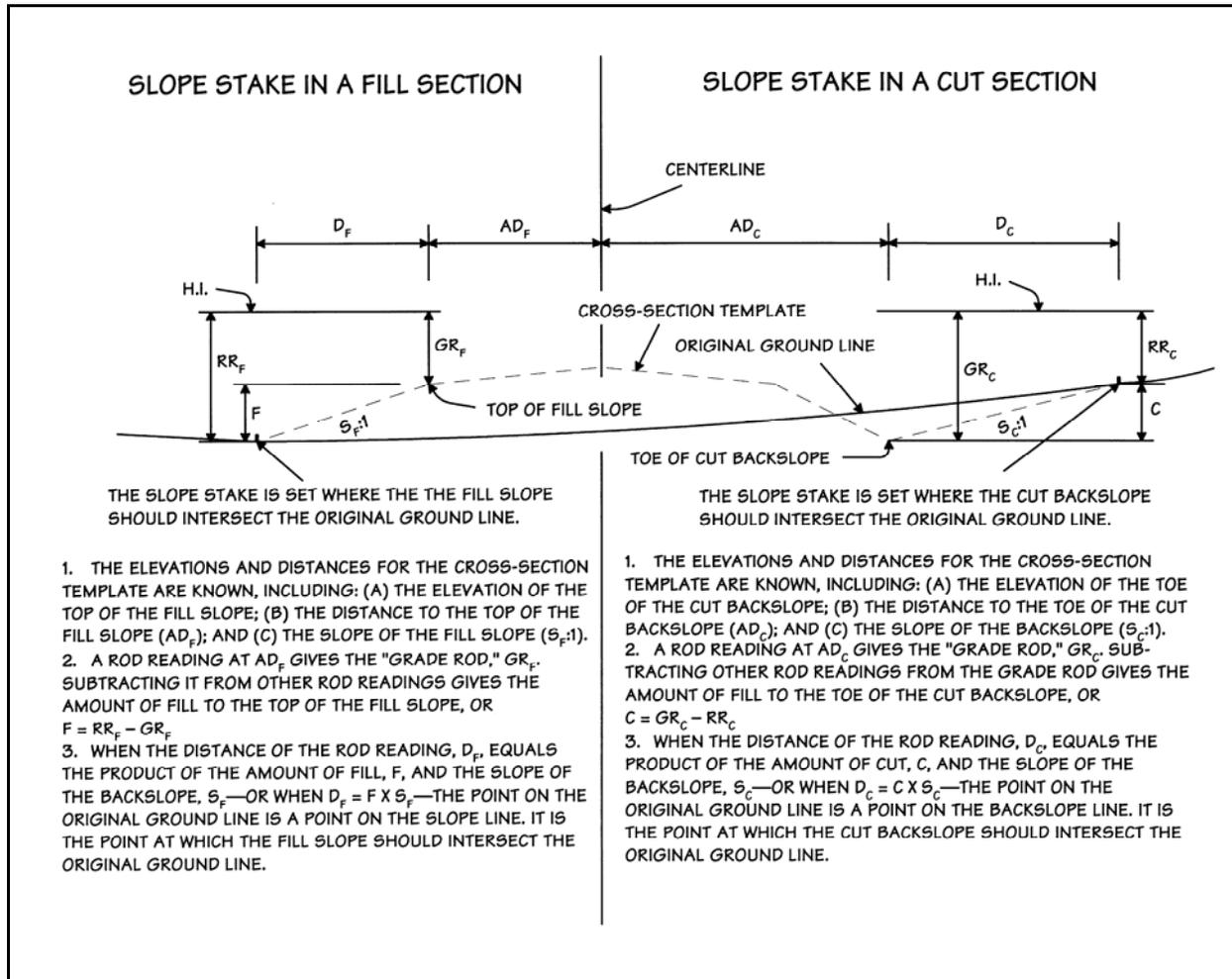
The clearing and grubbing of a project is usually the first construction operation performed on the job. It entails the removal of trees, stumps, roots, brush, rubbish and all other objectionable materials and objects from within the highway limits and from any adjoining areas designated by the contract. The removal of such objects and materials is necessary for the construction of highways and the installation of structures, drainage features, fences, ditches, and channels. While clearing and grubbing is usually considered one operation and is always considered a single pay item, it technically is two operations:

- *Clearing*, this is removal above natural ground (trees, brush, shrubs, and rubbish).
- *Grubbing*, which is removal below natural ground (roots, stumps, and similar objects).

Clearing and grubbing mainly suggests removing, but it also involves protecting from harm certain vegetation and objects designated to remain.

Figure 2-3.2

Setting Slope Stakes

**2-302B Preliminary Activities**

A meeting must be held to discuss clearing operations before they begin. Those attending should include project personnel, the designer, local officials, and the District Environmental Coordinator. If clearing concerns are raised, a follow-up field meeting should be held to address the specific concerns before any trees are cut. Accurate minutes of the meetings should be kept.

All trees scheduled to be removed outside the proposed gutter or curb lines must be visibly marked or flagged by the contractor at least seven days prior to cutting the trees. The Engineer must inspect the identified trees within the seven days and check the limits of clearing and grubbing before the contractor starts the work. Slope limits are to be verified by measurements both in plan and in cross section. If the rights-to-slope have been acquired and the top or toe of slope is outside the highway line by right of a deed easement, the contractor must not clear beyond the slope line.

2-302C Tree Removal and Protection

All large trees are to be saved if physically feasible by installing tree wells, modifying slopes, or using other means. Trees may also be designated for preservation because of historic value or other reasons.

If there are questions concerning the soundness or health of trees to remain, assistance should be sought from the District Environmental Coordinator or Office of Design landscape personnel. Obviously, the purpose of this action is to save trees wherever possible and prevent accidental removals. If there is any doubt about whether to remove or preserve trees, they should be preserved, even if there is an increase in cost for removal at a later date.

All tree removals must be reviewed before the work is done to ensure that only those trees that must be removed are removed.

2-302D Disposing of Materials

If the Engineer does not direct otherwise, the contractor should recycle wood, remove rubbish and refuse from within the highway limits, and bury rubble and stone either inside or outside the highway limits.

2-302E Disposal Outside the Highway Limits

If contractors elect to dispose of materials outside the limits of the highway, at one or more points of their choosing, they must first comply with the guidelines below.

- The contractor must ensure that no harm will be done to the project or the environment. Disposal locations must be outside of designated wetlands, watercourses and flood plains, unless otherwise approved by local, State, or Federal agencies.
- The contractor must submit the necessary documentation for review and approval by the Engineer, the Department of Environmental Protection (DEP), or the town's environmental agency. This includes:
 - + *Location Plan.* USGS Quad Map, town assessor's map, or town map showing the detailed location(s) of the disposal site(s).
 - + *USDA Soils Map.* Area of disposal site(s), obtainable from local town.
 - + *Local Permission.* A copy of the local (town or city) approval of disposal site ("fill permit," etc.), including all conditions and the required erosion and sedimentation controls (use of hay bales, silt fence, etc., to ring the site).
- The contractor must obtain permission from the Engineer and a permit from the DEP. To issue a permit, the DEP requires approval by the appropriate local, State, and Federal agencies.

2-302F Disposal Inside the Highway Limits

When contractors request permission for disposal within the highway limits, the work must be done according to the details and requirements shown on the plans, as well as the requirements below.

- Not less than fifteen days prior to disposing of cleared and grubbed materials within project limits, the contractor must submit to the Engineer for approval a written proposal delineating the locations and extent of the proposed disposal areas.
- The proposal must describe the nature of the materials and the methods to be used in placing and covering them.

- The proposal is reviewed for its effects on the completed construction and the environment of the highway.
- The proposal will be amended as required by the Engineer. No materials are to be disposed of within project limits until the proposal has been approved by the Engineer.

2-302G Areas Outside Roadway Limits but Within Highway Taking Lines

To conform to future Departmental roadside development and to minimize future expense, the Chief Inspector must pay particular attention to the area that is outside the roadway limits but within the highway taking lines. In the case of excess property taken during the acquisition of the right-of-way, a uniform distance from the centerline should be established by the District, with the assistance of the Assistant Director of Rights-of-Way (Boundaries). Within the area, the Inspector must ensure that all stumps are cut flush with the ground, and all dead or uprooted trees, brush, or other objectionable materials are removed and disposed of properly. The Inspector must take special care that no valuable or historic trees are destroyed, unless necessary.

2-303 Survey Markers and Monuments

The contractor is responsible for the protection of all benchmarks or permanent markers or monuments of the State, Federal or local governments; public utilities; or local property owners, including historical markers or areas. The contractor must notify the interested agencies in advance, so that the markers or monuments may be adequately referenced, protected, or reset before being disturbed.

2-304 Excavation and Embankment

2-304A Definitions

Excavation is the removal of soil or rock from its natural location. Embankment is the placement and compaction of layers of earth or rock to form a roadbed of the planned shape, density, and profile grade.

Excavation can be thought of as either roadway excavation or structure excavation. Each of these categories is further divided into several different classifications. Roadway excavation includes:

- earth excavation,
- rock excavation,
- earth channel excavation,
- rock channel excavation,
- unclassified excavation, and
- unsuitable excavation.

The *Standard Specifications* clearly define the classifications and uses them as pay items. The Chief Inspector should be familiar with them. The pay items applicable to a particular project are shown in the proposal form. Inspectors should exercise particular care to see that excavation is classified correctly.

2-304B Earth Excavation

This pay item includes the removal of all materials other than water, ledge rock, large boulders, or loam (if loam excavation appears as a contract item). Included in earth excavation are the:

- Excavation of drainage ditches that are located within the normal cut slope limits. (See *Standard Specifications* 2.06.04-1(a).)
- Removal of stone walls, except stones having a volume large enough to classify them as rock excavation in accordance with the current *Standard Specifications*.
- Removal of other man-made structures, such as old foundations, concrete or masonry walls, crib walls, bin walls, etc.

The quantities of earth excavation for the roadway proper, large quantities at side-road locations, and quantities at most stream locations are computed from cross sections. The plans indicate the locations. The Inspector must measure and record the volumes of all stone walls removed and any other earth excavation not included in the original cross sections.

Excavation quantities shown on the estimate sheets are estimated quantities. Final-quantity determinations are required and should be well documented in the project records. All notes related to final measurement, such as checks of the elevations of existing ground as noted on cross sections or of cross-section areas, should give the date that the work was performed, the name of the person or party performing the work, and the exact limits of the work.

Occasionally, excavation and filling are performed together as an operation, as in the case of benching slopes and removing unsuitable material. The necessary measurements should be obtained as promptly as is practicable. Unnecessary delays to a contractor's operations should be avoided.

A grading plan will occasionally be required by special provision on projects involving borrow, waste, or a large volume of rock.

2-304C Excavation Procedure

Before starting the grading operations, it is common practice for the contractor to set a row of grade stakes to be used for grade lines. The stakes are set at a uniform distance from the centerline of roadway, outside the grading limits, and for a considerable distance along the project.

If the cross sections for a cut show rock slopes or rock-and-earth slopes, the Inspector should pay particular attention to the elevations at which rock is encountered. The Inspector should immediately advise the Project Engineer of any discrepancy that prevents completion of the cut according to the designed cross section or that calls for acquisition of additional property or right-of-way.

Very often earth and other fine material overlie ledge that is to be excavated. Building an embankment from material excavated from this configuration often results in finer material being placed in the bottom of the embankment, while insufficient fines remain to fill the voids in the successive layers of rock fragment placed in the embankment. In other cases, much of the finer material is incorporated in the deeper embankment sections, while the rest of the available excavated material is composed of rock fragments too large to be placed in the remaining shallow embankment section.

If practicable, the contractor should arrange excavation schedules so that these situations do not occur, especially on closely balanced jobs. The Chief Inspector should have in mind an overall picture of the grading of the entire project.

As the *Standard Specifications* state, overhaul will not be allowed. Excavated material, including topsoil, must be transported where directed, provided the designated point of deposit is not more than 100 yards (90 meters) beyond the limits of the project contracted for, unless the special provisions or plans state otherwise.

2-305 Rock Excavation

This item includes the removal of rock in definite ledge formation and boulders or portions of boulders one cubic yard (one cubic meter) or more in volume.

2-305A Determining the Quantity To Be Removed

The contractor is required to strip or expose the rock to such an extent that the quantity to be removed can be measured. The Inspector must be satisfied that the ledge is exposed sufficiently to reveal the true conditions. It should not be necessary for State forces to bar, probe, or trench so that the survey party can take cross sections.

At the request of the Chief Inspector, the survey party must take careful cross sections of the rock. The work should be performed after the rock surface has been exposed but before rock excavation has begun. The cross sections should be taken on the same cross-section lines as the original sections and on the intermediate lines necessary for accurately determining the amount of rock to be excavated.

2-305B Blasting Safety Meeting

When blasting is anticipated, a combined blasting and safety meeting must be held to assure full compliance with safe practices in blasting and all other operations, with emphasis on protection of workers and property. The meeting may be combined with the Preconstruction Conference and/or Utility Conference. The meeting will be chaired by the Project Engineer, and the following persons will be invited to attend:

- District Safety Advisor,
- State Fire Marshal,
- representatives from affected utilities,
- contractor's field superintendent,
- local fire marshal,
- blaster,
- representative of the contractor's insurer, and
- representative of the contractor's supplier of explosives.

Notification of the proposed meeting will be sent by the District.

At this meeting, safe practices in transporting, storing, and using explosives will be discussed. Attention will be given to the pertinent *Connecticut General Statutes*, regulations of the Division of State Police, local ordinances, and *Standard Specifications* of the DOT. The *Specifications* have been developed to protect DOT personnel, owners and residents of adjacent properties, and the motoring public, including school buses and emergency vehicles. The contractor must comply with the pertinent sections of the documents mentioned above. In addition, the contractor must take full advantage of all services available from the insurer and from the manufacturer and supplier of explosives.

The meeting participants must review each rock cut and recommend safety precautions to be taken by the contractor before blasting. The recommendations are made in writing to the contractor, with copies to the committee members and the local fire marshal.

2-305C Presplitting Rock Slopes

Improvements in blasting procedures and the development of the presplitting concept now make it possible to control rock breakage and provide for smooth, stable rock-cut faces conforming to specified slope ratios. The Inspector should review the subsection “Excavation of Rock” under Section 202 of the current *Standard Specifications* to become familiar with this rock-removal technique.

2-306 Blasting Regulations and Good Practices

2-306A Regulations

The contractor or blasting subcontractor will obtain a permit from the local fire marshal in the town where the blasting is to be done.

All dynamite and cap magazines will be of the approved type and be inspected by the State Fire Marshal's Office.

2-306B Transport, Storage

The transporting of blasting caps in a vehicle containing other explosives is prohibited.

Each vehicle carrying explosives will bear signs on the front, rear, and each side displaying the word “Explosives” in letters not less than 4 in. (100 mm) in height. The lettering will be white. The approved vehicles will be painted bright red.

No explosives or caps will be left overnight on any job unless stored in a magazine.

If no magazine is located on the job, leftover dynamite and caps will be returned to the supplier at the end of the day's work.

All empty explosive cartons will be burned and will not be used for storing drills, tools, stemming, etc.

2-306C Warnings

Before each blast, the contractor will notify the local police department, fire department, fire marshal and, when necessary, any public utility company that may be involved.

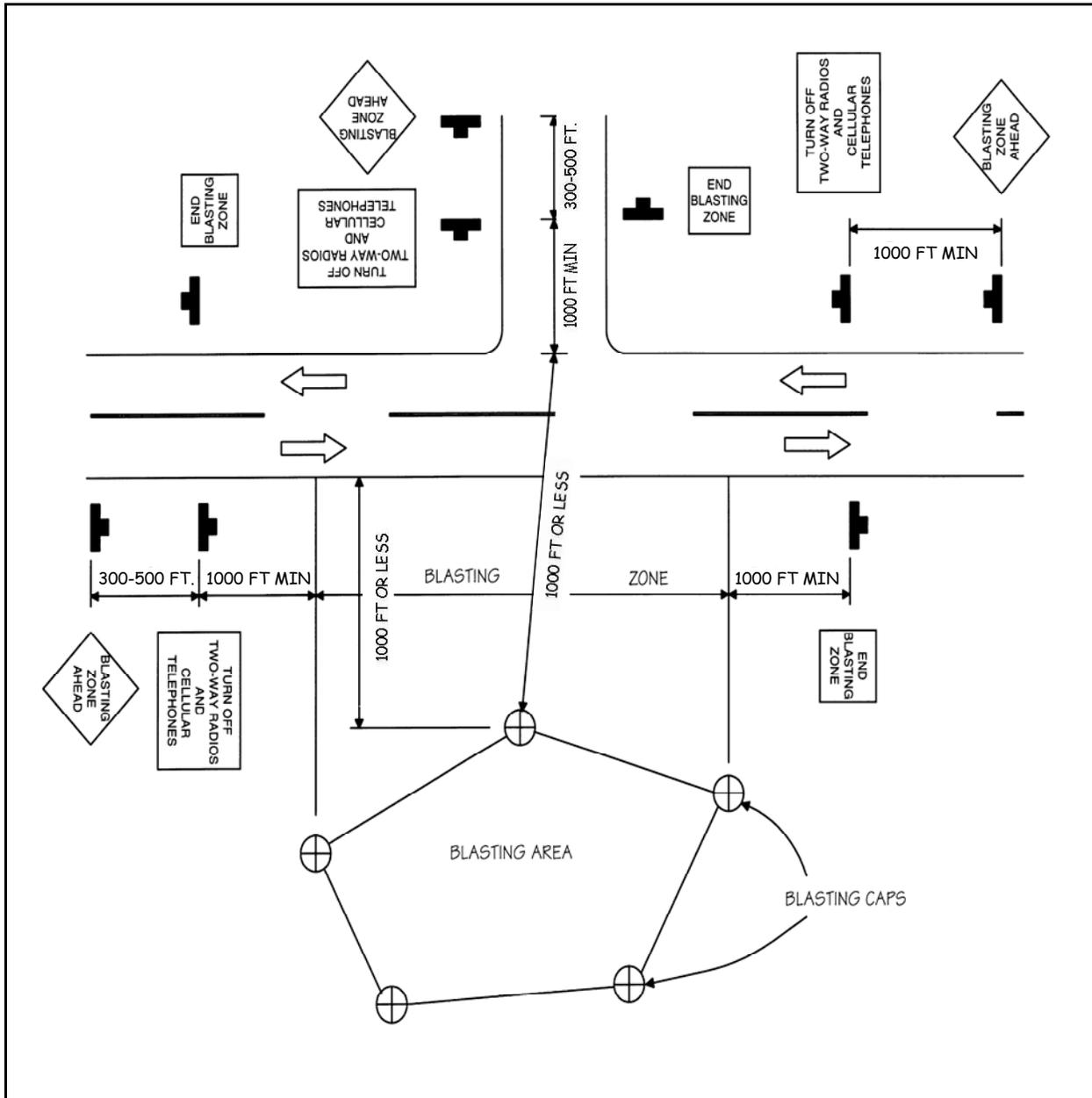
The contractor will post signs on all adjacent highways—a minimum of 1000 feet (300 meters) from the blasting site to warn motorists to turn off two-way radios and cellular telephones. The signs will be placed on the road just prior to the loading of the holes and will be taken down immediately after a blast is detonated. The standard sign layout is shown in Figure 2-3.3, on the next page.

The contractor will send out individual workers prior to the detonation to warn occupants of all buildings in the area. This warning will be given prior to the whistle blasts (described below).

The contractor will install a whistle, so that, 15 minutes prior to each detonation, the public will be warned by six 10-second blasts of the whistle. Just prior to the detonation, the whistle will be blown ten short blasts.

The contractor will station flaggers on all highways adjacent to the blasting area to stop traffic before a blast is detonated.

Figure 2-3.3 Signs for Blasting



2-306D Special Precautions

Special care will be exercised near broadcasting stations and towers by checking the frequency wave lengths with the stations in question. This is to prevent accidental detonation of wired caps and dynamite by radio transmitters.

In marine construction, proper precautions will be taken to prevent marine transmitting radios from setting off a blast.

In the event of an electrical storm, after loading has started, all operations will cease and the area will be cleared. Whenever possible, the load should be fired before the storm arrives.

Presplit holes should be checked visually along the face for missing patterns that may indicate misfired holes.

In the event of a misfire, all operations in the area will stop and the contractor will notify the Chief Inspector.

2-306E Normal Operations

- All trench or boulder blasts will be covered with a mat constructed to prevent fragments from being thrown.
- For electrically fired shots, the lead wires will be kept short-circuited until the time for firing.
- When testing circuits to charge holes, blasters will only use a blasting galvanometer designed for this purpose.
- No loading operation will be conducted within 25 feet (7.5 meters) of a drilling operation.
- A constant guard will be kept over loaded charges until the blast is fired.
- After each blast an attempt will be made to recover all wires.

2-306F Recordkeeping

The contractor's blasting supervisors will keep a permanent record of all blasting operations in a bound notebook (not loose leaf).

The records will include the following: date, location, time of blast, number of holes, diameter, depth and spacing of holes, pounds and type of explosive used, number of delay fuses, results of blast, and precautions taken.

2-306G Operations

None of the preceding regulations or practices relieves the contractor of responsibility for protecting the public and property, even though specific protective measures may not be mentioned in the report of the blasting meeting. The contractor should be advised of this responsibility.

DOT employees should not influence the contractor's method of drilling and loading, unless the drilling methods are specified in the contract, because it is the contractor's responsibility. However, it may be necessary, as stated above, to ask the contractor to obtain the advice of the explosives company. A representative of the Department of Transportation, usually the Chief Inspector, will see that the recommendations are followed.

Department personnel or representatives will cooperate with the State Police in regard to all blasting operations. All DOT personnel are responsible for seeing that the provisions of the specifications regarding the use of explosives are enforced.

During the progress of the work, any condition found by the contractor or DOT personnel that represent a change from the conditions anticipated at the original blasting meeting will be pointed out to the Chief Inspector.

To excavate to the bottom of a rock cut, it is necessary to extend the drill below the proposed excavation elevation. The extent of this additional depth is up to the contractor. The Inspector must ensure that no rock ledge protrudes above the required excavation elevation, and must have the contractor remove any overhanging ledge and loose or unstable rock fragments from the slopes, even if they are outside the pay lines.

If the contractor's operations appear to cause excessive "back-breakage"—fracturing the rock beyond the intended limits—the Inspector should alert the Assistant District Engineer. A conference may be needed to determine if other methods of blasting are warranted.

2-306H Payment

In accordance with the current *Standard Specifications*, all boulders must be measured and recorded separately by the Inspector as they are encountered, in cubic feet (meters) and decimals. The Inspector must also designate whether the boulders recorded are in section or out of section, the date of removal, and the location from which the boulders are removed. Boulders that are out of section are those lying on top of the ground or situated so that they are not included in the volume computed from the regular cross section. Out-of-section boulders are not deducted from the earth excavation.

Payment lines for rock excavation, where presplitting bedrock is required by the specifications, will extend to the slope and depth line shown on the plans or as directed, to include only the rock actually removed within this limit.

Where removal of rock is necessary for safety, or due to conditions clearly not attributable to the contractor's methods of operation, the payment lines for rock excavation where presplitting is required will be fixed to coincide with limits ordered by the Engineer.

2-307 Surplus and Unsuitable Material

Excavated material is used to build the project's embankments. If more material is excavated than needed for the embankments, the extra material is termed "surplus." Material that is unfit for embankment construction is termed "unsuitable." The disposal of surplus and unsuitable materials is governed by *Standard Specifications* 2.02.03-8 and 2.02.03-10, respectively.

2-308 Surplus Material

Earthwork that calls for more cutting than filling produces a surplus of excavated material. The excess material may consist of both suitable and unsuitable embankment material. The Project Engineer will indicate where the contractor is to place it. For example, surplus material may be used to widen embankments, to flatten slopes, to fill in low places in the right-of-way, or for other purposes. The only provision is that the area designated by the Engineer for depositing the surplus material does not conflict with the *Standard Specifications* governing placement of excavated material (2.02.03-5). Any surplus or unsuitable material that is not required or permitted to be used for such purposes must be disposed of in accordance with Section 2.02.03-10 of the *Specifications*.

2-309 Unsuitable Material

2-309A General

Some material encountered during excavation is not suitable for placement in embankments. It usually is located below the surface of the original ground and has not been disturbed. The material typically is high in clay or organic content and would not be stable if placed as fill. However, loam or topsoil usually is classified as unsuitable, even though it is found on the surface. There is no hard-and-fast rule that classifies a material as suitable or unsuitable. A useful guide is to ask the following questions about the material under consideration.

- Is it wet?
- Does it retain moisture?
- Does it have organic material in it?
- Is it compactable? When equipment drives over it, is it compacted rather than displaced?

For unsuitable material, the answers to the questions next to the first three bullets probably would be “yes,” and the answers to the questions by the last bullet probably would be “no.”

The disposition of unsuitable material is generally determined during the design stage of the project, and the manner of treatment is indicated in the plans or special provisions. If material of questionable quality has to be removed from locations not specified on the plans, samples should be submitted to the Division of Soils and Foundations for analysis and classification. A field meeting should be arranged with DOT Soil representatives to review unsuitable material. All recommendations should be documented.

2-309B Topsoil

The locations of topsoil areas should be determined well in advance of the work. Approximate locations are usually given in the computations, in the field review reports, and in the plans (primarily on the estimate sheets). The areas from which topsoil is removed can be either cut or fill areas. In-place samples of the material should be submitted to the Laboratory for approval as topsoil as far in advance of the work as is practical. Preliminary approval or rejection of the material will enable the Department to properly determine the disposition of the material.

When topsoil excavation is ordered from either cut or fill sections, the Inspector must see that it is stockpiled along the outside of the roadway limits, but within the highway limits, and placed where it will be readily accessible to the Division of Maintenance for use as required. The Inspector must contact the District Maintenance Manager to determine the most favorable location for these stockpiles with regard to future work.

A check of proposed fencing in the stockpile areas is important. Should it appear that there will not be sufficient area to stockpile the excavated topsoil; the Project Engineer should be notified so that other stockpile areas can be located.

All topsoil excavated and stockpiled must be free of boulders, roots, stumps, etc., but the contractor is not required to screen the material. Because topsoil depths vary, its removal should be closely watched to ensure that unsuitable material (unsuitable for topsoil) is not excavated and incorporated in the stockpiles.

Topsoil quantity is directly related to the cut and fill quantity columns on the estimate sheets in the plans. On borrow projects, changes in the quantity of excavated topsoil will affect the borrow volume. Regardless of the applicable item under which topsoil is stripped from the roadway area and stockpiled for future use, original and final cross sections of the excavation areas must be taken before any further grading operations are begun. The stockpiles will be available for measurement. However, a material shrinkage of 20 to 30 percent will probably occur, depending on the equipment used. The measurements of the piles will not give an accurate quantity unless a proper adjustment is made for shrinkage.

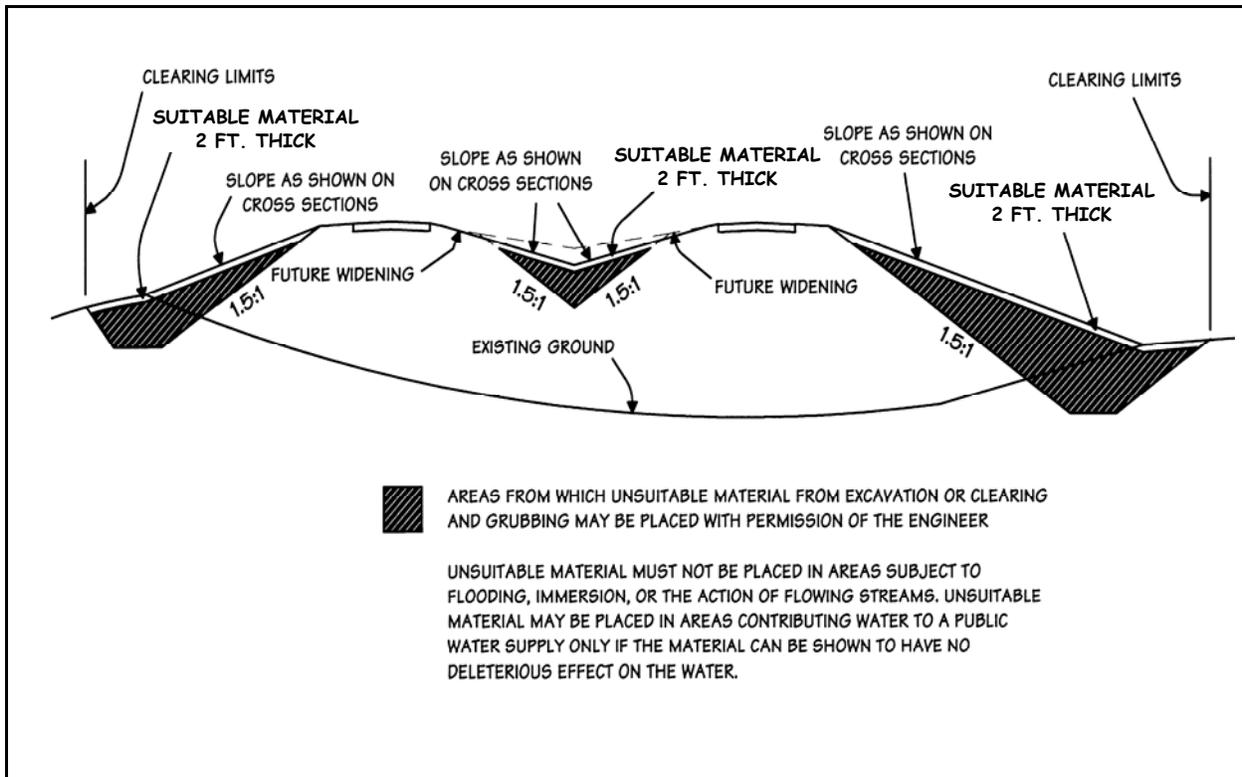
2-309C Use or Disposal of Material

“Unsuitable” does not mean “waste.” Every consideration should be given to using unsuitable material, especially on borrow projects. Generally, it can be used to advantage:

- In berms.
- On slopes, generally between specified lines. For example, between 2:1 and 1.5:1 or 1:1 slope lines.
- To widen embankments.
- To flatten slopes. Caution should be taken to avoid preventing water from bleeding through slopes. If water cannot bleed out it will create problems with embankment building.
- To fill low spots within the right-of-way.

Figure 2-3.4 indicates some of the places for disposing of unsuitable material within the clearing limits.

Figure 2-3.4 Disposal of Unsuitable Material



When the material is not required or permitted to be used for such purposes, the Project Engineer will order that it be removed and disposed of outside the limits of the highway, at locations determined by the contractor. The Engineer must approve of the disposal sites, which must in no way be detrimental to the project or the environment.

The Inspector must know where surplus or unsuitable material removed from the project is disposed of and verify that the disposal is not in an environmentally sensitive area or in a location that is detrimental to the project. The Inspector must be specific when instructing the contractor regarding removal of such unsuitable material and must record the location, depth, and quantity ordered wasted in the notebook. Should the contractor elect to waste any material that has not been judged unsuitable—including boulders or large fragments—the Inspector must inform the contractor by memorandum that such material is to be replaced at no expense to the State. An accurate record of all such removals must be made in the notebook.

2-310 Salvageable Material

Chief Inspectors must be responsible for the contractors' removal and preservation of all designated salvageable material on the project. They should carefully review Section 1.04.07 of the *Standard Specifications*, titled "Rights In and Use of Materials Found on the Work." In addition, they should contact DOT Stores at the start of each project to review the items that are to be salvaged.

2-311 State's Property

The Inspector must see that the contractor removes and disposes of all highway structures and appurtenances that are not to remain in place. Until they can be delivered to DOT Stores, all drainage pipes and railing material that are not designated to remain in place, or that are not designated for use in the construction and are to remain the property of the State, have to be removed without damage and stored at a convenient location along the highway. The storage location must be a safe distance, a minimum of 30 feet (9 meters) from the traveled portion of the highway.

2-312 Contractor's Property

All structures that become the property of the contractor must be removed and disposed of before final acceptance, unless instructions to the contrary are contained in the plans or special provisions.

2-313 Use of Reclaimed Waste Materials on Construction Projects

The sources of “reclaimed waste” include debris from demolished buildings, structures, and pavements and residue from resource recovery plants. The materials themselves may include portland cement concrete, bituminous concrete, glass, ceramics, bricks, pavement subbase and base course, and incinerator clinkers. Metal is acceptable only when contained within large fragments of concrete.

Reclaimed waste brought onto the project must be accompanied by a Materials Certificate and Certified Test Report stating that the material is environmentally acceptable and structurally sound in accordance with Section 1.06.07 of the *Standard Specifications*, unless the material's source is a transportation project acceptable to the Engineer.

Follow these guidelines in regulated areas when the Department uses reclaimed waste material on construction projects:

- Avoid the use of reclaimed waste on all projects in the immediate vicinity of public water supply reservoirs or tributaries.
- Limit the use of reclaimed waste to areas outside—3 to 5 feet (1 to 1.5 meters) in both the horizontal and vertical directions—of any water resource-regulated area, including the stream channel encroachment line.

2-314 Conditions Requiring Corrective Work

Field observations during the excavation and embankment stage of construction often reveal troublesome soil or water conditions that were not apparent at the time of the soils survey. Corrective work is often needed to ensure the stability of the roadway. Subsurface drainage requirements are particularly difficult to assess accurately when a preliminary subsurface investigation is made.

During excavation operations, therefore, the Chief Inspector must notify the Project Engineer immediately upon encountering any wet condition that has not been provided for in design. The Project Engineer must arrange to have proper drainage features installed with as little delay as possible. One common wet condition is a natural water flow in underground strata. It can be corrected by the use of open ditches, open channels, or underdrains that effectively intercept and carry off the subsurface water. A high water table is another typical problem. It results in a subgrade that becomes saturated and softened by capillary action. Again, underdrains, open ditches, and open channels are means of removing the water and protecting the roadway.

Besides wet conditions, slip planes in earth and rock slopes are also common. These conditions can lead to severe slides if they are not corrected. To remedy the condition, slopes can be benched, high-level drainage ditches can be constructed to intercept surface water, or high-level underdrains can be installed to intercept subsurface water.

Problems that cannot be corrected as described above should be reported to the District Office immediately. Depending on their nature and seriousness, the Assistant District Engineer may prescribe the necessary corrective work, or the District may refer the problem to the Soils and Foundation Section for recommendations.

2-315 Embankment Building

2-315A General

During the formation of embankments, the Inspector must be vigilant in enforcing the provisions of the *Standard Specifications* regarding the placement and compaction of fill material. Observing the action of fill material under the weight of hauling equipment is the best indicator of relative embankment stability. Any material that continues to pump should be immediately brought to the attention of the Project Engineer.

The Inspector must see that the embankment is constructed to the required width from the bottom up, so that dumping material over the edge of the embankment to widen it will not be necessary later on. If it is necessary to widen existing slopes, the added material should be cut in and compacted, and not just end-dumped and spread. Improperly placed material is very susceptible to erosion and may develop into a minor slide.

The practice of compacting embankments chiefly with hauling, excavating, and grading equipment is not acceptable. The entire area of each layer must be uniformly compacted to at least 95 percent of the dry density for the soil, as determined by AASHTO T180, Method D. Compaction equipment, consisting of rollers, compactors, or a combination of the two, must be used. Earth-moving and other equipment that is not specifically manufactured for compaction purposes will not be considered compaction equipment.

Attempts should be made to alternate haul roads on fills whenever possible to promote uniform compaction.

2-315B Borrow

In general, borrow will be permitted only after all usable excavation has been placed. The contractor may request the Engineer's permission to place borrow before all of the available and suitable excavated material has been incorporated in the work. Such permission, when granted, will specify that the contractor will be held responsible for the proper placing of all suitable excavated materials and that no payment will be allowed for any borrow placed in lieu of suitable excavated material. All borrow banks will be preapproved so that "Proctors" may be determined and cross sections may be taken prior to any excavation.

In embankments being constructed from borrow material, the responsibility of obtaining the necessary consolidation and stability is entirely the contractor's. If consolidation and stability are not being achieved, the operations should be stopped until the contractor demonstrates that a thoroughly compacted and stable embankment can be made with the material being used.

2-315C Corrections

When embankments are formed from excavated material but are unstable after the contractor has complied with the density and other requirements of the specifications, the Assistant District Engineer must be alerted. After viewing the condition, the ADE will determine if corrective measures are necessary and, if so, may direct the contractor to improve the embankment's stability. The corrective work that is deemed necessary will be paid for as extra work, or at contract

unit prices if such items appear in the contract. For Federal-aid contracts, the Federal Highway Administration must provide clearance for corrective procedures.

2-316 Monthly Pay Quantities

The practice of determining daily quantities of excavation and borrow by taking load counts is usually recognized as the most practical method. However, it is not acceptable to use the summation of these daily counts to determine monthly pay quantities. Instead, methods must be used to check load-count totals to prevent overpayments. Inspectors should verify load count accuracy as follows.

- The hauling units should be measured and their water-level capacity should be computed. This information will serve as a basis for determining the quantity to be allowed per vehicle load.
- The load-count data should be submitted, in writing, on a daily basis. For example, the contractor could provide a tally sheet listing each hauling vehicle, showing the number of loads per vehicle, and indicating the work location. The tally sheet should be signed by the contractor's superintendent to authenticate it.
- An inspector checks the contractor's load count tally daily by actual tally count.
- Periodic checks of the load-count quantities also should be made by independent methods of measurement (other than load-count data), and the progress quantities should be adjusted as required. The checks usually can be made against the estimate sheet on completion of a particular excavation area or borrow pit.
- The elevations of the cut areas and borrow banks will be determined just prior to the monthly estimate. This may be done by survey party profiles and cross sections. As an alternative, inspectors may take elevations or make visual determinations—nothing elaborate.

The data will be used independently or in conjunction with information available from grading quantity sheets, detailed estimate sheets, etc., to compute the approximate amount of material excavated. This quantity will be compared to the load-count quantity to determine the accuracy of the load counts. If large discrepancies exist between those quantities, more detailed checking must be performed and the load-count quantities must be adjusted accordingly.

- The results of the checks above and the methods used to determine and check the monthly pay quantities for the various excavation and borrow items must be documented in the project records.

It is the Inspector's responsibility to maintain an accurate load count. If load counts are not available, the Inspector should include a daily entry in the project records documenting the approximate:

- carrying capacity of each hauling vehicle,
- number of loads, and
- total cubic yards (meters) for the day.

These estimates will also be considered as load counts.

Intermediate final sections must be taken in borrow banks if borrow operations are suspended for about a week or more. The information must be included in the permanent project records.

2-317 Final Pay Quantities

To assure compliance with the *Standard Specifications* and to ensure proper documentation of this item, the following policy will apply to all projects:

- All final quantities greater than 5000 cu. yd. (3800 m³) must be measured by cross-section measurements at the borrow pit or by cross-section measurements made in place. The appropriate shrinkage factor mentioned in *Standard Specifications* Section 2.07.04, paragraph (d), must be applied. Only in the case of extenuating circumstances may this method be waived in favor of alternatives mentioned in the *Specifications*. The Office of Construction must be informed of the specific reason or reasons why other methods were utilized.
- Under *Standard Specifications*, Section 2.07.04, paragraph (b), payment by load count, less the shrinkage factor, may be considered an acceptable method of measurement for quantities less than 5000 cu. yd. (3800 m³).

2-318 Winter Embankment Operations

If a contractor requests permission to begin or continue the construction of embankments during the winter, the contractor will be required to remove all frozen material, within specified limits, at no cost to the State. The requirement applies to the removal of frozen, existing ground or embankments constructed of earth excavation or borrow located within the following limits:

- As measured from the outside edges of the tops of slopes, the portion of the embankment area that falls within the 1.5:1 slope lines.
- As room permits, between the outside of the 1.5:1 slope and the designated 1:1 slope.

Fat slopes resulting from the placement of the frozen material should be graded to the prescribed slope limits after all material has thawed and become stabilized.

No additional payment will be made for any work involved.

2-319 Embankment Density

Proctor tests are used to determine the laboratory densities of the soils used for embankment construction. Nuclear density gauges typically are used to determine field densities for comparison with the laboratory densities.

2-319A Field Sampling for Proctor Determinations

To be able to compare each field density value with the laboratory density for the same soil, the Inspector must sample and send sufficient material to the District Laboratory so that enough Proctor determinations are made. Each laboratory density test requires approximately 80 pounds (36 kilograms) of material.

For each sample submitted to the Laboratory, the field forces must obtain a small representative sample and retain it on the project as a reference sample. These samples should be placed in glass jars labeled with the following information:

- soil type,
- source,
- Proctor density (at optimum moisture content),
- percent of material retained on the 2 in. (50 mm) sieve,
- percent of material passing the 2 in. (50 mm) sieve and retained on the ¾ in. (19 mm) sieve,
- sample number, and

- laboratory number.

At the time a source sample is taken for approval of a new borrow bank, the Inspector should request a Proctor density and optimum moisture of the material. The request expedites the moisture-density control process in the field, by providing the Inspector with the values that will be needed as soon as the contractor begins the embankment.

If embankment material is obtained from several sources, the importance of comparing the field test results to the laboratory results for the same soil cannot be over-stressed.

2-319B Field Density Test Equipment

Embankment densities can be determined by conventional methods based on a soil sample weight- volume relationship, or by using a nuclear testing device. The Department currently determines field densities by the nuclear method.

Because nuclear-density units contain radioactive material, they are subject to the control and regulation of the Nuclear Regulatory Commission (NRC). Only qualified, NRC-certified employees of the Department are authorized to operate the equipment. Usually, the District nuclear-density staff performs the tests. All applicable safety regulations must be observed.

Nuclear-density devices consist of adjustable moisture and density probes that are power-operated counters. The probes are sealed units containing radioactive material. Each probe has a safety lock-type trigger mechanism that effectively shields the radioactive charge if the mechanism is in the off position. Readings generated by the probes are displayed electronically on an illuminated panel. The readings are referred to as counts per minute, or CPM. For each test run, the panel readings are interpolated on calibration charts for a density and moisture determination.

Each probe has a sending unit. The moisture probe senses the hydrogen molecule content of the water in the soil and transmits the information to the unit. Low readings reflect low moisture content. The density probe senses the resistance of the soil to the radioactive transmissions, and the resultant readings reflect inverse soil densities. That is, low readings indicate high soil densities.

The effective depth of detection for each probe's units is between 6 and 12 in. (150 and 300 mm). For accurate test results, the lower surface of each probe must develop full surface contact with the material being tested. Minor surface irregularities and voids result in count differences of 400 to 500 CPMs. Soils with different densities, if placed in lifts of less than 12 in. (300 mm), require special consideration.

2-319C Field Density Test Procedures and Steps

Before field density tests are run, the inspector who will be responsible for them must be familiar with both the representative samples of material submitted to the laboratory for density determinations and the material currently being used. For a density test to have significance, the material being tested and the results obtained have to be compared to the proper laboratory sample.

Not all field density tests on a project are expected to pass, that is, have results that meet the required minimum percentage of laboratory density. If they all passed, it would indicate that:

- They were made only in hard spots.
- They were compared to a laboratory density for a different, poorer soil.
- The contractor did an outstanding job by thoroughly compacting every layer for its entire width.

The proper procedure is to run the field density test in a portion of the layer that seems representative of the layer as a whole. The test result is then compared to the laboratory (Proctor) density for that soil. If the field density does not pass, the contractor is immediately told to re-roll the area. After the area is rolled again, a new test is performed to

determine whether the additional compaction was sufficient. If the new result also fails to pass, the rolling-and-testing process is repeated until a passing result is obtained.

Additional compaction passes and subsequent tests should be noted under “Remarks” on the Data and Computation Sheet for Nuclear Field Density Tests, Figure 2-3.5, at the end of the chapter. As noted above, the dry density after compaction must not be less than 95 percent of the dry density for the soil when tested in accordance with AASHTO T 180, Method D. If density tests still fail after several re-rollings, it is possible that the wrong Proctor is being used. The Inspector should then resample the material to determine a new laboratory density.

If necessary, the Inspector should have density tests performed in cuts and borrow banks for comparison to densities in fills to determine the amounts of shrinkage and swelling of material incorporated in the work. The information should be given to Soils and Foundations to be used for estimating earthwork on similar projects in the future.

2-320 Water Pollution

2-320A Sedimentation Control Plan

The contractor is required, by the contract “Best Management Practices for Protection of the Environment,” to submit a sedimentation control plan for approval. The plan may be revised after approval when actual field conditions dictate that different controls or more controls are needed.

If possible, the project should be reviewed during a rainstorm to observe high runoff areas and check the sedimentation control plan. This can be critical in determining if the sedimentation control plan is practical and effective. The use of sedimentation silt fence, stone dikes, sedimentation pools, or other controls may be needed. Other options for protecting slopes include temporary bituminous curbing or temporary leakoffs or slope drains.

2-320B Responsibilities

The contractor is responsible for placing and maintaining sedimentation controls. The Chief Inspector is responsible for ensuring that controls are placed and maintained for the duration of the project.

The Inspector should be familiar with all DEP and Army Corps of Engineers permits associated with the project, ensure the contractor's compliance with their conditions, and be familiar with the required erosion and sedimentation controls and other special project requirements. The Inspector should arrange a site meeting with DOT Environmental personnel to review the erosion-control measures implemented.

2-320C Operations

All sedimentation controls must be in place before construction begins. The contractor's approved dump site for excess material should also be protected before actual dumping occurs.

On rehabilitation projects, curb removal may present a potential runoff and sedimentation problem. If possible, curbing should be left in place until the disturbed slopes have a good stand of grass.

Temporary pollution control measures, other than those shown on the plans or stipulated in the specifications, may be ordered by the Engineer to correct conditions that develop during construction. The field personnel must anticipate possible erosion and pollution during construction and provide or recommend timely installation of necessary temporary controls to prevent those problems from occurring.

Figure 2-3.5 Data and Computation Sheet for Nuclear Field Density Tests (Form CON-125)

CON-125 Rev. 10/90
STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS
Printed on Recycled or Recovered Paper

Lab # _____

DATA AND COMPUTATION SHEET FOR NUCLEAR FIELD DENSITY TESTS

Town _____ Rte. No. _____ Project No. _____ Dist. No. _____

Contractor _____ Project Engineer _____

Location of Test Station _____

Offset _____ Depth Below F. Gr. _____

Soil Hauled From (Cut Sta. or Borrow Bank) _____

Tested By _____ Gage Number _____ Date Tested _____

Test Number _____ Soil Type _____

DENSITY		DENSITY		DENSITY	
wet density	dry density	wet density	dry density	wet density	dry density
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
ave. _____	_____	ave. _____	_____	ave. _____	_____

MOISTURE		MOISTURE		MOISTURE	
lbs. water	% water	lbs. water	% water	lbs. water	% water
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
ave. _____	_____	ave. _____	_____	ave. _____	_____

CALCULATIONS

A. Wet Unit Wt.	_____	_____	_____ LBS./C.F.
B. Weight of Water	_____	_____	_____ LBS. H ₂ O/C.F.
C. Dry Unit Wt. (A-B)	_____	_____	_____ LBS./C.F.
D. Water Content (B/C)	_____	_____	_____ %
E. Maximum Density (Proctor)	_____	_____	_____ LBS./C.F.
F. Percent of Proctor Density (C/E)	_____	_____	_____ %
G. Optimum Moisture (Proctor)	_____	_____	_____ %

REMARKS:

The Engineer has the authority to control the surface area of earth material exposed by construction operations and to direct the contractor to immediately provide permanent or temporary pollution control measures in accordance with Section 1.10 of the *Standard Specifications*. The Inspector may direct the work to be done by an on-call contractor if not performed by the project contractor within the period required by the specifications. Additional information can be found in Chapter Three, "Environmental Protection," in the section "24-Hour Rule."

The contractor must operate all equipment and perform all construction operations so as to minimize pollution problems. In the event pollution-control measures are required due to the contractor's negligence, carelessness, or failure to install permanent controls as part of the contract or perform work ordered by the Engineer, the work needed for implementing the pollution-control measures must be performed by the contractor at no expense to the State.

2-321 Call Before You Dig

Companies that will excavate should be thoroughly briefed on Call Before You Dig (CBYD) requirements and procedures before project startup. The CBYD program is operated by the Department of Public Utility Control (DPUC). State regulations require that excavating contractors and subcontractors contact CBYD before starting digging, drilling, driving or other operations that might hit an underground utility. After this contact is made, the contractor or subcontractor must wait two days for the area to be completely marked out. Initially requesting a generously wide mark-out of the construction site can both avoid delays and prevent incidents.

Not all utilities are on the CBYD system. Most municipalities are not, and the State of Connecticut is not. Contractors should contact agencies directly that may have utilities that could be damaged but that are not on the CBYD system.

The DOT has an Incident Management System (IMS) along the major expressways in the State. The IMS uses fiber optic cables and conduits. As an exception to the State's exclusion from the CBYD system, contractors should contact CBYD to have the IMS conduits marked.

2-321A Utility Warning Tapes

DPUC regulations require that all underground utility facilities (including railroad facilities) installed after January 1, 1989, be identified with warning tapes above the facility. The warning tape must be located 12 in. (300 mm) above all conduits, wires, cables, utility pipes, drainage pipes, underdrains, etc. The tape must be durable, designed to withstand extended underground exposure, durably imprinted with an appropriate warning message, and of the color assigned to the type of facility for surface markings.

- *Green.* Storm and sanitary sewers and drainage systems, including force mains and other non-hazardous materials.
- *Blue.* Water.
- *Orange.* Communication lines or cables, including but not limited to telephone, telegraph, fire signals, cable television, civil defense, data systems, and electronic controls and other instrumentation.
- *Red.* Electric power lines, electric power conduits, and other electric power facilities.
- *Yellow.* Gas, oil petroleum products, steam, compressed air, compressed gases, and all other hazardous materials.
- *Purple.* Radioactive materials.
- *White.* Proposed excavations.
- *Brown.* Other.

2-321B Reporting

Digging incidents involving public utility facilities call for timely, accurate, and legible reporting of each occurrence. Incidents are to be reported on the Department of Public Utility Control's Incident Report Form, Figure 2-3.6 at the end of the chapter, and submitted to:

Call Before You Dig, Inc.
105 Sanford Street
Hamden, CT 06514

Regulations of Connecticut State Agencies require each public utility to notify CBYD monthly of any excavating activity that has resulted in contact or damage to its underground facilities for electricity, gas, telephone, other communications, sewage, water, traffic and fire signals, community television antennas, and steam and other products carried by pipelines. Contact includes—without limitation—the striking, scraping or denting, however slight, of any underground utility-line protective coating or housing, or other disturbance of the structural or lateral support of any underground utility facility. Additionally, public utilities must also file a report annually with CBYD if their underground facilities have not sustained damage. Failure of compliance by any public utility regarding the submission of the reports may result in a civil penalty.

The Incident Report Form may be used in evidence in actions imposing a civil penalty for any violation of any portion of the law. Detailed information in cases of alleged “excavator negligence” are particularly important and must be clearly stated. Consequently, accuracy, neatness, and timeliness are essential in its preparation and submission. When each report is completed, the preparer should be certain that the top two copies (white and yellow) are sent to CBYD, while the third copy (pink) remains with the preparer.

