CREDITS

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The Construction and Materials Sections of the Louisiana Department of Transportation and Development and the DOTD Chief Engineer have approved this manual for publication.

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FOREWORD

This manual is designed to standardize department policies and procedures with reference to applicable sections (201, 202, 203, 204, 301, 302, 303, 304, and 305, and the earthwork involved in Sections 701, 702, and 802) of the *Standard Specifications* and *Supplemental Specifications*. The book details the responsibilities of the contractor and the department in the areas of certification, design, production, transportation, placement, quality control, inspection and acceptance of projects built under these specifications for embankment, base courses, and related construction using soils and aggregates. Other detailed manuals are available for use when references are made to sections 501, 502, or 901 and should be consulted. This manual will refer to these sections when differences occur or for clarity. This manual is to be used in conjunction with the *Standard Specifications*, the contract, the *Materials Sampling Manual*, the *Testing Procedures Manual,* and all applicable EDSM's and department memoranda to ensure that operations are performed in complete accordance with all department policies and procedures.

Examples of forms and specification requirements in this booklet are based on the 2000 *Standard Specifications*. **These specifications, tables, forms, etc., are subject to change. Hence, the contract for a particular project should always be checked for the applicable specification requirements.**

Bold type has been used within the text of this manual to emphasize certain statements which the department considers to be of significant importance or which delineate a substantial departure from previous department policies or procedures. The user should pay special attention to all phrases or sentences that are printed in bold typeface.

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QUALITY ASSURANCE

The concept of quality assurance refers to the combined efforts of the contractor through quality control and the department through inspection and acceptance to produce a project that will provide the public with a durable product exhibiting a high level of performance. To this end, a system of inspection by qualified personnel (both department and contractor) and statistically based sampling and testing has been established. To ensure that the quality assurance concept functions properly, it is critical that the contractor's quality control and the department's inspection and acceptance process be a cooperative coordinated effort. **When any part of the process fails, the contractor's risk for payment adjustments and the department's risk of accepting substandard work increase. The increase of these risks caused by a failure on the part of either the contractor or the department is unacceptable.**

The obvious concept behind statistically based testing practiced by the department is the determination of project quality in terms of a specific parameter by a randomly distributed number of tests. Some element of risk exists for both the department and the contractor; however, historical data has established that this risk is minimal and evenly distributed. **Additional tests are not to be performed unless it is clear that the initial, statistically-based test is in a location that is not representative of the zone, but is obviously deficient and must be replaced.**

The performance of random quality control and acceptance testing in no way relieves the contractor of the duty to produce a consistently uniform project meeting all specification criteria, nor does the performance of random acceptance testing relieve the department from requiring the correction of any deficiencies identified during the inspection process which fall outside a test location.

Quality assurance specifications are not "end result." It is not the intent of quality assurance specifications to allow the contractor to use construction practices or materials that may lead to a less than optimum product. If the contractor attempts to achieve only the minimum criteria for which the department will allow 100% payment, the risk of the discontinuance of operations and/or payment adjustments will be significantly increased due to the nature of statistically based acceptance parameters. The department will not allow continued operations when tests result in less than 100% payment or show less than minimum specification requirements when no payment adjustment is applicable.

The department and the contractor use the same test methods and identical or equivalent equipment; however, the responsibilities of each entity are clearly separate and significantly different. For this reason, it is important for all parties to understand the concept and commit themselves to the process. The contractor’s role is clearly to construct quality into each phase of a project. At the end of a construction phase, through the statistical sampling, testing and visual inspection program, the department can only establish the level of quality already constructed. The department has no part in the construction of quality, only quantifying the results. Because of these different responsibilities and the contractor trying to build quality and to avoid payment adjustments, it is obvious that the QC program will be more intense, at times, necessitating many samples and/or tests beyond the normal situation. The department’s

program is rigid, based on historical data with specified inspection requirements. At the completion of a project, in most cases, the contractor will have taken more samples, conducted more tests, and made more inspections than the department. Contractors w ith specification materials, proper equipment, qualified personnel, knowledge of materials and construction

processes, and a commitment to their QC program will generally construct the highest quality with the least demand for sampling and testing.

FIELD CURVE

One of the most important innovations in the 2000 specifications is the development, validation, and implementation of what is commonly referred to as the “field curve” (TR 415 and, by reference, TR 418) for determining the maximum dry density and optimum moisture of a specific material under field conditions. This test provides, for the first time, a method to accurately and quickly, determine these values by conducting the analysis on material that is actually being processed. No sample has to be submitted to the lab, no time delays are involved beyond actual testing, and there are no correlation problems between the material being processed and the material tested at the lab. The reliability level placed on the results of this test is higher than for a lab curve or other test methods, since the test is conducted on the project during construction activities using samples of the material being placed. processed, spread, and compacted The field curve enhances the entire quality assurance process and is especially effective in the quality control activities of the contractor. This method provides the contractor with a tool to quickly obtain reliable results to control the work effort and identify solutions to compaction problems. The timely results can yield quick solutions saving significant time and resources while reducing the potential for payment adjustments and conflict.

With the implementation of the field curve, **the department no longer allows the averaging two one-point proctors to calculate the maximum dry density (target density)** for determining percent compaction and subsequent percent pay for soil cement. Averaging two one-point proctors yielded only a dry density at the moisture content in the soil or soil aggregate at the time of test. If this moisture content was not exactly at or very close to the true optimum moisture of the material being tested, the dry density determined was not relevant to the actual maximum density (true target density) of the material. The accuracy of the dry density was dependent on the extent of the difference between true optimum moisture content and the moisture content of test. This situation could cause payment adjustments or substandard compaction leading to premature failure.

CONTRACTOR'S RESPONSIBILITIES - QUALITY CONTROL (QC)

The contractor is responsible for meeting all specification requirements. The contractor shall employ competent trained personnel and provide equipment that is in good condition and appropriate for the tasks for which it is used.

The *Materials Sampling Manual* publishes the official department sampling and testing schedules for construction materials. In addition to formal sampling, these requirements include Qualified Products Lists (QPL'S), certifications, and visual inspections. The contractor or material provider is to refer the *Materials Sampling Manual* for the minimum acceptable QC Sampling and Testing requirements.

The department may require additional sampling and testing when needed to ensure the quality of the product. The contractor may elect to perform additional sampling and testing to ensure the quality of the product prior to department acceptance testing and inspection.

Sampling and testing requirements for materials or processes specified in Supplemental Specifications or Special Provisions are not included in the *Materials Sampling Manual.* If no sampling or testing requirements are published, sampling and testing will be as directed by the DOTD Materials Engineer Administrator.

The contractor shall locate, select, place and process uniform materials meeting specification requirements. The contractor shall sample and test the materials and final product to ensure that no failures will be identified by the department during inspection or acceptance testing. Prior to the preconstruction conference the contractor is to provide the project engineer with a list of quality control personnel, their assigned responsibilities and their prior experience in their areas of responsibility, the types of equipment proposed for the various construction activities, and a proposed quality control program including a basic schedule of sampling and testing and the testing equipment to be used. If the contractor is unable to provide details at the preconstruction conference, these topics are to be thoroughly discussed. The contractor will not be permitted to begin construction until the project engineer approves this information. If changes to personnel or any other aspect of the QC program must be made, the contractor shall notify the project engineer immediately.

The contractor shall obtain copies of appropriate department manuals needed for the work. Such documents may include specifications, plans, contract, *Materials Sampling Manual*, *Testing Procedures Manual*, "*Quality Assurance Manual*," etc. for the field representatives on the project.
The contractor is to ask the project engineer for information on how to obtain these documents.

PERSONNEL

The successful completion of all prerequisite training materials is required whenever DOTD certification is required by the specifications. It is imperative that QC technicians be thoroughly familiar with department specifications, policy and procedural documents, and sampling and testing procedures. The project engineer or the district laboratory engineer will approve QC technicians.

Each equipment operator shall be fully knowledgeable of the safety features, limitations, and uses of the machine. The contractor shall require that personal safety equipment be used as appropriate, including the wearing of film badges by nuclear device operators.

Personnel employed by the contractor to operate equipment shall be properly trained in its operation and be capable of using the equipment to ensure compliance with specification requirements. For example, motor patrol operators shall know how to maneuver the machine and position the blade to obtain a cut that uniformly conforms to grade for the full width and length of the area being shaped. Each operator of compaction equipment shall understand the relationship between the compactive effort of the machine in terms of speed, weight, vibratory impact, number of passes and the material being compacted. It is critical to the proper compaction of soils that compaction equipment be properly operated. Failure to operate compaction equipment properly may cause earthwork not to meet specification density requirements, resulting in additional work and expense for the contractor and the department.

DIMENSIONAL CONTROL

The contractor shall routinely check alignment and grade, thickness and cross section to ensure that layout matches the plans. These checks shall be in accordance with standard survey practices or published DOTD procedures. Such checks shall be made at intervals of adequate frequency to ensure that alignment, thickness, or grade do not deviate between marked station locations. Irregularly shaped grades are not acceptable and shall be corrected by the contractor. There are no tolerances allowed by the specifications for QC grade or alignment. Therefore, it is the contractor's responsibility to ensure that the project is completed to the dimensions shown on the plans.

MATERIAL QUALITY

It is the contractor's responsibility to locate and furnish materials which meet specifications. It is also the responsibility of the contractor to ensure that those materials, after being placed and processed, will meet department acceptance criteria. Once the contractor feels certain that the proposed material sources will meet specifications, it shall be the contractor's responsibility to request testing of those sources by the district laboratory. The contractor is responsible for coordinating the arrangements for materials acceptance testing and approval and the planned work schedule with the project engineer and the district laboratory engineer. **The contractor is to schedule work so that the laboratory or project engineer can arrange the sampling and testing of materials prior to their planned incorporation into the project.** Failure to do so will result in a delay of the contractor's proposed schedule, since no material can be placed on a project without approval. When scheduling work, the contractor must consider the additional time required for the approval of materials that must be tested by the Materials and Testing Section in Baton Rouge.

The contractor shall obtain uniform materials. For example, the method of excavating soils and/or processing materials can impact uniformity. Soils vary both laterally and vertically within a source. Therefore, the method of excavation can contribute to the variability of material on the project. Soils are to be excavated and processed to minimize variance on the project. If the contractor's methods of obtaining soils contribute to their nonuniformity, the engineer will direct that these methods be altered to ensure the placement of uniform material on the project. Placing nonuniform soil on the project can cause test data to be invalid and increases the risk of premature failure.

SAMPLING AND TESTING

The contractor shall conduct tests during the progress of the work to ensure continuous compliance with specifications. The contractor is to take as many samples and perform as many tests as necessary to ensure that materials and processes are producing a uniform product within the specification limits. When test results are near the borderline of specifications, the contractor may be advised to adjust operations and/or materials sources to ensure that no failure to meet specifications occurs and that borderline conditions do not continue. Materials and operations at the borderline of specification requirements often result in failing acceptance tests, which can result in payment adjustments, loss of production time, and significant alterations to the QC program. When borderline materials or operations result in failing acceptance tests, immediate adjustments will be required. The contractor shall use test procedures and methods which correspond with the department's quality assurance program. These procedures are designated in the specifications, *Testing Procedures Manual*, and *Materials Sampling Manual*. When department procedures are published in an engineering directive (*EDSM*), the contractor shall conform to these guidelines. The project engineer will provide the contractor with appropriate *EDSM* or other directives. Testing equipment shall be appropriately calibrated and in good working condition. The contractor shall contact the district laboratory engineer for policies and procedures to be followed for each piece of testing equipment.

The contractor is not to wait until a change in materials or a test result from DOTD indicates a deficiency, but is to stay continually abreast of construction progress and activity. When the contractor identifies failing materials or processes, the contractor shall take whatever measures are necessary to correct the deficiency and prevent its recurrence. These measures shall include, but not be limited to the following:

- removal of personnel or equipment not performing in an acceptable manner
- removing and replacing materials
- locating and selecting other material sources
- reprocessing the deficient area
- additional testing both to establish the total limits of the deficient area and to ensure that corrective action has been successful

The contractor is to complete QC testing and make any needed corrections prior to requesting acceptance testing by the department. The contractor is not to rely on the department's acceptance program and acceptance test results to prevent the application of payment adjustments or delays caused by suspensions of operations due to failures or deficiencies.

The contractor is to document all QC testing and provide copies to the project engineer as directed. The contractor shall stamp all QC documents "QC" with red ink, in minimum one-inch high letters.

CONSTRUCTION LAYOUT

Unless otherwise stipulated in the contract, the department will be responsible for construction layout. When any construction stakes or marks are carelessly or willfully destroyed or disturbed by the contractor, the cost of replacement will be deducted from payments to the contractor. Such deductions will be coordinated through the Chief, Construction Division.

When the contract requires the contractor to provide layout, the engineer may inspect the contractor's staking, elevations, station numbers, etc. The Project engineer shall approve the location, placement, and number of stakes. The project engineer has the authority to require additional stakes. The contractor shall correct any deficiencies prior to continuing operations. The project engineer's inspection of construction layout by the contractor in no way implies that the department accepts liability for layout errors by the contractor. In accordance with Specification Subsection 105.08, the contractor shall be responsible for the preservation of all stakes and marks.

TRAFFIC CONTROL

It is the responsibility of the contractor to control traffic, to install signs and other warnings and traffic control devices that meet *MUTCD,* DOTD, and other applicable requirements, in accordance with the plans. The project engineer is authorized to require additional traffic control, as needed, in accordance with the *MUTCD*. It is also the responsibility of the contractor to maintain all control devices in good condition. If traffic control is not adequate or if signs or devices lean, become damaged, misplaced, dirty, or lose reflectivity, the contractor shall correct the deficiency immediately. **Operations will not be allowed to proceed if traffic control is not effective. Corrections are not to be delayed, since the safety of the traveling public is of prime importance**.

RESPONSIBILITIES OF THE PROJECT ENGINEER

The project engineer is the legal representative of DOTD for the administration of the contract and represents the department directly as well as through the inspection staff. The department is responsible for inspecting, sampling, and testing for acceptance. The process of acceptance is on-going. The department evaluates the contractor's construction process, materials, personnel, equipment, and quality control program to determine if specifications are being uniformly met. Additionally, the department takes samples and conducts tests to ensure that the contractor's QC test results are accurate and reflect the actual quality of the product. **The department's results are used to determine the acceptability of the product and take precedence over any other test results.** The contractor shall correct any deficiency identified by the department through inspection, sampling or testing at no direct pay. **Consistent or repeated failures identified by test results or repeated deficiencies identified by inspection will result in the suspension of operations until the cause is identified and corrected and the QC program is reviewed and modified to eliminate such repeated or consistent failures.**

MONITORING QUALITY CONTROL (QC)

At the preconstruction conference, the project engineer is to review the contractor's proposed QC program and provide a copy to the district laboratory engineer. The project engineer may require the contractor to modify the proposed program either at the preconstruction conference, before construction begins, or during construction. During construction, based on good construction processes and no failing acceptance test results, at the request of the contractor, the project engineer may allow a reduction in the number of tests required in the approved QC program, but not less than the minimum required by specifications. When acceptance inspection or tests indicate that the contractor's QC program is not effective, modifications to the program will be required. The project engineer has the right to require changes in personnel, equipment, construction methods, testing methods or frequency. **The contractor will not be allowed to proceed with construction operations without an effective, approved QC program.**

The project engineer will be certain that the contractor's representative on the project has the appropriate department documents, such as the specifications, plans, contract, *Materials Sampling Manual*, *Testing Procedures Manual*, *"Quality Assurance Manual*." Any required document can be obtained from the department at a published price through General Files. The project engineer will provide information on the appropriate procedure for obtaining published documents. When department policies or procedures applicable to the contractor in the performance of contractual responsibilities are published in engineering directives (*EDSM*) or other construction memoranda, the project engineer will provide the contractor with a copy of the document at the preconstruction conference or when it becomes apparent that a directive must be applied.

Evaluations of the QC effort to ensure that additional failing acceptance tests do not occur may include, but not be limited to, the following:

- Observation of the contractor's sampling and testing procedures for conformance to department procedures and proper testing techniques
- Evaluation of the contractor's testing equipment for proper working condition and conformance to the requirements of the appropriate test procedure
- Observation of construction procedures for uniformity of effort and results

INSPECTION

PERSONNEL

The project engineer is responsible for providing qualified inspectors on the project. Each inspector will successfully complete the department's training materials for the level of responsibility assigned. The chief inspector will be certified in Embankment and Base Course Inspection. The operators of nuclear devices will be Authorized Nuclear

Device operators and will wear their film badges at all times when handling or operating nuclear equipment.

CONSTRUCTION LAYOUT

Unless otherwise stipulated in the contract, the engineer will be responsible for construction layout. In accordance with Specification Subsection 105.08, the contractor shall be responsible for the preservation of all stakes and marks. When any construction stakes or marks are carelessly or willfully destroyed or disturbed by the contractor, the cost of replacement will be deducted from payments to the contractor. Such deduction will be coordinated through the Chief, Construction Division.

If the contract requires the contractor to provide layout, the engineer will inspect the contractor's staking, elevations, station numbers, etc. The project engineer's inspection of the contractor's construction layout in no way implies that the department accepts liability for layout errors by the contractor. ### EQUIPMENT

Prior to construction, the project engineer will inspect the equipment to be used on the project to ensure that it is in good condition and appropriate for the activity for which it is to be used. The project engineer will require that equipment that leaks or is damaged be repaired or replaced before it operates on the project. The project engineer will require the replacement of equipment that is not appropriate for the project prior to its being used.

During the progress of construction, construction personnel are to inspect equipment daily to ensure that it has been maintained in good condition and that no damage which would affect its operation has occurred. Damaged equipment shall be repaired prior to its continued use. Project personnel will evaluate the effectiveness of equipment. Equipment which does not perform properly or which does not produce a quality product meeting specifications is to be replaced with acceptable equipment.

ACCEPTANCE

VISUAL INSPECTION

Although the random, statistically-based sampling and testing performed by the department represents the entire area being tested, this methodology does not replace visual inspection. Department personnel will observe the contractor's operations and inspect the project throughout its construction. When nonuniform materials or nonuniform processes result in areas which do not appear to be acceptable or which are obviously not in conformance with the quality of construction expected, the department will require the contractor to correct these deficient areas. Such deficiencies for earthwork and base course construction may include soft spots, nonuniform gradation or pulverization, nonuniform blending of materials, failure to stabilize, laminations, waves or undulations in the surface, varying width or depths, etc. **It has never been the intent of the department to accept a project solely on the basis of the statistically-based sampling and testing program.** It is always necessary for the project engineer and inspector to be aware of the quality of construction and performance of the project during construction and acceptance phases before final acceptance.

SAMPLING AND TESTING

Sampling and testing is a support for visual inspection. Project personnel will sample and test material for acceptance in accordance with the *Project Sampling Plan*, based on the schedule published in the *Materials Sampling Manual*. It is to be noted that the *Materials Sampling Manual* establishes the minimum required level of sampling and testing. The engineer has the authority to require additional tests to ensure uniformity, acceptability, and quality of the work. When samples or tests yield failing results, the department will require the contractor to correct the area represented by the sample or test, unless the specifications allow the application of payment adjustments. **Materials are to be sampled, tested and approved prior to incorporation into the project. Materials that do not meet specifications are not to be placed.**

Acceptance sampling and testing is to be performed by department personnel independently of the contractor's QC program. Under no circumstances is the inspector to use the results of the contractor's QC tests for independent acceptance results.

TRAFFIC CONTROL

Project personnel will inspect traffic control daily and will monitor its effectiveness continually. Nighttime effectiveness of traffic control arrangements and their continued reflectivity will be regularly inspected after dark. Inspections will be documented on the Project Diary (DOTD Form 03-40-3093). Any deficiencies noted during inspections or during operations are to be documented along with instructions to the contractor regarding corrections. Follow-up inspections of the contractor's corrections are also to be documented. If the deficiency creates a dangerous traffic situation or is detrimental to the course being constructed, the engineer will require immediate correction or the discontinuance of operations until the deficiency is corrected. The contractor shall repair traffic damage.

RESPONSIBILITIES OF THE DISTRICT LABORATORY

The district laboratory engineer is the coordinating authority of the district's quality assurance program and is the legal representative of the department in the area of materials quality. The district laboratory is responsible for assuring that the quality assurance program is applied uniformly. This coordination of the QA program is performed in conjunction with the DOTD Materials Engineer Administrator. The district laboratory has specific and implied responsibilities, including but not limited to the following:

- Administer the district Quality Assurance Program
- Certification of and inspection of central mix plants
- Certification or approval of testing equipment
- Training, testing and evaluation of the qualifications of DOTD employees and personnel associated with the DOTD construction industry

- Assisting and providing expertise for construction processes and problem solving
- Establishing the *Project Sampling Plan*
- Identifying the appropriate test to be performed
- Identification of proper sampling and testing techniques
- Interpretation of test results
- Sampling and approving project material sources
- Acceptance testing for selected parameters
- Coordination of application of *Project Sampling Plan*
- Project Materials Certification (2059 Review)
- FHWA mandated Independent Assurance Sampling and Testing
- Mix Design Approval

RESPONSIBILITIES OF THE MATERIALS AND TESTING SECTION

The Materials and Testing Section is responsible for updating sampling and testing procedures, providing lists of approved materials sources, performing acceptance testing on materials not tested by the district laboratories or project engineers, testing materials for inclusion on approved source lists, and distributing the *Materials Sampling Manual, Testing Procedures Manual*, *Qualified Products List*, and MATT System documentation. **When no specific sampling or testing is referenced, the Materials Engineer Administrator will determine the appropriate sampling frequency, methods, and tests to be used.** The Materials and Testing Section also provides technical support to district construction and materials forces.

DEDICATED STOCKPILES

A dedicated stockpile is defined as a stockpile built for a specific project. It is sampled, tested and approved during its construction. Dedicated stockpiles are to be constructed in final position. If the engineer allows the contractor to move material from a dedicated stockpile, except for placement in the project, such disturbance shall be at the contractor's risk. The disturbed material will be subject to additional approval sampling and testing. If the disturbed material has become contaminated, segregated or fails specification requirements when retested, it shall not be placed in the project. The contractor may attempt to correct any deficiency in a disturbed stockpile which has failed subsequent approval testing at no direct pay. If the contractor is unable to correct the deficiency, the material will not be used on the project.

Material in dedicated stockpiles may be used only on the project for which it has been dedicated, unless otherwise approved in writing by the project engineer. Once the department has approved a dedicated stockpile, no material can be removed or added without the approval of the project engineer. **The project engineer will not approve the addition of material to a dedicated stockpile until such material has been sampled, tested and approved for placement in the stockpile.** Material approved for addition to a dedicated stockpile will be sampled and tested under the same conditions as the dedicated stockpile. To avoid the risk of the department rejecting a disturbed dedicated stockpile, in lieu of requesting that material be added to an existing dedicated stockpile, the contractor is expected to make every effort to create a new stockpile.

During the construction of a dedicated stockpile, the engineer will sample the stockpile in accordance with the *Materials Sampling Manual* and submit the samples to the district laboratory for testing. It shall be the responsibility of the contractor to notify the project engineer and request sampling and testing during stockpile construction and to keep the project engineer and district laboratory engineer apprised of the building schedule of stockpiles to be dedicated. Failure to do so can result in the rejection of the stockpile, disallowance of or substantial delay in advance payment for the materials, or substantial delay in the construction process.

NONDEDICATED STOCKPILES

Stockpiles which are not dedicated for use on a specific project are nondedicated. Advance payment will not be made for materials in nondedicated stockpiles. In general, nondedicated stockpiles are those to which material is randomly added or removed, or which will subsequently be moved to another location. Nondedicated stockpiles remain in the control of the contractor. Material from nondedicated stockpiles is sampled and tested as it is used in accordance with the *Materials Sampling Manual*.

ENVIRONMENTAL PROTECTION

During the construction of roads and bridges, the contractor utilizes myriad construction techniques, operates many different types of equipment, and incorporates a significant number of different liquids, powders, and solids. These activities carry with them the potential for polluting the environment. Storm water runoff is a primary source of pollutants from constructions sites, material producing plants, and equipment staging areas. The goal to protect the environment from storm water extends beyond the concern of soil particles in waterways (erosion control). Storm water contains residues from asphalts, oils, fuels, fertilizers, stabilizing chemicals such as cement, chemicals from the natural breakdown of certain aggregates, and has the potential for transporting many other materials hazardous to the environment.

Air, in addition to water, can be an efficient carrier of pollutants. Dusting is a major concern in the construction industry. Construction and public traffic traversing lime and cement spreads on construction sites cause particles to become airborne and subsequently, pollutants. Material manufacturing plants use dry materials in the production of their products. Escaping particles, when not controlled properly, become airborne pollutants. Liquids, such as fuels and oils, vaporize and add gaseous material to the air. Open burning of vegetation after clearing and grubbing operations can be detrimental to air quality. In addition, smoke is a safety issue since a heavy smoke accumulating over roadways creates sight distance problems increasing the potential for accidents.

Vibration and noise can be significant in impacting the environment. Vibration from construction activity, such as pile driving and compaction efforts can be environmentally detrimental. Vibration can cause the reorientation of soil layers resulting in subsidence. Impact waves can cause structural damage and result in water table changes. Noise from construction sites can reach decibel ranges that impact the hearing of individuals. Therefore, vibration and noise are considered pollutants and environmental threats.

Activities that negatively impact the environment potentially exist on every construction project. There are local, state, and federal guidelines that control these activities to minimize environmental harm. The contractor shall abide by these regulations and is to take every step necessary to prevent damage to the environment.

EROSION CONTROL

Erosion control is critical on almost every project. The goal of erosion control is to ensure that no soil leaves the right-of-way or moves into any existing ditch, stream, pond or other body of water. Pursuant to the clean Water Act and the Louisiana Environmental Quality Act, a Louisiana Pollution Discharge Elimination System (LPDES) General Permit is required from the Louisiana Department of Environmental Quality (LADEQ) for any construction activity that disturbs five or more acres. A Storm Water Pollution Prevention Plan (SWPPP) is required for these projects. The SWPPP normally consist of (a) the plan sheets indicating the locations of erosion control items, (b) Standard Plan EC-01 and (c) Standard Specification Section 204. If there is no erosion control plan in the project plans, the project engineer is to contact the Headquarters Construction Section to ascertain if there is a reason for its not being included. The SWPPP will be discussed at the Plan-in-Hand.

To conform to the LADEQ's mandate, the department and the contractor are regarded as coapplicants for the permit to discharge storm water from construction activities. A Notice of Intent (NOI) form is submitted to LADEQ by the designer prior to the letting of the contract and the approved permit must be posted on the project. Fines can be assessed by LADEQ for failure to comply to these regulations. The contractor shall be required to obtain a separate permit for pits, plant sites or storage areas beyond the limits of the right-of-way. It is not the Department's intent to pay for erosion control measures for pits, plant sites, or storage areas. Upon completion and final acceptance of the project, a Notice of Termination (NOT) form must be completed by the Project Engineer and submitted to LADEQ.

In accordance with Specification Subsection 107.14, the contractor shall protect the project and adjoining properties from soil erosion and siltation by effective and continuous erosion control methods. The area of bare soil exposed by construction operations shall be kept to a minimum. The contractor is also required to adhere to the requirements of Specification Subsection 107.15 for all projects.

Erosion control, including the sequence of operations, is to be discussed at the preconstruction conference. The project engineer will evaluate and approve the contractor's proposed erosion control and evaluate the erosion control plan sheet in terms of the proposed sequence of operations and topography. The SWPPP is to be adhered to as closely as possible. The contractor is to consider erosion control problems when determining the proposed sequence of operations. The project engineer has the authority by specifications to limit the quantity of exposed earth and to order erosion control in addition to that originally stipulated in the plans or contract. If the project engineer or inspector recognizes a potential erosion problem, the contractor will be directed to install erosion control measures to prevent erosion from occurring. It may be necessary to adjust initial erosion control plans to prevent erosion as the project progresses.

Standard Plan EC-01 provides details for the proper installation of specific erosion control measures commonly used on DOTD projects. When such measures are used, project personnel shall be installed in accordance with EC-01 or other contract documents, as applicable.

In addition to installing erosion control measures, the contractor shall maintain erosion control so that it will not fail. The contractor is to provide qualified personnel to monitor erosion control on the project. To conform to LADEQ requirements, erosion control

measures are to be inspected at least once every seven calendar days and within 24 hours following the end of storm that deposits 0.5 inch or more of precipitation. Seeded areas are to be checked regularly to ensure that a good stand of cover is maintained. Seeded areas are to be fertilized and reseeded as needed. Sediment basins are to be cleaned at 50% capacity minimum. Should erosion control fail and soil be deposited outside the right-of-way, in accordance with Specification Section 204, it shall be immediately removed and the surface repaired at no direct pay. Operations shall be discontinued until erosion deposits have been cleared and the area restored.

Construction personnel will inspect erosion control measures regularly and after storms. When maintenance is needed on erosion control measures, they will direct the contractor to take action immediately. If erosion control measures are not placed or maintained in a timely manner to the satisfaction of the engineer, the engineer is to discontinue all operations until appropriate erosion control measures are installed or maintenance is completed. **Weather conditions will not be considered an acceptable reason for not immediately maintaining erosion control.**

The cost of maintenance, clean out, or removal of siltation for temporary erosion control features, such as but not limited to silt fencing and sediment basins will be included in the unit price of the respective item and shall be performed at no direct pay. The accumulation of silt in the temporary erosion control feature is not to exceed 50% of the capacity of the feature prior to the beginning of soil removal and clean out.

CERTIFICATION

PERSONNEL

GENERAL CERTIFICATION REQUIREMENTS

Basic certification requirements and procedures are published in EDSM III. 1.1. 26. Certification is awarded by the department upon satisfactory completion of all requirements, including six months on-the-job training in all phases of the certification area, successful completion of required training courses, and successful completion of certification testing. Arrangements for enrollment in the certification program and testing are made through the district training office. The DOTD Materials Engineer Administrator is the certifying authority for the department. He has full authority to grant or to revoke certification.

Any individual certified under this program who is performing substandard work will be removed from the project and is subject to having certification revoked. Proceedings to revoke certification can be initiated by the district training specialist, district laboratory engineer, project engineer or construction engineer and will be processed in accordance with current department procedures.

DEPARTMENT PERSONNEL A DOTD inspector certified in the area of Embankment and Base Course Inspection will be present at the project site or at the plant during earthwork operations or base course operations. When an asphaltic concrete base course or subgrade layer is being constructed, the onsite inspector will be certified in Asphaltic Concrete Paving Inspection; the plant inspector will be certified in Asphaltic Concrete Plant Inspection. When Portland cement concrete is used in lieu of base course, the inspector will be certified in Portland Cement Concrete Paving Inspection. **Certified inspectors are official representatives of LA DOTD. They have the authority to accept or reject materials and project construction and have the responsibility to discontinue operations whenever the project does not meet department standards or when improper construction practices are employed. The certified inspector is responsible for ensuring that the contractor's materials and production meet the requirements of the department's quality assurance program and conform to all requirements of the contract, plans, specifications and department policies.**

NONDEPARTMENT PERSONNEL

The contractor is required to provide a certified Soil and Base Course Technician when central plant mixed Class I Base Course (Specification Section 301) is being produced. This individual shall be present at the plant at all times when production is in progress. **The certified technician is responsible for the contractor's quality control program and shall organize a sampling program and perform tests as established in the specifications, this manual and other department publications. The contractor's certified technician is also responsible for identifying the causes of deficiencies in base course production or operations and making the appropriate adjustments to bring the product into conformance with DOTD requirements.**

When asphaltic concrete is used as base course or as a subgrade layer, the requirements for the use of certified contractor personnel shall be as outlined in Specification Section 501 or 502 and the *Application of Quality Assurance Specifications for Asphaltic Concrete Mixtures*.

When Portland cement concrete is used in lieu of base course, the requirements for the use of certified contractor personnel shall be as outlined in Specification Section 901, and the *Application of Quality Assurance Specifications for Portland Cement Pavement and Structures*.

For Class II Base Courses, In-Place Stabilized Base Courses, Embankments, Lime Treatment, and Treated Subgrade Layers, **without central plant mixing**, the contractor is responsible for ensuring that the person in charge of quality control is knowledgeable about LA DOTD requirements and capable of overseeing operations and performing tests in accordance with LA DOTD standards to construct a project meeting all specification requirements. When the contractor elects to use a central mix plant for Class II Base Course, all specification requirements of Class I Base Course, including the use of a certified Soil and Base Course Technician, will be required.

EQUIPMENT

CENTRAL MIX PLANT

Central mix plants required for Soil Cement and Cement Stabilized Class I Base Courses under Specification Section 301 must be certified. Certification procedures for these plants will be in accordance with this manual. When a contractor elects to use a central mix plant to produce cement stabilized or treated base course not under Specification Section 301, the plant must meet the specification requirements of Section 301, including certification. When the Class I or Class II base course or treated subgrade layer is asphaltic concrete, the certification requirements shall be in accordance with Specification Section 501 or 502 and the *Application of Quality Assurance Specifications for Asphaltic Concrete Mixtures*. When Portland cement concrete is used in lieu of base course, the certification requirements shall be in accordance with Specification Section 901 and the *Application of Quality Assurance Specifications for Portland Cement Concrete Pavement and Structures*.

The department's laboratory in the district in which the plant is located will certify plant equipment (except sampling and testing equipment) and plant operations, and evaluate and approve materials prior to the delivery of any mixture to a DOTD project. Plant certification requires an on-going, in-depth inspection by district laboratory personnel to ensure that the plant's equipment, stockpiles, storage bins, scales, metering devices, etc., are in conformance with department specifications and standards. It is advisable that engineering staff involved with construction projects receiving material from the plant participate in the certification inspection to ensure that the requirements of individual contracts are met. This inspection is preliminary to the actual granting of certification and should begin when the plant is being erected. It is the responsibility of the contractor to keep the project engineer and the district laboratory engineer informed of the sequence of plant installation and stockpile construction. Failure to keep the

department informed of the status of the plant's installation sequence may cause delay in plant certification and production for DOTD projects.
Certification by the district laboratory signifies that the plant is capable of producing cement stabilized or treated mixtures that meet department standards of quality. Therefore, in order to be certified, a plant must be in production and able to demonstrate its performance. **Material produced during the certification process shall not be incorporated into the project without approval.**
Plant certification is valid for two years, provided the plant is maintained in accordance with the conditions under which certification was issued. Relocation of the plant will invalidate certification. A silver and red certification sticker will be placed in an obvious location on or near the control panel of a certified plant. An example of this sticker is reprinted in the Appendix on page A-3.

The district laboratory will reinspect the plant for conformance to certification requirements at least every 90 calendar days. The department's certified inspector inspects the plant and operations on a daily basis to ensure that the equipment and activities are within requirements. Inspections by the laboratory will be made more frequently if equipment, materials or processes are modified or if deficiencies occur. **It is the responsibility of both contractor and department personnel to notify the certifying district laboratory when modifications are made to equipment, processes or materials**. The district laboratory engineer will routinely distribute communications concerning plant certification to project engineers receiving material from the plant.

The *Base Course Central Mix Plant Certification Report* (DOTD Form No. 03-22-0753) will be used to inspect the central mix plant for conformance to certification requirements and to document this inspection. A copy of this form is reprinted in the Appendix on page A-5. Construction personnel will also use this completed form for daily plant inspections.
Department representatives shall be allowed free access to plant facilities for inspection of plant and operations and certification. These inspections will be conducted at the option of the department and shall not relieve the contractor of any responsibility under the specifications.

REVOCATION OF PLANT CERTIFICATION

When a plant fails to conform to department standards under which certification is issued, certification will be revoked. The certifying district laboratory engineer can revoke plant certification. The project engineer or the department's certified Embankment and Base Course Inspector have the authority to discontinue plant operations when a plant or the mixture exhibits deficiencies. When this occurs, it is the responsibility of the project engineer or certified inspector to notify the district laboratory engineer immediately, so that the plant's certification status can be reviewed. **Once certification has been revoked, the plant will be prohibited from supplying material for any department project until all deficiencies have been corrected and certification is reinstated.**

SCALE AND METER CALIBRATION

In order to meet certification requirements, the contractor shall arrange for all plant scales and meters to be calibrated at least every 90 days by the Weights and Measures Division of the Louisiana Department of Agriculture and Forestry or an approved independent company. **Approved independent companies must be licensed by the Louisiana Department of Agriculture and Forestry. The district laboratory engineer will approve the independent companies for the district.**

Independent companies shall be required to use standards and methods of scale and meter calibration that are approved by the district laboratory engineer. The district laboratory engineer will determine the ranges within which the scales and meters will be calibrated and the increments to be checked.

The calibration of scales and meters shall state that the equipment meets all department requirements for accuracy. The calibration shall be documented and reported to the district laboratory engineer on the *Certification Report for Scales and Meters* (DOTD Form No. 03-22-3065). A copy of this form is reprinted in the Appendix on page A-11. The technician representing the independent company shall sign and stamp the form with the company's identification and/or attach the company's scale certificate. The technician shall place a dated calibration sticker on each device.

Testing equipment used by the contractor or producer shall be independently certified every ninety days. If equipment does not remain in the plant laboratory but is imported for each operation, the department's certified inspector will inspect the equipment, check its calibration, and approve the equipment prior to use. Testing equipment not available at the plant during the certification inspection shall be calibrated by an approved independent service prior to use.

FEED BIN CALIBRATION CURVES

When a plant is controlled by feed bins, the contractor shall develop feed bin calibration curves for each type of material, denoting rate of feed expressed in terms of belt speed and gate opening. These curves shall be submitted to the district laboratory engineer for approval prior to certification inspection. Certification will not be awarded to a plant until these curves are approved. An example of these curves is shown in the Appendix on page A-17.

CONSTRUCTION EQUIPMENT

Equipment used for construction under Specification Parts II, III, or IV must be approved. Certification is not required, except for asphalt distributors when specified. Procedures for the approval of this equipment will be in accordance with this manual. When Class I or Class II base course or treated subgrade layer is asphaltic concrete, placement and compaction equipment must be certified. The certification requirements shall be in accordance with Specification Part V and the *Application of Quality Assurance Specifications for Asphaltic Concrete Mixtures*. When Portland cement concrete is used in lieu of other base course material, placement, compaction, and finishing equipment shall meet the requirements of Specification Section 706.

CLEARING AND GRUBBING - Section 201

Clearing and grubbing is basically a surface operation for the cutting and removing of timber, logs, brush, stumps and debris within or encroaching onto the right-of-way. The term also covers excavating and removing stumps, roots, submerged logs, snags, and other perishable or objectionable material not covered under other contract items. The contractor is to identify the clearing limits of the project as shown on the plans and is not to operate outside of those limits.

EQUIPMENT The contractor is responsible for providing adequate equipment and personnel to perform the work within the time limits of the contract and in accordance with specification requirements. Personnel must be familiar with the operation of the equipment and trained to operate it safely.

CONSTRUCTION PRACTICES

Prior to the beginning of clearing or grubbing activities, the project engineer or the certified inspector is to inspect the area to determine if these activities are likely to cause damage or require access to adjacent private property. Typical damage that may occur to adjacent properties includes cutting through tree roots, pushing excavated material onto adjacent lands, and damaging septic systems or public utilities. Erosion may become a problem after ground cover is disturbed. The contractor is to install erosion control devices or procedures to protect the project limits, the environment, and private property. These operations shall be in accordance with the plans or as directed. For more details on erosion control, refer to **TEMPORARY EROSION CONTROL**.

If damage occurs to private property during construction operations, the contractor is responsible for making restitution. The project engineer must be certain that the contractor's work arrangements are designed to prevent damage to private property. If access to private property will be required, the contractor must obtain written permission from the land owner prior to operating on property outside the right-of-way. The project engineer shall not allow the contractor's forces to operate on private property until a copy of the owner's written permission is in the possession of the project engineer.

The contractor is to check the location of all utility lines, both overhead and underground, prior to bidding and before beginning clearing and grubbing operations. The contractor is to call LA 1 Call or make other appropriate contacts before grubbing or performing any excavation in an area where utilities could be disturbed. When grubbing or performing any work involving excavation, underground utilities are not to be disturbed. When felling, topping or trimming trees, broken or cut limbs are not to fall on or damage overhead wires. Personnel climbing trees in the vicinity of overhead utilities are to be trained in appropriate safety precautions and exercise extreme caution when working in the vicinity of overhead utilities.
Unless the area is to be further excavated, the contractor shall backfill holes left in the natural ground from the removal of stumps or other obstructions with usable soil

conforming to Specification Section 203 and compact the area to at least the density of the surrounding ground.
The specifications require that low hanging branches and unsound or unsightly branches on trees or shrubs designated to remain shall be removed as directed. Branches of trees extending over the roadbed shall be trimmed to a height of 20 feet above the pavement surface. All trimming shall be done in accordance with accepted horticultural and tree surgery practices published by the American Association of Nurserymen. It shall be the responsibility of the contractor to obtain a written agreement with the owner of the property upon which such trees are located to access the property, if necessary, and to perform necessary surgery to the trees. The contractor shall provide the project engineer with a copy of this agreement prior to trimming trees located off the right-of-way.

VEGETATION ON PRIVATE PROPERTY

Representatives of both the contractor and the department are to be aware that there are legal ramifications involved in trimming trees rooted on private property that overhang the right-of-way. The project engineer is to check the right-of-way agreements with reference to trees on adjacent property that may be affected by construction activity. No tree rooted on private property is to be trimmed without the written permission of the property owner. The contractor is responsible for obtaining such written permission and for providing a copy to the project engineer.

If a tree or any portion of a tree rooted on private property is dead or so severely damaged that it will be a hazard to the traveling public, that portion must be removed even without written permission of the owner. Should such a situation develop, the project engineer is to notify the District Construction Engineer. The department's Right-of-Way Section, Construction Section, and Legal Section are to be notified before any cutting is performed.

The project engineer or inspector is to inspect the project area for any trees or other vegetation located on private property near enough to the right-of-way to be in danger of damage from construction activity. The situation is then to be assessed and appropriate arrangements made to prevent such damage or to compensate the property owner for the damage.

DISPOSAL OF EXCESS MATERIAL

The disposal of all cleared or grubbed materials is the responsibility of the contractor. Such materials must be removed from the right-of-way and disposed at locations off the project outside the limits of view of the traveling public. The disposal of such material shall be in conformance with all federal, state and local regulations and Specification Section 202. If the disposal area is not owned by the contractor, the contractor shall obtain a written agreement with the property owner allowing the placement of excess material on the property and specifying the type(s) of material to be disposed. The contractor shall provide the project engineer with a copy of this agreement with the property owner prior to the removal of any material from the right-of-way. If the contractor owns the disposal area, the contractor shall provide the project engineer with a letter indicating the location and ownership of the disposal area and relieving the

department of any responsibility. **Excess material is not to be buried within the right-of-way.**

INSPECTIONS FOR HAZARDOUS SUBSTANCES AND ARCHAEOLOGICAL OR PALEONTOLOGICAL REMAINS

HAZARDOUS MATERIALS Prior to the contractor's operations, the project engineer or certified inspector is to inspect the area to be cleared and grubbed for evidence of hazardous materials, both surface and subsurface. Evidence of subsurface hazardous materials includes dying vegetation, abandoned pits or levees, discolored soils, odors, abandoned disposal containers (e.g., 55-gallon drums), cattle dipping vats, garbage dumps, standing liquids other than water, and powdery residues. If such items are present or the history of the area leads to concerns about the presence of hazardous waste materials, the project engineer is to contact the Materials and Testing Section's Environmental Unit. No work is to begin until a complete evaluation has been made and any hazardous materials removed. If evidence of hazardous materials is uncovered during clearing or grubbing operations, operations in the immediate area shall be stopped at once. The project engineer is to contact the Environmental Unit of the department's Materials and Testing Section. Operations shall not be restarted in the area until an evaluation has been completed and any hazardous material removed. If no hazardous materials are located during the department's evaluation of the site, operations may restart when the project engineer receives a release from the Environmental Unit of the department's Materials and Testing Section.

Inspection for hazardous materials is to continue throughout all excavation activities. If evidence of hazardous materials is uncovered at any point during construction, activity in the area shall be discontinued immediately. Construction shall not be resumed in the affected area until all contamination has been removed and a release received from the Environmental Unit of the Materials and Testing Section.

Hazardous materials are to be removed from the project right-of-way and disposed in accordance with Specification Section 202.

ARCHAEOLOGICAL OR PALEONTOLOGICAL INSPECTIONS

Prior to grubbing or excavation and continually during operations, the contractor, project engineer, and certified inspector are also to inspect the construction zone for areas of archaeological or paleontological significance or endangered plant or animal species, cemeteries, etc. Areas of archaeological or historical significance are those showing evidence of past civilizations. Such evidence would be burial grounds, isolated graves, building remains, pottery shards, arrow heads, Indian middens (rather small hill elevated above the surrounding surface, may occur in both hilly and coastal terrain throughout the state), or dark discoloration of the soil with visible artifacts. Middens may be composed of shell as well as soil.

Paleontological sites are areas where evidence of preexisting fauna or flora are located. Such evidence will be in the form of fossils of either prehistoric animal or plant remains. Fossils may be either the imprint of remains in soil or rock or the minerally replaced

remains of preexisting life forms. If deposits of paleontological remains are uncovered, the contractor is to discontinue excavation and notify the project engineer. The project engineer is to notify the department's Public Hearings and Environmental Impact Section and headquarters Construction Section. All work is to cease in the affected area until a proper evaluation has been made and the appropriate authorities have removed any significant finds.

Inspections for hazardous materials, archaeological and historical significance are also required for borrow pits. The contractor is to investigate the proposed pit area prior to any clearing, grubbing or excavation. The initial investigation of these areas by the department is the responsibility of the district laboratory engineer. The project engineer will receive a report of the laboratory findings regarding archaeological cultural or historical finds, in accordance with EDSM III. 1. 1. 22. A copy of the report form from the EDSM is reprinted in the Appendix on page A-37. During construction, project personnel are to continue to inspect the material removed from borrow pits as it is placed on the project. Any findings shall be reported immediately to the Department's Materials Environmental Unit or Public Hearings and Environmental Impact Section, as applicable. The excavation of the affected borrow pit shall be discontinued until an evaluation has been made.

BURNING VEGETATION

The contractor may dispose of vegetation by burning. The burning of such material on the right-of-way shall be in accordance with all applicable laws and ordinances, including, but not limited to the current regulations of the Louisiana Department of Environmental Quality and Subsection 107. While materials are being burned, they shall be under the constant attention of watchmen provided by the contractor. The burning of perishable materials shall not damage anything designated to remain on the right-of-way, surrounding forest cover or other adjacent property.

Burning of vegetation can take place only between the hours of 8:00 a.m. and 5:00 p.m. Material to be burned is to be stacked in piles that can be completely reduced during this time period. All burning must be controlled so that no traffic hazard is created. The amount of dirt contained in the material being burned must be minimal. Materials which may produce unreasonable amounts of smoke, such as oils, asphaltic materials, rubber tires, etc., may neither be burned nor used to start a fire. Piles of material to be burned must be at least 1,000 feet (305 m) from any dwelling, other than a dwelling located on the property on which the burning is being conducted. Prevailing winds must be blowing away from any nearby town or city while material is being burned. If the wind direction shifts while material is being burned, so that smoke will be blown toward a municipality or across a roadway, the fire is to be put out and not restarted until safe conditions are available. If material is to be burned on private property, the contractor is responsible for meeting all regulations. Regulations for burning material on private property may differ from those governing burning material within the right-of-way. Additionally, the contractor shall obtain a written agreement from the property owner giving permission for burning and stating the type and quantity of material(s) to be burned. The contractor shall provide a copy of this agreement to the project engineer prior to removing materials to be burned. If the contractor owns the property on which the burning will take place, the contractor shall provide the project engineer with a letter indicating the location and ownership of the disposal area and relieving the department of any responsibility.

The project engineer is responsible for monitoring the disposal of vegetation and for ensuring that the contractor is in conformance with applicable regulations.

SELECTIVE CLEARING

Whenever any vegetation is scheduled to remain in-place, selective clearing techniques shall be employed. Project engineer's personnel are to clearly mark each tree, shrub or other greenery scheduled to remain on the right-of-way. The contractor shall notify the project engineer at least two weeks in advance of the planned beginning of clearing operations, so that all vegetation scheduled to remain can be flagged and an inspector made available.

Contractor's personnel are not to damage remaining shrubs, trees or their root systems during selective clearing or subsequent construction operations. Personnel must remember that tree roots extend at least to the limits of the tree canopy (drip line). Disturbing the ground under a tree, either by removing or adding dirt, or damaging the bark on a tree leads to a weakened condition from which many trees cannot recover. Any activity that may damage a tree's root system will be prohibited. Some common construction activities that can damage a root system are:

- Hitting trees or shrubs with equipment.
- Using heavy equipment over the roots, resulting in excessive soil compaction in the root area and/or damage to the roots.
- Placing soil around trees over the root zone.
- Exposing roots or disturbing their soil cover.
- Disturbing the vegetation's environment, altering water quantities or patterns.
- Spilling hydraulic fluids or any petroleum substance in the root zone.
- Disking in the vicinity of the roots of trees or shrubs when preparing soil for seeding operations.

There is a Roadside Development Specialist available to assist the project engineer in identifying and evaluating the condition of vegetation scheduled to remain on the right-of-way. The Roadside Development Specialist can also be of assistance in identifying activities that could damage vegetation.

QUALITY ASSURANCE DOCUMENTATION

QUALITY CONTROL

The contractor will keep detailed records of all activities, permits, correspondence, and related documents until the department has accepted the clearing and grubbing as required by the contract and plans.

INSPECTION AND ACCEPTANCE

Project personnel will document clearing and grubbing operations in a field book in accordance with standard department practice.

REMOVING OR RELOCATING STRUCTURES AND OBSTRUCTIONS - Section 202

The removal of structures and obstructions includes removing and disposing of anything not designated or permitted to remain on the right-of-way, except obstructions to be removed under other contract items.

Relocation of a structure involves moving it to a new location specified by the department and restoration to original condition with all connections properly made, all in accordance with the contract and plans.

When contaminated soil, underground tanks, friable asbestos, or contaminated fluids are encountered, the contractor shall immediately stop all construction activity in the vicinity and contact the Materials and Testing Section. The Materials and Testing Section will provide a cleanup plan for the contractor to follow. All coordination of activity surrounding the hazardous site will be through the Materials and Testing Section. The contractor shall follow the cleanup plan and guidance provided by the department.

Structures, pipes, culverts or other objects to be salvaged in total or in part shall be dismantled, handled and stored so that no damage will occur. If salvaged materials are to be stored on private property that does not belong to the contractor, the contractor must provide the project engineer with a copy of the written agreement made with the property owner. If salvaged materials are to be stored on property owned by the contractor, the contractor shall provide the project engineer with a letter indicating the location and ownership of the storage area and relieving the department of any responsibility. This agreement is also to designate the type(s) and quantity of material to be stored. If materials are to be disposed on such property, a copy of the agreements discussed under **CLEARING AND GRUBBING** must also be provided to the project engineer.

If the contract requires the contractor to deliver salvaged material to a DOTD location, the contractor and project engineer shall make arrangements for this delivery. A department representative will be assigned to inventory the material to be salvaged and delivered and to receive the material at the designated DOTD location.

Cavities outside construction limits shall be backfilled and compacted as directed by the project engineer. Holes left by structure removal, except in areas to be excavated, shall be filled to the level of the surrounding ground with usable soil conforming to Subsection 203.06(a) and shall be compacted as directed to at least the density of the surrounding soils. The filling operation shall be performed as directed in accordance with standard embankment construction procedures. Large cavities beneath the roadway or other structures are to be filled and compacted in lifts not exceeding 12-inches loose thickness, in accordance with Specification Section 203.

When a bridge or other drainage structure used by traffic is slated for removal, operations are not to begin until arrangements have been made to accommodate traffic. Substructures in stream beds shall be removed to natural stream bottom. Parts of

substructures outside of stream beds shall be removed to one foot below natural ground. Cavities created by removal of structures are to be backfilled with usable soil and compacted to at least the density of the surrounding ground. Large cavities beneath the roadway or other structures are to be filled and compacted in lifts not exceeding 12-inches loose thickness, in accordance with Specification Section 203.

Objects such as trees, structures, culverts, pipes, etc., designated to remain on the right-of-way or which are situated on private property adjacent to the right-of-way are not to be damaged during the removal of other objects. The contractor is responsible for any damage which occurs to objects that are not slated for removal. The contractor shall repair or replace any damaged object not slated for removal as directed.

When archaeological or paleontological remains are located or suspected, the project engineer will proceed as instructed under **CLEARING AND GRUBBING**.

QUALITY ASSURANCE DOCUMENTATION

Project personnel will document the removal or relocation of structures and obstructions in a field book in accordance with standard department practice. The contractor will keep detailed records of all activities, permits, correspondence, and related documents until the department has accepted the removal and relocation as required by the contract and plans.

EXCAVATION AND EMBANKMENT - Section 203

EXCAVATION

Excavation is designed for shaping the project, including cut sections. It includes the excavation of materials, both usable and nonusable, and the disposal of excess or nonusable materials for which provision is not made in other specification items. Specification Section 203 includes excavation for roadways, ditches, channels and structures, as well as all associated grading operations.

When hazardous materials, archaeological or paleontological remains, or endangered flora or fauna, or cemeteries are located or suspected, the project engineer will proceed as required in Section 201 and Section 202 in this manual, contract and plans.

EXCAVATION OUTSIDE THE RIGHT-OF-WAY

Excavation for lateral drains or other activities outside the right-of-way may require access to private property. If it is obvious that the contractor's forces require access to property not owned by the department, the project engineer must have possession of a written agreement from the owners of the property allowing access during construction. This agreement may be obtained by the Right-of-Way section prior to letting and may appear as the construction or drainage servitude on the plans. If such an agreement is not available, the project engineer is not to allow the contractor to perform any work that requires access to adjacent property until written permission is obtained. It is the responsibility of the department to obtain this agreement. The contractor will be provided a copy of the agreement. Prior to final acceptance of the project, the contractor shall obtain a written release from the property owner stating that the property has been restored to a condition that is satisfactory to the owner.

DISPOSAL OF EXCESS OR UNUSABLE MATERIALS

The disposal of unusable excavated materials shall be the responsibility of the contractor. If these materials are to be disposed on property not owned by the contractor, the contractor shall obtain a written agreement from the property owner, designating the type(s) and quantities of materials, to be disposed. A copy of this agreement must be provided to the project engineer before excavation operations begin. If excavated materials are to be stored on property owned by the contractor, the contractor shall provide the project engineer with a letter indicating the location and ownership of the disposal area and relieving the department of any responsibility. This agreement is also to designate the type(s) and quantity of material to be stored.

EQUIPMENT

The project engineer shall approve equipment used to perform general excavation. The equipment shall be in good condition with no fluid leaks that could be detrimental to the embankment. No equipment shall be used on the project that will cause damage to any area of the project, subsurface strata or hauling areas.

GENERAL EXCAVATION

General excavation is the excavation of materials from within the right-of-way, except for drainage or muck excavation. Materials that meet specification requirements and are approved for use may be used in the construction of the project.

UNDERCUTTING

Under cut materials will be paid under general excavation. Undercutting is the removal of materials discovered during construction operations that are not suitable to be left in place. The department will determine which materials are to be undercut.

DRAINAGE EXCAVATION

Drainage excavation is designed to remove water from the roadway area to natural drainage systems. It includes excavation for drainage beyond the limits of the roadway section, except for wing ditches at cuts. Wing ditches at cuts will be paid under general excavation. The contractor shall dispose of material from drainage excavation that does not conform to Specification Subsection 203.06 in accordance with Specification Section 202. If the contractor elects to use material obtained from drainage excavation in the embankment or in other project areas, it must be sampled, tested and evaluated by the department for conformance to Specification Subsection 203.06. Materials that conform to the applicable requirements of Specification Subsection 203.06 may be used when approved by the engineer.

Drainage excavation that is critical to keeping the work well-drained shall be done as soon as possible as directed by the engineer. Failure to provide and maintain adequate drainage can result in construction delays and additional work, because of the saturation and subsequent degradation of approved materials, yielding subgrades, additional processing of materials and other construction problems related to water standing on the project. The contractor shall correct construction problems caused by the failure of the contractor to construct or maintain adequate drainage at no direct pay.

MUCK EXCAVATION

Muck excavation refers to the removal of material that is not suitable to be left in place as foundation material. Muck excavation will be identified as such in the contract. The contractor shall remove muck from the area of the embankment and dispose of it in accordance with Specification Subsection 202.02. The contractor shall remove all material determined by the engineer not to be suitable to be left in place as foundation material.

EMBANKMENT

Embankment construction includes all work associated with the building of embankments for roadways, structures or other similar department projects.

Embankment Constructed With Usable or Lime Modified Soils

Earthen embankments must be constructed of usable soils, which may be obtained from excavation or borrow. All soil used in the embankment, regardless of source must be tested in its original location or in dedicated stockpiles by the district laboratory. The soil shall be classified by application of DOTD TR 423. Soils shall not be incorporated into the embankment until they have been approved for embankment use. Soil usage shall be as specified in Specification Subsection 203.06.

SOIL USAGE	P.I.	LIME TREATMENT
All soils used in embankments must have an organic content of 5% or less and a silt content of 65% or less according to the 2000 *Standard Specifications*. Always check the contract for the latest requirements.		
Headers (full height)	12 - 25	None Allowed
Embankment (non header) Height ≤ 8'	0 - 25 26 - 34	None Required 6% by Volume*
Embankment (non header) Height > 8'		
Below 8'	0 - 34 35 - 45	None Required 10% by Volume*
Above 8'	0 - 25 26 - 34	None Required 6% by Volume*
		*Treatment shall conform to Type E (Section 304)

SOIL USAGE TABLE - BASED ON 2000 STANDARD SPECIFICATIONS

SOIL BORING INFORMATION

Plans provided by the department may include the results of soil borings and the classification of soil materials within the right-of-way. **The department does not guarantee the accuracy of such information.** These borings are taken to establish the general character of area soils during the design phase of the project. They are not intended to provide detailed subsurface information for bidding or construction. **The contractor is advised to obtain independent samples and evaluate the subsurface material prior to entering a contract bid.**

SOIL QUALITY INSPECTION

If the department is satisfied with the subsurface soil information shown in the plans, the project engineer can allow the contractor to use material obtained from general excavation that meets specification requirements for embankment construction. However, such permission does not release the contractor or the inspector from observing the soil during construction. During construction, contractor personnel and department inspectors are to observe exposed soils for conformance to specification requirements. Should unanticipated materials or subsurface conditions be encountered, the inspector shall notify the project engineer and the district laboratory engineer immediately. The contractor shall cease operations in that area until the soils or subsurface conditions can be evaluated. Some examples of soils or conditions which will require department investigation include collapsible soils, perched water tables, high PI material, erodible material, muck, or any other material that is not acceptable for use in the proposed construction area.

Construction personnel must be aware that soil classifications and conditions are subject to change, even within close proximity to borings. When excavated material is to be used for construction, the quality and physical characteristics of this material are to be evaluated prior to its incorporation into the project. The department will perform additional testing at the project engineer's request.

SOILS WITH SWELL POTENTIAL

Soils with a high PI are indicative of soils with swell potential. Such soils will have a high clay content and may be sticky, hard to process and slickensided. The department has limited the use of such soils in embankment construction. Some soils that exhibit swell potential can be used with lime treatment. Refer to the Soil Usage Table, page 29.

BORROW

Generally, sources of material located outside the right-of-way will not be designated in the plans. If possible sources of local materials are designated in the plans, the quality of such material will be acceptable in general. However, material obtained from such sources must be sampled, tested and approved for its specific use. When material sources are designated in the plans, the requirements of Specification Subsection 106.02 will apply.

When material deposits are not designated in the project specifications, the contractor shall provide sources of material acceptable to the engineer. When the contractor

provides sources of materials or material deposits, the department may absorb the cost of processing samples to determine suitability of material.

Sources of soil needed for construction and not available from excavation for the project are referred to as "borrow." Borrow sources must be approved by the district laboratory engineer. It is the responsibility of the contractor to provide the department all information required by the latest policies and the *Materials and Sampling Manual* and this manual. **The contractor shall submit any request for sampling and testing to the project engineer a minimum of 30 calendar days prior to the anticipated date of needing borrow.** This request shall be in writing and shall identify the location of the proposed source. When the request includes a prospective pit, the proposed depth and type of excavation shall be specified. It shall also include a written agreement between the contractor and the property owner that allows department personnel access to the property. This written agreement with the property owner shall state that the contractor has agreed to purchase material from the owner if the material is approved for project use. The contractor shall obtain a separate agreement allowing department personnel access to property from each property owner through whose property access will be necessary. The contractor shall be responsible for clearing both the proposed site and access area to permit the easy entry of department personnel and equipment. The contractor shall survey and stake all corners of the proposed borrow pit and establish a base line. The request to approve the source shall include a drafted, detailed survey plat and a general area location plat. (Refer to page A-1 for an example of an acceptable pit sketch.) **The project engineer will ascertain that the contractor has complied with all department requirements before submitting the request to the district laboratory engineer. The department will not act on any request until these conditions are met**. **No material can be placed on any DOTD project until it has been approved by the department.**

The district laboratory engineer will notify the project engineer of the results of source sampling and testing. The project engineer will base the approval or disapproval of the proposed site on the findings of the district laboratory and will notify the contractor.

Borrow areas which will result in a depression cannot be located closer than 300 feet from any public right-of-way. No borrow area can be located closer than 300 feet from the bank of a stream listed on the National System of Wild and Scenic Rivers or the LA Natural and Scenic Rivers System.

Embankment Constructed With Aggregates

Nonplastic Embankment

Nonplastic embankment is generally constructed over unstable areas subject to subsidence. They are constructed of aggregates with a surcharge lift that is removed after the required design time has elapsed. This surcharge is designed to consolidate the underlying unstable materials by dewatering and moving the particles closer together. It is critical when constructing these embankments that, as the material is being placed in lifts, the unstable materials (muck) underneath do not become intermingled with the specification aggregates. Such contamination will immediately cause the loss of support value that the design demands. Such areas shall be

immediately corrected and construction operations modified to avoid any further occurrences.

Nonplastic embankments are constructed by mechanical equipment, first building a working table, then placing the aggregate in lifts. After building the working table to the satisfaction of the engineer and in accordance with the contract and plans, each lift shall be constructed in accordance with general construction requirements for embankments.

This type embankment is constructed using sand, shell, stone, or blended calcium sulfate. When blended calcium sulfate is used, certain chemical characteristics must be considered. Special test equipment and modified operations as listed below are necessary while constructing embankment with this material.

- The material must be transported and processed in the damp state to avoid dusting. Dust from this material may create a hazardous air pollution situation.
- The lift thickness is modified.
- When determining moisture content (TR 403) for moisture control and density testing, the sample must be dried for a minimum of 24 hours at 140^{o} F in a forced draft oven. This material changes in characteristics when overheated; therefore, a lower temperature for a longer period must be used.
- This material requires a plastic soil blanket for environmental purposes and support of vegetation.
- The material cannot be placed within 10 feet of a metal structure due to corrosion potential.
- The material must be blended with an approved aggregate that will control the pH.
- The Materials and Testing Section must approve the quality control plan.
- All materials shall be from approved sources.
- Environmental clearance must be obtained from the Department of Environmental Quality.

PLASTIC SOIL BLANKET

When soils with a P.I. less than 10 or a pH less than 5.5 or greater than 8.5 are used in embankment construction or form the final surface of a cut slope, the slopes of the embankment must be protected with a plastic soil blanket conforming to Specification Subsection 203.10. Soils with a P.I. less than 10 are highly erodible and, therefore, cause immediate and severe loss of material and do not easily develop a vegetative cover. Soils with a pH less than 5.5 or greater than 8.5 will not support appropriate vegetation cover. Thus when either of these conditions occur, both cut and fill slopes must be protected. Embankment material will be sampled in-place by project personnel and tested by the district laboratory to determine the need for a plastic soil blanket.

The plastic soil blanket must be able to support vegetation and will usually be seeded with an approved grass to provide temporary and permanent erosion control. For approved grasses, refer to Specification Sections 204 and 717. If the plastic soil blanket will not support vegetation, the contractor shall remove and replace the material or treat the material as necessary.

On slopes when the material has a P.I. greater than 10, but has a pH less than 5.5 or greater than 8.5, in lieu of placing a plastic soil blanket on the slopes, the contractor may treat the slopes to bring the pH into the range of 5.5 to 8.5. When the pH is above or

below these values the Roadside Development Section will be contacted to provide the appropriate treatment. The modified soil will be sampled by project personnel and tested by the district laboratory to determine the acceptability of the pH value.
Plastic soil blanket shall be placed in lifts of uniform thickness and compacted with a cultipactor. There shall be no low spots, voids or lumps in the completed blanket. Plastic Blanket material shall be evenly distributed. The minimum thickness of the completed blanket shall not be less than 12 inches. The plastic blanket shall be finished to a well-drained surface, so that water will neither reach the underlying materials nor stand on the surface.

STABILIZATION WITH GEOTEXTILE FABRIC

Areas of unstable foundations may require stabilization with geotextile fabric. This requirement will be shown on the plans. Geotextile fabric is designed to prevent the intermingling of usable embankment material with underlying unstable material. It helps distribute the load from overlying material onto a less structurally sound layer. To be effective, the geotextile fabric must form a complete barrier. Therefore, it is critical that the fabric be protected from deterioration before and during placement. Ultraviolet damage, tears, failed seams, improper installation in curves, and other similar defects can lead to premature failure of the embankment.

Geotextile fabric shall not be unwrapped prior to use and shall be spread directly in front of the operation. Geotextile fabric exposed to sunlight prior to installation will be tested for ultraviolet damage prior to placement. Geotextile fabric that has been installed shall be covered with embankment within seven calendar days. Installed fabric that is not covered within seven calendar days shall be removed and replaced or protected from further light damage until test results are obtained.

The specifications allow the joining of geotextile fabric to be overlapped or sewn. When soil is inundated with water or saturated the fabric must be sewn. When edges are sewn, Specification Subsection 203.11 requires the use of the ***J***-Stitch with a Type 401, two-thread chain stitch. To create a ***J***-Stitch, two parallel edges are placed together, turned in the same direction and sewn. The appearance of the turned and stitched fabric looks like the letter "J," hence, the name. Refer to the diagram on page A-35 in the Appendix for a sketch of a completed ***J***-Stitch. Although there is no specification for the amount of material to be turned when making the ***J***-Stitch, industry standards recommend two - four inches of overlap. The number of lines of stitching required shall be in accordance with the plans or as directed by the Design Section. The two-thread chain stitch looks like interlocking Figure-8's on the bottom. The 401 stitch is a locking stitch which protects the seam from unraveling if a thread breaks. Specification Section 203 requires thread of polyester or kevlar. These materials are resistant to moisture damage.

EQUIPMENT

Equipment weight and construction methods shall be compatible with soil conditions at the time of construction. The equipment shall be in good condition with no fluid leaks that could be detrimental to the embankment. No equipment shall be used on the project that will cause damage to any area of the project, subsurface strata or hauling

areas. Equipment shall be capable of producing a uniform surface, density and moisture content for the full cross section and depth of the area being constructed.

Vibratory compaction equipment shall not be used in areas of excessive moisture, perched water tables, where underlying courses have not been compacted with vibratory equipment, or where the compaction characteristics of the soil are not compatible with vibratory compaction. (For example, soils with high silt content are not readily compacted with vibratory equipment.) When the use of vibratory equipment results in damage to the embankment or underlying support layers, the use of this type of equipment shall be discontinued immediately. The contractor shall correct damage caused by the improper use of vibratory compaction equipment, as directed, at no direct pay.

QUALITY ASSURANCE (QA)

The specifications delineate different conditions, based on embankment height and type (fill or cut section), which regulate the preparation of the existing ground, placement and compaction of soil for an embankment. The details of embankment construction are so varied and complex that personnel from the department and contractor must refer to contract, plans, and *Materials Sampling Manual* for specific requirements. QA requirements for sampling, testing, and documentation will generally be found in the Materials Sampling Manual.

The table on page 35 illustrates the complex details that personnel must be aware of to construct an embankment according to the department's requirements. This table outlines the different situations and requirements for preparing the existing (natural) surface of the ground before actually starting embankment construction.

EMBANKMENT HEIGHT	PREPARATION
Fill	
< 5 Feet	Remove heavy sod & objectionable vegetation. Before usable material is placed, scarify existing ground to 9" depth. Recompact to a minimum of 95% of maximum dry density.
□≥ 5 Feet	Before usable material is placed, scarify existing ground, then recompact satisfactorily.
Cut	
* Cut Surface	The top 12 inches of any cut section shall be processed by scarifying and compacting the exposed soil. The soil shall be compacted to the requirements of general embankment construction to achieve 100% payment density in base course above. When the soils encountered are unstable the material shall be undercut and removed as directed by the engineer or contract and plans. Usable soils placed in lieu of the undercut material shall be placed, processed, and compacted in accordance with general embankment construction to achieve 100% payment density in base course above. When stable soils cannot be reached, embankment materials will be bridged in and embankment meeting the requirements for general embankment construction will be constructed on top of the cut area to achieve 100% payment density in base course above.
Existing Roadbed Within Two Feet of Finished Subgrade	
	Scarify to at least 9" depth. Recompact to at least 95% of maximum dry density.
* For direct placement of subbase or base course only.	

EXISTING SURFACE PREPARATION FOR EMBANKMENTS, SUBBASES AND BASES

BASED ON 2000 STANDARD SPECFICATIONS

TRANSITIONS FROM CUT TO FILL

Transition zones between cut and fill sections are traditionally unstable areas that lead to premature failures. In order to ensure a smooth transition and to minimize the instability of the transitional area, the cut section should be extended for the full width of the embankment into the area to be filled to a point where the embankment fill height will reach full depth or at least three feet, whichever is less. The sloped area of the transition of the cut is the most critical. This slope should be at a ratio of approximately 1:1 or cut in steps in accordance with Specification Subsection 203.07. The engineer will determine the construction to be used, based on field conditions, fill and cut heights and depths, and material qualities. However, it is recommended that required additional excavation be limited to 50 feet on each side of a transition point. The intent of this construction technique is to eliminate the placement of only a thin edge of embankment material caused by the featheredging of the fill into the cut area. In areas of low relief, the project engineer will make whatever modifications are necessary to this technique to ensure a stable transition from cut to fill. Refer to the sketch on page A-13.

QUALITY CONTROL (QC)

The contractor is responsible for supplying materials and using construction methods and equipment that will produce a project which uniformly meets all specification requirements. The contractor shall employ personnel who are knowledgeable about embankment construction, including soils identification, layout, traffic control, plan reading, and testing, and are capable of controlling the work to conform to the plans and specifications. **Although a certified DOTD inspector will be present on the project, it remains the contractor's responsibility to recognize deficiencies in materials or construction and to take corrective action**.

Each lift of material is to be uniformly blended by a mixing process approved by the engineer. Blending shall ensure that the material is uniform for the full thickness and width of the lift. Blending may be accomplished by using a in-place mixer, disking, the use of a motor patrol, or equipment designed to pulverize and blend soils. The in-place mixer is the most effective for vertical blending of material. **The use of a sheepsfoot roller is not an approved method for blending soils.** Any of the techniques mentioned can be effective in blending material vertically; however, to properly blend material across the roadway, special techniques may be required. Equipment used to spread material across the roadway (e.g., motor patrol) is **not** effective in blending material throughout its depth; however, is very effective at moving material across or up and down roadway..

The specifications establish a moisture content tolerance that must be met during compaction. This tolerance is based on the optimum moisture content established by the department for each section per lift. After the contractor has placed and uniformly blended the material, construction personnel will sample the section and determine the optimum moisture content prior to compaction. Additional samples may be required if material is not uniform as placed longitudinally in the section or if areas within the section are processed at different times. Optimum moisture content will be determined in accordance with DOTD TR 415 or DOTD TR 418. **Moisture content is to be uniformly maintained within the specification tolerance (-2 to +4) of optimum and is to be matched to the characteristics of the soil being compacted.** For example,

the moisture content of a coarse, sandy soil is critical for compaction purposes. Therefore, if the contractor maintains a coarse sandy soil at +4.0 of optimum moisture content, it may be impossible to meet specification density.

The contractor shall test embankment materials in-place for moisture content prior to compaction during processing. This test is to be in accordance with DOTD TR 403. The materials are to be within the specification range of -2.0 to +4.0 of the optimum moisture content when compaction is begun and remain within this range throughout compaction. The contractor is to conduct moisture content testing in accordance with DOTD TR 403 as necessary during compaction to ensure that the material remains within this specification requirement until compaction is complete. **Moisture content obtained by nuclear device during density testing is not allowed for this control process**. If the material is not within this range or is not uniform, the contractor is to make adjustments to conform to this specification or discontinue compaction operations. This range is the maximum deviation from optimum moisture content allowed by the specifications. The contractor is to maintain embankment materials at a uniform moisture content. Variations in moisture content may cause the constant adjustment of compactive effort. Material that has been compacted at other than this moisture content tolerance is to be reprocessed at the proper moisture content and recompacted. When the material is below the -2.0 tolerance, additional water shall be added to the material after it has been scarified. The material shall then be uniformly blended to ensure uniform moisture throughout. The addition of water to the surface of the compacted section without reprocessing will not be allowed. If the material is above the +4.0 tolerance, it shall be aerated until it is within specification tolerance for moisture content, then recompacted.

During the placement of embankment fills, the contractor is to check the thickness of each lift at random locations to ensure that the maximum loose thickness per lift is not being exceeded. For cuts, the contractor is to check the top layer to ensure that it has been prepared to the correct depth and width and compacted to at least the minimum density required by the specifications.

During embankment construction, the contractor is to check density in accordance with DOTD TR 401 to ensure that specification density requirements are being met. **The department's acceptance tests are not to be used for control.** If a proctor is to be used to determine the maximum dry weight density, the material to mold the proctor will be obtained from underneath the nuclear device at the location where the density test is taken. If a sand cone is used in place of the nuclear device, the material for the proctor shall be taken from the material surrounding the hole.

The contractor is to routinely check each section for alignment, grade and cross slope. Deviations from the plans are to be corrected prior to requesting inspection of the section by the department.

INSPECTION AND ACCEPTANCE

Prior to placement, all soil will be sampled, tested, and approved for use. During the placement of embankments, project personnel are to check the thickness of each lift at random locations to ensure that the maximum loose thickness per lift is not being exceeded. For cuts, project personnel will check the top layer to ensure that it has been prepared to the correct depth and width and compacted to at least the minimum density

required by the specifications. The inspector will visually inspect the processing operation of the surface being prepared for embankment, subbase or base course placement, as well as the processing of fill material. Samples and tests for optimum moisture content, actual moisture content or density will not be taken until the material is blended thoroughly and to the satisfaction of the inspector.

The department will test the material for moisture content during processing prior to beginning of compaction. If the material is not within the specification tolerance (-2.0 - +4.0), the contractor will be required to reprocess the material before beginning compaction. Additional acceptance testing will be performed for moisture content in accordance with the frequency stated in the *Materials Sampling Manual* or as necessary to ensure that the moisture content of the material is uniform, within specification requirements, and matches the compaction characteristics of the material being compacted. When acceptance tests indicate that the material is not within specification tolerances, the contractor will be required to reconstruct the area represented by the test at the proper moisture content. Acceptance tests for moisture content are to be taken at the beginning of the compaction process to verify the contractor's quality control program and the conformance of the material to specification requirements. Acceptance tests for moisture will be performed in accordance with DOTD TR 403. **Moisture content obtained by nuclear device during density testing is not allowed for this process**.
After compaction, the inspector will inspect the section carefully prior to taking any density tests. The section must meet the inspector's approval prior to acceptance density being performed. It is to be noted that the acceptance of the embankment is not based solely on the results of the density tests. The embankment material must be uniformly mixed
and compacted with a uniform compactive effort and at a uniform moisture content within specification tolerances. The inspector will look for deficiencies such as pumping, differences in texture, laminations, cracking, nonuniform moisture content (dry/wet areas), nonuniform mixing, movement under traffic, rutting, etc. Deficiencies identified by the inspector by visual observation are to be corrected by the contractor before the acceptance density test is performed. The inspector is also to check the section for alignment, grade and cross slope prior to final acceptance of the section.

The embankment is to be tested for conformance to density requirements in accordance with DOTD TR 401. Acceptance testing will be performed after the contractor has completed QC testing and has notified the inspector that the section is ready for acceptance testing. If a failing density test occurs, the section is to be reprocessed by the contractor at no direct pay. If a proctor is to be used to determine the maximum dry weight density, the material to mold the proctor is to be obtained from underneath the nuclear device at the location where the density test is taken. If a sand cone is used in place of the nuclear device, the material for the proctor is to be taken from the material surrounding the hole.

When acceptance tests indicate that the contractor has not controlled the process to meet any specification requirement, the chief inspector and/or project engineer is to evaluate the contractor's QC effort and require modifications to ensure improved quality control.

VISUAL INSPECTION

Visual inspection is the most important part of the department's quality assurance program. It is the department's intent that courses be uniform and meet all specification requirements. The minimum testing requirements of the statistically based acceptance program reflect actual values of small, specified areas. Therefore, it is always mandatory that a strong visual inspection program be established and maintained during the construction process to guarantee that these acceptance tests do, in fact, represent a uniform product. Prior to final acceptance, the inspector will visually inspect the entire section. If visual inspection shows that the course is not uniform or that the test values may not be representative of the entire section, additional tests may be performed and deficiencies shall be corrected. **Deficiencies identified by visual inspection, such as laminations, dimensional deficiencies, soft areas, etc. shall be corrected before the section will be accepted. The section must be accepted prior to the placement of the next lift.**

QUALITY ASSURANCE DOCUMENTATION

The contractor shall document the QC program and tests as required by this manual, the *Materials Sampling Manual,* and the Quality Control Plan approved by the Project Engineer.

Project personnel will document construction progress, inspection, and acceptance testing in a field book in accordance with standard department practice. Thickness, width, grade, and cross slope will be particularly noted. Sections and lifts are to be numbered for easy identification. Each test is to be identified by a descriptive numerical system that includes the project number, section number, lift number and test number. When failing tests occur, a letter designation should be used for any additional tests taken in that section to correlate them to the initial failing test.

Density & Moisture Content Worksheet

The test procedure DOTD TR 401 - The Determination of In-Place Density, contains a worksheet to be used to facilitate the calculations associated with the determination of density, moisture, and pulverization. This worksheet is to be completed in conjunction with this procedure and used for these calculations. Department personnel will submit this form for acceptance testing regularly to the district laboratory for MATT system entry. The district laboratory will return the original to the project engineer for inclusion in the 2059 Review. A copy of the documentation of QC tests and results shall be given to department personnel.

TEMPORARY EROSION CONTROL - Section 204

In accordance with Specification Subsection 107.14, the contractor shall protect the project and adjoining properties from soil erosion and siltation by effective and continuous erosion control methods. The area of bare soil exposed by construction operations shall be kept to a minimum. The contractor is also required to adhere to the requirements of Specification Subsection 107.15 for all projects.

The contractor shall install and maintain temporary erosion control to prevent sediment from escaping from the right-of-way. Erosion control features shall be in accordance with the Storm Water Pollution Control Plan in the plans as modified by the engineer to adapt to field conditions, as needed, and as otherwise directed by the engineer. **The intent of erosion control is to prevent sediment pollution of streams, lakes, tidal waters, reservoirs, canals, and other impoundments as a result of construction operations.**

EQUIPMENT

Equipment used to construct or install temporary erosion control measures shall be appropriate for the activity for which it is being used and shall be approved by the engineer prior to use. Equipment used for erosion control activities shall not be detrimental to any area of the project.

TEMPORARY SEEDING

Temporary seeding shall be performed in accordance with Specification Section 717, except that complete bed preparation may not be needed. It is to be noted that only rye grass is approved for winter cover. However, since even rye grass will not germinate at temperatures below 35^{O}F (1.6^{O}C), temporary grass must be planted early enough in the year to ensure germination and grass cover. . Rye will not grow below 55^{O}F (13^{O}C). Rye should be planted from September to November. Seeding for temporary grass cover should be completed prior to November. To ensure good cover, it is necessary to have adequate root structure and vegetative growth. From November to April, it is too late to plant grass to protect slopes from wintertime erosion. The recommended application rate for rye grass for temporary cover is 30-40 pounds per acre. It is possible to interseed other grasses with rye to provide continuous cover in late spring and summer when rye dies. When other grasses are interseeded with rye, it will be necessary to mow the rye grass in mid-spring to ensure the germination of other seeds. The use of perennial rye grass is not recommended, because it will regerminate each year and become a maintenance problem. Fertilizer is needed to ensure grass growth. Water must be adequate to ensure germination and growth. If rye or other grass is used as a nurse crop for permanent cover, complete bed preparation in accordance with Specification Section 717 will be required before the rye is planted. When temporary grass is to function as an erosion control measure for an extended time period, top dressing with an appropriate fertilizer will be required to maintain growth.

When temporary seeding is used as an erosion control measure late in the year, alternate measures should also be used to ensure that erosion control is in place, in the event the grass fails to develop adequate cover.

TEMPORARY MULCHING

Construction details for temporary mulching are published in Specification Section 716. Materials specifications for mulch and tacking agents are published in Specification Subsection 1018.19 and Section 1002 for emulsified asphalt. It is critical that the mulch be kept dry prior to application. If the mulch becomes wet, it cannot be applied properly. It is to be kept covered and stored in accordance with Specification Section 106.09. Mulch is used to slow the velocity of water flow, reduce the impact force of raindrops, and to provide moisture retention in seeded areas.

SANDBAGGING

Sandbags are to be stacked. Sandbags restrict the flow of water; therefore, they are to be used to direct the flow of water or to stop water flow. The length of time that sandbags will be effective as erosion control depends on the time it takes the bag itself to deteriorate or the area upstream of the bag to fill with soil.

BALED STRAW OR HAY

Baled straw or hay acts as a dam to water. When baled straw/hay is not properly installed, water will flow around or underneath the bales; therefore, it is necessary to bury straw/hay bales approximately four-six inches (100 - 150 mm). Water velocity can move unstaked straw/hay bales out of place. To ensure that they will remain in place, they must be firmly anchored with stakes in accordance with Specification Subsection 204.07. When sediment build-up occurs in front of the straw/hay bales, additional bales are not to be placed on top of the existing bales. A new row of straw/hay bales is to be constructed in front of the existing one, burying the new bales in the sediment build up. It is important to observe the effectiveness of straw/hay bales and to add additional bales prior to anticipated failure. Straw/hay bale barriers are to be used in minor swales or ditches; they are not to be used in live streams.

SLOPE DRAINS

Slope drains are used to channel water off the project to a proper discharge area. Slope drains direct the water down slope through a protected sluice, a ditch or channel that has been lined to protect the bottom from erosion. The most commonly used lining material is plastic sheeting; however, other materials may be used, including paving the sluice with concrete. Baffles are sometimes used in the sluice to slow the velocity of the water; the discharge area at the end of the drain must be protected from erosion. Slope drains are usually used in conjunction with an earth berm to collect water from the project and direct it into the slope drain.

SEDIMENT BASINS

A sediment basin is an artificially created pool that decreases the velocity of running water, allowing sediment to settle to the bottom of the pool. Sediment basins are often used in conjunction with check dams or silt fences. They are often dug at naturally occurring low places to ensure the collection of sediment. Sediment basins must be large enough to accommodate anticipated runoff from the drainage area. It may be necessary to use multiple basins, especially if the sediment basin is used alone. **Regular maintenance is the key to the proper functioning of a sediment basin.** Sediment must be removed from the basin before it reaches a height at which heavy or prolonged rain will cause the basin to overflow, carrying silt outside the basin. When maintaining a sediment basin, the contractor is to consider the accessibility of the surrounding terrain to equipment after rain. When heavy or prolonged rains occur, the surrounding area can often become too wet for cleaning equipment to maneuver. Therefore, the basin is to be cleaned prior to becoming too full under circumstances where cleaning is not practical.

SEDIMENT CHECK DAMS

Sediment check dams are usually constructed of hay/straw bales, sandbags or stone. They may be used in conjunction with a sediment basin. Check dams of hay/straw bales or sandbags are used to slow the velocity of a concentrated flow. Storm water will be held behind the check dam and sediment will be trapped. Check dams can also be constructed of brush and logs and encircled with a fence to keep the brush from being moved out of place by water flow. Such check dams will allow water to flow through while catching some sediment.

SILT FENCING

Silt fencing materials shall conform to Specification Subsection 204.03. Posts shall be installed a minimum of two feet into the ground. It is good practice to incline the posts slightly toward the direction of water flow to ensure that the force of water and sediment build-up forces the posts upright, not backward. It may be necessary to add additional posts and bracing to prevent the fence from being moved out of place. The bottom of the fencing should be buried about four inches (100 mm) to prevent sediment from washing under the fence. Silt fences often require a sediment basin in front to catch and slow water velocity before it reaches the fence. It is critical to the effectiveness of a silt fence that it be maintained properly. Holes in the fencing must be immediately repaired. The sediment basin must be cleaned at regular intervals and fence support checked and braced to ensure that runoff does not undermine or wash out the fence. The contour of the land must be taken into account when aligning a silt fence. The fence should be strung across the path of drainage to entirely block runoff. Wings can be constructed at each end to direct water and to prevent sediment from flowing around the ends of the fence. Silt fencing is not to be used in live streams.

BERMS

Earth berms can be used independently as check dams or to direct water off the project. They are often used in conjunction with slope drains. To protect the berm from eroding, it should be compacted to adequate density (85%) and be built of soils that do not erode easily. Sediment deposits adjacent to the berm must be checked and cleared regularly to prevent the water from flowing over the top of the berm.

TEMPORARY CONSTRUCTION ENTRANCE

Temporary construction entrances are used to reduce dust or mud generated by construction traffic as it enters or leaves construction sites. They are constructed of specified aggregate over geotextile fabric. The contractor must routinely maintain them due to the construction stresses to which they are subjected. Mud tracked on adjacent roadways is not to be allowed. A wash rack may be required to remove mud from tires before leaving the construction entrance.

QUALITY ASSURANCE

Erosion control is a very sensitive environmental issue involving the contractor, the department, the public, and a variety of other governmental agencies. Occasionally, the news media is involved.

Due to the nature of this construction activity, it is important to keep a complete and accurate record of all actions taken, all permits, all correspondence, and all agreements in a permanent file continuously available to authorized personnel.

Each requirement specified in the plans, contract, specifications, *Materials Sampling Manual*, Quality Control Plan, and agreements with other agencies shall be closely adhered to and carefully documented. The contractor and project engineer are to work in close unity in conforming to the quality intended in the performance of these construction activities.

The daily routine of checking erosion control devices shall be done promptly with any necessary corrections completed immediately. When severe weather threatens an extensive inventory of erosion control will be taken to ensure that any damage is minimized. When severe weather causes extensive damage to erosion control devices, the contractor will take immediate steps to correct damage and return the project to its initial state.

CLASS I BASE COURSE - Section 301

Class I Base Courses will be placed on a subgrade layer built in accordance with Specification Section 305. This design feature is the primary difference between Class I and Class II Base Courses. Class I Base Courses that are stabilized with cement must always be produced in a central mix plant. Unless otherwise specified, the contractor may elect to use any of the types of Class I Base Course listed in Specification Section 301; however, the same type must be used throughout the project, unless a plan change is submitted and approved by the DOTD Chief Engineer. The plan change will stipulate the type of Class I Base Course to be allowed in each location of the project.

In locations where normal construction practices for Class I Base Course are seriously impeded, the department may allow the contractor to use Portland cement concrete conforming to Section 901 in lieu of the Class I Base Course type selected for the project. The district construction office will coordinate the decision to allow the use of Portland cement concrete and the determination of the areas in which it is to be allowed. Such concrete construction shall be performed in accordance with the Specification Section 706.

MATERIALS

Specification Section 301 prohibits the blending of individual soils which do not meet specification requirements with other soils meeting specification requirements even if the resulting combination will meet specification requirements. (For example, for materials to be cement stabilized, a soil with a P.I. of 20 shall not be blended with an A-4 classified material, even if the resulting blend meets specifications. The blending is prohibited because soil with a P.I. of 20 does not meet specifications for Class I Base Course and uniform blending cannot be guaranteed.)

ASPHALTIC CONCRETE AND PORTLAND CEMENT CONCRETE The materials selected and used for asphaltic concrete and Portland cement concrete must conform to Specification Part V or Part IX, respectively. Sampling, testing, approval or other procedures shall be in accordance with the appropriate *Quality Assurance* manual.

TREATED LAYER UNDER ASPHALTIC CONCRETE

A layer of soil treated with either Portland or Portland-pozzolan cement must be placed under asphaltic concrete constructed as Class 1 base course. The details covering this material will be found in this manual under **Subgrade Layer-Section 305.**

AGGREGATES TO BE USED WITHOUT STABILIZATION

Stone, slag, and recycled Portland cement concrete may be used for Class I Base Course without stabilization. These materials must meet all specification requirements and be sampled, tested and approved from dedicated stockpiles prior to placement on the subgrade. For regulations for dedicated stockpiles, refer to page ? and the *Materials Sampling Manual*.

MATERIALS TO BE USED WITH STABILIZATION

Sand clay gravel, sand-shell, and soils will be stabilized with Portland or Portland-pozzolan cement for Class I Base Course. It shall be the responsibility of the contractor to locate and select materials which meet the specifications and which are appropriate for use in the central mix plant to be used on the project. It may not be possible to use all materials that are approved for use in Class I Base Course in all central mix plants. The contractor shall determine which materials can be uniformly fed and mixed by the plant. To ensure uniformity of materials and the validity of cement percentages and test results, the selection, storage, and handling of materials to be stabilized for Class I Base Course will be in accordance with **STORAGE AND HANDLING OF MATERIALS**. **DOTD plant certification and approval of materials for use in no way guarantees their success on the project. Such approvals only mean that the contractor may use the equipment and materials. It remains the contractor's responsibility to ensure the materials when processed meet specification requirements.** Soils for Class I Base Course are to be naturally occurring and undisturbed. In-place soils, which have been disturbed and may have been treated or otherwise modified, are not approved for Class I Base Course. The following chart summarizes the specification requirements for soils to be used as soil cement.

CHARACTERISTIC	TEST	SPECIFICATION
Classification	TR 423	A-1-a, A-1-b, A-2-4, A-2-6, A-4, A-6
Liquid Limit	TR 428	35 or less
Plasticity Index	TR 428	12 or less
Organic Content	TR 413	2% or less
Sand Content	TR 407	79% or less
Silt Content	TR 407	60% or less
Topsoil*		Prohibited
Stabilization (% Cement)	TR 432	Must Stabilize
Failure to meet any one of the above criteria will result in the disapproval of the material for use in stabilized base course.		

MATERIALS SPECIFICATION REQUIREMENTS FOR SOIL CEMENT

***** Topsoil: Topsoil is the top layer of a layered soil profile, which is present when soils are found in their original position. These soils are normally darker in color due to their higher organic content, resulting from the breakdown of vegetative residue. This zone supports the roots of grasses and small shrubs and is highly leached. The leaching process by rainwater results in a soil which contains the most weather resistant materials, usually sand and silt particles composed of silica. Also due to the leaching process, many topsoils have particles of similar size creating a poorly graded material. This poor gradation, in conjunction with higher organic contents and chemical characteristics that cause the soil to be unsuitable for chemical treatment or stabilization, results in an inferior construction material. Topsoils that have been removed from their original position, even for long periods, do not lose the characteristics that make them unsuitable for chemical stabilization. Spoil areas are typical examples of topsoil materials which are unsatisfactory for certain construction uses. Blending topsoil with other materials also does not yield a satisfactory material, especially for chemical stabilization.

DESIGN

Soil or soil-aggregates to be incorporated into a Class I Base Course will require a design based on either gradation or strength. The cement factors for sand-shell and sand clay gravel are specified; therefore, compressive strength testing is not necessary. Sand-shell shall be approved in individual component stockpiles before blending at the 35% sand, 65% shell ratio. Sand clay gravel shall be composited to ensure that the resulting blend of individual components meets the specification requirements for the base course material. It shall be the responsibility of the contractor to determine the gradation of the composited material and to submit it to the district laboratory engineer for approval. The contractor shall contact the district laboratory engineer if there are any questions regarding the proper materials or the appropriate percent cement. This design shall be submitted to the district laboratory on the *Base Course Design for Central Plant Materials Mixtures* (DOTD Form No. 03-22-0752). Refer to page A-15.

When cement is to be added to soil or soil-aggregates and the percent cement is not included in the contract specifications, materials will be subjected to procedures to determine minimum design strength. When a method other than DOTD TR 432 - Method A is used to determine the percent cement needed to stabilize a soil, the department may require the maximum time allowed by specifications to perform the test. Method A will require at least five days. When soils are to be stabilized with cement, the district laboratory engineer will determine which method of test is appropriate. The department will perform all cement design. It shall be the responsibility of the contractor to build the dedicated stockpile and request approval far enough in advance of planned construction operations to allow for this testing and design. The contractor shall provide stockpiles of actual materials that are to be tested for stabilization.

The cement factor to be used for soil stabilization will be determined by the department and will be based on strength. It is the responsibility of the contractor to advise the district laboratory engineer and the project engineer of the type of cement to be used for stabilization (Type I, IB, II, or IP). The district laboratory will use the same type of cement to determine the cement factor. If the contractor does not inform the district laboratory of the type of cement to be used, the cement factor will be determined using Type IB. The contractor will then be required to use Type I or IB for stabilization. If the

contractor does not use Type 1 or 1B, operations will be delayed until the district laboratory can determine a new cement factor.

When any type other than I or IB cement is used for soil stabilization, the department will not use DOTD TR 432 - Method A to determine the cement factor.

DOTD TR 432 - METHOD A will be used to determine the percent cement only when soils to be stabilized are naturally occurring, previously undisturbed in a borrow pit, and are materials with a history of not having stabilization problems.

STORAGE AND HANDLING OF MATERIALS

STOCKPILES The contractor shall place all soils and aggregates used in Class I Base Course in dedicated stockpiles. For regulations for dedicated stockpiles, refer to page 10. No segregation or significant variance in moisture content shall occur during the building of the stockpile and subsequent handling of the material. Individual materials shall be kept in separate stockpiles. The removal of material is not to cause contamination, nonuniform gradation or any other change in the quality of the stockpile.

Materials to be placed in a single stockpile shall be uniform in terms of classification, Atterberg limits, moisture content, moisture-density relationships, gradation, feedability (flow), stabilization, and compaction characteristics.

The moisture content in the stockpile must be coordinated with the optimum moisture content of the material to ensure that at the time of compaction all material will be within the specification tolerance for optimum moisture content. It is not acceptable to attempt to dry excessively wet material during blending, hauling or placement on the project.

Soils in a single stockpile must exhibit close moisture-density relationships. If the moisture-density relationships of materials vary, the compaction effort being used for one material will not yield the same density on the other material. It is critical to the uniformity of compaction that once an effective compaction procedure is established, continual adjustment due to changing material conditions not be necessary. Such need for procedural modification will subject the contractor to an increased risk of payment adjustment or the discontinuance of operations until the contractor can demonstrate a uniform compactive effort and material blend that will yield density meeting the specification requirements for 100% payment.

When materials are to be cement stabilized, it is mandatory that all materials in a single stockpile stabilize with the same percentage of cement. When multiple stockpiles are used to produce a mixture to be cement stabilized, material in the individual stockpiles shall be uniform and the resulting blend shall stabilize with a single percentage of cement.

CEMENT

The contractor shall protect cement at a central mix plant to prevent the intrusion of dampness, water or other contaminants. Cement that has partially set or has visible signs of moisture damage shall not be used. Seals from transports shall be checked to

ensure that they match the numbers on the Cement Certificates of Delivery. If the seal number does not match the Cement Certificate of Delivery, the transport of cement is not to be accepted.

WATER

Water shall be from approved sources and shall not be contaminated during storage or handling.

EQUIPMENT

All equipment for the production, transport, placement, compaction, and finishing of Class I Base Course materials shall be approved prior to use. Project personnel will inspect equipment daily prior to use. Equipment shall be in good working condition and shall not leak fluids onto the grade or roadway. Equipment initially approved for use shall continue to conform to the standards upon which this approval is based. When approved equipment fails to meet these requirements, it shall be removed from the project until repairs are made and approval reinstated.

ASPHALTIC CONCRETE AND PORTLAND CEMENT CONCRETE

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ASPHALTIC CONCRETE AND PORTLAND CEMENT CONCRETE

For equipment inspection, certification, and approval processes for asphaltic concrete (501 or 502) and Portland cement concrete (706 or 901) refer to the appropriate *Quality Assurance* manual.

PRODUCTION EQUIPMENT

All plants used to produce Class I Base Course shall be certified. For certification requirements and procedures for Central Mix Plants, refer to page 16.

TRANSPORT EQUIPMENT

RAW BASE COURSE

Trucks used to transport raw Class I Base Course are to be inspected prior to use and daily by project personnel. Trucks that haul material over state or federal roadways shall be weight certified. Trucks shall be capable of hauling material without loss of material, excessive drying, or segregation. If necessary, covers may be required to prevent nonuniform moisture contents or loss of fines. Beds shall be smooth metal, clean, with no holes. Extensions shall meet the requirements of EDSM III. 5.1.3. Covers shall be large enough to completely cover the mixture and extend over the sides and ends of the bed, be in good condition with no tears or holes, and be equipped with adequate tie-downs. Covers are to be large enough to prevent excessive air circulation or the intrusion of rain.

STABILIZED BASE COURSE

Trucks used to transport cement stabilized Class I Base Course from the central mix plant to the project site shall meet all requirements listed for trucks used to transport raw Class I Base Course. Covers shall be kept in place until the material is actually placed to protect the material from excessive loss of moisture.

PLACEMENT AND SPREADING EQUIPMENT

Class I Base Course shall be placed and spread without segregation and in uniform thickness and fluff to allow for uniform compaction and finish to plan dimensions, cross slope and grade. The equipment shall leave the material at a uniform moisture content, without excessive drying.

Class I Base Course may be spread with a base course spreader or other approved equipment. The equipment shall be operated to leave the surface slightly above grade so that finish grade, cross slope, thickness, and width requirements are met after finishing.

COMPACTION EQUIPMENT

Rollers for Class I Base Course may be either self-propelled or tractor powered. When vibratory compactive effort is permitted, the rollers shall be capable of independently controlling amplitude and frequency.

RAW BASE COURSE

Stone, recycled Portland cement concrete, and crushed slag shall be compacted with equipment designed for the compaction of each specific material. The compaction equipment may be either static or vibratory. The department reserves the right to require only static compaction equipment when the engineer determines that vibratory compaction may damage the base course or underlying or adjacent materials. (Examples of indications of damage to the base or underlying layers are loss of density, cracking, movement, free water, perched water tables, breaking down compaction in underlying layers due to silty or sandy characteristics, etc.)

The compacted material shall be finished with pneumatic tire rollers or static, smooth, steel-wheeled rollers as required by the specifications.

STABILIZED BASE COURSE

Stabilized base course shall be initially compacted with a conventional sheepsfoot roller or a self-propelled tamping foot compactor-type roller. The spikes shall be sufficient in size and number to provide uniform compaction for the full width and depth of the base course. **Compaction equipment with waffle-type or similarly styled drums, smooth wheel vibratory rollers, steel wheel, or pneumatic rollers will not be permitted for compaction.** Such equipment will cause lamination and nonuniform compaction, even though the average density may meet specifications. The nonuniform density caused by this equipment will lead to premature failure due to the lack of adequate density in the bottom of the base course.

The compacted material shall be finished with pneumatic tire rollers except that a smooth steel wheeled roller shall be used for sand shell bases. The pneumatic roller shall have an odd number of tires, arranged so that the spaces between one row of tires are covered by the tires of the other row. All tires shall be in place and shall be in good condition and properly inflated. Tires shall be smooth tread, of the same size and ply, and inflated to within □5 psi of each other.

FINISHING EQUIPMENT

Class I Base Course shall be finished with an approved automatic finishing machine. The approved automatic finishing machine shall be capable of being operated from an erected stringline, and capable of automatically controlling grade and cross slope meeting the requirements of Specification Subsection 501.07(b)(2) or 502.07(b)(2). The stringline shall be set to produce a uniform grade and cross slope, meeting the specification acceptance requirements. The stringline shall be supported adequately to ensure that there are no dips or humps between supports. The stringline shall be erected by the contractor and will be inspected by project personnel. It shall be kept clean and taut. The finishing machine shall leave a smooth surface at proper, uniform grade and cross slope. The finishing machine shall leave no loose material on the surface. The automatic finishing machine shall cut the material across the full width of the roadway without damaging the surface. **Cold planers will not be approved.**

WATER TRUCKS

Water trucks are to be equipped with spray bars which uniformly spray water across the surface and do not apply water in streams or cause water to puddle on the surface. Water trucks shall be weight certified and shall not be loaded in excess of the permitted load limit.

ASPHALT DISTRIBUTOR

When prime coat is being applied, the asphalt distributor shall conform to Specification Subsection 503.07, as required by Specification Section 505. Asphalt distributors used to spray prime coat over the completed base shall be equipped with a spray bar which uniformly sprays the prime coat across the surface and does not apply the prime coat in streams or cause it to puddle on the surface. Clogged nozzles will not be allowed. Asphalt distributors shall be weight certified and shall not be loaded in excess of the permitted load limit.

Equipment used to distribute asphaltic curing membrane shall conform to Specification Section 506. Asphalt distributors spraying asphaltic curing membrane must be equipped for easy determination of the rate of application.

CONSTRUCTION DETAILS

Construction details, both plant and roadway, for asphaltic concrete and Portland cement concrete must meet the requirements of the appropriate Specification Sections, 501, 502, 706, or 901 as outlined in the Quality Assurance Manuals.

PLANT OPERATIONS

The central mix plant and location shall be maintained in a safe, clean condition. The plant shall be equipped with a laboratory conforming to Specification Section 722. The plant shall be located where it will not be necessary for haul trucks to traverse newly placed base course. The district laboratory engineer will approve testing equipment. Scales and metering devices will be calibrated, documentation submitted to the district laboratory engineer, and their calibration approved by thedistrict laboratory engineer prior to production. Calibration shall be by an approved, independent service or by the Weights and Measures Division of the Department of Agriculture and Forestry. Independent calibration services must be licensed by the Department of Agriculture and Forestry.

Testing equipment not available at the plant during the certification inspection will be inspected, calibrated and approved prior to use.

WEATHER LIMITATIONS Both contractor and department personnel need to be constantly aware of weather conditions. For all base courses, when inclement weather is predicted, the contractor is to monitor operations to prevent material from being shipped to the jobsite where weather conditions will prohibit its use. If the material

cannot be maintained within the specification range of optimum moisture content due to weather conditions, placement of the material will not be permitted. If the weather causes stockpiles to be too wet to produce material that will meet the specification tolerance for optimum moisture content, production is not to be started. Additionally, the contractor should not produce mixture during borderline weather conditions that may have a detrimental effect on construction operations or materials. When scheduling operations, the contractor and the department's representative are to consider such factors as length of haul, speed of placement, compaction and finishing, current temperature and weather, past weather conditions (e.g., standing water, wet subgrade or stockpiles, excessively dry conditions, etc.), predicted weather changes (e.g., approaching weather fronts, winds, temperature changes, rain, changes in humidity, etc.).

The specifications prohibit the production or placement of Class I Cement Stabilized Base Course when the subgrade or stockpiles are frozen, when the ambient temperature is less than 35^{O}F, the temperature from the nearest weather forecasting station is to be 25^{O}F or less within the 24 hour period following placement, or during rain. This information is also available from the DOTD, Maintenance Engineer. Ambient temperature is determined in the shade, at the jobsite, away from artificial heat. However, it is imperative that operations be scheduled and monitored to ensure that these conditions do not occur during production or placement.

If, despite precautions for inclement weather, rain falls on freshly spread cement or base material mixed with cement prior to the completion of compaction, the inspector will document the affected area. Immediately after completion of compaction, new moisture content tests will be taken after rain to determine if the material is within the □2% specification tolerance of optimum. After 7 days the area will be cored and tested for percent cement and strength. If the area does not meet design requirements, the area shall be restabilized or retreated in accordance with the specifications at no direct pay.

STOCKPILES

Stockpiles shall be built on a well-drained surface, far enough apart that no intermixing of materials will occur during operations. If the area is not large enough to permit adequate distance between stockpiles, a bulkhead shall be erected between stockpiles to prevent intermixing of materials. The bulkhead shall be of sufficient height and length to prevent intermixing of materials or spillage over the top. The method of removing material from the stockpiles must be approved prior to the beginning of plant operations and will be subject to continual department inspection for satisfactory operation. No contamination or intermixing of materials between stockpiles shall occur during the removal of material from stockpiles. If a dragline is used to remove material from stockpiles, no material is to be dropped onto other stockpiles. The dragline is not to be overfilled.

The specifications require that the cement stabilized or treated mixture on the roadway at the time of compaction be within □2% of optimum. Therefore, it is critical that the moisture content of material removed from the stockpile not vary significantly. In order to ensure that the mixture on the roadway will be within specifications, once a working face has been established, material is to be removed only from this level. Removing material from above or below the level of the working area will result in widely varying moisture contents, especially after rain. When material is added to a working stockpile

from another approved stockpile, if the moisture content of the added material is not close to that of the working stockpile, material is not to be removed from the added material until the moisture content has stabilized. If the moisture contents of the two stockpiles or of different areas of the same stockpile are significantly different, it will not be possible to blend the materials together and still produce a final mixture within specification tolerance for moisture content.

Stockpiles of recycled Portland cement concrete must be approved at the source. Refer to the *Materials Sampling Manual*, DOTD Designation S:801.

FEEDER SYSTEM

The feeder system of the central mix plant is composed of bins, belts, scales, moisture control mechanism, automatic shut-off device, and any other plant components used to move or temporarily store soils, aggregates, and cement between the stockpiles and the pugmill. Feed rate shall be adjustable. When control is accomplished by gate openings the gates shall be adjustable and lockable. Belt speed shall be adjustable to control plant production rate.

Bins shall be free of holes, shall not allow material to bridge or collect in corners, and shall not allow material to intermix at the top or during loading. If vibrators do not effectively result in an even flow of material through the bin, other methods shall be used to achieve satisfactory results. Material will not flow through a bin if it is too wet; in this situation, it will be necessary to allow time for the stockpile to reach a lower, uniform moisture content.

Belts shall be free of sags, tears, or holes. They shall move smoothly and carry material from bins to the pugmill without spillage.

The moisture control mechanism will consist of the spray bar and metering or weighing system. It shall be capable of adjusting the flow rate and of being locked into position. The spray bar shall apply water uniformly across the full width of material. Blocked nozzles shall be cleaned immediately. When nozzles become blocked, operations will be stopped immediately until they are cleared. Lines shall not leak water.

An operational variation of 1% by weight in cement is allowed. The tolerance of 1% by weight is only intended to compensate for normal variations in plant operation. For aggregates and soils, the specifications allow an operational variation of 2% of the individual weight of each component; however, the total weight of the aggregate and soils shall be within 1% of the required weight of the total material.

MIXING SYSTEM

The Central Mix Plant mixing system shall be adequate to handle the production rate on the *Base Course Design for Central Plant Materials Mixtures*. It shall provide a uniformly blended material, showing no segregation. All paddles shall be in place and within the manufacturer's requirements for wear. The mixing chamber shall be equipped with a spray bar to provide uniform water spray to the material during mixing with volume and spray pattern adjusted to ensure that the material will be uniformly at the proper moisture content during compaction. Gates shall lock and not leak during mixing. To regulate the mixing time, the mixing system in a batch type plant shall be equipped with an automatic timing device that counts in seconds and is interlocked with the mixing system of the pugmill. For continuous type plants, to ensure a uniform blend, the feeder system shall be coordinated with the pugmill to match the feed rate to the mixing rate. The mixing rate is the speed at which the pugmill can uniformly mix and discharge the materials. The mixing system shall be arranged to discharge the material completely; no build-up shall occur in the mixing chamber. Material shall be discharged directly into haul trucks.

MATERIAL	MEASURING DEVICE ACCURACY	FEED TOLERANCE
Soil/Soil-Aggregate	0.05% (wt)	2% (wt)
Cement	0.05% (wt)	1% (wt)***
Water	1% (vol) 0.5% (wt)	**
Liquid Additive	3% (wt)	3%

*Individual aggregates and soils within 2% of individual weight.
Total weight of aggregate within 1% of total material weight.
**Must be accurate enough to ensure □2% of optimum at time of compaction.
***Tolerance for payment adjustment in accordance with Table 301-4 is not affected by this feed tolerance.

CALIBRATION AND FEED TOLERANCES

NOTE

Exceeding the feed tolerances will cause the inspector to require the contractor to discontinue operations. Varying within the limits of the feed tolerances can result in payment adjustments.

TRANSPORT

Stabilized, treated or raw material in transport shall be protected en route from loss of fines or moisture, contamination, and segregation. Cement stabilized or treated materials shall arrive at the project quickly enough for placement and compaction to be completed within the time frame established by the specifications.

PLANT LOT

A basic plant lot for central mix plant operation consists of a day's production of an individual plant from one mix design. When an acceptance test indicates that a payment adjustment for percent cement is required, the lot shall be terminated. A new lot number will be assigned for the material produced following adjustments by the contractor that result in a QC test showing successful correction. If a plant discontinues the day's operations before an acceptance test has been performed, acceptability and percent pay will be determined based on investigation of QC tests, knowledge of the plant's condition and performance, and other department tests necessary to evaluate the material (e.g., cement content, compressive strength). The department may unilaterally terminate a lot when inspection procedures, QC or acceptance tests indicate loss of control of the product or operation that may cause nonspecification material to be delivered to the project.

QUALITY ASSURANCE REQUIREMENTS

QUALITY CONTROL (QC)

Raw Base Course

For raw bases, the contractor is responsible for establishing a QC program that is approved by the project engineer. The contractor shall follow the approved plan. If failing results occur during LA DOTD testing, the contractor will be required to modify the QC program to ensure that failing results do not continue.

Treated Layer Under Asphaltic Concrete

Quality control operations must meet the requirements of Specification Section 305.

Cement Stabilized Base Courses

The contractor shall perform tests as needed to ensure that the plant continually operates within specifications. When separate materials are being blended to meet specification gradation, the contractor shall perform gradation testing on the composited material. Gradation testing shall be performed **at least twice each day** in accordance with DOTD TR 112 and DOTD TR 113. The results of each gradation test shall be documented. When gradation testing shows that there is a tendency for the composited material to move toward the outside limits of the gradation tolerances approved on the *Base Course Design for Central Plant Materials Mixtures*, the contractor shall make

corrections immediately to prevent the gradation from deviating from the approved design.

The contractor shall perform tests for moisture content in accordance with DOTD TR 403. Tests shall be performed on material in stockpiles and on the blended material discharged from the pugmill. Tests shall be performed at the beginning of each day's operation and at least twice more each day on both stockpile material and blended material. Tests for moisture content shall also be performed whenever the plant resumes operations after a period of discontinued operation or when the contractor or engineer believes a change has occurred in operations or materials. The moisture content of the stockpile material will determine the quantity of water to be added to the material as it is processed; the moisture content of the material discharged from the pugmill will determine if the correct quantity of water has been added to ensure that the Class I Base Course will be within □2% of optimum at the time of compaction. When the moisture content of the material being processed varies or when the Class I Base Course is not within □2% of optimum during compaction, **the contractor shall perform as many moisture content tests as necessary to produce a material that meets specifications**. When the contractor is not able to control moisture content to within □2% of optimum at compaction, the contractor shall discontinue operations.

The contractor shall check the percent cement being incorporated into the mixture at the beginning of each day's operation and at least four additional times each day. Tests for percent cement (TR 436) shall also be performed whenever the plant resumes operations after a period of discontinued operation. Cement shall be diverted for a specific time period, weighed, and compared to the required percent cement. Cement shall be diverted from the silo before it is placed on the belt. The testing of cement and the results of the tests shall be documented. Material produced during calibration or design shall not be sent to the project. Additionally, the contractor shall continually monitor the proportioning of the other individual components of the base course mixture. This shall include monitoring flow rates and weighing the material to check the calibration of the feeder system as often as necessary to ensure continuous production of the mixture approved on the *Base Course Design for Central Plant Materials Mixtures*. When materials are diverted, weighed and compared to the required percent cement, the tests shall be documented. When flow rate is interrupted, the calibration of the feeder system is altered, or the percentage of cement being incorporated varies from that approved on the *Base Course Design for Central Plant Materials Mixtures*, the contractor shall immediately discontinue plant operations. Corrections shall be completed, material produced conforming to the mixture approved on the *Base Course Design for Central Plant Materials Mixtures*, and the recommencement of operations approved by the engineer before additional material is delivered to the project.

It is the department's intention that the design percent cement be incorporated into the material. Although there is no payment adjustment for material with cement in excess of the design percent, such material with cement quantities more than 1% over required percent is not to be sent to the project site. The values for optimum moisture content will not be valid for extra cement; therefore, compaction problems may develop. If the contractor elects to add more cement than the design percent, additional testing must be performed to determine the optimum moisture content. **The additional cement shall not exceed 1% by weight; however, up to 1% more than design percent is acceptable**.

The contractor shall check the percent pulverization of the blended material discharged from the pugmill at least twice daily. The percent pulverization shall be performed in accordance with DOTD TR 431. The test results for pulverization shall be documented. When pulverization testing shows that there is a tendency for the composited material to move toward the outside limits of the specifications, the contractor shall make corrections immediately to prevent the mixture from deviating from the specifications.
The contractor shall set the plant controls at a production rate that will maintain a continuous operation. Because of the two-hour time limit for the completion of soil cement placement and compaction, **stop and go operations will not be allowed**. Plant operations shall be discontinued early enough in the day to allow the completion of final finish and application of the curing membrane at the end of the day's operations.

INSPECTION AND ACCEPTANCE

When central mix plant operations are used, DOTD construction personnel will inspect plant operations and the material for continual conformance to specifications. **Inspectors are to observe the operation of plant equipment and visually inspect the material.** Changes in production or the appearance of any individual component or the blended material are to be promptly investigated. Deficiencies in equipment are to be reported to the contractor and immediate repair required. Inspectors will perform tests on the blended material from the pugmill for gradation and pulverization and will check the percent cement and proportioning of materials. Test procedures used by the department will be the same as those to be used by the contractor for QC testing (Gradation for aggregates - DOTD TR 112 and DOTD TR 113, Pulverization - DOTD TR 431, Moisture Content - DOTD TR 403, Percent Cement - DOTD TR 436).

Acceptance tests for gradation will be performed whenever a gradation requirement is applicable. Tests will be performed whenever the gradation is questionable or whenever sand clay gravel or sand-shell is being blended from individual components. Gradation tests are to be performed at least once each day. When department tests show that the gradation deviates from specification tolerance, the contractor will be required to make immediate adjustments or discontinue operations.

Acceptance tests for pulverization will be performed at least twice per day. The results of these tests will be used to ensure that material that does not meet pulverization specifications will not be delivered to the roadway. When department tests show that the pulverization deviates from specification tolerances, the contractor will be required to make immediate adjustments or discontinue operations.

Acceptance tests for percent cement will be performed at least twice per day. The results of each test will represent the material delivered to the project since the previous acceptance test or beginning of the current day's operation. When department tests show that the percent cement varies from that approved for 100% payment, the contractor will be required to make immediate adjustments or discontinue operations.

Acceptance tests for proportioning of other individual components will be performed at least twice per day. The results of these tests will be used to ensure that material that does not meet the proportions approved on the *Base Course Design for Central Plant Materials Mixtures* will not be delivered to the roadway. When department tests show that the proportioning of components varies from that approved, the contractor will be required to make immediate adjustments or discontinue operations.

ROADWAY OPERATIONS

PLACEMENT AND SPREADING

Material shall be placed on the subgrade layer, constructed in accordance with Specification Section 305, and spread across the roadway and longitudinally up and down station to uniform thickness, without segregation, excessive moisture loss, or subgrade damage. **The addition of water during placement or spreading is prohibited.** Haul trucks shall not be allowed to travel across freshly placed or spread material. Therefore, the placing and spreading operation shall be planned and arranged so that this prohibition will not become a problem.

JOINT CONSTRUCTION

On soil cement base courses, transverse joints shall be formed by cutting back into the previous day's completed base course to sound material forming a vertical face for the total width and depth of the base course. The base course at the joint shall conform to the typical section shown on the plans. Fresh material from present construction shall be placed and uniformly compacted against the vertical joint face. All loose or broken material shall be removed from the joint area. Care is to be exercised to prevent joint areas from premature failure. Premature failure is a special problem at joints because they form a weakened plane in the base.

Transverse joint construction for bases composed of untreated or unstabilized materials shall be as directed by the engineer.

Class I Base Course shall be constructed for the full width of the roadway without longitudinal joints, unless specified or approved by the project engineer. When the construction of a longitudinal joint is approved, the joint area shall be trimmed to a vertical surface after compaction, but prior to final set. The longitudinal joint shall consist of sound, stable material, meeting specification requirements for base course density.

COMPACTION

Cement Stabilized Bases

For cement stabilized bases, initial compaction shall be performed with a conventional sheepsfoot roller or a self-propelled tamping foot compactor type roller. The weight of the roller shall be adequate to achieve penetration for the full depth of the base course on the first pass and to achieve specification requirements for density. If bridging occurs or full depth compaction is not achieved, the contractor shall immediately adjust the operation or replace the equipment.
After initial compaction and rough shaping, it will be permissible to apply water uniformly to the surface if necessary to prevent surface drying. The addition of water will require the approval of the engineer. If the application of water to the surface is allowed, it shall be done with a manifold system that uniformly spreads the water across the path of the water truck. **The addition of water to modify the moisture content of the base course will not be permitted. Optimum moisture must be controlled at the pugmill.**

Final compaction will be performed with a static pneumatic roller, except that a smooth steel wheel roller shall be used on stabilized sand shell. The surface shall be left in a reasonably smooth condition with no laminations, corrugations, dips or bumps. The compaction equipment shall leave the surface of the base course sufficiently above grade for the finishing equipment to achieve a proper, uniform grade and cross slope.

All compaction must be completed within the specified time limit or the base is unacceptable and construction processes will immediately be modified.

Treated Layer Under Asphaltic Concrete

Compaction shall meet the requirements of Section 305.

Raw Aggregate Base

Compaction requirements are the same as those for stabilized bases except that no time limit will apply. A vibratory roller may be used with approval when it is not detrimental to any portion of the roadway.

FINISHING

Cement Stabilized Base

When the final finish on the compacted Class I Base Course is completed using an automatic finishing machine, it shall be controlled from an erected stringline. The stringline and construction techniques must meet the requirements of **Erected Stringline,** Sections 501 or 502. The planer blades shall be set to establish plan cross slope; the erected stringline shall be set and the wire stretched so that final grade is at plan grade. The final surface shall exhibit no waves, dips, bumps, laminations, or high or low areas. Because curing membrane must be applied the same day as placement and compaction, the final finish must also be completed the same day as placement and compaction.

The specifications require that the manipulation (placement and compaction) of stabilized Class I Base Course be completed within two hours of initial mixing. Only final finishing, moist curing, and the application of asphalt curing membrane will be allowed on soil-cement after two hours. No traffic, including construction equipment (except equipment needed for the application of asphaltic curing membrane), shall be allowed on the base course after two hours. Asphalt distributors used for the application of curing membrane shall not be large enough to damage the partially cured base course. When time allows, low areas may be corrected using fresh material thoroughly blended with the in-place material by an approved in-place mixer meeting the requirements of Specification Subsection 303.03, compacted and refinished. Any corrected area will need to meet the same specifications as an area which did not require correction during operations. Laminated areas or areas exhibiting waves, dips, or other deficiencies which cannot be corrected with the automatic finishing machine will be removed and replaced with fresh material in the same manner as low areas. Bumps and high areas may be corrected with the automatic finishing machine.

No manipulation of the stabilized Class I Base Course will be permitted once two hours have elapsed from initial mixing. When time does not allow correction before or during finishing, correction shall be made after the curing period and shall be by an approved method conforming to the requirements Specification Subsection 301.16.

All corrections will require the approval of the engineer. Correction methods that may damage adjacent or surrounding Class I Base Course or other construction will not be permitted. Areas in which an attempt is made to correct a deficiency, but for which correction cannot be completed prior to the two-hour specification time limit, shall be reconstructed in accordance with Specification Subsection 301.16.

Raw Aggregate Base

Compaction requirements are the same as those for stabilized bases except that no time limit will apply. Water can be added for compaction purposes if excess water does not cause the underlying materials to deteriorate, and prime coat is used rather than curing membrane.

Treated Layer Under Asphaltic Concrete

Compaction shall meet the requirements of Section 305

QUALITY ASSURANCE

QUALITY CONTROL (QC)

Stabilized and Raw Base Course

The contractor shall observe the placement, spreading, compaction, and finishing operations and perform tests as needed to ensure that the base course meets all specification requirements. **The contractor shall make adjustments to correct deficiencies and maintain the project uniformly within specifications as soon as any deficiency is noticed. The specification time constraints of stabilized Class I Base Course do not allow the contractor the luxury of waiting for the department to direct that corrections be made. Prompt identification and correction of deficiencies will significantly lessen the contractor's risk of payment adjustments or costly reconstruction**.

The material shall be tested for moisture content in accordance with DOTD TR 403 during placement and compaction to ensure that the moisture content is within □2% of optimum at compaction. If the moisture content cannot be maintained within this tolerance, the contractor shall notify the plant to adjust the moisture content. If the problem persists, the plant is to be notified to discontinue sending material to the project until the moisture content can be controlled. **Material that does not conform to the specification tolerances for moisture content will not be evaluated for acceptance and shall be removed and replaced.**

The contractor shall check rough grade, thickness, and cross slope during placement, spreading and compaction to ensure that the completed base course will meet specification parameters, including density, after final finishing. Areas which may not meet department standards are to be corrected prior to final finishing.

The contractor is to perform density testing in accordance with DOTD TR 401 during the compaction process. The results of these density tests are to be used to establish rolling patterns, to evaluate the appropriateness of the equipment selected, and to ensure that the finished base course will meet the department's specifications for density.

The contractor shall actively look for nonuniform areas, such as varying thickness, segregation, wet spots, laminations, pumping areas, grade changes, warped cross slopes, excessive dusting, etc. which require correction. Such areas are to be corrected immediately.

Treated Layer Under Asphaltic Concrete

Quality assurance requirements of Section 305 shall be met.

INSPECTION AND ACCEPTANCE

Stabilized and Raw Base Course

Before the contractor begins operations, the project engineer, in conjunction with the district laboratory engineer, will establish 1000-foot sections for QC and acceptance. It is to be noted that bridges and exceptions and equations are not to be included in the continuity of 1,000 feet. All sections are to be approximately 1000 feet in length, with the exception of the first and last sections that may vary between 750 and 1250 feet in length. Section lengths will be measured and reported to the nearest foot and be delineated by station numbers and sketches, as needed. These sections will be used for all acceptance measurements and testing, including density and DOTD TR 602.

It is the responsibility of the department to inspect the project for conformance to specifications and good construction techniques. The department will observe the contractor's quality control program as part of the inspection process. **When deficiencies in the QC program are found, the inspector will require immediate correction or construction operations will be discontinued**. The department will independently inspect the project and perform tests as needed to ensure that the final project meets specifications.

Moisture content of the material being compacted will be checked **at least** twice each day in accordance with DOTD TR 403. Additional testing may be performed if excessive variations in moisture content at placement are noted. If the material is not within the specification tolerance, immediate correction will be required. The contractor will be required to modify the QC program to ensure that additional failing acceptance tests do not occur. Material that is not within the specification tolerance for moisture content at compaction will not be evaluated for acceptance and shall be removed and replaced.

The density of the completed base course will be checked in accordance with DOTD TR 401 once per each 1000 linear feet of roadway and once per each 2000 linear feet of shoulder. The results of these acceptance tests will determine the acceptability of the area represented by the test.
Grade and cross slope of the finished base course will be inspected for acceptance by project personnel. Areas that do not conform to the specifications will be isolated and correction will be required. Project personnel will measure the thickness and width of the base during construction in accordance with DOTD TR 602 and document these measurements in a field book set up for thickness and width measurements. Areas that do not conform to specification tolerances for plan thickness or width are to be isolated longitudinally and corrected for the entire width of the section. To isolate a deficient area, move up and down station five feet and retest. Then, test at 25-foot intervals until the limits of deviation from specification tolerance are identified. The district laboratory will determine thickness and width of the completed base course in accordance with DOTD TR 602 for final acceptance. The district laboratory engineer will notify the project engineer of areas that do not meet specification requirements. The project engineer will require the contractor to correct these areas. Additional thickness and width measurements will be taken by the district laboratory as necessary on the corrected areas prior to final acceptance. If the contractor elects to correct a deficient area by restabilizing, a new design will be required.

Deficiencies identified by visual inspection, such as laminations, dimensional deficiencies, soft areas, etc., shall be corrected before the section will be accepted.

Visual Inspection

It is the department's intent that courses be uniform and meet all specification requirements. Visual inspection is the most important method of determining if the completed work meets the department's standards of quality. The minimum testing requirements of the acceptance program reflect actual values of small, specified areas. Therefore, it is always mandatory that a strong visual inspection program be established and maintained during the construction process to guarantee that these acceptance tests do in fact represent a uniform product. Prior to final acceptance, the inspector will visually inspect the entire section. If visual inspection shows that the course is not uniform or that the test values may not be representative of the entire section, corrections will be required. Deficiencies identified by visual inspection, such as laminations, dimensional deficiencies, soft areas, etc., shall be corrected before the section will be accepted. **When deficiencies are identified by visual inspection, the section will not be accepted until they have been corrected, regardless of the results of routine acceptance tests.**

Treated Layer Under Asphaltic Concrete

Inspection and acceptance shall meet the requirements of Section 305

PROTECTION AND CURING

When traffic, including construction traffic, is allowed on the base course, and the surfacing is to be asphaltic concrete, at least the first lift of surfacing shall be placed within thirty days of the completion of the base course section.

Soil Cement, Cement Stabilized Sand Clay Gravel, Cement Stabilized Sand-Shell, or Treated Layer Under Asphaltic Concrete.

Immediately after finishing the base course, the contractor shall spray an asphalt curing membrane over the finished section in accordance with Specification Section 506. This membrane shall completely cover the finished base course. Complete coverage shall be maintained until the placement of the next course. Unless required by the department, no traffic, including construction traffic, shall be allowed on the base course for at least 72 hours after the application of the curing membrane. When traffic, including construction traffic, is allowed on the base course, at least the first lift of surfacing shall be placed within thirty days of the completion of the base course section.

Stone, Crushed Slag, or Recycled PCC

Immediately after finishing the base course, the contractor shall spray a prime coat over the finished section in accordance with Specification Section 505. This prime coat shall completely cover the finished base course. Complete coverage shall be maintained until the placement of the next course. Unless required by the department, no traffic, including construction traffic, shall be allowed on the base course for at least 72 hours after the application of the prime coat. When traffic, including construction traffic, is allowed on the base course, at least the first lift of surfacing shall be placed within thirty days of the completion of the base course section.

MAINTENANCE OF THE BASE COURSE

The contractor shall be responsible for the completed base course. It shall be protected from damage from public or construction traffic or construction operations. The contractor shall maintain the base course in the condition in which it was accepted until the next lift is placed. The contractor shall make any necessary repairs, including patching or reconstruction, and reapplication of the protective coating. For the first 72 hours after the completion of the base course, unless required by the department, no traffic, including construction traffic, shall be allowed on the base course. This period is designed to allow stabilized base course to develop adequate strength to support axle loads without structural damage and it allows the prime coat on raw base courses to cure without damage. All correction of deficiencies shall be completed at least 24 hours prior to the placement of the subsequent lift over the base course.

QUALITY ASSURANCE DOCUMENTATION

Tests and inspections required by the specifications, this manual, or other department publications must be documented. QA documentation for asphaltic concrete or Portland cement concrete when used as a Class 1 base course must meet the requirements of the appropriate application manual for Sections 501, 502, or 901. The department provides standard forms for documentation that are to be used by both contractor and department personnel, as specified. These forms are required in addition to field book entries and the Project Diary required of DOTD construction personnel. Forms are to be properly completed and, when indicated, submitted with the Form 2059 - Summary of Test Results. QA documentation verifies that the project has been built in accordance

with the contract, plans and specifications. Copies of QC documentation shall be provided to the project engineer as directed.

CENTRAL MIX PLANT CERTIFICATION REPORT

Plant certification is required when a central mix plant is used. District laboratory personnel will use the form, *Central Mix Plant Certification Report,* to document the certification inspection of central mix plants. The completed form is used for ninety-day review inspections or any intermediate inspections that may be required. Ninety-day review and intermediate inspections will be documented by date, remark and signature at the end of the form. The completed form will be kept on file at the district laboratory and a copy sent to the project engineer(s) receiving material from the plant, the DOTD Materials Engineer Administrator, and the contractor. Refer to Appendix page A-5 for a copy of the *Base Course Central Mix Plant Certification Report*. Notification of the certification of the plant will also be sent to the headquarters Construction Section.

SOILS/SOIL-AGGREGATE FORM AND AGGREGATE TEST REPORT

As dedicated stockpiles are being built, the material will be sampled and tested by DOTD personnel. When there are specifications requirements for the individual materials, test results will be documented on the *Soils/Soil-Aggregate* form (DOTD Form No. 03-22-0723) or the *Aggregate Test Report* (DOTD Form No. 03-22-0745) in accordance with standard department procedures. Gradations for material composites will be documented on the *Aggregate Test Report*.

BASE COURSE DESIGN FOR CLASS 1 STABILIZED BASE COURSE

CONTRACTOR'S PROPOSAL

When materials are composited and mixed at a central mix plant, the contractor shall submit the *Base Course Design* proposal to the district laboratory engineer for approval. The contractor shall complete the information for the Header, Materials, and Gradation (if applicable). The department will design, provide, and enter the additive rate. This information is derived from the test results documented during the approval process for dedicated stockpiles, included composited materials, and other documents provided by the department. When two or more soils are being composited and mixed, each stockpile will require individual approval. Once the stockpiles are approved, the mix design may be submitted with the proposed percentages of each for composite. Soil cement design, the percent cement, optimum moisture, and maximum dry density will be determined on the proposed composite. Refer to the *MATT System Manual Field Handbook* for MATT Codes. Note that the date first used and the project number are to be left blank by the contractor.

DEPARTMENT APPROVAL

The district laboratory will complete the *Base Course Design* form, recording the maximum dry density and optimum moisture content. A copy of the *Base Course Design* will be provided to the contractor and the project engineer. The *Base Course Design* is to be incorporated into the 2059 Review. If the design proposal is not approved, the district laboratory engineer is to sign the form, emphasize "not approved," enter the reason for disapproval in the remarks, and return the form to the contractor. **No mixture is to be delivered to the project until a mix design has been approved**; therefore, there will be no MATT entry of a disapproved mix design proposal.

DAILY CENTRAL MIX PLANT REPORT

The *Daily Central Mix Plant Report* is provided for the contractor to document routine testing at the central mix plant. It serves as both a worksheet and final documentation of plant operations. Department personnel will use the plant report as a worksheet during testing. The contractor's *Daily Central Mix Plant Report* is to be kept on file at the plant and made available for review by DOTD personnel upon request. All *Daily Central Mix Plant Report* forms completed by DOTD personnel for the project shall be provided to the project engineer for inclusion with Form 2059.

GRADATION AND SOIL PROPERTIES

If more than one material is used to create a composite for the soil or aggregate portion of the base, the contractor shall perform gradation testing to ensure that the materials in the stockpile match the gradations shown on the *Base Course Design* and, when mixed, create a material which meets specification requirements.
The contractor shall set the cold feed system from this data. The gradation of the material composited from the cold feed and sampled from the belt, shall meet the gradation requirements, when applicable. Sampling of aggregates shall be performed in accordance with DOTD S-101 at the minimum frequency stipulated in the *Materials Sampling Manual*.

When the soil component of the base course is a composite of more than one soil, the composite shall be checked to ensure that it uniformly meets the parameters shown on the *Base Course Design for Central Plant Materials Mixtures*. The contractor shall check for QC and the department for acceptance.

The data required by specifications shall be documented on the *Daily Central Mix Plant Report*. Gradation shall be checked at least twice per day. Refer to Appendix, page A-19.

PROPORTIONING OF COMPONENTS

The cold bin feed percentages shall be checked against the percentages approved on the *Base Course Design* form. The actual bin percentages shall be reported on the *Daily Central Mix Plant Report*. Proportions of all components shall be checked each time cement content is checked. Proportions are to be checked in accordance with DOTD TR 436.

ADDITIVE CONTENT

The actual percentage of cement being incorporated into the mixture shall be checked and compared to the approved percentage from the *Base Course Design*. Following the test, the actual percentage shall be recorded on the *Daily Central Mix Plant Report* for the initial truck. The percent cement shall be checked at the beginning of each day's operation and at least four more times each day by the contractor. Additionally, whenever the plant discontinues operations during a day, the percent cement shall be rechecked when operations are resumed. These checks shall be performed by the contractor for QC and by the department for acceptance at the minimum frequency stipulated in the *Materials Sampling Manual*.

QC results are to be entered only when a test is performed. When new QC tests are performed, they are to be documented on the form, indicating the test number, time, and load number of the material from which the test sample was taken. Test results are to be entered on the form on the next truckload after results are obtained. When there is no test data to be entered, the certified technician is to check the appropriate block regarding design criteria and sign the form. The signature indicates that there have been no changes in production since the last QC test.

MOISTURE CONTENT

Prior to beginning daily operations, the contractor's certified inspector shall determine the moisture content of stockpile material. This moisture content shall be used to adjust the amount of water to be added to the mixture. Once operations have begun, the moisture content of the material from the pugmill discharge shall be checked to ensure that the moisture in the mix at the time of compaction will be within the specification range of □2%. Moisture content of the blend shall be checked at the beginning of each day's operation, when operations are resumed after a discontinuance, and at least two more times each day. This moisture content data is to be recorded on the *Daily Central Mix Plant Report*.

ACCEPTANCE TESTS

Tests for percent cement, moisture content, and pulverization will be documented on the *Daily Central Mix Plant Report* by the DOTD inspector. The contractor's Certified Technician is to review the form and sign it to indicate that this review has taken place.

CERTIFICATE OF MATERIAL PROPORTIONS (HAUL TICKET)

Central Mix Plant

The *Certificate of Material Proportions for Base Course* is used by the contractor's certified technician to document testing at the plant. The form is to be completed by the contractor's certified technician for each truck and updated each time a QC test is performed. The contractor's certified technician shall summarize the results of the most recent tests from the *Daily Central Mix Plant Report* as required on the *Certificate of Material Proportions for Base Course*. The "Lot No." shown on the form refers to the "plant lot." The load numbers will be consecutive per plant lot. The department will control the assignment of lot numbers. The lot number will correlate to the lot number shown on the *Daily Central Mix Plant Report*. The original *Certificate of Material Proportions for Base Course* completed by the contractor's certified technician is to be given to the driver of each hauling unit. The driver is to give the completed form to the DOTD inspector at the job site. The contractor's technician is to keep at least one copy of each *Certificate of Material Proportions for Base Course* at the plant for the review of department personnel.

The inspector at the project site will use the *Certificate of Material Proportions for Base Course* to document the location of material on the project. The location of material to which a payment adjustment will apply must be identified to determine the final percent

pay for each section. The beginning and ending stations of each lot must be documented. The location of any material placed on the project that does not meet specification requirements is to be documented for later correction. Refer to page A-21 for a reprint of the *Certificate of Material Proportions for Base Course*.

DENSITY & MOISTURE CONTENT WORKSHEET

The test procedure DOTD TR 401 - The Determination of In-Place Density, contains a worksheet to be used to facilitate the calculations associated with the determination of density, moisture, and pulverization. This worksheet is to be completed in conjunction with this procedure and used for these calculations. Department personnel will submit this form for acceptance testing regularly to the district laboratory for MATT system entry. The district laboratory will retain the original for inclusion in the 2059 Review. A copy of the documentation of QC tests and results shall be given to department personnel as noted on page 4. The percent pay for density will be completed for treated or stabilized base only.

PAYMENT

For asphaltic concrete or Portland cement concrete, refer to Section 501, 502, or 901 and the applicable *Quality Assurance* manual.

For treated subgrade layer refer to Section 305.

ACCEPTANCE WITHOUT PAYMENT ADJUSTMENT

Acceptance criteria other than payment adjustments apply to Class I Base Course. If the section does not meet specification requirements for depth, width, grade, cross slope, percent moisture at compaction, pulverization, or other deficiencies identified through visual inspection, the deficiency must be corrected by the contractor at no direct pay in accordance with Specification Section 301. Corrections must be completed, inspected and approved in accordance with the timetable established by the engineer prior to the final documented acceptance of the course.

ACCEPTANCE WITH PAYMENT ADJUSTMENT

Stabilized base has payment adjustments attached for both percent cement and percent density per section. **These payment adjustments are cumulative for stabilized base.** Raw base has a payment adjustment attached for percent density per section. Payment for a section to which a payment adjustment is applicable for both parameters will be made at a combined adjustment in pay, as shown in the following example.

EXAMPLE OF CUMULATIVE PAYMENT ADJUSTMENT - PER SECTION

Percent Pay - Density: 90% (10% reduction in pay)

Percent Pay - Cement : 80% (20% reduction in pay)

Cumulative Reduction in Pay: 30%

Therefore, payment for this section will be made at 70% (100% - 30% = 70%) of the contract unit price.

When a deficiency in cement content causes production to be discontinued partway through a section, the percent payment for the section will be adjusted to reflect the failing portion for cement rate, as shown in the following example. When the payment adjustment is for insufficient density, the adjustment shall be applied to the entire section.

EXAMPLE OF CUMULATIVE PAYMENT ADJUSTMENT - PARTIAL SECTION (ROADWAY) AFFECTED BY CEMENT

Percent Pay - Density: 90% (10% reduction in pay for 1000')

Percent Pay - Cement : 80% - (20% reduction in pay - applies to 350 linear feet {7% reduction in pay for 1000'})

$$\frac{350}{1000} \times 20 = 7\% \text{ pay reduction for } 1000'$$

Cumulative Reduction in Pay: 17%

10% (density reduction) + 7% (cement reduction for section) = 17% total reduction for section

Therefore, payment for this 1000-linear foot section will be made at 83% (100% - 17% = 83%) of the contract unit price.

REMOVAL AND REPLACEMENT OF STABILIZED BASE

Any failing section will require documentation and a plan change for acceptance below the 100% payment level. The documentation will consist of the project engineer's statement of disposition of failing material to be incorporated in the 2059 Review.

When the payment adjustment for either density or cement is in the 50% or remove category, the department will investigate and may require that the material be removed and replaced. When removal is caused by failing density, the material shall be removed for the full width of the roadway for the entire length of the section. When removal is caused by failing cement, the material shall be removed for the full width of the roadway for the entire length of the plant lot placed in the section.

When the cumulative payment adjustment is less than 50%, the entire section shall be removed and replaced with central mix processed material.

CLASS II BASE COURSE - Section 302

Class II Base Courses are similar to Class I Base Courses, with the exception that placement on a subgrade layer built in accordance with Specification Section 305 is not required. Also, central plant mixing is not always required for cement treated Class II Base Courses. When construction is in a dust sensitive area and cement treated Class II Base Course is to be constructed, central plant requirements will be specified in the project plans. **When central plant mixing is necessary or is elected by the contractor, the requirements of Class I Base Course, Specification Section 301, will apply, except that a subgrade layer may not be required.**

In locations where normal construction practices for soil cement, cement treated or aggregate base are seriously impeded, the project engineer may allow the contractor to use asphaltic concrete conforming to Specification Sections 501 or 502 or Portland cement concrete conforming to Specification Section 901 in lieu of the Class II Base Course type selected for the project. Such concrete construction shall be performed in accordance with Specification Section 706 and shall be of the same thickness and width as the base course shown on the plans.

MATERIALS

For general information about materials for Class II Base Course, refer to **Class I Base Course**. In addition to the materials listed for Class I Base Course, both shell and sand-shell without treatment are permissible for use in Class II Base Course. The requirements of soil for soil cement are modified from Section 301 by increasing the P.I. to a maximum of 15. Additionally, asphaltic concrete is placed on an embankment layer rather than a treated layer. The embankment layer must meet the same requirements as the top layer of embankment in accordance with Section 203.

STORAGE AND HANDLING OF MATERIALS

STOCKPILES

Aggregates, to be used in Class II base course shall be placed in dedicated stockpiles. For regulations for dedicated stockpiles, refer to page 10. No segregation or significant variance in moisture content shall occur during the building of the stockpile and subsequent handling of the material. When two or more materials are to be composited and mixed, the individual materials are to be placed in separate stockpiles and maintained so that the resulting blend meets specification requirements. The removal of material is not to cause contamination, segregation or any other change in the quality of the stockpile.

CEMENT

Cement to be used for Class II Base Course shall be delivered in weather tight, sealed transports. A Certificate of Delivery shall accompany each transport.. It shall be the responsibility of the contractor to verify that the transports are sealed and that the seal number matches that indicated on the Cement Certificate of Delivery. Seals shall be removed and turned over to the project engineer daily.

DESIGN

As part of the design process, all materials for Class II Base Course will be subject to the determination of optimum moisture and maximum density in accordance with DOTD TR 415 or TR 418 It shall be the responsibility of the contractor to provide materials which meet specification requirements. When cement is to be added to soil or soil-aggregate and the percent cement is not included in the contract specifications, the department will determine the cement content. **If it is necessary to perform a method other than DOTD TR 432 - Method A to determine the percent cement needed to stabilize the base course material, normal testing time to determine the percent cement may require the maximum allowed by specifications.** When Type II or Portland-pozzolan cement is to be used, Method A will not be used. When soils are to be stabilized or treated with cement, the district laboratory engineer will determine which method of test is appropriate. The district laboratory or the Materials and Testing Section will perform cement design at the department's option. Design shall be performed on samples submitted by the project engineer from material in-place on the roadway after all blending and initial compaction to 93% of maximum density is completed. **The percent cement for sand clay gravel and sand-shell will be as specified**.

Maximum dry density and optimum moisture content for the determination of 93% density will be determined in accordance with DOTD TR 415 or DOTD TR 418 as applicable.

When materials are to be cement treated or stabilized and no percentage is specified in the contract, the cement factor to be used will be determined by the district laboratory and will be based on strength. It is the responsibility of the contractor to advise the district laboratory engineer and the project engineer of the type of cement to be used for stabilization (Type I, IB, II, or IP). The district laboratory will use the same type of cement to determine the cement factor. If the contractor does not inform the district laboratory of the type of cement to be used, the cement factor will be determined using Type IB. The contractor will then be required to use Type I or IB for stabilization or treatment. If the contractor does not use Type 1 or 1B, operations will be delayed until the district laboratory can determine a new cement factor.

If the soil for soil cement is not naturally occurring, or cement other than Types I or IB are used, design will be in accordance with DOTD TR 432 – Method A.

Design will also be necessary when a cement-stabilized or treated area is to be corrected by restabilization or retreatment.

TRAFFIC CONTROL

When local or through traffic is allowed and in-place mixing of cement is in progress, the contractor shall develop a system of control that will minimize the movement of cement on the surface prior to mixing, for the approval of the project engineer. When possible, traffic is not to be allowed to traverse the unmixed cement. Traffic will create nonuniformity in cement application, excessive dusting and material loss, thus affecting the required cement factor. If traffic displaces cement, a uniform spread shall be redeveloped prior to blending by the in-place mixer. When traffic is maintained, the contractor shall control the operation to maintain the free flow of traffic through the project. Equipment shall not obstruct the steady flow of traffic.

EQUIPMENT

All equipment for the in-place mixing, compaction, and finishing of Class II Base Course shall be approved prior to use. Project personnel shall inspect the equipment daily prior to use. Equipment shall be in good working condition and shall not leak fluids onto the grade or roadway. Equipment initially approved for use shall continue to conform to the standards upon which this approval is based. When approved equipment fails to meet these requirements, it shall be not be used until repairs are made and approval reinstated. Back-up equipment required by the specifications is to be inspected and is to meet the same requirements as the primary equipment or is not to be approved. Operations shall not begin until both primary and back-up equipment have been approved. Central mix plant equipment, finishing and compaction equipment shall conform to the requirements listed under Class I Base Course.

When in-place mixing is used, equipment shall conform to the requirements of Specification Subsection 303.03. Equipment shall spread cement at the calculated rate that will ensure that the required cement factor is met. It shall be operated to distribute cement over the prepared surface at a uniform rate for the full length and width of the spread, without excessive dusting. If excessive dusting occurs, central plant mixing may be necessary. Excessive dusting also indicates that the minimum cement factor is not being met due to material loss. If the equipment cannot be recalibrated and adjusted properly, replacement will be required. Back-up equipment must meet the same requirements as the primary equipment. If the primary equipment is replaced with the back-up equipment and the spreading problem is not corrected, operations will be discontinued until additional equipment is provided, inspected and approved.

Finishing equipment used with central mix plant operations shall meet the requirements of Class I Base Course, except that the automatic grade machine and erected stringline will not be required. Class II Base Course shall be finished to a tight, uniformly smooth surface meeting the grade and cross slope requirements of the specifications.

CEMENT SPREAD RATE

It shall be the responsibility of the contractor to check the spread rate and determine the length of spread for each transport to be certain that the minimum cement factor is being met in accordance with DOTD TR 436. It will be the responsibility of the inspector to check the spread rate at the minimum frequency designated in the *Materials Sampling Manual*. The inspector will also verify the length of spread several times per day or whenever the spread rate is not correct.

The method of test and calculations for spread rate and length of spread are to be performed and documented in accordance with DOTD TR 436.

QUALITY ASSURANCE

QUALITY CONTROL (QC)

ASPHALTIC CONCRETE AND PORTLAND CEMENT CONCRETE

When asphaltic concrete or Portland cement concrete are used to construct a Class II Base Course, QC requirements will be in accordance with the applicable part of the specifications and the applicable *Quality Assurance Manual*.

SUBGRADE LAYER

When a subgrade layer is specified, the QC requirements will be the same as Section 305.

RAW BASE COURSE

When raw base course is placed, the QC requirements will be the same as for stabilized base course, with the exception of the stabilization process.

STABILIZED OR TREATED BASE COURSE

When central plant mixing is used, the QC requirements of Class I Base Course, Specification Section 301 will apply.

Specifications require that the contractor conduct a quality control program on Class II Base Course. The contractor is required to perform adequate testing to ensure that the materials being used and the course being constructed meet specification requirements for 100% payment.

It is expected that contractor quality control personnel will communicate with the department's inspectors continually during the construction process regarding the results of the QC program and the results of QC tests. It is not acceptable for the contractor's personnel to perform QC tests and complete documentation at a later date. Should the QC program identify a deficiency, it is the responsibility of the contractor's QC personnel to inform the department immediately and to provide the department's representative with information regarding the corrective measures to be taken, both for the failing material and to prevent the recurrence of the deficiency.

The contractor shall select and furnish material that conforms to Specification Subsection 302.02 and will stabilize with cement. The department will not sample or test the material which the contractor proposes to use until it is in-place on the project; therefore, it is critical that the contractor be certain that the material will be approved for use by the department before beginning placement. If the material does not meet specifications or will not stabilize with cement when tested by the department, the contractor will be required to remove the failing material from the project and replace it with new material meeting department approval. Such

removal and replacement will be at no direct pay. It is to be noted that the specifications prohibit the mixing of material which does not meet specifications with material which does meet specifications, even if the resulting blend meets specifications. **Material which does not conform to all requirements of Specification Subsection 302.02 or will not achieve the required strength when stabilized or treated with cement when tested by the department shall not be incorporated into a project.**

Placement of Base Material

The contractor shall control the placement of base material to ensure that there is sufficient material to finish the roadway and/or shoulders to plan width, thickness, grade, cross slope, and alignment.

Density Before Mixing With Cement

After the raw base material has been uniformly blended and compacted and the roadbed shaped to cross slope and grade, the density is to be checked in accordance with DOTD TR 401. The density of the untreated base must meet a minimum of 93% of maximum dry density. This initial compaction will help to ensure that uniform depth of cut is maintained, grade and cross slope requirements are met prior to stabilization, and that final compaction deficiencies are minimized. Additionally, all soft or excessively wet spots shall be located and repaired. **No cement shall be spread until all deficiencies are corrected and the 93% density requirement has been met.**

The 93% density requirement is very important in locating any areas under the material to be stabilized that are subject to cause density problems during compaction and finishing of the base. Materials that are soft, even at depth, have high moisture contents, high organic contents, or objects such as logs or stumps may cause the soil to be unstable. If 93% is unobtainable these conditions can be located and repaired prior to spreading cement. These density tests provide insurance that construction effort and cement are not wasted.

Pulverization

Soil cement mixtures shall be pulverized until specification requirements for pulverization are met; however, the time limit for mixing and compacting shall not be exceeded. The department will test for pulverization conformance to specifications after the addition of cement and water and prior to compaction. **It is advantageous for the contractor to ensure pulverization requirements will be met during in place mixing while he is shaping, blending, and compacting to 93% density before any cement is spread.**

Weather Limitations

Both contractor and department personnel are to be constantly aware of predicted weather conditions. Cement shall not be placed in preparation for mixing when the base is frozen, ambient temperature is below 35^{O}F (1.7^{O}C), temperature from the nearest weather forcasting station is to be 25^{0}F or less within the 24 hour period following placement, or during rain. This

information is also available from the DOTD, Maintenance Engineer. Ambient air temperature shall be determined in the area of operations, out of direct sunlight, and away from artificial heat. If the base is too wet to effectively get the base uniformly within the □2% moisture content tolerance, no cement shall be placed. The project engineer will determine if the base is too wet to begin placement. It is recommended that the project engineer not allow the contractor to spread cement if the moisture content of the base is greater than 2% above optimum. It is imperative that operations be scheduled and monitored to ensure that these conditions do not occur during production. When inclement weather is predicted, the contractor is to monitor operations to prevent operations from being interrupted by weather conditions. If the base material cannot be maintained within the specification range of optimum moisture content due to weather conditions, placement of cement will not be permitted. Additionally, the contractor should not produce mixture during borderline weather conditions that may have a detrimental effect on construction operations or materials. When scheduling operations, the contractor and the department's representative are to consider such factors as speed of cement placement, mixing time, compaction and finishing, current temperature and weather, past weather conditions (e.g., standing water, wet subgrade, excessively dry conditions, etc.), predicted weather changes (e.g., approaching weather fronts, winds, temperature changes, rain, changes in humidity, etc.).

If despite precautions for inclement weather, rain falls on freshly spread cement or base material mixed with cement prior to the completion of compaction, the inspector will document the affected area. Immediately after completion of compaction, new moisture content tests will be taken after rain to determine if the material is within the □2% specification tolerance of optimum. After 7 days the area will be cored and tested for percent cement and strength. If the area does not meet design requirements, the area shall be restabilized or retreated in accordance with the specifications at no direct pay.

Moisture Content After Initial Compaction and Prior to Spreading Cement

The contractor shall determine the moisture content of the base prior to spreading cement. DOTD TR 403 shall be used to determine this moisture content. This moisture content may be used to plan construction activities to complete preparation of base material to receive cement. If there is a delay between the moisture content test and cement placement, additional moisture tests may be required to determine if the moisture content of the prepared base has been altered during the delay. The moisture content of the base material prior to spreading cement must be within a range that will ensure that the material will be within the □2% of optimum at compaction after mixing with cement. If the moisture content of the base is greater than 2% above optimum, it should be considered too wet to produce a finished product that meets specifications in terms of moisture content at compaction. The moisture content determined during density testing may not reflect the moisture content throughout the base course; therefore, additional moisture tests may be required to ensure that the base material is within the □2% tolerance of optimum. **Moisture content determined with the nuclear device shall not be used for moisture control**.

Spreading Cement

Cement shall be spread from transports through approved, calibrated, mechanically adjustable spreader boxes. The spreader box shall be adjusted to provide a uniform coverage at the cement spread rate determined in accordance with DOTD TR 436. In addition to a stringline for alignment guidance, the contractor shall define the edge of cement spread on each side of the roadway by a stringline or other method approved by the engineer. The coverage shall be uniform for the full width of the roadway and the full length of spread for a transport. The appropriate length of spread for a transport will be determined in accordance with DOTD TR 436. If traffic displaces cement, a uniform spread shall be redeveloped prior to blending by the in-place mixer. In no case shall less than the minimum required percent cement be spread.

Cement Spread Rate and Length

It shall be the responsibility of the contractor to check the spread rate and length of spread for each transport to be certain that at least the minimum cement factor is being met. The contractor is to provide these values to the project engineer for approval. No cement is to be placed until the spread rate and length of spread have been approved.

In-Place Mixing

The cement is to be mixed with the base material for the full depth and width of the course at the appropriate moisture content. It is recommended that mixing be done in at least three passes of the in-place mixer. No water shall be added during the first pass, which will accomplish blending and pulverization. Additional passes without water should be made, if needed, to achieve uniform blending and pulverization. Water shall be added through the in-place mixer during subsequent passes, if needed to bring the moisture content within the □2% range of optimum. Additional passes shall be made as needed to achieve a uniform blend of base material and cement at a uniform moisture content. The moisture content should be on the high side of the □2% range to be sure the base is within the proper range at compaction. When water is added to the base during mixing, it shall be added through the spray bar on the in-place mixer. Water spray shall be uniform at all times; no clogged nozzles will be allowed. There shall be no overlap of water spray between passes. Spray nozzles shall be blocked if necessary. There are to be no dry areas between side-by-side passes of the in-place mixer. The cutting operation is to be slightly overlapped.

Moisture Content After Mixing with Cement

The contractor shall determine the moisture content of the individual base course section prior to spreading cement. Moisture content shall be determined in accordance with DOTD TR 403. **Moisture content determined with the nuclear device shall not be used for moisture control**. The moisture content of the section is to be adjusted during stabilization to ensure that the material is within the □2% of optimum at the time of compaction. If the moisture content of the section is excessive, the base is to be aerated until the material will meet these requirements. The three-hour time limit for the completion of placement, spreading, mixing and compacting the base must be considered when planning operations. Specifications require that compaction be completed within three hours of initial soil-cement contact; therefore, the time for aeration is limited. The three-hour time limit ends after final rolling for compaction. When the contractor must adjust the moisture content of the material to bring it into specification

tolerances, the contractor shall back up operations and adjust the moisture content to meet specifications in deficient areas. It shall be the responsibility of the contractor to conduct additional moisture tests to determine the effectiveness of aeration. If the moisture content is too low, water shall be added through the in-place mixer to bring the base within the □2% tolerance. When there is a question about moisture content, DOTD TR 403 will be used as the standard.

Protection and Curing

Immediately after finishing the base course, an asphalt curing membrane shall be sprayed over the finished section in accordance with Specification Section 506. The asphaltic curing membrane is to be placed on the same day the area is stabilized, except the membrane on the last two transports cut may be placed the following morning if the base is kept in a uniformly moist condition. This membrane shall completely cover the finished base course and complete coverage shall be maintained until the placement of the next course. Unless required by the department, no traffic, including construction traffic, shall be allowed on the base course for at least 72 hours after the application of the curing membrane. When the surfacing is asphaltic concrete, the first lift of shall be placed within 30 calendar days. If there is any delay between sealing the base and applying the curing membrane, the surface shall be kept uniformly moist by the application of water.

Maintenance of the Base Course

The contractor shall be responsible for the completed base course. It shall be protected from damage from public or construction traffic or construction operations. The contractor shall maintain the base course in the condition in which it was accepted until the next lift is placed. The contractor shall make any necessary repairs, including patching or reconstruction, and reapplication of the protective coating. For the first 72 hours after the completion of the base course, unless required by the department, no traffic, including construction traffic, shall be allowed on the base course. This period is designed to allow the base course to develop adequate strength to support axle loads without structural damage. All correction of deficiencies shall be completed at least 24 hours prior to the placement of the subsequent lift over the base course. The contractor shall correct raveled areas immediately and take steps to ensure that additional raveling will not occur.

INSPECTION AND ACCEPTANCE

VISUAL INSPECTION

It is the department's intent that courses be uniform and meet all specification requirements. The minimum testing requirements of the acceptance program reflect actual values of small specified areas. Therefore, it is always mandatory that a strong visual inspection program be established and maintained during the construction process to guarantee that these acceptance tests do in fact represent a uniform product. Prior to placement of the next lift, the inspector will visually inspect the entire section. If visual inspection shows that the course is not uniform or that the test values may not be representative of the entire section, additional tests may be performed and deficiencies shall be corrected. **Deficiencies identified by visual inspection, such as laminations, dimensional deficiencies, soft areas, etc., shall be corrected before the section will be accepted.**

It is the responsibility of the department to inspect the project for conformance to specifications and good construction techniques. The department will observe the contractor's quality control program as part of the inspection process. **When deficiencies in the QC program are found,**

the inspector will require immediate correction or construction operations will be discontinued. The department will independently inspect the project and perform tests as needed to ensure that the final project meets specifications. Cement stabilized or treated bases not compacted within the specification time limit will not be accepted. Reconstruction will be required after a new design is approved.

DENSITY BEFORE MIXING WITH CEMENT

After the base material has been uniformly blended and compacted and the roadbed shaped to cross slope and grade, the density is to be checked in accordance with DOTD TR 401. The density of the untreated base must meet a minimum of 93% of maximum dry weight density. This initial compaction will help to ensure that uniform base course depth is maintained, grade and cross slope requirements are met prior to stabilization, and that final compaction deficiencies are minimized. Additionally, all soft or excessively wet spots shall be located and repaired. **No cement shall be spread until all deficiencies are corrected and this density requirement is met.** Density will be checked once per each 1000 linear feet of roadway and once per each 2000 linear feet of shoulder.

When a soil or soil-aggregate with less than 20% aggregate is being used and DOTD TR 415 is used to determine maximum dry density, both QC and acceptance moisture and density testing will be in accordance with Section 203 of this manual.

CEMENT SPREAD RATE AND LENGTH

It will be the responsibility of the inspector to check the spread rate in accordance with the minimum frequency in the *Materials Sampling Manual*. The inspector will independently determine spread rate and length of spread. The calculations for spread rate and length of spread are to be performed and documented in accordance with DOTD TR 436.

PULVERIZATION

Soil cement mixture shall be pulverized until specification requirements for pulverization are met; however, the time limit for mixing and compacting shall not be exceeded. The department will test for pulverization conformance to specifications after the addition of cement and water and prior to compaction.

MOISTURE CONTENT

RAW BASES

Moisture content shall be uniform throughout the base and at or near optimum at compaction to ensure uniform density meeting the requirements of the specifications.

PRIOR TO SPREADING CEMENT

Department personnel will check the base material to ensure that all materials are blended to a uniform moisture content. All wet areas should be detected and corrected. Tests for moisture content will be taken to validate quality control testing.

AFTER SPREADING CEMENT

The department will check the moisture content of the material being compacted in each section at the time of compaction in accordance with DOTD TR 403. If the material is not within the specification tolerance, immediate correction will be required. The contractor will be required to adjust operations to ensure that the moisture content for subsequent sections will meet specification requirements. The contractor will be required to modify the QC program to ensure that additional failing acceptance tests do not occur.

DENSITY

Density of both cement stabilized or treated bases and raw bases will be checked for acceptance after compaction in accordance with DOTD TR 401. The maximum dry density, determined in accordance with DOTD TR 415 or TR 418, will be used to determine the percent of maximum density for final payment. The application of DOTD TR 415 *Family of Curves* for final density acceptance testing is not allowed for Class II cement stabilized or treated base course.

GRADE, CROSS SLOPE, THICKNESS AND WIDTH

Grade and cross slope of the finished base course will be inspected for acceptance by project personnel at locations and at a frequency determined by the engineer. Areas not in conformance with the specifications will be isolated and correction will be required.

Project personnel will measure the thickness and width of the base during construction in accordance with DOTD TR 602 to verify the contractor's QC and will document these measurements in a field book set up for thickness and width measurements. Areas not in conformance with specification tolerances for plan thickness or width are to be isolated and corrected. The district laboratory will inspect thickness and width in accordance with DOTD TR 602 for final acceptance. The district laboratory engineer will notify the project engineer of areas that do not meet specification requirements. The project engineer will require the contractor to correct these areas. Additional thickness and width measurements will be taken by the district laboratory as necessary on the corrected areas prior to final acceptance. If the contractor elects to correct a deficient area by restabilizing or retreatment, the district laboratory engineer will determine a new cement content and optimum moisture content. To isolate a deficient area, move up and down station five feet and retest. Then, test at 25-foot intervals until the limits of deviation from specification tolerance are identified.

QUALITY ASSURANCE DOCUMENTATION

GENERAL

All tests conducted shall be recorded on the standard DOTD form applicable to the test and retained in accordance with department requirements to develop a complete history of the quality of construction on the project. These documents are to be available to authorized individuals at all times.

When asphaltic concrete base course is used, the documentation requirements for Part V of the specifications will apply. When Portland cement concrete is used, the documentation required for specification sections 706 and 901 will apply.

When a subgrade layer is specified the documentation requirements for Section 305 will apply.

When a central mix plant is used to produce stabilized or treated base course, the documentation requirements for Class I Base Course will apply.

When in-place mixing is used to produce a stabilized or treated base course, the documentation requirements for Section 303 will apply..

When the base course being constructed is raw aggregate the documentation requirements of Section 301 will apply.

There are no cumulative payment adjustments in Section 302. The only specification requirement for acceptance with a payment adjustment is density of the completed base course. The contractor shall correct any other criteria and raw base course density that do not meet specification requirements before the base is accepted.

QUALITY CONTROL

The contractor shall determine the moisture content of the material prior to spreading cement to identify the construction processes necessary to bring the material into specification requirements for moisture content at compaction. Moisture content testing shall be performed in accordance with DOTD TR 403.

CONTRACTOR DOCUMENTATION

Specifications require that the contractor conduct a quality control program on Class II Base Course. The contractor is required to perform adequate testing to ensure that the materials being used and the course being constructed meet specification requirements for 100% payment. It shall be the responsibility of the contractor to conduct all QC testing as required by the project and district laboratory engineers. It is the responsibility of the contractor to document the performance and results of QC tests. Copies of this documentation shall be made available to the project engineer as tests are taken. It is expected that contractor quality control personnel will communicate with the department's inspectors continually during the construction process regarding the results of the QC program and the results of QC tests. It is not acceptable for the contractor's personnel to perform QC tests and deliver documentation at a later date. Should the QC program identify a deficiency, it is the responsibility of the contractor's QC personnel to inform the department immediately and to provide the department's representative with information regarding the corrective measures to be taken, both for the failing material and to prevent the recurrence of the deficiency. All corrective procedures shall be documented and upon completion the contractor shall advise the project engineer of what action was taken and the outcome.

INSPECTION AND ACCEPTANCE

DENSITY AND MOISTURE CONTENT WORKSHEET

The test procedure DOTD TR 401 - The Determination of In-Place Density, contains a worksheet to be used to facilitate the calculations associated with the determination of density, moisture, and pulverization. This worksheet is to be completed in conjunction with this procedure and used for these calculations. Department personnel will submit this form for acceptance testing regularly to the district laboratory for MATT system entry. The district laboratory will retain the original for inclusion in the 2059 Review. A copy of the documentation of QC tests and results shall be given to department personnel.. Theoretical dry density and optimum moisture content will be obtained from DOTD TR 415 or TR 418 test results. The percent pay for density will be completed for treated or stabilized base only. Raw base courses having density values less than the minimum required shall be recompacted until the required density is achieved. All density tests are to be recorded on the worksheet and submitted.

FIELD BOOK

Thickness, width and cross slope are to be documented in a field book.

IN-PLACE CEMENT STABILIZED BASE COURSE - Section 303

In-place cement stabilized base course is intended for the reconstruction of existing roadways in which the department provides the base material already in-place. This work is defined in Specification Section 303. If insufficient material exists on the roadway to meet grade and cross slope or the existing material will not stabilize, the contractor will be required to provide additional material and construct the base in a manner similar to that required for Class II Base Course. When the contractor must supply additional material to be blended with existing in-place materials, the resulting blend creates unique soil problems that must be considered in base design. It is important to note that materials supplied by the contractor must meet the requirements of Section 302; however, these materials will be paid for under Section 203.

When the existing surface is asphaltic concrete, to construct an in-place cement stabilized base course the contractor shall cold plane the existing surface in accordance with Specification Subsection 303.04, Section 509, and scarify the remaining material. When specified the removed asphaltic concrete will be replaced with approved base material. The material will then be blended and pulverized vertically and for the full width of the area to be stabilized to form a uniform material composite. Once the roadway is properly blended, prior to spreading cement, the contractor is to shape and compact the roadbed, stabilize with cement, compact, and finish to grade and cross slope.

In locations where normal construction practices for in-place cement stabilized base course are seriously impeded, the project engineer may allow the contractor to use asphaltic concrete meeting the requirements of Specification Section 501 or 502, or Portland cement concrete conforming to Specification Section 901 in lieu of the in-place cement stabilized base course type selected for the project. Such concrete construction shall be performed in accordance with the Specification Section 706.

MATERIALS

Generally, the base materials to be used for in-place cement stabilized base course will be furnished by the department. They will be reclaimed materials and may have been previously stabilized or treated. They will usually be materials approved by the department under earlier contracts and specifications. They may include raw or treated sand clay gravel, asphaltic concrete/soil blends, aggregate surface courses, embankments, stabilized soil, etc.

In order to be used for in-place cement stabilized base course, the existing material must stabilize with cement. However, if no subgrade survey has been performed, if unusual conditions are encountered, if the resulting blend of materials will not stabilize, or if asphaltic pavement has been removed and specified to be replaced, the contractor shall furnish additional material. When the contractor supplies material for stabilization, either to replace existing materials or to supplement them to meet grade requirements, the materials supplied shall meet the material specifications for Specification Section 302.

Generally, the cement factors for the in-place stabilization of existing material have been predetermined at the time the department was designing the roadway. The design engineer cannot complete an effective design without information on the existing soils, including their suitability for stabilization. These cement factors may then be placed in the contract. If there are no cement factors in the contract and none have been predetermined, project personnel will sample the in-place material from selected sites after it has been satisfactorily pulverized and blended by the contractor. **If lime treatment is necessary and the percentage of lime additive has not been predetermined samples for lime treatment will be taken at the same time.** Contractor provided materials will require adjustment to the sampling and testing schedule to ensure that all materials are in-place and thoroughly pulverized and blended before sampling for the determination of cement factors. The sample will be delivered to the district laboratory for the determination of cement factor. The cement factor will be determined in accordance with DOTD TR 432. No cement is to be distributed until the cement content has been determined. In order to ensure an effective, timely operation, it is critical that the contractor's operation and project engineer's sampling and delivery to the district laboratory be closely coordinated.

ASPHALTIC CONCRETE AND PORTLAND CEMENT CONCRETE

The materials selected and used for asphaltic concrete and Portland cement concrete must conform to Specification Sections 501, 502, or 901. Sampling, testing, approval or other procedures shall be in accordance with the appropriate *Quality Assurance* manual.

CEMENT

Cement to be used for In-Place Cement Stabilized Base Course shall be delivered in sealed transports. Each transport shall be accompanied by a Cement Certificate of Delivery. It shall be the responsibility of the contractor to verify that the transports are sealed and that the seal number matches that indicated on the Cement Certificate of Delivery. Seals shall be removed and turned over to the project engineer daily.

DESIGN

The cement content to be used will be determined by the district laboratory and will be based on strength. In-place materials to be stabilized under this section do not naturally occur as soil, are usually modified chemically, have a long history of manipulation and weathering, and have no predictable strength gain when mixed with cement. The strength of in-place materials must be determined by actual laboratory design procedures. It is the responsibility of the contractor to advise the district laboratory engineer and the project engineer of the type of cement to be used for stabilization (Type I, IB, II, or IP). The district laboratory will use the same type of cement to determine the cement factor. If the contractor does not inform the district laboratory of the type of cement to be used, the cement factor will be determined using Type IB. The contractor will then be required to use Type I or IB for stabilization. If the contractor does not use Type 1 or 1B, operations will be delayed until the district laboratory can determine a new cement factor.

EDSM I. 1. 1. 11 directs the district laboratory engineer, as part of the district design procedure, to make recommendations for the redesign of existing roadways to be upgraded under the district overlay program. Prior to plan development, the district laboratory engineer is to determine the type, depth and width of the pavement, overlay (if applicable), base, and subbase (if applicable), and the thickness and type of material in the top layer of embankment for both roadway and shoulders. It is the responsibility of the district laboratory engineer to determine if in-place stabilization of existing material is an effective construction option. When reaching this determination, the district laboratory engineer is to consider that all but one inch of surfacing will be removed. If in-place stabilization (Specification Section 303) is recommended by the district laboratory engineer, the laboratory is to determine how much material is available for stabilization, if the material will stabilize, if lime treatment of any material to be stabilized is necessary, and if it will be necessary for the contractor to furnish additional material. Approximately twelve inches of suitable material are needed for stabilization to accommodate grade, cross slope, depth of cut, and other factors of construction operations. These design recommendations are made far in advance of the contract letting date. The district laboratory engineer is to establish that in-place stabilization under Specification Section 303 will be viable and an option in the final typical section. This determination requires coordination with the District Design and Water Resources Engineer with respect to the final design. When the district laboratory engineer makes recommendation for in-place stabilization on Attachment 6, laboratory personnel are to identify the design percent cement in accordance with DOTD TR 432 for the various soils identified under the existing pavement. When lime treatment of the base is recommended, tests are to be performed on soils with the addition of lime at the recommended percentage.

When specified and the contractor provides additional material to adjust grade, the process for determining cement factors will need modification. If the laboratory engineer determines that a full design is required, samples will have to be taken from the roadway after the new material has been added, pulverized, and blended. Otherwise the cement factor will not be representative of the blend being stabilized. Predetermined cement factors do not apply to this situation. This process may require the maximum time allowed by DOTD TR 432 to determine the percent cement.

TRAFFIC CONTROL

When local or through traffic is allowed, the contractor shall develop a system of control that will minimize the movement of cement on the surface prior to mixing. This proposal will require the approval of the project engineer. When possible, traffic is not to be allowed to traverse the unmixed cement. Traffic will create nonuniformity in cement application, excessive dusting and material loss, thus affecting the required cement factor. If traffic displaces cement, a uniform spread shall be redeveloped prior to blending with the in-place mixer. When traffic is maintained, the contractor shall control the operation to maintain the free flow of traffic through the project. Equipment shall not obstruct the steady flow of traffic.

EQUIPMENT

All equipment for the spreading, in-place mixing, compaction, and finishing of in-place stabilized base course shall be approved prior to use. Project personnel shall inspect

equipment daily prior to use. Equipment shall be in good working condition and shall not leak fluids onto the grade or roadway. Equipment initially approved for use shall continue to conform to the standards upon which this approval is based. When approved equipment fails to meet these requirements, it shall be removed from the project until repairs are made and approval reinstated. Back-up equipment required by the specifications is to be inspected and is to meet the same requirements as the primary equipment or is not to be approved. Operations shall not begin until both primary and back-up equipment have been approved.

CEMENT SPREADER

The cement spreader shall have a mechanically adjustable, calibrated spreader box. The box shall be calibrated to distribute cement at the required cement factor. Equipment that adjusts the rate of spread solely by means of adjusting forward speed is not to be used. The spreader shall be operated to distribute cement over the prepared surface at a uniform rate for the full length and width of the spread, without excessive dusting. The spreader shall be mechanically adjustable for variable spread widths. Excessive dusting also indicates that the minimum cement factor is not being met due to material loss. If the equipment cannot be recalibrated and adjusted properly, replacement will be required. Back-up equipment must meet the same requirements as the primary equipment. If the primary equipment is replaced with the backup equipment and the spreading problem is not corrected, operations will be discontinued until additional equipment is provided, inspected and approved.

IN-PLACE MIXER

The in-place mixer is used to blend and pulverize the base material prior to the incorporation of cement. The equipment used for preliminary blending shall be capable of achieving specification requirements for the pulverization of the untreated base material.

The in-place mixer shall be designed for soil cement construction, shall have sufficient tines, arranged in a configuration which will result in a uniform blend of base material, cement, and water, across the full width of the roadway. It will be equipped with a spray bar system adjustable across the width of the stabilizer box and on each end to prevent overlapping of water from one path to an adjacent path. The spray nozzles shall be equipped with individual cutoffs to block nozzles as necessary to prevent excessive moisture content and overlap of water. Any overlap of water spray leads to excessive moisture in narrow strips, resulting in density problems and early roadway failure. Clogged nozzles shall be immediately cleaned and restored to normal function before operations are continued.

COMPACTION EQUIPMENT

Compaction equipment shall be conventional sheepsfoot-type roller or a self-propelled tamping foot compactor-type roller for initial compaction. The spikes shall be sufficient in size and number to provide uniform compaction for the full width and depth of the base course. **Compaction equipment with waffle-type or similarly styled drums will not be permitted for initial compaction. Vibratory compaction is prohibited by specification.**

The compacted material shall be finished with pneumatic tire rollers. The pneumatic roller shall have an odd number of tires, arranged so that the spaces between one row of tires are covered by the tires of the other row. All tires shall be in place and shall be in good condition and properly inflated. Tires shall be smooth tread, of the same size and ply, and inflated to within □5 psi of each other.

In-place cement stabilized base course shall be finished to a tight, uniformly smooth surface meeting the grade and cross slope requirements of the specifications.

WATER TRUCKS

Water trucks may be used to spray water over the surface of the completed base during finishing operations and to maintain moisture content only. **They are not to be used to apply water directly to the base prior to or during the mixing process.** Water trucks are to be equipped with spray bars which uniformly spray water across the surface and do not apply water in streams or cause water to puddle on the surface. Water trucks are used to supply water to the in-place mixer. The tank or connections with the in-place mixer are not to leak allowing water to fall directly onto the base course. All spray nozzles must be clean and functioning properly.

FINISHING EQUIPMENT

In-place Stabilized Base Course shall be finished with approved equipment. When a motor patrol is used, the blade shall be adjustable to finish the surface to a smooth, uniform grade and cross slope, without undulations, humps, dips or waves.

ASPHALT DISTRIBUTOR

Asphalt distributors used to spray asphaltic curing membrane over the completed base shall be equipped with a spray bar that uniformly sprays the curing membrane across the surface and does not apply the curing membrane in streams or cause it to puddle on the surface. Clogged nozzles shall not be allowed.

PREPARATION OF ROADBED

SURFACE REMOVAL

When the asphalt surfacing is to be replaced, the contractor shall remove existing pavement as specified before performing any other preparation. Asphaltic concrete

surfacing shall be removed using standard cold planing operations in accordance with Specification Section 509. For additional information regarding cold planing operations, refer to the *Application of Quality Assurance Specifications for Asphaltic Concrete Mixtures*. Other types of pavement shall be removed in accordance with contract requirements. The removal of aggregate surfacing may not be required.

When the asphalt surfacing is to be replaced, it shall be replaced with base material meeting the requirements of Specification Section 302. The minimum loose quantity required shall be equal to the thickness of the surfacing removed multiplied by 1.30. (For example: Four inches of removed asphaltic concrete shall be replaced with a minimum of 5.20 inches [132.08 mm] of base material [4.0 x 1.30 = 5.20 in.] {1016 x 1.30 = 132.08 mm}.) This adjustment factor ensures that the compacted thickness of the completed in-place stabilized base course, when the replacement material is combined with the existing base material, will result in the compacted thickness shown on the plans.

Without approval, removal operations shall not be conducted more than 2 miles in advance of base course stabilization. Weather conditions or the speed and sequence of construction operations may limit the removal of surfacing to less than two miles. This restriction will minimize the difficulties that arise in maintaining public and/or construction traffic through the unsurfaced area. It minimizes the deterioration of the stability of the remaining base and embankment materials. It minimizes traffic hazards to the traveling public and the accompanying liability to both the contractor and the department. It provides the contractor with a moving construction section for the hauling and placement of additional material to replace the surfacing that has been removed.

The remnants of asphaltic concrete surfacing which remain after the cold planing operation shall be thoroughly pulverized and blended with the existing base material during the preparation of the roadbed. Pieces of surfacing or patches that cannot be adequately pulverized for inclusion in the new base course are to be identified by the contractor and project engineer jointly, then removed and disposed of in accordance with Specification Section 202.

SCARIFICATION, BLENDING AND PULVERIZATION

The existing base material (with new material, if required) shall be scarified to its full depth for the total width of the section to be stabilized. **It is imperative that materials for stabilization be blended vertically and horizontally for the full width and depth to be stabilized. Without proper blending the cement factor established by design will not be appropriate. This is especially critical when widening, shoulders, or other areas of dissimilar materials are incorporated. Without proper blending, non-uniform base materials are created that will not stabilize as designed. In-place mixers are very effective, but only blend vertically. Therefore, to achieve horizontal blending across the full width of the base, motor patrols or other approved equipment must be used. Blending processes shall be approved by the project engineer and continued until all the varying materials have been completely mixed.** Specification requirements for pulverization shall be achieved prior to spreading any cement.

SHAPING AND INITIAL COMPACTION

After specification pulverization requirements and a uniform blend of existing base materials have been achieved, the contractor shall shape the roadway to a rough grade and cross slope. The shaped roadway shall then be compacted, using a conventional sheepsfoot roller, to at least 93% of maximum dry density. The roadbed will then be finished to ensure that after stabilization there will be sufficient material to achieve final grade and cross slope meeting plan requirements. All deficient areas shall be corrected.

MOISTURE CONTENT AFTER INITIAL COMPACTION AND PRIOR TO SPREADING CEMENT

QUALITY CONTROL

The contractor shall determine the moisture content of the base prior to spreading cement. This moisture content may be used to plan construction activities to complete preparation of base material to receive cement. If there is a delay between the moisture content test and cement placement, additional moisture tests may be required to determine if the moisture content of the prepared base has been altered during the delay. The moisture content of the base material prior to spreading cement must be within a range that will ensure that the material will be within the □2% of optimum at compaction after mixing with cement. When the moisture content is greater than 2% above optimum, the base material may be too wet for spreading cement. The moisture content determined during density testing may not reflect the moisture content throughout the base course; therefore, additional moisture tests may be required to ensure that the base material is within the □2% tolerance of optimum.

STABILIZATION

WEATHER LIMITATIONS

Both contractor and department personnel are to be constantly aware of predicted weather conditions. Cement shall not be placed in preparation for mixing when the base is frozen, ambient temperature is below 35^{O}F (1.7^{O}C), temperature from the nearest weather forecasting station is to be 25^{0}F or less within the 24 hour period following placement, or during rain. Ambient air temperature shall be determined in the area of operations, out of direct sunlight, and away from artificial heat. If the base is too wet to effectively get the base uniformly within the □2% moisture content tolerance, no cement shall be placed. The project engineer will determine if the base is too wet to begin placement. It is imperative that operations be scheduled and monitored to ensure that these conditions do not occur during production. When inclement weather is predicted, the contractor is to monitor operations to prevent operations from being interrupted by weather conditions. If the base material cannot be maintained within the specification range of optimum moisture content due to weather conditions, placement of cement will not be permitted. Additionally, the contractor should not produce mixture during borderline weather conditions that may have a detrimental effect on construction operations or materials. When scheduling operations, the contractor and the

department's representative are to consider such factors as speed of cement placement, mixing time, compaction and finishing, current temperature and weather, past weather conditions (e.g., standing water, wet subgrade, excessively dry conditions, etc.), predicted weather changes (e.g., approaching weather fronts, winds, temperature changes, rain, changes in humidity, etc.).

If despite precautions for inclement weather, rain falls on freshly spread cement prior to the completion of compaction, the inspector will document the affected area. If a reduction in percent cement occurs, the area shall be restabilized in accordance with the specifications at no direct pay. Immediately after completion of compaction, new moisture content tests will be taken after rain to determine if the material is within the □2% specification tolerance of optimum. After 7 days the area will be cored and tested for percent cement and strength. If the area does not meet design requirements, the area shall be restabilized in accordance with the specifications at no direct pay.

SPREADING CEMENT

Cement shall be spread from transports through an approved, calibrated, mechanically adjustable spreader box that is in good working condition. A calibrated spreader box is one that is capable of consistently spreading cement within the tolerance allowed by the specifications, when verified by application of DOTD TR 436. The spreader box shall be adjusted to provide a uniform coverage at the cement spread rate determined in accordance with DOTD TR 436. In addition to a stringline for guidance, the contractor shall lay a stringline to define the edge of cement spread on each side of the roadway or other approved edgeline control methods or as directed by the project engineer. The coverage shall be uniform for the full width of the roadway and the full length of spread for a transport. The appropriate length of spread for a transport will be determined in accordance with DOTD TR 436. If traffic displaces cement, a uniform spread shall be redeveloped prior to blending by the in-place mixer. In no case shall less than the minimum required percent cement be spread.

CEMENT SPREAD RATE AND LENGTH

QUALITY CONTROL

It shall be the responsibility of the contractor to check the spread rate and length of spread for each transport to be certain that at least the minimum cement factor is being met. The contractor is to provide these values to the project engineer for approval. No cement is to be placed until the spread rate and length of spread have been approved.

INSPECTION AND ACCEPTANCE

It will be the responsibility of the inspector to check the spread rate in accordance with the minimum frequency in the *Materials Sampling Manual*. The inspector will independently determine spread rate and length of spread. The calculations for spread rate and length of spread are to be performed and documented in accordance with DOTD TR 436.

IN-PLACE MIXING

The cement is to be mixed with the base material for the full depth and width of the course at the appropriate moisture content. No water is to be added during the first pass, which will accomplish blending and pulverization. The blend is to be uniform in terms of cement content; moisture content is to be within the □2% range of optimum. The moisture content should be on the high side of the □2% range to be sure the base is within the proper range at compaction. When water is added to the base during mixing, it shall be added through the spray bar on the in-place mixer. Water spray shall be uniform at all times; no clogged nozzles will be allowed. There shall be no overlap of water spray between passes. Spray nozzles shall be blocked if necessary. There are to be no dry areas between side-by-side passes of the in-place mixer. The cutting operation is to be slightly overlapped. Specification pulverization obtained prior to spreading cement shall be uniformly maintained throughout the mixing process.

MOISTURE CONTENT AFTER MIXING WITH CEMENT

QUALITY CONTROL

The contractor shall determine the moisture content of the individual base course section prior to spreading cement. The moisture content of the section is to be adjusted before stabilization to ensure that the material will remain within the □2% of optimum at the time of compaction. If the moisture content of the section is excessive after mixing cement and water, the base is to be aerated until the material will meet these requirements. The three-hour time limit for the completion of placement, spreading, mixing and compacting the base must be considered when planning operations. Specifications require that compaction be completed within three hours of initial soil-cement contact; therefore, the time for aeration is limited. When the contractor must adjust the moisture content of the material to bring it into specification tolerances, the contractor shall back up operations and adjust the moisture content to meet specifications in deficient areas. It shall be the responsibility of the contractor to conduct additional moisture tests to determine the effectiveness of aeration. If the moisture content is too low, water shall be added through the in-place mixer to bring the base within the □2% tolerance. When there is a question about moisture content, DOTD TR 403 will be used as the standard.

THICKNESS AND WIDTH

QUALITY CONTROL

The contractor is to check the thickness and width of the base. It is recommended that the contractor check the depth of cut immediately behind the in-place mixer to ensure that it is correct. Too deep or too shallow a cut may cause the area to be rejected by the department.

INSPECTION AND ACCEPTANCE

The project engineer will inspect the base in accordance with the frequency requirements of the *Materials Sampling Manual* and will monitor the contractor's quality control measurements.

COMPACTING AND FINISHING

QUALITY CONTOL

The contractor shall use a conventional sheepsfoot roller or a self-propelled tamping foot compactor-type roller for initial compaction of the blended base material and cement. The prongs of the roller are to reach the full depth of the base for complete and uniform compaction. Compaction shall be performed efficiently and quickly, beginning immediately after in-place mixing of material with cement, with a minimum of drying of the base. The base shall remain within the □2% range of optimum moisture content during compaction and finishing. Final compaction shall be with a pneumatic roller.

The contractor shall check the moisture content of the material being compacted in each section at the time of compaction in accordance with DOTD TR 403. If the material is not within the specification tolerance, immediate correction will be required. Deficiencies shall be corrected when they can be completed within the same three-hour time limit. The contractor will be required to modify the QC program to ensure that additional failing tests do not occur. **If the material does not remain within the 2% of optimum moisture content, the density of the material will be determined for acceptance by comparison against maximum dry density determined in accordance with TR 415 or DOTD TR 418.** If the moisture content of the material deviates from optimum and failing density occurs when tested for acceptance, the contractor may be required to remove and replace the entire section or payment must be made at an adjusted price. The deviation of moisture content from optimum can also cause nonuniform areas (wet spots, yielding areas, etc.). The contractor will be required to correct these areas.

Compaction and finishing of the in-place stabilized base shall be completed within three hours of initial placement of cement. **The time that the cement comes in contact with the base material is the beginning point of the three-hour time limit.** It is the contractor's responsibility when establishing the QC program for the project to ensure that the sequence of construction can be accomplished and completed without exceeding this three-hour limitation. If the three-hour limitation is exceeded, the

contractor will be required to make immediate adjustment to operations to prevent a recurrence. **Material that was not compacted and finished within three hours of initial cement placement will not be accepted. The contractor will be required to reconstruct the entire section.** When reconstruction is required, the district laboratory will provide a new cement content.

Once the three-hour time limit has expired, only tight blading will be permitted. The purpose of tight blading is to remove only loose uncompacted material from the surface of the base. Blading to bring an overthick or overwide base into specification tolerances will not be permitted. The removal of excessive material can cause the base to be underthick. Blading is to leave the base at a uniform grade and cross slope, with a tight-knit surface having no undulations. When grade has been established, achieving uniform grade at station markers with varying elevation between stations will not be accepted. The contractor will be required to correct this type of deficiency to produce a surface at uniform elevation at no direct pay.

The base course contractor is to be aware of the type of surfacing to be placed over the base. The base shall be finished so that variances in cross slope or longitudinal grade shall not be reflected in the surface of the surface course.

PROTECTION AND CURING

Immediately after finishing the base course, an asphalt curing membrane shall be sprayed over the finished section in accordance with Specification Section 506. The asphaltic curing membrane is to be placed on the same day the area is stabilized. When the base is wet cured and with the approval of the project engineer, the last two sections may be tight bladed and covered with curing membrane the following morning if the base is kept uniformly moist. This membrane shall completely cover the finished base course and complete coverage shall be maintained until the placement of the next course. Unless required by the department, no traffic, including construction traffic, shall be allowed on the base course for at least 72 hours after the application of the curing membrane. When traffic, including construction traffic, is allowed on the base course, and the surfacing is to be asphaltic concrete, the first lift of surfacing shall be placed within thirty calendar days of the completion of the base course section. If there is any delay between sealing the base and applying the curing membrane, the surface shall be kept uniformly moist by the application of water by fog spray.

MAINTENANCE OF THE BASE COURSE

The contractor shall be responsible for the completed base course. It shall be protected from damage from public or construction traffic or construction operations. The contractor shall maintain the base course in the condition in which it was accepted until the next lift is placed. The contractor shall make any necessary repairs, including patching or reconstruction, and reapplication of the protective coating. For the first 72 hours after the completion of the base course, unless required by the department, no traffic, including construction traffic, shall be allowed on the base course. This period is designed to allow the base course to develop adequate strength to support axle loads without structural damage. All correction of deficiencies shall be completed at least 24 hours prior to the placement of the subsequent lift over the base course. The contractor

shall correct raveled areas immediately and take steps to ensure that additional raveling will not occur.

INSPECTION AND ACCEPTANCE

It is the responsibility of the department to inspect the project for conformance to specifications and good construction techniques. The department will observe the contractor's QC program as part of the inspection process. **When deficiencies in the QC program are found, the inspector will require immediate correction or construction operations will be discontinued**. The department will independently inspect the project and perform tests as needed to ensure that the final project meets specifications.

Project personnel will determine the percent pulverization of the base material prior to the spreading of cement in accordance with DOTD TR 431. The percent pulverization must be at least 60% passing the No. 4 sieve uniformly throughout the project. Project personnel will determine the percent compaction of the material during initial compaction in accordance with DOTD TR 401. The percent compaction must be at least 93% before the contractor is allowed to proceed with stabilization. Maximum dry density may be determined in accordance with either DOTD TR 415 or DOTD TR 418.

The 93% density requirement is very important in locating any areas under the material to be stabilized that are subject to cause density problems during compaction and finishing of the base. Materials that are soft, even at depth, have high moisture contents, high organic contents, or objects such as logs or stumps may cause the soil to be unstable. If 93% is unobtainable these conditions can be located and repaired prior to spreading cement. These density tests provide insurance that construction effort and cement are not wasted.

When the contractor supplies material for grade adjustment, samples for determining cement factor will be obtained after the hauled in materials are thoroughly pulverized and blended with the in-place materials across the roadway for the full depth to be stabilized

Prior to allowing the contractor to spread cement, project personnel will inspect the section for cross slope, grade, thickness, width, and uniformity of material. The contractor will be required to correct any soft spots prior to being allowed to spread cement. Deviations in dimensional tolerances and alignment problems shall also be corrected prior to the spreading of cement.

Project personnel will inspect the mixing process for uniformity, continued adequate pulverization, uniform coating of soil particles with cement, and uniform moisture without wet or dry streaks or puddles.

The project engineer will approve the length of spread and verify spread rate determined by the contractor. The spread rate must result in at least the minimum cement content specified by the district laboratory being applied. During cement placement, project personnel will check the spread rate in accordance with the frequency in the *Materials Sampling Manual* and the length of spread several times per day. The length of spread is also to be checked whenever the spread rate is not correct. If the spread rate is not

correct or is not uniform, the inspector is to require the contractor to make immediate corrections to ensure that the minimum cement factor is uniformly met. Continuous placement of cement is not to be allowed until it has been established by the department that the minimum cement factor is being uniformly met.
Project personnel will determine the moisture content of the base being compacted after mixing with cement at least twice each day in accordance with DOTD TR 403. If the material is not within the specification tolerance, immediate correction will be required. The contractor will be required to modify the QC program to ensure that additional failing acceptance tests do not occur. The department will evaluate the section that is not within □2% of optimum moisture.

Project personnel will determine the density of the completed base course in accordance with DOTD TR 401 once per each 1000 linear feet of roadway and once per each 2000 linear feet of shoulder. If the moisture content is within the □2% of optimum tolerance, maximum dry density and optimum moisture may be determined in accordance with DOTD TR 415. Density testing is to be performed at the same location where the sample was taken for the determination of optimum moisture and maximum dry density to ensure that the material is representative of the material tested.

Project personnel will randomly check the cross slope with a 10-foot metal, static straightedge. Cross slope must meet specification requirements. If the cross slope does not meet specification requirements, the contractor will be required to make corrections and to adjust the operation to ensure that subsequent sections do not fail to meet specifications. The area that is out of tolerance is to be isolated up and down station and correction required.

DOTD TR 602 MEASUREMENTS

Project personnel will perform thickness and width measurements in accordance with DOTD TR 602 to verify the contractor's QC prior to requesting acceptance measurements by the district laboratory. The district laboratory will determine thickness and width for final acceptance in accordance with DOTD TR 602. The district laboratory engineer will notify the project engineer of areas that do not meet specification requirements. Deficient areas must be corrected for the entire width of the roadway. To isolate an area, move up and down station five feet and retest. Then, retest at 25-foot intervals until the limits of deviation from specifications are found. The project engineer will require the contractor to correct deficient areas prior to final acceptance. Additional thickness and width measurements will be performed on corrected areas by the district laboratory prior to final acceptance.

VISUAL INSPECTION

Deficiencies identified by visual inspection, such as inadequate pulverization, laminations, dimensional deficiencies, soft areas, etc., shall be corrected before the section will be accepted. Project personnel will inspect the entire completed base regularly and daily when the base is open to traffic for damage to the curing membrane or to the base. The contractor is to repair deficiencies that develop prior to the placement of the next course at no direct pay.

QUALITY ASSURANCE DOCUMENTATION

When in-place mixing is used to produce a stabilized base course, the documentation requirements for Class II Base Course Specification Section 302 will apply.

When asphaltic concrete base course is used, the documentation requirements for Part V of the specifications will apply.

When Portland cement concrete is used for base course, the documentation requirements for Part IX of the specifications will apply.

IN-PLACE CEMENT STABILIZED BASE COURSE - Section 303

In-place cement stabilized base course is intended for the reconstruction of existing roadways in which the department provides the base material already in-place. This work is defined in Specification Section 303. If insufficient material exists on the roadway to meet grade and cross slope or the existing material will not stabilize, the contractor will be required to provide additional material and construct the base in a manner similar to that required for Class II Base Course. When the contractor must supply additional material to be blended with existing in-place materials, the resulting blend creates unique soil problems that must be considered in base design. It is important to note that materials supplied by the contractor must meet the requirements of Section 302; however, these materials will be paid for under Section 203.
When the existing surface is asphaltic concrete, to construct an in-place cement stabilized base course the contractor shall cold plane the existing surface in accordance with Specification Subsection 303.04, Section 509, and scarify the remaining material. When specified the removed asphaltic concrete will be replaced with approved base material. The material will then be blended and pulverized vertically and for the full width of the area to be stabilized to form a uniform material composite. Once the roadway is properly blended, prior to spreading cement, the contractor is to shape and compact the roadbed, stabilize with cement, compact, and finish to grade and cross slope.

In locations where normal construction practices for in-place cement stabilized base course are seriously impeded, the project engineer may allow the contractor to use asphaltic concrete meeting the requirements of Specification Section 501 or 502, or Portland cement concrete conforming to Specification Section 901 in lieu of the in-place cement stabilized base course type selected for the project. Such concrete construction shall be performed in accordance with the Specification Section 706.

MATERIALS Generally, the base materials to be used for in-place cement stabilized base course will be furnished by the department. They will be reclaimed materials and may have been previously stabilized or treated. They will usually be materials approved by the department under earlier contracts and specifications. They may include raw or treated sand clay gravel, asphaltic concrete/soil blends, aggregate surface courses, embankments, stabilized soil, etc.

In order to be used for in-place cement stabilized base course, the existing material must stabilize with cement. However, if no subgrade survey has been performed, if unusual conditions are encountered, if the resulting blend of materials will not stabilize, or if asphaltic pavement has been removed and specified to be replaced, the contractor shall furnish additional material. When the contractor supplies material for stabilization, either to replace existing materials or to supplement them to meet grade requirements, the materials supplied shall meet the material specifications for Specification Section 302.

Generally, the cement factors for the in-place stabilization of existing material have been predetermined at the time the department was designing the roadway. The design engineer cannot complete an effective design without information on the existing soils,

including their suitability for stabilization. These cement factors may then be placed in the contract. If there are no cement factors in the contract and none have been predetermined, project personnel will sample the in-place material from selected sites after it has been satisfactorily pulverized and blended by the contractor. **If lime treatment is necessary and the percentage of lime additive has not been predetermined samples for lime treatment will be taken at the same time.** Contractor provided materials will require adjustment to the sampling and testing schedule to ensure that all materials are in-place and thoroughly pulverized and blended before sampling for the determination of cement factors. The sample will be delivered to the district laboratory for the determination of cement factor. The cement factor will be determined in accordance with DOTD TR 432. No cement is to be distributed until the cement content has been determined. In order to ensure an effective, timely operation, it is critical that the contractor's operation and project engineer's sampling and delivery to the district laboratory be closely coordinated.

ASPHALTIC CONCRETE AND PORTLAND CEMENT CONCRETE

The materials selected and used for asphaltic concrete and Portland cement concrete must conform to Specification Sections 501, 502, or 901. Sampling, testing, approval or other procedures shall be in accordance with the appropriate *Quality Assurance* manual.

CEMENT

Cement to be used for In-Place Cement Stabilized Base Course shall be delivered in sealed transports. Each transport shall be accompanied by a Cement Certificate of Delivery. It shall be the responsibility of the contractor to verify that the transports are sealed and that the seal number matches that indicated on the Cement Certificate of Delivery. Seals shall be removed and turned over to the project engineer daily.

DESIGN

The cement content to be used will be determined by the district laboratory and will be based on strength. In-place materials to be stabilized under this section do not naturally occur as soil, are usually modified chemically, have a long history of manipulation and weathering, and have no predictable strength gain when mixed with cement. The EDSM I. 1. 1. 11 directs the district laboratory engineer, as part of the district design procedure, to make recommendations for the redesign of existing roadways to be upgraded under the district overlay program. Prior to plan development, the district laboratory engineer is to determine the type, depth and width of the pavement, overlay (if applicable), base, and subbase (if applicable), and the thickness and type of material in the top layer of embankment for both roadway and shoulders. It is the responsibility of the district laboratory engineer to determine if in-place stabilization of existing material is an effective construction option. When reaching this determination, the district laboratory engineer is to consider that all but one inch of surfacing will be removed. If in-place stabilization (Specification Section 303) is recommended by the district laboratory engineer, the laboratory is to determine how much material is available for stabilization, if the material will stabilize, if lime treatment of any material to be stabilized is necessary, and if it will be necessary for the contractor to furnish additional material. Approximately

twelve inches of suitable material are needed for stabilization to accommodate grade, cross slope, depth of cut, and other factors of construction operations. These design recommendations are made far in advance of the contract letting date. The district laboratory engineer is to establish that in-place stabilization under Specification Section 303 will be viable and an option in the final typical section. This determination requires coordination with the District Design and Water Resources Engineer with respect to the final design. When the district laboratory engineer makes recommendation for in-place stabilization on Attachment 6, laboratory personnel are to identify the design percent cement in accordance with DOTD TR 432 for the various soils identified under the existing pavement. When lime treatment of the base is recommended, tests are to be performed on soils with the addition of lime at the recommended percentage.

When specified and the contractor provides additional material to adjust grade, the process for determining cement factors will need modification. If the laboratory engineer determines that a full design is required, samples will have to be taken from the roadway after the new material has been added, pulverized, and blended. Otherwise the cement factor will not be representative of the blend being stabilized. Predetermined cement factors do not apply to this situation. This process may require the maximum time allowed by DOTD TR 432 to determine the percent cement.

TRAFFIC CONTROL

When local or through traffic is allowed, the contractor shall develop a system of control that will minimize the movement of cement on the surface prior to mixing. This proposal will require the approval of the project engineer. When possible, traffic is not to be allowed to traverse the unmixed cement. Traffic will create nonuniformity in cement application, excessive dusting and material loss, thus affecting the required cement factor. If traffic displaces cement, a uniform spread shall be redeveloped prior to blending with the in-place mixer. When traffic is maintained, the contractor shall control the operation to maintain the free flow of traffic through the project. Equipment shall not obstruct the steady flow of traffic.

EQUIPMENT

All equipment for the spreading, in-place mixing, compaction, and finishing of in-place stabilized base course shall be approved prior to use. Project personnel shall inspect equipment daily prior to use. Equipment shall be in good working condition and shall not leak fluids onto the grade or roadway. Equipment initially approved for use shall continue to conform to the standards upon which this approval is based. When approved equipment fails to meet these requirements, it shall be removed from the project until repairs are made and approval reinstated. Back-up equipment required by the specifications is to be inspected and is to meet the same requirements as the primary equipment or is not to be approved. Operations shall not begin until both primary and back-up equipment have been approved.

CEMENT SPREADER

The cement spreader shall have a mechanically adjustable, calibrated spreader box. The box shall be calibrated to distribute cement at the required cement factor. Equipment that adjusts the rate of spread solely by means of adjusting forward speed is not to be used. The spreader shall be operated to distribute cement over the prepared surface at a uniform rate for the full length and width of the spread, without excessive dusting. The spreader shall be mechanically adjustable for variable spread widths. Excessive dusting also indicates that the minimum cement factor is not being met due to material loss. If the equipment cannot be recalibrated and adjusted properly, replacement will be required. Back-up equipment must meet the same requirements as the primary equipment. If the primary equipment is replaced with the backup equipment and the spreading problem is not corrected, operations will be discontinued until additional equipment is provided, inspected and approved.

IN-PLACE MIXER

The in-place mixer is used to blend and pulverize the base material prior to the incorporation of cement. The equipment used for preliminary blending shall be capable of achieving specification requirements for the pulverization of the untreated base material.

The in-place mixer shall be designed for soil cement construction, shall have sufficient tines, arranged in a configuration which will result in a uniform blend of base material, cement, and water, across the full width of the roadway. It will be equipped with a spray bar system adjustable across the width of the stabilizer box and on each end to prevent overlapping of water from one path to an adjacent path. The spray nozzles shall be equipped with individual cutoffs to block nozzles as necessary to prevent excessive moisture content and overlap of water. Any overlap of water spray leads to excessive moisture in narrow strips, resulting in density problems and early roadway failure. Clogged nozzles shall be immediately cleaned and restored to normal function before operations are continued.

COMPACTION EQUIPMENT

Compaction equipment shall be conventional sheepsfoot-type roller or a self-propelled tamping foot compactor-type roller for initial compaction. The spikes shall be sufficient in size and number to provide uniform compaction for the full width and depth of the base course. **Compaction equipment with waffle-type or similarly styled drums will not be permitted for initial compaction. Vibratory compaction is prohibited by specification.**

The compacted material shall be finished with pneumatic tire rollers. The pneumatic roller shall have an odd number of tires, arranged so that the spaces between one row of tires are covered by the tires of the other row. All tires shall be in place and shall be in good condition and properly inflated. Tires shall be smooth tread, of the same size and ply, and inflated to within □5 psi of each other.

In-place cement stabilized base course shall be finished to a tight, uniformly smooth surface meeting the grade and cross slope requirements of the specifications.

WATER TRUCKS

Water trucks may be used to spray water over the surface of the completed base during finishing operations and to maintain moisture content only. **They are not to be used to apply water directly to the base prior to or during the mixing process.** Water trucks are to be equipped with spray bars which uniformly spray water across the surface and do not apply water in streams or cause water to puddle on on the surface. Water trucks are used to supply water to the in-place mixer. The tank or connections with the in-place mixer are not to leak allowing water to fall directly onto the base course. All spray nozzles must be clean and functioning properly.

FINISHING EQUIPMENT

In-place Stabilized Base Course shall be finished with approved equipment. When a motor patrol is used, the blade shall be adjustable to finish the surface to a smooth, uniform grade and cross slope, without undulations, humps, dips or waves.

ASPHALT DISTRIBUTOR

Asphalt distributors used to spray asphaltic curing membrane over the completed base shall be equipped with a spray bar that uniformly sprays the curing membrane across the surface and does not apply the curing membrane in streams or cause it to puddle on the surface. Clogged nozzles shall not be allowed.

PREPARATION OF ROADBED

SURFACE REMOVAL

When the asphalt surfacing is to be replaced, the contractor shall remove existing pavement as specified before performing any other preparation. Asphaltic concrete surfacing shall be removed using standard cold planing operations in accordance with Specification Section 509. For additional information regarding cold planing operations, refer to the *Application of Quality Assurance Specifications for Asphaltic Concrete Mixtures*. Other types of pavement shall be removed in accordance with contract requirements. The removal of aggregate surfacing may not be required.

When the asphalt surfacing is to be replaced, it shall be replaced with base material meeting the requirements of Specification Section 302. The minimum loose quantity required shall be equal to the thickness of the surfacing removed multiplied by 1.30. (For example: Four inches of removed asphaltic concrete shall be replaced with a minimum of 5.20 inches [132.08 mm] of base material [4.0 x 1.30 = 5.20 in.] {1016 x 1.30 = 132.08 mm}.) This adjustment factor ensures that the compacted thickness of the completed in-place stabilized base course, when the replacement material is combined with the existing base material, will result in the compacted thickness shown on the plans.
Without approval, removal operations shall not be conducted more than 2 miles in advance of base course stabilization. Weather conditions or the speed and sequence of construction operations may limit the removal of surfacing to less than two miles. This restriction will minimize the difficulties that arise in maintaining public and/or construction traffic through the unsurfaced area. It minimizes the deterioration of the stability of the remaining base and embankment materials. It minimizes traffic hazards to the traveling public and the accompanying liability to both the contractor and the department. It provides the contractor with a moving construction section for the hauling and placement of additional material to replace the surfacing that has been removed.

The remnants of asphaltic concrete surfacing which remain after the cold planing operation shall be thoroughly pulverized and blended with the existing base material during the preparation of the roadbed. Pieces of surfacing or patches that cannot be adequately pulverized for inclusion in the new base course are to be identified by the contractor and project engineer jointly, then removed and disposed of in accordance with Specification Section 202.

SCARIFICATION, BLENDING AND PULVERIZATION

The existing base material (with new material, if required) shall be scarified to its full depth for the total width of the section to be stabilized. **It is imperative that materials for stabilization be blended vertically and horizontally for the full width and depth to be stabilized. Without proper blending the cement factor established by design will not be appropriate. This is especially critical when widening, shoulders, or other areas of dissimilar materials are incorporated. Without proper blending, non-uniform base materials are created that will not stabilize as designed. In-place mixers are very effective, but only blend vertically. Therefore, to achieve horizontal blending across the full width of the base, motor patrols or other approved equipment must be used. Blending processes shall be approved by the project engineer and continued until all the varying materials have been completely mixed.** Specification requirements for pulverization shall be achieved prior to spreading any cement.

SHAPING AND INITIAL COMPACTION

After specification pulverization requirements and a uniform blend of existing base materials have been achieved, the contractor shall shape the roadway to a rough grade and cross slope. The shaped roadway shall then be compacted, using a conventional sheepsfoot roller, to at least 93% of maximum dry density. The roadbed will then be finished to ensure that after stabilization there will be sufficient material to achieve final grade and cross slope meeting plan requirements. All deficient areas shall be corrected.

MOISTURE CONTENT AFTER INITIAL COMPACTION AND PRIOR TO SPREADING CEMENT

QUALITY CONTROL

The contractor shall determine the moisture content of the base prior to spreading cement. This moisture content may be used to plan construction activities to complete preparation of base material to receive cement. If there is a delay between the moisture content test and cement placement, additional moisture tests may be required to determine if the moisture content of the prepared base has been altered during the delay. The moisture content of the base material prior to spreading cement must be within a range that will ensure that the material will be within the □2% of optimum at compaction after mixing with cement. When the moisture content is greater than 2% above optimum, the base material may be too wet for spreading cement. The moisture content determined during density testing may not reflect the moisture content throughout the base course; therefore, additional moisture tests may be required to ensure that the base material is within the □2% tolerance of optimum.

STABILIZATION

WEATHER LIMITATIONS

Both contractor and department personnel are to be constantly aware of predicted weather conditions. Cement shall not be placed in preparation for mixing when the base is frozen, ambient temperature is below 35^{O}F (1.7^{O}C), temperature from the nearest weather forecasting station is to be 25^{0}F or less within the 24 hour period following placement, or during rain. Ambient air temperature shall be determined in the area of operations, out of direct sunlight, and away from artificial heat. If the base is too wet to effectively get the base uniformly within the □2% moisture content tolerance, no cement shall be placed. The project engineer will determine if the base is too wet to begin placement. It is imperative that operations be scheduled and monitored to ensure that these conditions do not occur during production. When inclement weather is predicted, the contractor is to monitor operations to prevent operations from being interrupted by weather conditions. If the base material cannot be maintained within the specification range of optimum moisture content due to weather conditions, placement of cement will not be permitted. Additionally, the contractor should not produce mixture during borderline weather conditions that may have a detrimental effect on construction operations or materials. When scheduling operations, the contractor and the

department's representative are to consider such factors as speed of cement placement, mixing time, compaction and finishing, current temperature and weather, past weather conditions (e.g., standing water, wet subgrade, excessively dry conditions, etc.), predicted weather changes (e.g., approaching weather fronts, winds, temperature changes, rain, changes in humidity, etc.).

If despite precautions for inclement weather, rain falls on freshly spread cement prior to the completion of compaction, the inspector will document the affected area. If a reduction in percent cement occurs, the area shall be restabilized in accordance with the specifications at no direct pay. Immediately after completion of compaction, new moisture content tests will be taken after rain to determine if the material is within the □2% specification tolerance of optimum. After 7 days the area will be cored and tested for percent cement and strength. If the area does not meet design requirements, the area shall be restabilized in accordance with the specifications at no direct pay.

SPREADING CEMENT

Cement shall be spread from transports through an approved, calibrated, mechanically adjustable spreader box that is in good working condition. A calibrated spreader box is one that is capable of consistently spreading cement within the tolerance allowed by the specifications, when verified by application of DOTD TR 436. The spreader box shall be adjusted to provide a uniform coverage at the cement spread rate determined in accordance with DOTD TR 436. In addition to a stringline for guidance, the contractor shall lay a stringline to define the edge of cement spread on each side of the roadway or other approved edgeline control methods or as directed by the project engineer. The coverage shall be uniform for the full width of the roadway and the full length of spread for a transport. The appropriate length of spread for a transport will be determined in accordance with DOTD TR 436. If traffic displaces cement, a uniform spread shall be redeveloped prior to blending by the in-place mixer. In no case shall less than the minimum required percent cement be spread.

CEMENT SPREAD RATE AND LENGTH

QUALITY CONTROL

It shall be the responsibility of the contractor to check the spread rate and length of spread for each transport to be certain that at least the minimum cement factor is being met. The contractor is to provide these values to the project engineer for approval. No cement is to be placed until the spread rate and length of spread have been approved.

INSPECTION AND ACCEPTANCE

It will be the responsibility of the inspector to check the spread rate in accordance with the minimum frequency in the *Materials Sampling Manual*. The inspector will independently determine spread rate and length of spread. The calculations for spread rate and length of spread are to be performed and documented in accordance with DOTD TR 436.

IN-PLACE MIXING

The cement is to be mixed with the base material for the full depth and width of the course at the appropriate moisture content. No water is to be added during the first pass, which will accomplish blending and pulverization. The blend is to be uniform in terms of cement content; moisture content is to be within the □2% range of optimum. The moisture content should be on the high side of the □2% range to be sure the base is within the proper range at compaction. When water is added to the base during mixing, it shall be added through the spray bar on the in-place mixer. Water spray shall be uniform at all times; no clogged nozzles will be allowed. There shall be no overlap of water spray between passes. Spray nozzles shall be blocked if necessary. There are to be no dry areas between side-by-side passes of the in-place mixer. The cutting operation is to be slightly overlapped. Specification pulverization obtained prior to spreading cement shall be uniformly maintained throughout the mixing process.

MOISTURE CONTENT AFTER MIXING WITH CEMENT

QUALITY CONTROL

The contractor shall determine the moisture content of the individual base course section prior to spreading cement. The moisture content of the section is to be adjusted before stabilization to ensure that the material will remain within the □2% of optimum at the time of compaction. If the moisture content of the section is excessive after mixing cement and water, the base is to be aerated until the material will meet these requirements. The three-hour time limit for the completion of placement, spreading, mixing and compacting the base must be considered when planning operations. Specifications require that compaction be completed within three hours of initial soil-cement contact; therefore, the time for aeration is limited. When the contractor must adjust the moisture content of the material to bring it into specification tolerances, the contractor shall back up operations and adjust the moisture content to meet specifications in deficient areas. It shall be the responsibility of the contractor to conduct additional moisture tests to determine the effectiveness of aeration. If the moisture content is too low, water shall be added through the in-place mixer to bring the base within the □2% tolerance. When there is a question about moisture content, DOTD TR 403 will be used as the standard.

THICKNESS AND WIDTH

QUALITY CONTROL

The contractor is to check the thickness and width of the base. It is recommended that the contractor check the depth of cut immediately behind the in-place mixer to ensure that it is correct. Too deep or too shallow a cut may cause the area to be rejected by the department.

INSPECTION AND ACCEPTANCE

The project engineer will inspect the base in accordance with the frequency requirements of the *Materials Sampling Manual* and will monitor the contractor's quality control measurements.

COMPACTING AND FINISHING

QUALITY CONTOL

The contractor shall use a conventional sheepsfoot roller or a self-propelled tamping foot compactor-type roller for initial compaction of the blended base material and cement. The prongs of the roller are to reach the full depth of the base for complete and uniform compaction. Compaction shall be performed efficiently and quickly, beginning immediately after in-place mixing of material with cement, with a minimum of drying of the base. The base shall remain within the □2% range of optimum moisture content during compaction and finishing. Final compaction shall be with a pneumatic roller.

The contractor shall check the moisture content of the material being compacted in each section at the time of compaction in accordance with DOTD TR 403. If the material is not within the specification tolerance, immediate correction will be required. Deficiencies shall be corrected when they can be completed within the same three-hour time limit. The contractor will be required to modify the QC program to ensure that additional failing tests do not occur. **If the material does not remain within the 2% of optimum moisture content, the density of the material will be determined for acceptance by comparison against maximum dry density determined in accordance with TR 415 or DOTD TR 418.** If the moisture content of the material deviates from optimum and failing density occurs when tested for acceptance, the contractor may be required to remove and replace the entire section or payment must be made at an adjusted price. The deviation of moisture content from optimum can also cause nonuniform areas (wet spots, yielding areas, etc.). The contractor will be required to correct these areas.

Compaction and finishing of the in-place stabilized base shall be completed within three hours of initial placement of cement. **The time that the cement comes in contact with the base material is the beginning point of the three-hour time limit.** It is the contractor's responsibility when establishing the QC program for the project to ensure that the sequence of construction can be accomplished and completed without exceeding this three-hour limitation. If the three-hour limitation is exceeded, the contractor will be required to make immediate adjustment to operations to prevent a recurrence. **Material that was not compacted and finished within three hours of initial cement placement will not be accepted. The contractor will be required to reconstruct the entire section.** When reconstruction is required, the district laboratory will provide a new cement content.

Once the three-hour time limit has expired, only tight blading will be permitted. The purpose of tight blading is to remove only loose uncompacted material from the surface of the base. Blading to bring an overthick or overwide base into specification tolerances will not be permitted. The removal of excessive material can cause the base to be underthick. Blading is to leave the base at a uniform grade and cross slope, with a tight-knit surface having no undulations. When grade has been established, achieving uniform grade at station markers with varying elevation between stations will not be accepted. The contractor will be required to correct this type of deficiency to produce a surface at uniform elevation at no direct pay.

The base course contractor is to be aware of the type of surfacing to be placed over the base. The base shall be finished so that variances in cross slope or longitudinal grade shall not be reflected in the surface of the surface course.

PROTECTION AND CURING

Immediately after finishing the base course, an asphalt curing membrane shall be sprayed over the finished section in accordance with Specification Section 506. The asphaltic curing membrane is to be placed on the same day the area is stabilized. When the base is wet cured and with the approval of the project engineer, the last two sections may be tight bladed and covered with curing membrane the following morning if the base is kept uniformly moist. This membrane shall completely cover the finished base course and complete coverage shall be maintained until the placement of the next course. Unless required by the department, no traffic, including construction traffic, shall be allowed on the base course for at least 72 hours after the application of the curing membrane. When traffic, including construction traffic, is allowed on the base course, and the surfacing is to be asphaltic concrete, the first lift of surfacing shall be placed within thirty calendar days of the completion of the base course section. If there is any delay between sealing the base and applying the curing membrane, the surface shall be kept uniformly moist by the application of water by fog spray.

MAINTENANCE OF THE BASE COURSE

The contractor shall be responsible for the completed base course. It shall be protected from damage from public or construction traffic or construction operations. The contractor shall maintain the base course in the condition in which it was accepted until the next lift is placed. The contractor shall make any necessary repairs, including patching or reconstruction, and reapplication of the protective coating. For the first 72 hours after the completion of the base course, unless required by the department, no traffic, including construction traffic, shall be allowed on the base course. This period is designed to allow the base course to develop adequate strength to support axle loads without structural damage. All correction of deficiencies shall be completed at least 24 hours prior to the placement of the subsequent lift over the base course. The contractor shall correct raveled areas immediately and take steps to ensure that additional raveling will not occur.

INSPECTION AND ACCEPTANCE

It is the responsibility of the department to inspect the project for conformance to specifications and good construction techniques. The department will observe the contractor's QC program as part of the inspection process. **When deficiencies in the QC program are found, the inspector will require immediate correction or construction operations will be discontinued**. The department will independently inspect the project and perform tests as needed to ensure that the final project meets specifications.

Project personnel will determine the percent pulverization of the base material prior to the spreading of cement in accordance with DOTD TR 431. The percent pulverization must be at least 60% passing the No. 4 sieve uniformly throughout the project. Project personnel will determine the percent compaction of the material during initial compaction in accordance with DOTD TR 401. The percent compaction must be at least 93% before the contractor is allowed to proceed with stabilization. Maximum dry density may be determined in accordance with either DOTD TR 415 or DOTD TR 418.
The 93% density requirement is very important in locating any areas under the material to be stabilized that are subject to cause density problems during compaction and finishing of the base. Materials that are soft, even at depth, have high moisture contents, high organic contents, or objects such as logs or stumps may cause the soil to be unstable. If 93% is unobtainable these conditions can be located and repaired prior to spreading cement. These density tests provide insurance that construction effort and cement are not wasted.

When the contractor supplies material for grade adjustment, samples for determining cement factor will be obtained after the hauled in materials are thoroughly pulverized and blended with the in-place materials across the roadway for the full depth to be stabilized

Prior to allowing the contractor to spread cement, project personnel will inspect the section for cross slope, grade, thickness, width, and uniformity of material. The contractor will be required to correct any soft spots prior to being allowed to spread cement. Deviations in dimensional tolerances and alignment problems shall also be corrected prior to the spreading of cement.

Project personnel will inspect the mixing process for uniformity, continued adequate pulverization, uniform coating of soil particles with cement, and uniform moisture without wet or dry streaks or puddles.

The project engineer will approve the length of spread and verify spread rate determined by the contractor. The spread rate must result in at least the minimum cement content specified by the district laboratory being applied. During cement placement, project personnel will check the spread rate in accordance with the frequency in the *Materials Sampling Manual* and the length of spread several times per day. The length of spread is also to be checked whenever the spread rate is not correct. If the spread rate is not correct or is not uniform, the inspector is to require the contractor to make immediate corrections to ensure that the minimum cement factor is uniformly met. Continuous placement of cement is not to be allowed until it has been established by the department that the minimum cement factor is being uniformly met.
Project personnel will determine the moisture content of the base being compacted after mixing with cement at least twice each day in accordance with DOTD TR 403. If the material is not within the specification tolerance, immediate correction will be required.

The contractor will be required to modify the QC program to ensure that additional failing acceptance tests do not occur. The department will evaluate the section that is not within □2% of optimum moisture.

Project personnel will determine the density of the completed base course in accordance with DOTD TR 401 once per each 1000 linear feet of roadway and once per each 2000 linear feet of shoulder. If the moisture content is within the □2% of optimum tolerance, maximum dry density and optimum moisture may be determined in accordance with DOTD TR 415. Density testing is to be performed at the same location where the sample was taken for the determination of optimum moisture and maximum dry density to ensure that the material is representative of the material tested.

Project personnel will randomly check the cross slope with a 10-foot metal, static straightedge. Cross slope must meet specification requirements. If the cross slope does not meet specification requirements, the contractor will be required to make corrections and to adjust the operation to ensure that subsequent sections do not fail to meet specifications. The area that is out of tolerance is to be isolated up and down station and correction required.

DOTD TR 602 MEASUREMENTS

Project personnel will perform thickness and width measurements in accordance with DOTD TR 602 to verify the contractor's QC prior to requesting acceptance measurements by the district laboratory. The district laboratory will determine thickness and width for final acceptance in accordance with DOTD TR 602. The district laboratory engineer will notify the project engineer of areas that do not meet specification requirements. Deficient areas must be corrected for the entire width of the roadway. To isolate an area, move up and down station five feet and retest. Then, retest at 25-foot intervals until the limits of deviation from specifications are found. The project engineer will require the contractor to correct deficient areas prior to final acceptance. Additional thickness and width measurements will be performed on corrected areas by the district laboratory prior to final acceptance.

VISUAL INSPECTION

Deficiencies identified by visual inspection, such as inadequate pulverization, laminations, dimensional deficiencies, soft areas, etc., shall be corrected before the section will be accepted. Project personnel will inspect the entire completed base regularly and daily when the base is open to traffic for damage to the curing membrane or to the base. The contractor is to repair deficiencies that develop prior to the placement of the next course at no direct pay.

QUALITY ASSURANCE DOCUMENTATION

When in-place mixing is used to produce a stabilized base course, the documentation requirements for Class II Base Course Specification Section 302 will apply.

When asphaltic concrete base course is used, the documentation requirements for Part V of the specifications will apply.

When Portland cement concrete is used for base course, the documentation requirements for Part IX of the specifications will apply.

LIME TREATMENT - Section 304

Lime treatment is defined as the addition of lime to soil or soil-aggregate to modify the material's characteristics. Water also is required to be added to adjust the moisture content of the mixture to facilitate the chemical reaction of the lime and aid compaction.

Specification Section 304 designates the following types of lime uses.

TYPE	USE
Type B	Base or Subbase
Type C	Conditioning for Cement Treatment or Stabilization
Type D	Working Table under Embankment
Type E	Conditioning and Drying for Embankment

TYPES AND USES OF LIME TREATMENT

MATERIALS

Approved sources of lime will be published in QPL No. 34. Lime used in any type of treatment must be from an approved source listed in the QPL. Either hydrated or quicklime may be used.

Lime is supplied in various forms. The most common form is dry, hydrated (powder) lime. Quicklime (non-hydrated) comes in granular form often termed pelletized. Since quicklime is non-hydrated, it has a high demand for moisture. This characteristic creates a condition that requires constant vigilance on the part of personnel. This material can cause serious burns when contact with human tissue occurs. Lime slurry minimizes the problem due to the water added to the mixture. Quicklime is supplied in two different gradations, a 3/8-inch size which the department allows to be used in the same manner as powdered lime and a 3/4 inch size which is used for forming lime/water slurries.

Lime may be applied dry (powder or granular) or in slurry form. Lime may be applied directly to the prepared surface or may be mixed with the material in a central mix plant. In dust sensitive areas, designated in the plans, either granular (pelletized), slurry application, or central plant mixing may be required. The engineer will approve the type of material and application method to be used.

Lime may be delivered to the project site in bulk transports or in bags. Lime slurry is delivered in special transports that keep the slurry in its blended form until the material is spread on the project. A Certificate of Delivery shall accompany each transport. It shall be the responsibility of the contractor to verify that the transports are sealed and that the

seal number matches that indicated on the Certificate of Delivery. Seals shall be removed and turned over to the project engineer daily.

Lime must be protected from moisture prior to application or mixing in a plant or slurry. Caked or contaminated lime is not to be used. Lime which has been exposed to air for more than six hours and lime lost or damaged before incorporation due to rain, wind or other cause will be rejected, deducted from measured quantities, and shall be replaced by the contractor at no direct pay. Lime oxidizes when exposed to the atmosphere and loses its ability to react chemically with the soil. Lime exposed to air prior to placement, stored for an excessive length of time, or for which there is a significant delay between placement and mixing is not to be used. Lime which is improperly stored, exposed to the elements, gets damp, etc., is not to be used. If the lime's usability is questionable, project personnel are to sample the lime and submit it to the Materials and Testing Section for evaluation.

Water must meet the requirements of Specification Section 1018.

EQUIPMENT

The engineer must approve all equipment used in lime treatment.

SPREADING EQUIPMENT

The equipment used to spread lime must ensure a uniform coverage at the approved spread rate. Excessive dusting will not be allowed.

MIXING EQUIPMENT

The in-place mixer defined in Specification Section 303 is required for all types of lime uses. The engineer may approve other types of equipment for Types D and E when certain conditions occur (e.g., boggy areas) where in-place mixers are not practical. When high PI soils are to be modified, the in-place mixer may not be adequate for complete mixing due to the heaviness of the soil. Initial mixing may necessarily be achieved with a disc and final mixing with an in-place mixer.

WATER TRUCKS

Water trucks may be used to spray water over the lime treated material during construction operations. Water trucks are to be equipped with spray bars which uniformly spray water across the surface and do not apply water in streams or cause water to puddle on the surface.

COMPACTION EQUIPMENT

It is recommended that lime treated areas be compacted with a conventional sheepsfoot roller or a self-propelled tamping foot compactor-type roller. The type of material and the thickness of the lime treatment shall be considered in determining the proper length and size of the spikes. The length of the spike shall be sufficient to achieve uniform

compaction for the full depth of the layer being compacted. The number and size of the spikes shall be selected to match the compaction characteristics of the material being compacted. Generally, in order to achieve full-depth uniform compaction, the spike must be long enough to penetrate the full depth.

The compacted material should be finished by sealing with static, smooth steel-wheel or pneumatic tire rollers. The drum of smooth steel-wheel rollers shall be smooth, with no flat spots, cracked, or damaged surfaces. They shall be equipped with scrapers to prevent the material from sticking to the wheels or drum. The pneumatic roller shall have an odd number of tires, arranged so that the spaces between one row of tires are covered by the tires of the other row. All tires shall be in place and shall be in good condition and properly inflated. Tires shall be smooth tread, of the same size and ply, and inflated to within □5 psi of each other.

Lime treatment shall be finished with approved equipment. It shall leave a tight, uniformly smooth surface meeting grade and cross slope requirements, if applicable.

SPECIAL TRAFFIC CONSIDERATIONS

The contractor shall provide a flagger who will stop vehicles before they enter the limed area. The flagger is to impress on the drivers the need to travel extremely slowly through the loose lime. Loose lime is highly flowable and dust prone; therefore, if traffic is allowed to disregard the situation the lime will be displaced and the percent incorporated into the soil will not be uniform or proper. The lime dusts in such a manner that it can be sucked into the intake of an automobile causing engine failure. This dusting characteristic also results in airborne particles that impact the environment and may invoke environmental protection regulations.

When traffic is maintained, the contractor shall control the operation to maintain free traffic flow through the project. Equipment shall not obstruct the orderly flow of traffic.

TYPE B TREATMENT

MIXING EQUIPMENT (Type B)

For Type B treatment, an approved in-place mixer that meets the same requirements of In-Place Cement Stabilized Base Course (Specification Section 303) must be used.

CONSTRUCTION DETAILS (Type B)

The lime is to be spread fully in a single application. Extra water is required to activate the lime. When lime slurry is used, the amount of water in the slurry will have to be considered when determining the amount of water to be added. Generally the water in the slurry is not sufficient to chemically treat the soil material and additional water will have to be added before the construction sequence is complete. Material at the proper moisture content for the chemical reaction to occur will appear excessively wet. The lime is to be mixed into the soil or soil-aggregate with an approved in-place mixer.

Sufficient water is to be added through the in-place mixer to provide for the chemical reaction between the lime, water, and soil. The amount of water required to activate the chemical reaction will bring the soil/lime mixture significantly above optimum moisture content determined by DOTD TR 415 or TR 418. The area is then sealed with rollers and allowed to mellow for 48 hours. Lime that is not sealed will oxidize through exposure to air and will not perform as required. The timing for the 48-hour mellowing period will begin when sealing is completed.

Following the 48-hour mellowing period, the lime treated area is pulverized with the in-place mixer until specification pulverization requirements on the 3/4-inch and No. 4 screen are met. The addition of a small amount of water may be necessary to bring the soil/lime mixture to within the specifications for optimum moisture content. Acceptance samples for moisture content and maximum dry density are to be taken immediately prior to compaction for acceptance. DOTD TR 415 or TR 418 may be used for this determination. The area is then compacted to at least 95.0% of maximum dry density and finished. Compaction and finishing must be completed within 6 hours of achieving pulverization. If the area cannot be compacted to specification density and finished within the six-hour time limit, the contractor will be required to make adjustments in the operation to prevent this from recurring in subsequent sections. **Sections not completed within the time limit will not be accepted.** Reconstruction with an addition of the original percent lime will be required at no direct pay. Sections that do not meet the minimum density requirements after the six-hour time limit will not be accepted.

PROTECTION AND CURING (Type B)

The lime modified soil shall never be allowed to dry out. The contractor shall apply an asphaltic curing membrane over the surface of the completed area as soon as smooth rolling is completed. No traffic, public or construction, shall be allowed over the completed lime treatment for the 72-hour curing period. When traffic must be maintained, it is to be routed off the completed course onto shoulders or other suitable areas, when conditions permit. Any damage to the lime treatment is to be corrected by the contractor.

QUALITY ASSURANCE

QUALITY CONTROL (QC) (Type B)

When lime is delivered in bulk, it shall be the responsibility of the contractor to determine the spread rate and length of spread for each transport. The contractor is to provide these values to the project engineer for approval. No lime is to be placed until the spread rate has been approved. The length of spread is to be calculated for each individual truck before lime is discharged on the surface.

If the percent of lime is not designated, it will be determined by the district laboratory. The contractor is to control the spread rate and length of spread to ensure that no less than the minimum required percent of lime is placed. The contractor shall perform DOTD TR 436 for each transport to ensure that the correct percent of lime is applied. The contractor shall observe the spread for uniformity and complete coverage. The

contractor is expected to adjust operations whenever the QC program indicates that deficiencies are occurring.
When lime is delivered in bags, the contractor will space the bags to meet at least the minimum spread rate requirements, in accordance with the approval of the project engineer. When bags are used, bags shall be opened, the contents spread uniformly, and the empty bags removed and discarded in an appropriate manner. The project engineer will approve the bag spacing to meet the spread rate requirements. The contractor is to monitor water application to ensure that the spray is uniform and that wet or dry spots do not occur.

After the 48-hour mellowing period, the contractor is to observe the blended material for uniformity of mixing. QC personnel shall determine the moisture content of the lime treated material after the 48-hour mellowing period, but before compaction begins, to ensure that the material will be within an acceptable range of optimum moisture during compaction. This test will be performed in accordance with DOTD TR 403. When maximum dry weight density is to be determined in accordance with DOTD TR 415, the material to mold the proctor will be obtained from beneath the nuclear device or from the area immediately adjacent to the sand cone density hole. The contractor is to determine the percent pulverization following the in-place mixer in accordance with DOTD TR 431. If the specification requirements are not met, the contractor is expected to alter the operation or equipment to ensure that all specification requirements are met. The contractor is to monitor pulverization and finishing to ensure that they are completed within the six-hour time limit.

Additionally, the contractor is to monitor the operation to ensure uniformity. No segregation, contamination, soft spots, laminations, undulations or other variations in elevation are to be left uncorrected. The contractor is to check thickness, width, cross slope, and grade (when applicable), to ensure that the finished project matches plan requirements.

INSPECTION AND ACCEPTANCE (Type B)

If the percent of lime is not designated, the district laboratory will determine it in accordance with DOTD TR 416.

Project personnel will independently determine spread rate and length of spread. The spread rate must result in at least the minimum percent lime designated or specified by the district laboratory being uniformly applied. During lime placement, project personnel will check the spread rate in accordance with the DOTD TR 436 in accordance with the schedule listed in the *Materials Sampling Manual* and the length of spread several times per day. When lime is delivered in bags, the project engineer will approve the bag spacing to ensure that the minimum spread rate is met. Project personnel will check bag spacing for conformance to the department's requirements. The length of spread and spread rate are also to be rechecked whenever visual inspection indicates a nonuniform spread. If the spread rate is not correct or is not uniform, the inspector is to require the contractor to make immediate corrections to ensure that the minimum percent lime is uniformly applied. Continuous placement of lime is not to be allowed until it has been established by the department that the minimum percent of lime is being uniformly applied.

Project personnel will determine the moisture content of the lime treated material after the 48-hour mellowing period, but before compaction begins, to ensure that the material will be within an acceptable range of optimum moisture during compaction. This test will be performed in accordance with DOTD TR 403. When maximum dry density is to be determined in accordance with DOTD TR 415 or TR 418, the material to mold the proctor will be obtained from beneath the nuclear device or from the area immediately adjacent to the sand cone density hole.

Project personnel are to determine the percent pulverization prior to compaction in accordance with DOTD TR 431. The pulverization process is to be continued until the acceptance test indicates that the percent pulverization meets the specifications. The inspector is not to allow compaction to begin until this test is completed. The inspector is also to monitor the six-hour time limit between pulverization and completion of compaction and finishing. Compaction is to be started as soon as pulverization is achieved.

Project personnel are to determine the percent compaction in accordance with DOTD TR 401 after compaction and finishing are completed. If the minimum percent density defined by the specifications has not been met, the contractor is to be required to reconstruct the area, beginning with reapplication of lime.

DOTD TR 602 MEASUREMENTS (TYPE B)

Project personnel will perform thickness and width measurements in accordance with DOTD TR 602 to verify the contractor's QC prior to requesting acceptance measurements by the district laboratory. The district laboratory will determine thickness and width for final acceptance in accordance with DOTD TR 602. The district laboratory engineer will notify the project engineer of areas that do not meet specification requirements and must be corrected. The project engineer will require the contractor to correct deficient areas prior to final acceptance. Additional thickness and width measurements will be performed on corrected areas by the district laboratory prior to final acceptance. To isolate an area, move up and down station five feet and retest. Then, retest at 25-foot intervals until the limits of deviation from specifications are found.

VISUAL INSPECTION (TYPE B)

Deficiencies identified by visual inspection, such as inadequate pulverization, laminations, nonuniform spread rate, dimensional deficiencies, soft areas, etc., shall be corrected before the section will be accepted. Project personnel will inspect the entire completed base regularly and daily when the base is open to traffic for damage to the curing membrane or to the base. The contractor shall repair deficiencies that develop prior to the placement of the next course at no direct pay.

Throughout the lime treatment process, project personnel are to inspect the operation for uniformity. No deficiencies such as wet spots, contamination, laminations, soft spots, etc., are to be allowed. When a deficiency is identified, the contractor is to be required to make immediate correction.

TYPE C TREATMENT

Type C lime treatment is used for preparation of material prior to cement treatment or stabilization.

MIXING EQUIPMENT (Type C)

For Type C treatment, an approved in-place mixer that meets the requirements of In-Place Cement Stabilized Base Course (Specification Section 303) must be used.

CONSTRUCTION DETAILS (Type C)

Construction operations for Type C Treatment are the same as for Type B treatment, with the following exceptions.

- There are no Atterberg Limits specified for Type C Treatment.
- There is no specified percent compaction required for Type C Treatment. The contractor is to make a reasonable effort to comply with the compaction requirements of Type B. Optimum rolling patterns are required when compaction in accordance with Type B is not achieved.
- No formal depth and width measurements in accordance with DOTD TR 602 will be required.
- No 72-hour cure is required for Type C Treatment.

QUALITY ASSURANCE

QUALITY CONTROL (QC) (Type C)

QC requirements for Type C Treatment shall be the same as for Type B Treatment.

INSPECTION AND ACCEPTANCE (Type C)

Inspection and acceptance for Type C Treatment are the same as for Type B Treatment, with the following exceptions. There is no percent compaction specified for Type C Treatment; project personnel will check density to ensure the contractor makes a reasonable effort to comply with the compaction requirements of Type B. Inspectors must make sure that the rolling patterns established by the contractor achieve the maximum compaction possible for the conditions when Type B compaction requirements are not met.

However, prior to cement treatment or stabilization, the lime treated material must be compacted to at least 93% of maximum dry density before cement is spread. Project personnel will take depth and width measurements and compare them to plan requirements. Since there are no tolerances in the specifications, it will be the responsibility of the project engineer to determine that plan dimensions are satisfactorily met by using the guidelines of DOTD TR 602. Underwidths or underdepths will not be accepted and shall be corrected before beginning the next operation.

TYPE D TREATMENT

Type D treatment is intended for constructing a working table upon which to place an embankment. It is to provide stability to support equipment to begin construction of the first lifts of embankment. **Type D Treatment is not to be used in construction of embankment lifts or Base Course or Subbase conditioning**.

MIXING EQUIPMENT (Type D)

For Type D Treatment, an approved in-place mixer that meets the requirements of In-Place Cement Stabilized Base Course (Specification Section 303), is required unless the engineer approves the use of other equipment. The equipment shall be capable of pulverizing the soil or soil-aggregate into particles small enough to be effectively coated with lime. If the soil is not adequately pulverized, the lime treatment will be ineffective. Heavy clays (e.g., above 30 P.I.) will require special effort to achieve adequate pulverization to allow the chemical reaction between soil and lime to take place. Double tandem disks may be acceptable for mixing lime with the soil. A plough disk will not adequately pulverize the material for effective coating. The plough disk may be necessary for initial cutting to proper depth, followed by the double tandem disk in lieu of a stabilizer for mixing of lime with the soil. Multiple passes will be necessary. Final blending with an in-place mixer is a superior method to ensure proper mixing and efficient use of the lime additive to achieve the highest quality product with the least amount of compaction difficulty.

CONSTRUCTION DETAILS (Type D)

Lime is to be spread fully in a single application. Lime is to uniformly cover the entire area at the spread rate approved by the engineer. The spread rate shall meet the percent lime to be incorporated as determined by the district laboratory or as specified. Lime may be mixed into
the soil or soil-aggregate by in-place mixer or by disk, when approved by the engineer. There are no pulverization requirements established by the specifications; however, the material must be uniformly blended and the soil or soil-aggregate uniformly coated with lime to the satisfaction of the engineer. The specifications do not establish a minimum percent compaction. The lime treatment is to be compacted to the satisfaction of the engineer. The contractor shall obtain the maximum density possible as determined by the engineer.

PROTECTION AND CURING (Type D)

There is no curing method or time limit established by the specifications; however, it is important to the quality and effectiveness of the lime treatment process to keep the treated material moist, never allowing it to dry out. The contractor shall protect the completed lime treatment as directed. The contractor shall prevent damage to the lime treatment from traffic in the same manner as for Type B. Any damage is to be corrected as directed.

QUALITY ASSURANCE

QUALITY CONTROL (QC) (Type D)

QC requirements for Type D Treatment shall be the same as for Type C Treatment, with the exception that DOTD TR 431, pulverization test or control of a mellowing period will not be required.

INSPECTION AND ACCEPTANCE (Type D)

Inspection and acceptance procedures will be the same for Type D Treatment as for Type C Treatment, except that curing and pulverization will be to the satisfaction of the engineer.

TYPE E TREATMENT

Type E treatment is designed for use in embankment construction. Type E lime treatment is embankment construction with lime treatment of the individual lifts of soil or soil-aggregate.

MIXING EQUIPMENT (Type E)

The requirements for mixing equipment for Type E Treatment shall be the same as for Type D Treatment.

CONSTRUCTION DETAILS (Type E)

Lime is to be spread fully in one application for each lift of embankment. **After the lime is spread and mixed, the embankment lift is to meet the requirements for embankment construction in accordance with Specification Section 203 and the guidelines of this manual for embankment.**

PROTECTION AND CURING (Type E)

The contractor is responsible for the stability of embankments until final acceptance. Therefore, the contractor is to make every effort not to damage a lime treated lift of embankment in the same manner as required for raw embankment. Heavy loads, excessive exposure to hauling, too much water, or too little water are examples of conditions that may damage a lift (and underlying lifts) requiring reconstruction. There is no curing period or time limit established by the specifications, however, it is important to the quality and effectiveness of the lime treatment process to keep the treated material moist, never allowing it to dry out.

QUALITY CONTROL (QC) (Type E)

QC requirements for Type E Treatment shall be the same as for Type B Treatment, with the exceptions that there is no mellowing period and DOTD TR 431, pulverization test will not be required. There are no pulverization requirements specified; however, a poorly pulverized and blended material will be difficult to compact to specification density. The individual lifts of lime treated embankment will be constructed and the quality controlled by the contractor in accordance with Specification Section 203.

INSPECTION AND ACCEPTANCE (Type E)

The inspection and acceptance procedures, including visual inspection, for Type E Treatment shall be in accordance with Type B treatment and Embankment Construction, Specification Section 203.

QUALITY ASSURANCE DOCUMENTATION

Quality Control

The contractor shall maintain documentation of the QC program in accordance with the Quality Control Plan, and as required by the project engineer, and the *Materials Sampling Manual*.

Inspection and Acceptance

Department personnel will maintain documentation of construction progress, inspection, acceptance tests, etc., in a field book and on proper MATT forms if applicable, in accordance with standard department practice. The length of spread, spread rate, pulverization (for Type B), time of application, mellowing times, and thickness and width shall be noted.

Density & Moisture Content Worksheet

The test procedure DOTD TR 401 - The Determination of In-Place Density, contains a worksheet to be used to facilitate the calculations associated with the determination of density, moisture, and pulverization. This worksheet is to be completed in conjunction with this procedure and used for these calculations. Department personnel will submit this form for acceptance testing regularly to the district laboratory for MATT system entry. The district laboratory will retain the original for inclusion in the 2059 Review. A copy of the documentation of QC tests and results shall be given to department personnel as noted on page 5.

SUBGRADE LAYER - Section 305

A subgrade layer is composed of soil materials treated with Portland cement or Portland-pozzolan cement, untreated aggregate materials, blended calcium sulfate, or asphaltic concrete, as specified. A subgrade layer is constructed beneath a Class I Base Course or other designated layers to improve the quality and increase the support value of the top layer of material in the embankment.

After the contractor has selected the type of materials for the subgrade layer, the same type shall be used throughout the project.

MATERIALS

ASPHALTIC CONCRETE

The materials selected and used for asphaltic concrete must conform to Specification Section 501 or 502. Sampling, testing, approval, and other procedures shall be in accordance with the *Application for Quality Assurance for Asphaltic Concrete Mixtures*.

PORTLAND CEMENT CONCRETE

Portland cement concrete **is not an approved** material for the construction of a Subgrade Layer under Specification Section 305.

AGGREGATES FOR AGGREGATE SUBGRADE LAYER

Stone, shell, sand-shell, crushed slag, and recycled Portland cement concrete may be used for subgrade layer without stabilization. These materials must meet all specification requirements and be tested and approved prior to incorporation in the project. If the contractor requests advance payment, the materials shall be placed in dedicated stockpiles. For regulations for dedicated stockpiles, refer to page 10.

BLENDED CALCIUM SULFATE

Blended calcium sulfate may be used as an untreated subgrade layer. Blended calcium sulfate must be blended with an approved aggregate for pH control and placed in dedicated stockpiles. All sampling will be accomplished in accordance with Specification Section 203, non-plastic embankment.

SOILS FOR TREATED SUBGRADE LAYER

To be acceptable for treatment, soils can contain no more than 79% sand or 69% silt. The district laboratory will determine the percent sand or silt in accordance with DOTD TR 407 from samples obtained by department personnel. Additionally, to be acceptable for treatment, materials can have a P. I. no greater than 25. The district laboratory will determine P.I. in accordance with DOTD TR 428 from samples obtained by department personnel. When in-place materials do not meet these specifications, they shall be removed and replaced with specification material under the appropriate bid item. It shall be the responsibility of the contractor to locate and provide materials which meet the specifications and which are appropriate for use.

CEMENT

Cement shall be Types 1, 1(B), Type II, or 1P meeting the requirements of Specification Subsections 1001.01 or 1001.02 and be from an approved source listed in QPL 7. Cement is to be delivered in bulk transports. It must be protected from dampness, water or other contaminants. Cement that has partially set or has visible signs of moisture damage shall not be used.

WATER

Water must meet the requirements of Specification Section 1018.

EQUIPMENT

When central plant mixing is used, all equipment shall meet the requirements for Class I Base Course (Specification Section 301).

Equipment for asphaltic concrete subgrade layer shall conform to Specification Section 503.

Equipment for in-place treated subgrade layer shall conform to Specification Section 303.

Equipment for aggregate or blended calcium sulphate subgrade layer shall conform to Specification Section 301.

CONSTRUCTION DETAILS

SUBGRADE LAYER CONSTRUCTED WITH ASPHALTIC CONCRETE

Subgrade layers built with asphaltic concrete shall be constructed in accordance with Specification Section 501 or 502. For construction details, refer to the appropriate *Application of Quality Assurance Specifications for Asphaltic Concrete Mixtures*.

SUBGRADE LAYER CONSTRUCTED WITH AGGREGATE

Aggregate subgrade layer is to be constructed in accordance with Specification Section 302. For construction details, refer to Class II Base Course.

SUBGRADE LAYER CONSTRUCTED WITH TREATED SOILS

When central plant mixing is used, Specification Section 301 will apply. Refer to Class I Base Course.

When in-place mixing is used, Specification Section 303 will apply. Refer to In-place Cement Stabilized Base Course.

Regardless of the mixing process, the mixture will be treated with 9% cement unless adjusted by the project engineer and pulverized to meet the specification requirements when tested in accordance with DOTD TR 431.

SUBGRADE LAYER CONSTRUCTED WITH BLENDED CALCIUM SULFATE

When blended calcium sulfate is used, refer to Specification Sections 203, non-plastic embankment, and 302, Class II Base Course.

QUALITY ASSURANCE

QUALITY CONTROL (QC)

Refer to the QC section for the appropriate type of construction listed in the preceding section entitled **Construction Details**.

INSPECTION AND ACCEPTANCE

Refer to the Inspection and Acceptance section for the appropriate specification reference listed in the preceding section entitled **Construction Details**.

QUALITY ASSURANCE DOCUMENTATION

The contractor shall maintain documentation of the QC program as required by the engineer.

When a central mix plant is used, the documentation requirements for Class I Base Course will apply.

For in-place treatment, the documentation requirements for Section 303 will apply.

For aggregate subgrade layer, the documentation requirements for Class II Base Course will apply.

For asphaltic concrete subgrade layer, the documentation requirements for Part V of the specifications will apply.

For blended calcium sulfate subgrade layer, the documentation requirements for non-plastic embankment, Specification Section 203 and Class II Base Course, Specification Section 302 will apply.

SCARIFYING AND COMPACTING ROADBED - Section 306

This section is designed for use when an existing road is being incorporated into new construction under traffic. The existing road must be prepared for reconstruction as a raw subbase or base course.

MATERIALS

Materials will be those in the existing roadbed.

EQUIPMENT

The engineer will approve equipment prior to use. Equipment shall be capable of scarifying and blending the full width of the roadway to a minimum depth of six inches or plan depth. All teeth on the scarifier shall be in place and adequate to break up the existing roadbed into a uniform, compactable material.

CONSTRUCTION DETAILS

The contractor shall not scarify more than a mile of material in advance of compaction. The contractor is to be aware of predicted weather and changing weather patterns and schedule operations to minimize the chance of getting pulverized and underlying materials wet. Damage to the roadway or materials prior to compaction shall be corrected at no direct pay.

It shall be the responsibility of the contractor to coordinate operations with the project engineer and the district laboratory engineer to obtain information needed for density testing in accordance with DOTD TR 415 or TR 418 and DOTD TR 401.

The scarified material shall be blended across the roadway to form a uniform mixture. Pieces of roadbed that cannot be adequately broken and blended shall be removed. The scarified and compacted roadbed shall be finished to a uniform, smooth, tightly-knit surface. There shall be no undulations between stations. A prime coat shall be applied in accordance with Specification Section 505.

QUALITY ASSURANCE

QUALITY CONTROL (QC)

The contractor shall check the depth of the scarification to ensure that the minimum specification depth of six inches or plan depth is being met. The contractor shall check that the material is uniformly blended and compacted to the specification requirements. If density is not achieved, the contractor shall continue the compaction process or

reconstruct until density is met. The contractor is to check the surface for smoothness and conformance to grade and cross slope.

INSPECTION AND ACCEPTANCE

Project personnel will obtain a sample of the blended, pulverized material after it has been mixed uniformly across the roadway for determination of maximum dry density and optimum moisture in accordance with DOTD TR 415 or 418.

Following compaction by the contractor, project personnel will determine the percent compaction in accordance with DOTD TR 401 using the maximum dry density. If density is not met, reconstruction will be required.

TYPE	% OF MAXIMUM DENSITY, Min.
Base	100.0 %
Subbase	95.0 %

SPECIFICATION DENSITY REQUIREMENTS FOR BASE AND SUBBASE

VISUAL INSPECTION

Project personnel will inspect the surface of the finished base or subbase for conformity to specifications and plans. The contractor will be required to correct any deficiencies caused to the scarified roadbed prior to compaction, loose materials, soft spots, irregular surface or other deviations.

QUALITY ASSURANCE DOCUMENTATION

Documentation will follow the general requirements of Class II base course, Section 302, since the processing and compaction are parallel to the construction of a base course.

QUALITY CONTROL

The contractor shall maintain documentation of the QC program as directed by the project engineer. A copy of the documentation of QC tests and results shall be given to department personnel as noted on page 5.

INSPECTION AND ACCEPTANCE

Department personnel will maintain documentation of inspection, acceptance tests, and construction progress in a field book, the appropriate MATT forms, or other documents in accordance with standard department procedures.

Density & Moisture Content Worksheet

The test procedure DOTD TR 401 - The Determination of In-Place Density, contains a worksheet to be used to facilitate the calculations associated with the determination of density, moisture, and pulverization. This worksheet is to be completed in conjunction with this procedure and used for these calculations. Department personnel will submit this form for acceptance testing regularly to the district laboratory for MATT system entry. The district laboratory will return the original to the project engineer for inclusion in the 2059 Review.

MAINTENANCE

The contractor shall be responsible for the completed, compacted roadbed. It shall be protected from damage from public or construction traffic or construction operations. The contractor shall maintain the compacted roadbed in the condition in which it was accepted until the next lift is placed. The contractor shall make any necessary repairs, including patching or reconstruction, and reapplication of the asphaltic prime coat. All correction of deficiencies shall be completed prior to the placement of the subsequent lift over the base course.

CULVERTS AND STORM DRAINS - Section 701

Earthwork forms a part of the installation procedures of conduit. In order to ensure an adequate foundation for such conduits, backfill material must meet certain specifications and be compacted to adequate density by acceptable methods. The use of poor soils as a bed for conduit, the failure to adequately compact soils surrounding conduit, or poor construction techniques can lead to premature failure of drainage systems, embankments, and surfacing.

The scope of this section is limited to the earthwork associated with the installation of culverts and storm drains.

TRENCH EXCAVATION AND BEDDING

For all types of drainage structures, the trench must be at least 18 inches wider than the conduit on each side or as indicated on the plans. For example, the bottom of the trench must be at least 36 inches wider than the diameter of the pipe, plus wall thickness. The bottom of the trench must be graded so that the flow line of the conduit will match the flow line shown on the plans. In the case of multiple lines of conduit, the trench shall be at least 36 inches plus the outside dimensions edge to edge of the multiple lines of conduit including the plan distance between the lines of conduit.

When the trench is in suitable, stable foundation material, the trench shall conform to plan grade and dimensions.

When the excavation must be below specified grade because of unsuitable, but stable foundation material (e.g., rock, dense, heavy clay), a cushion must be formed for the conduit. The cushion must be constructed with backfill material appropriate to the type of pipe and location of the installation. The depth of the trench shall be at least one-half inch per foot of fill height over the top of the conduit. The minimum depth of excavation, regardless of fill height, shall be eight inches. For example, if 18 feet of fill are required above the top of the pipe, the trench must be excavated to a depth of at least nine inches (1/2 inch x 18 = 9 inches). For 16 feet of fill or less, the minimum depth of the excavated trench shall be at least 8 inches. (For example, if 12 feet of fill are required over the top of the pipe, even though 12 x 1/2 inch = 6 inches, the minimum depth of the excavated trench shall be at least 8 inches.)

When excavation must be below specified grade because of unsuitable, unstable foundation, unstable soil below established grade shall be removed and replaced. If there is no item for bedding material in the contract, the bottom of the trench shall be reconstructed with usable or selected soils conforming to Specification Subsection 203.06. Replacement material shall be compacted as directed to at least the density of the surrounding soils. If bedding material is specified, the trench shall be excavated below grade and bedding material or granular material shall be placed and constructed in accordance with the requirements of Specification Subsection 726. Even when bedding material is not specified, it may be necessary when unstable or unsatisfactory

material is encountered. Examples of unsatisfactory or unstable material include excessive moisture content, high organic content, water seepage, soft materials, and excessive P.I. **When water seepage occurs, bedding material will be required. Clay seals are not an acceptable solution**.

When no trench is to be excavated, the contractor shall construct a uniformly firm bed on which to place the pipe. The bed shall be composed of usable or selected soils conforming to the requirements of Specification Subsection 203.06 and compacted as directed to at least the density of the surrounding soils.

SHORING The contractor shall adhere to all state and federal guidelines in providing protection against the cave-in of any excavated area. The contractor shall not conduct operations in the trench unless adequate shoring is in place, when needed, all safety provisions are met, and all federal and state guidelines for protection are met. The safety of the excavation depends on the characteristics of the material in which the excavation is made, seepage, depth of excavation, and side slopes. Trenches shall be braced when needed to prevent the sloughing of side or top material. The contractor shall take all measures necessary to protect workers in the trench area and shall provide them with safety equipment as needed. The design of shoring in no way affects the specification density requirements for the full width and depth of the trench.

BACKFILL MATERIALS

All materials shall be tested and approved prior to use.

This manual specifically addresses pipe trench and backfill construction using soil or aggregate. However, **flowable fill** is an approved backfill material composed of Portland cement, fly ash, concrete sand, and water. When specified or allowed this material must meet the requirements of Specification Section 710.

Exposed pipe backfill shall be covered with an outside layer of plastic soil blanket in accordance with Specifications Subsection 203.10. When flowable fill is used for backfill, the exposed backfill area will be covered and protected as directed.

SIDEDRAINS - NONPAVED AREAS

Plastic Pipe

Sidedrain trenches in which plastic pipe has been placed shall be backfilled with granular material conforming to Specification Subsection 1003.07.

Pipe Other Than Plastic Pipe

Sidedrain trenches in which pipe other than plastic pipe has been placed shall be backfilled with usable soils conforming to Specification Subsection 203.06(a).

SIDEDRAINS - PAVED AREAS

For backfill requirements for sidedrains under paved areas, refer to **Pipes Other Than Sidedrains**.

PIPES OTHER THAN SIDEDRAINS

Plastic Pipe

Trenches in which plastic pipe has been placed shall be backfilled with granular material conforming to Specification Subsection 1003.07.

Corrugated Metal Pipe

Trenches in which corrugated metal pipe has been placed shall be backfilled with selected soil conforming to Specification Subsection 203.06(b) or granular material conforming to Specification Subsection 1003.07. Both selected soils and granular material placed as backfill for corrugated metal pipe must also meet resistivity and pH requirements. The resistivity of the material shall be greater than 1500 ohm-cm when tested in accordance with DOTD TR 429. The pH shall be greater than 5.0 when tested in accordance with DOTD TR 430.

Pipe Other than Plastic or Corrugated Metal (Concrete Pipe)

Other pipe shall be backfilled with either selected soil conforming to Specification Subsection 203.06(b) or granular material conforming to Specification Subsection 1003.07.

CONSTRUCTION DETAILS

Soil and aggregate backfill material shall be of uniform characteristics and moisture content and shall be placed in lifts of uniform thicknesses. Lift thickness may require adjustment based on those characteristics, but shall not be increased above the specification requirements. Lift thickness shall be uniform both vertically and horizontally and shall be correlated with compactive effort to achieve specification density. The portions of any lifts in excess of specification requirements shall be removed and the lift recompacted. Backfill material shall be brought up evenly on both sides of the conduit for its full length in accordance with Specification Subsection 701.08.

Pipe backfill using flowable fill will be in accordance with Specification Section 710 and as directed by the project engineer.

SIDE DRAINS UNDER UNPAVED AREAS

Backfill material shall be placed by methods approved by the engineer and shall be compacted as directed.

PIPES OTHER THAN SIDE DRAINS AND SIDE DRAINS UNDER PAVED AREAS

Before any construction equipment is allowed to cross the installed pipe, at least 2 feet, compacted thickness, of backfill shall be placed over the top. The backfill will help prevent the equipment from damaging the pipe or moving it out of alignment or flow line. If the final thickness of cover over the installed pipe is less than two feet, the contractor shall install the pipe after all heavy hauling has been completed. If it is not possible to install the pipe after the need to cross the line with heavy equipment, with the approval of the engineer, the contractor shall install the pipe and place excess material over the installed pipe to a compacted depth of at least two feet. After all heavy hauling is completed, the contractor shall remove the excess material to grade.

TOP OF PIPE EVEN WITH OR BELOW TOP OF TRENCH

When the top of the conduit is even with or below the top of the trench, backfill material shall be placed and compacted in lifts evenly on both sides of the conduit for its full length. The top of the compacted backfill shall be one foot above the top of the conduit or to subgrade (if less than one foot), or to natural ground elevation, whichever is greater.

TOP OF PIPE ABOVE TOP OF TRENCH

When the top of the conduit is above the top of the trench, backfill material shall be placed and compacted in lifts evenly on both sides of the conduit for its full length. The top of the compacted backfill shall be one foot above the top of the conduit or to subgrade, if the distance from the top of the conduit to the subgrade is less than one foot. Specification backfill material shall be used for backfilling the trench and as cover at least one foot above the pipe. The backfill shall extend on each side of the pipe for at least a distance equal to the outside diameter of the pipe.

COMPACTION

Compaction of backfill material by flooding will not be permitted.

Backfill placed in the haunch shall be compacted by positive mechanical means. This area will be inspected and approved by the engineer prior to the placement of the full lift. Areas that are inaccessible to conventional backfill compaction equipment shall be compacted by hand-held pneumatic tampers. Backfill shall be placed and compacted for each lift in the haunch area prior to the placement of the full lift until backfill reaches the midpoint of the pipe. Backfill shall be placed and compacted without disturbing the alignment or flowline of the conduit.

Culverts for sidedrain ramps and driveways to be paved, cross drains, storm sewers and sanitary sewers under or immediately adjacent to roadways, driveways, parking lots, or

other paved areas will be backfilled and compacted in lifts to 95% of maximum dry density with soil or aggregate, at or near optimum moisture, meeting the specification requirements for backfill materials.

When flowable fill is used there are no compaction requirements. The material flows and consolidates under its weight while being placed at the appropriate consistency.

Selected Soils

Selected soils backfill shall be placed and compacted in lifts not to exceed six inches compacted thickness. Optimum moisture will be determined in accordance with DOTD TR 415 or TR 418 . Each layer shall be compacted to at least 95% of maximum density as determined in accordance with DOTD TR 415 or TR 418. Project personnel will determine percent compaction in accordance with DOTD TR 401.

Granular Material

Granular material backfill shall be placed and compacted in lifts not to exceed twelve inches compacted thickness. Optimum moisture will be determined in accordance with DOTD TR 415 or TR 418. Each layer shall be compacted to at least 95% of maximum density as determined in accordance with DOTD TR 415 or TR 418. Project personnel will determine percent compaction in accordance with DOTD TR 401.

QUALITY ASSURANCE

QUALITY CONTROL

The contractor shall submit a quality control plan for approval. Plan modifications or additional control sampling and testing may be directed by the project engineer.

When flowable fill is specified, or allowed, the contractor shall submit a mix design for approval. The mix design and control of the mixture will follow the general guidelines of Specification Section 710 and the appropriate Application of Quality Assurance manual.

INSPECTION AND ACCEPTANCE

Materials will be sampled and tested for specification compliance in accordance with requirements for each type of material. Trenching, bedding, pipe placement (alignment, slope, etc.) and material placement (lift thickness, staggered lifts, moisture control, etc.) will be constantly monitored to ensure that installations which do not meet specifications do not occur.

When flowable fill is used as backfill, the inspector shall ensure that the material has a suitable flow, that it is filling all voids, that the backfill is being placed equally around the pipe, that containment is satisfactory, and that the material is setting up (hardening) properly.

When density is a requirement, the project engineer will ascertain that the compaction and moisture requirements are met by taking a minimum of one compaction test per three feet thickness and in the top six inches of backfill material per 100 linear feet of

conduit installation. Each individual pipe installation less than 100 feet in length will be tested in accordance with the above backfill thickness frequency requirement. The project engineer will take as many tests as necessary to ensure that each layer of backfill material meets the density requirements. Compaction reports will document the location of the test, both vertically and horizontally. Compaction equipment required will be at the discretion of the contractor; however, the equipment selected must be approved and maintain the structural integrity of the pipe.

MANHOLES, JUNCTION BOXES AND CATCH BASINS - Section 702

The scope of this section is limited to the earthwork associated with the installation of manholes, junction boxes, and catch basins.

Backfill materials and construction for manholes, junction boxes and catch basins shall be in accordance with the general information under Culverts and Storm Drains and the specific information presented for Side Drains Under Paved Areas and Pipes Other than Side Drains in Section 701. Backfill materials shall be compacted in lifts to a minimum of 95% of maximum dry density. If existing backfill has been saturated with water, it shall be removed, replaced, and recompacted.

Backfill placement and compaction shall be adjusted for the shape of the structure. If these structures are backfilled separately from adjoining conduit, existing backfill disturbed by the installation shall be removed, replaced and recompacted.

QUALITY ASSURANCE

Quality Assurance, both QC and Inspection and Acceptance, shall be conducted in accordance with Specification Section 701.

STRUCTURAL EXCAVATION AND BACKFILL - Section 802

Earthwork forms a part of the installation procedures of box culverts, retaining walls, foundations, and substructures. In order to ensure an adequate foundation for such structures, backfill material must meet certain specifications and be compacted by acceptable methods to adequate density. The use of poor soils as a bed for a structure and the failure to adequately compact soils surrounding any foundation can lead to premature failure.

Backfill shall be of acceptable quality, free from large or frozen lumps, wood or other foreign material.
No backfill shall be placed against a concrete abutment, wing wall or reinforced concrete box culvert until concrete has been in place at least 14 calendar days or until test cylinders made in accordance with DOTD TR 226 and tested in accordance with DOTD TR 230 have obtained a minimum compressive strength of 3000 psi.

The scope of this section is limited to the earthwork associated with the construction of structures.

SHORING

The contractor shall adhere to all state and federal guidelines in providing protection against the cave-in of any excavated area. The contractor shall not conduct operations in the trench unless adequate shoring is in place, when needed, all safety provisions are met, and all federal and state guidelines for protection are met. The safety of the excavation depends on the characteristics of the material in which the excavation is made, seepage, depth of excavation, and side slopes. Trenches shall be braced when needed to prevent the sloughing of side or top material. The contractor shall take all measures necessary to protect workers in the trench area and shall provide them with safety equipment as needed. The design of shoring in no way affects the specification density requirements for the full width and depth of the trench.

BOX CULVERTS

The contractor shall excavate the trench wide enough to allow for construction activity. Generally, at least 18 inches on each side of the neat lines of the box will be adequate to allow for normal construction activity. The bottom of the excavation must be graded to match the flow line shown on the plans. The subgrade shall be compacted as necessary when directed to provide a firm foundation for the box culvert.
When suitable foundation cannot be obtained, unstable soil below plan grade shall be removed and the bottom of the excavation shall be reconstructed with specified soil conforming to Specification Subsection 203.06. If bedding material is specified or required, the excavation shall be excavated below grade and bedding material used to achieve plan elevation. Even when bedding material is not specified, it may be necessary when unstable or unsatisfactory material is encountered. Examples of

unsatisfactory or unstable material include excessive moisture content, high organic content, water seepage, soft materials, and excessive P.I. **When water seepage occurs, bedding material will be required. A concrete seal may be permitted in lieu of bedding material at no direct pay. Clay seals are not an acceptable solution**. Replacement material shall be compacted as directed to at least the density of the surrounding soils.

Prior to the placement of forms or reinforcing steel in the box bottom, project personnel will check the foundation will be checked for flow line. It will also be visually inspected for uniformity of compaction, unstable areas, etc. the contractor shall correct deficiencies prior to proceeding with box culvert construction.

BACKFILLING

Compaction of backfill material by flooding will not be permitted.

Box culverts shall be backfilled with selected soil conforming to Specification Subsection 203.06(b), flowable fill meeting the requirements of Specification Section 710, or granular material conforming to Specification Subsection 1003.07. Plastic soil blanket for all installations shall conform to the requirements of Specification Subsection 203.10. All materials shall be tested and approved prior to use.

Before any construction equipment is allowed to cross the box culvert, at least 2 feet, compacted thickness, of backfill shall be placed over the top. The backfill will help prevent the equipment from damaging the culvert. If the final thickness of cover over the installed box culvert is less than two feet, the contractor shall install the box culvert after all heavy hauling has been completed. If it is not possible to install the box culvert after it is no longer necessary to cross the box culvert with heavy equipment, with the approval of the engineer, the contractor shall install the culvert and place excess material over the installed culvert to a compacted depth of at least two feet. After all heavy hauling has been completed, the contractor shall remove the excess material to grade.

Backfill material shall be of uniform soil characteristics and moisture content and shall be placed in lifts of uniform thicknesses. Lift thickness may require adjustment based on soil characteristics, but shall not be increased above the specification requirements. Project personnel will check the lift thickness during placement. Lift thickness shall be uniform both vertically and horizontally and shall be correlated with compactive effort to achieve specification density. The portion of lifts in excess of specification requirements shall be removed and the lift recompacted.

SELECTED SOILS

Selected soils backfill shall be placed and compacted in lifts not to exceed six inches compacted thickness. Optimum moisture will be determined in accordance with DOTD TR 415 or TR 418. Each layer shall be compacted to at least 95% of maximum density as determined in accordance with DOTD TR 415 or TR 418. Project personnel will determine percent compaction in accordance with DOTD TR 401.

GRANULAR MATERIAL

Granular material backfill shall be placed and compacted in lifts not to exceed twelve inches compacted thickness. Optimum moisture will be determined in accordance with DOTDTR 415 or TR 41. Each layer shall be compacted to at least 95% of maximum density as determined in accordance with DOTD TR 415 or TR 418. Project personnel will determine percent compaction in accordance with DOTD TR 401.

COFFERDAMS AND CRIBS

Cribs and cofferdams shall be backfilled with soil, approved by the engineer, and compacted as directed to the satisfaction of the engineer. The finished elevation of the compacted backfill shall be that of the surrounding ground. Backfilling will continue to the surface of the surrounding ground maintaining approximately equal elevations on both sides of the structure.

FOOTINGS

Final excavation to grade shall not be performed until just before the placement of reinforcing steel or concrete. When the bottom of the excavation is soil, the grade shall not be disturbed prior to the placement of concrete. When the bottom of the excavation is rock or other hard foundation material, it shall be cut to a firm surface as directed and all loose material removed. Any open seams shall be cleaned and filled with concrete, mortar or grout to the satisfaction of the engineer. Footing excavations shall be dewatered and made as dry as possible prior to the placement of backfill. Backfill material as specified shall be placed in lifts as directed and compacted as directed to the satisfaction of the engineer.

OTHER STRUCTURES

Excavations shall be dewatered and made as dry as possible prior to the placement of backfill. Backfill material, as specified, shall be placed in lifts not to exceed nine inches loose thickness as directed and uniformly compacted as directed to the satisfaction of the engineer.

No jetting of backfill behind abutments and wingwalls will be permitted.

QUALITY ASSURANCE

Quality Assurance, both QC and Inspection and Acceptance, shall be conducted in accordance with Specification Section 701.