Mississippi Department Of Transportation

Construction Manual

Introduction

This manual has been prepared to inform and assist construction inspection personnel in the performance of their duties and in the documentation of project activities. This is not a specification document and its content is not legally binding upon any Department contract and should be recognized as a guide only. Reference to certain sections of the Standard Specifications appear throughout in order to relate certain inspection activities to an applicable section of the Standard Specification.

Recognizing that any manual of this type must undergo continuous revisions, each recipient is encouraged to submit suggested changes through appropriate channels to the Construction Division. Approved changes, additions, or deletions will be issued as the need arises. Each recipient of the Construction Manual is responsible for keeping the contents of their copy up to date. Revision will be posted on the Construction Division Intranet site.

This Construction Manual is presented with the sincere belief that it will aid in maintaining the high quality construction standards which have been established over the years by the Department.

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CHAPTER 1
ADMINISTRATIVE AND GENERAL PROVISIONS

1.1 DEPARTMENT ORGANIZATION

1.1.1 Construction Organization And Personnel. The Mississippi Department of Transportation is organized and operated under the laws of the State of Mississippi, generally codified under Sections 65-1-1, *et seq*. Mississippi Code of 1972, Annotated, as amended.

The Mississippi Department of Transportation (MDOT) operates its programs and services without regard to race, color, national origin, sex, age, or disability in accordance with Title VI of the Civil Rights Act of 1964, as amended and related statues and implementing authorities.

The Mississippi Department of Transportation is responsible for providing a safe intermodal transportation network that is planned, designed, constructed and maintained in an effective, cost efficient, and environmentally sensitive manner. In order to do this, several goals have been developed. These goals are multimodal and comprehensive in scope. They are all important and interdependent.

Goal 1. Improve mobility for Mississippi's people, commerce and industry.
Goal 2. Ensure high standards of safety in the transportation system.
Goal 3. Provide a transportation system which encourages and supports Mississippi's economic development.
Goal 4. Improve intermodal efficiency and connectivity in transportation systems.
Goal 5. Establish and maintain effective transportation system management processes.
Goal 6. Maintain and preserve Mississippi's transportation system.
Goal 7. Ensure that the transportation system development is sensitive to environmental and energy conservation concerns.
Goal 8. Create effective transportation partnerships and cooperative processes.
Goal 9. Provide a sound financial basis for the transportation system.

In order that a mutual understanding may be in evidence to field personnel as to the functions and responsibilities of line and staff personnel, a review is here being made in part by reference to other Standard Operating Procedures, of the principal responsibilities and authorities of line functionaries and staff personnel as they relate to effective construction supervision.

A. The Mississippi Transportation Commission. The Mississippi Transportation Commission is the governing body of the Department acting through the Executive Director by promulgating rules, regulations and policies to effectively accomplish the statutory responsibilities of the Department.

B. Executive Director. Reference is made to S.O.P. No. ADM-01-01-00-000 for the principal responsibilities and authority of the Executive Director. See also Mississippi Code Section 65-1-10.

C. Chief Engineer. Reference is made to S.O.P. ADM-01-03-00-000 for the principal responsibilities and authority of the Chief Engineer. See also Mississippi Code Section 65-1-11.

D. Assistant Chief Engineer - Field Operations. It is through the Assistant Chief Engineer - Field Operations that administrative procedures and decisions are passed to and from the Construction Division.

E. Construction Division. The Construction Division functions as a staff organization in the overall administration of highway construction projects under State contracts and the coordination of matters relating to plan approval and contract preparation with other Divisions, the Districts, and the Federal Highway Administration. The State Construction Engineer is the head of the Division and supervisor of internal policies and operations. The State Construction Engineer's staff consists of the Assistant State Construction Engineer, Area Engineers, the Specifications Engineer, the State Estimator, their assistants, and the general office staff.

   Regarding construction field personnel, the Area Engineers are the key representatives of the Construction Division. The Area Engineer is assigned a regular territory to cover in the field, usually a District, and, in addition, may be assigned special functions in other areas as warranted by expediency. The Area Engineer is available for consultation with the District Engineer, Assistant District Engineer - Construction, District Materials Engineer, and Resident or Project Engineers on matters of contract preparation and construction beginning at the Location and Design Committee Review stage and continuing until completion and final acceptance of contract work. The Area Engineers are responsible for making inspections and reports to the State Construction Engineer which allows the Construction Division to coordinate contract preparation, work, methods, and procedures for similar construction throughout the State.

F. District Engineer. The responsibility and authority for the proper execution of contract work in the District rests with the District Engineer.

G. Assistant District Engineer - Construction. The Assistant District Engineer - Construction is assigned detail supervision, on behalf of the District Engineer, of all highway construction projects within the District. The Assistant District Engineer - Construction is responsible to the District Engineer for the activities of supervisory engineering personnel and contract work under the Assistant District Engineer - Construction's jurisdiction and has commensurate delegated authority.

The Assistant District Engineer - Construction supervises the work of Resident or Project Engineers and must be thoroughly familiar with the status of each contract by observation and information supplied by the Resident or Project Engineer. The Resident or Project Engineer must keep the Assistant District Engineer - Construction fully informed as to the technical and contractual status of each project. The Assistant District Engineer - Construction must be kept well informed on contract funds, whether the project is on schedule or the reason(s) for lack of progress, and any inconsistencies or inadequate performance.

1.1.2 Resident And Project Engineers. Reference to the Resident Engineer is understood to mean the Resident Engineer or Project Engineer, whichever is applicable. Likewise, reference to the

Project Engineer is understood to mean the Project Engineer or Resident Engineer, whichever is applicable. In SiteManager, the Resident Engineers and Project Engineers have the same authority and are included in under the same group name, “Project Engineer”.

Each contract will be under the supervision of a Resident Engineer. The Resident Engineer may also act as the Project Engineer, or in the case of multiple projects, the District Office may assign to the Resident Engineer one or more Project Engineers for direct supervision of one or more projects each.

Under the direction of the Assistant District Engineer - Construction, the Resident Engineers will have charge of all of the projects for which they are assigned and will report directly to the Assistant District Engineer - Construction. Resident Engineers will be responsible for the efficiency of all Department personnel on work under their jurisdiction and for the satisfactory prosecution of the work under their supervision. They are responsible for studying the plans and contract documents for correctness in the representation of existing physical features of the project site, the suitability of the features proposed on the plans for construction at the sites proposed, and the adequacy of each computed or estimated quantity shown on the plans and in the proposal. They are responsible for the supervision of layout and inspection of construction; the preparation and maintenance of proper records of the work, as required; the preparation of current and final estimates of work performed and payments allowed; and the maintenance of proper relationships between themselves and their organization and the Contractor, the Federal Highway Administration and the public.

Absolute integrity on the part of all Department personnel is essential if public confidence in the Department is to be maintained. There is no position within the Department for which integrity is of more importance than the Resident Engineer position.

Resident Engineers are responsible for all contract construction and payment. All other Department personnel perform in support of the functions of the Resident Engineer.

Resident Engineers, acting as the duly-appointed representative of the Chief Engineer, have the responsibility and authority for administering the contract construction of their projects in a firm, just and fair manner, equitable to the State and to the Contractor. Resident Engineers should expect to obtain no more than what is specified, nor can they accept any less than the contract requirements. In order to fulfill these functions, Resident Engineers should, at all times, know completely what all contract requirements are and should see that each member of the project organization knows precisely what the contract requirements are for the particular phase(s) of work to which they are assigned.

The responsibility of the handling and disbursement of entrusted public funds make it incumbent upon the Resident Engineers as a member of the Mississippi Department of Transportation’s administrative and supervisory team to be sure that the quality of the work is as intended in the contract and that measurement and computations for pay quantities for acceptable work are authentic.

Resident Engineers will sign all quantity adjustments, current and final estimates, final plans and important instructions or orders to the Contractor. They may, with the approval of the Assistant District Engineer - Construction, delegate authority to their Project Engineer(s) to sign certain correspondence and reports to the District or Divisions and final cross-sections and other computations supporting current and final estimates with which the Project Engineer is most familiar. The Project Engineers approve all SiteManager current and final estimates and change orders before they go to the next level of approval.

For projects on which the Resident Engineers are also the Project Engineer, they will sign all Project Diaries for such project(s) each day and all reports, final cross-sections, computations supporting estimates and all other papers requiring signature of the Resident or Project Engineer. In SiteManager, the Project Engineers authorize all Daily Work Reports for each day and creates the daily diary. The Project Engineers can create Daily Work Reports if they deem it necessary.

Project Engineers are responsible for obtaining results specified in the contract. Their responsibilities for the project(s) to which they are assigned are similar to those of a Resident Engineer, except that they report directly to the Resident Engineer. Their duties are similar to those of the Resident Engineer regarding the supervision of the contract, construction, the keeping of proper records and documentation, the preparation of current and final estimates, and the direct supervision of the project organization in the layout and inspection of the work and the fulfillment of all contract requirements.

Project Engineers must sign project diaries each day for each project under their supervision.

Project Engineers should remember that their assignment is one that may depend on their development and the scope of their knowledge, experience, judgment, diplomacy, and record of integrity. They should make every effort to familiarize themselves with all procedures which would best compliment the work of the Resident Engineer, and in so doing, will go a long way in qualifying themselves for advancement.

In SiteManager, Project Engineers have the authority to delegate certain duties to others under their supervision to act as Project Managers, Office Managers, and Office Aides. At the Project Engineers' discretion, the Project Manager can be granted the authority to create Daily Work Reports, generate current and final estimates, and create change orders. The Project Engineer can grant Office Managers and Office Aides the authority to create Daily Work Reports.

1.1.2.1 Assistant Project Engineers, Project Assistants, And Inspectors. Resident Engineers may, if they elect, serve as the chief inspector on certain phases of the work, or they may delegate this assignment to a Project Engineer, an Assistant Project Engineer, a Project Assistant, or one or more inspectors qualified to inspect the particular type of work being performed.

Usually an Assistant Project Engineer, a Project Assistant, or Chief Inspector will be assigned the responsibility for overall supervision of inspection. Personnel so assigned are expected to spend the major portion of their time in the field acting in the assigned capacity. Other inspectors will be assigned as the scope of the work requires.

Proper inspection requires good judgment, diplomacy, common sense and a thorough knowledge of the work and contract requirements.

Inspectors on construction projects have the authority and duty to enforce the specifications. If differences in interpretation arise with the Contractor, the matter should be decided by the Resident Engineer, or, if necessary, by the District. The inspector must always bear in mind that the management of the work is the Contractor's business; however, if any methods are employed which the inspector has reason to believe will impair the quality of the finished work, the inspector shall advise the Contractor's representative accordingly and notify the inspector's superior immediately. The matter, if considered to be serious, should be resolved by the Resident Engineer or higher authority, if appropriate.

No inspector, regardless of position, is authorized to revoke, alter, enlarge or release any requirements of the contract. The inspector is authorized to and is obligated to reject nonconforming materials and work.

All Department personnel should refrain from arguing with any Contractor supervisor or representative. Department personnel authority comes from the right to enforce the contract, not from superior knowledge or vocabulary.

The same inspector should generally not be utilized on successive jobs with the same Contractor. Certain personal relations and precedence can be established which may not be in the best public interest. However, it is sometimes desirable to assign the same inspector on successive jobs with the same Contractor because of the inspector's availability, knowledge, experience, and capacity for handling successively similar types of work. Such assignment, if made, should be based on the individual inspector's record of unqualified integrity and ability to provide firm, fair, equitable and proficient engineering inspection.

All inspectors must keep a diary in which matters of importance are entered daily and with such frequency as their superior considers necessary for documentation of work performed and materials used.

All diaries, measurements, layouts, sketches, computations, and other records of performance should be kept in a manner and with the completeness and accuracy as would be creditable evidence before the Commission.

1.2 RELATIONS WITH OTHERS

1.2.1 Relations With The Public. The general public judges the Department principally by the conduct of its employees and the orderliness and adequacy of the physical condition of that part of the work through which the public is passing.

The Department is a service organization and its employees are in daily contact with and under the surveillance of a large number of citizens. These may be adjacent property owners, local citizens of the nearby communities, public officials, tourists, or representatives of news gathering media, and it should be anticipated by each Department employee that at any given time someone is probably observing the work being performed and the attitudes and behavior of Department employees.

The prime responsibility of the employees is to perform their assigned function adequately and efficiently in order that the work being done is continuously in accordance with the requirements of the contract. Continuous performance and maintenance of the work is a credit to the Department as a public service organization. In fulfilling the prime responsibility, the employees must at all times be courteous and patient in their visual and verbal contacts with others. A courteous approach is practically always possible without any loss of prestige and will usually command respect.

When some inconvenience to adjacent property owners or to other segments of the general public is unavoidable, all precautions must be exercised in holding such inconvenience to the minimum reasonably necessary and for the shortest reasonable period of time. This is a responsibility of the Contractor under the contract; seeing that it is accomplished is a responsibility of the Department employee under the policies of this Department. A courteous explanation of the reasons for these inconveniences and knowledgeable answers to questions from the public are essential in creating good public relations. A Department employee should courteously offer to refer a question to a more knowledgeable employee rather than attempt to answer a question without a reasonably complete knowledge of the controlling facts involved.

The importance of proper public relations upon first contact cannot be overemphasized. The Resident Engineer should brief all field personnel on a courteous approach to initial contacts and should periodically hold briefing discussions in which reviews are made of particular questions asked or comments made by others and the replies that were given by the Department employee. Such discussions will enlighten and impress the employee into a consciousness of good public relations.

1.2.2 Relations With Property Owners. Property owners are most directly affected by the Department’s survey work and construction operations. Therefore, one of the most important phases of public relations work is in dealing with the property owners whose property the survey crosses or is near and with the owners of property affected by the construction.

Prior to entry on private lands for surveying, exploration for pits or for other purposes, the responsible Engineer should prepare a list of property owners. The Engineer should then visit the owners, in company with another member of the Department to serve as a witness, explain the nature of the proposed entry onto their lands, and seek permission to accomplish the work proposed. In the case of an absentee landlord operating from the site by considerable distance, lessees or tenants should be advised of proposed entry and tentative permission obtained. Careful notations of the date(s), time, place and discussion(s) details should be made and signed by the Engineer and owner or lessee (tenant), witnessed by the accompanying Department employee and, if practicable, by other parties present.

If it is not practical or economical to visit an absentee owner, this owner should be contracted by letter containing all necessary information, including any tentative permission of lessee or tenant to grant right-of-entry for the purpose(s) outlined. If the permission granted is overly restrictive, the District Engineer should be notified for advice. When the rights-of-entry are exercised, every precaution must be taken to observe and honor all agreements and to prevent any unauthorized or unnecessary damage.

After the contract is let and before construction starts, the Engineer and, if possible, the Contractor’s superintendent should meet with the property owner to outline the work to be done and to assure the owner that inconvenience and nuisances will be held to the practicable minimum.

As in all other public relations, the employee should courteously listen to the property owner’s problem, request, or question, and try to answer or explain intelligently. If the employee is not sure of the answer or explanation, the property owner should be advised that the question will be discussed with superiors and that the property owner will be advised of an answer as soon as possible. An appropriate follow-up should be made.

Frank, courteous, and factual discussions with the property owner can generate a feeling that the Department is not an impersonal organization running over the individual and the public, and will usually promote an atmosphere of cooperation.

1.2.3 Relations With Private Companies And Public Agencies. Good public relations have just as beneficial an effect in dealing with utility companies and other public agencies. The Resident Engineers should make personal contact with the officials or representatives of the utility company, governmental agency or department with whom they will be dealing. They will find it much easier to work with these people during the life of the contract if they have met them personally prior to actual business contact. Included in the government agencies with whose personnel they should have more than an impersonal telephone contact is the State Highway Patrol and local police organizations. Personal contact with all these people, during which the Engineer acquaints them with the planned operations prior to actual construction, will enable them to better schedule their work or services to the best advantage of all concerned.

It is of extreme importance that the State Highway Patrol and local police organizations be notified to making any change in the normal flow of traffic or in a change from an existing detour flow to another traffic flow pattern. The District Office should also be notified sufficiently in advance of any planned change in traffic patterns so that they may have time to assist in preparing proper information to inform the public of the change.

1.2.4 Inter-Departmental Relations. It is very important that inter-departmental relations be harmonious and all manpower resources and capabilities are utilized in the best public interest in the construction and maintenance of our highways.

If there are questions as to design, specifications, testing procedures, measurement and payment or some other feature, it is advisable to seek the advice of other Department personnel qualified to help resolve the questions raised. Constructive criticism and meaningful positive suggestions directed toward improvements will be expected, welcomed and given due consideration by other Divisions.

1.2.5 Public Relations By News Media. The main difference between public relations by personal contact and public relations by news media where information must be conveyed to a very large segment of the public at one time is the manner in which the information on a given subject is to be conveyed. S.O.P. No. ADM-01-07-01-000 adequately covers the procedures to be used in the distribution of information to the public by use of news media.

The Resident or Project Engineer should consult with the District Engineer or the District's representative prior to conferring with Public Affairs Division so that the information to be furnished will be as mutually helpful as possible.

1.2.6 Relations With The Federal Highway Administration (FHWA). On a project for which any money is furnished by the Federal Government, a contract between the State and the Federal Government is executed in which the State agrees that the project will be constructed in accordance with the approved plans, specifications and other contract documents. The federal government agrees thereupon to pay its portion of the cost of the work when the FHWA can certify that the work was constructed in accordance with the approved contract documents.

The FHWA is responsible for determining that the State requires the Contractor to perform the work in accordance with the contract. This relationship between FHWA and the Department does not directly involve the Contractor and FHWA has no occasion to instruct or admonish the Contractor directly. However, in order to certify that the Department is requiring the Contractor to perform in accordance with the contract, the FHWA Engineers must make periodic and sometimes in-depth inspections of the work being performed by the Contractor and procedures being used by the Department in the fulfillment of its contract with the Federal Government.

It is the Department's policy to facilitate these inspections and cooperate with the FHWA Engineers in performing their assignment. The FHWA Engineers do not make inspections on a project for the purpose of checking on the Project Engineers or any other individual, but rather to determine that covenants made between the Federal Government and the State Government are being fulfilled.

As with any other contract, contracts between the State and the Federal Government are binding on both the FHWA and the Department and requirements provided there under must not be changed by either without the prior concurrence of the other. Therefore, the Resident and Project Engineers should keep the FHWA Engineers fully informed on proposed and necessary changes or added work so a workable relationship between the two parties may exist and to facilitate formal approval of quantity adjustments and supplemental agreements when submitted to the FHWA. Department Engineers should understand that FHWA inspection personnel are fellow Engineers performing a similar function under separate but related contracts.

1.2.7 Relations With Bidders. It is to the mutual advantage of the State and the Contractors to make certain that all aspects of the work are investigated thoroughly prior to bidding and that all prospective bidders are given the same information.

Upon receipt of notice that a project is to be advertised, the Assistant District Engineer - Construction should furnish the Resident Engineer with copies of the construction plans and contract documents so that the Resident Engineer will have time to review them before showing the project to prospective bidders.

Normally, it will be the responsibility of the Resident Engineer to show the work to interested Contractors. In the event that the Resident Engineer cannot show the work, the Resident Engineer's assistant or a well-informed employee should be delegated the responsibility. It is important that, upon request, all prospective bidders be shown the work and given access to any appropriate information that may not be included in the standard plans. Any conflict discovered in the plans and specifications should be reported to the Assistant District Engineer - Construction in writing with copies to the Construction Division.

All prospective bidders must be treated impartially and alike. In no instance should the Resident Engineer make statements regarding the possibility or probability of changes in plans, specifications, or quantities without concurrence of those responsible for authorizing such changes.

1.2.8 Relations With The Contractor. Every construction contract is a joint effort between the Department and the Contractor. The effort of either party directly relates to the accomplishment of the other. The functions of the Engineer and inspectors are intermingled with the Contractor's efforts and accomplishments throughout the life of the contract. Each must depend upon the other and both are expected to be dependable.

All Department employees are expected to perform their function promptly and adequately and to cooperate with the Contractor to expedite the construction of the project without violating any of the contract documents or sacrificing the quality of work or materials. Any engineer or engineering party so performing should have justifiable pride of accomplishment.

The Contractor and all the Contractor's employees should cooperate with the Department toward the accomplishment of Department personnel functions and toward compliance with the contract documents without forcing the Engineer into a position of issuing demands.

The day-to-day relations with the Contractor should be amicable without being fraternal. Instructions to the Contractor should be within the scope of the plans and specifications and should be clear and precise.

The Resident or Project Engineer must see that instructions given to the Contractor are clearly understood.

Important instructions should be given or confirmed in writing and made a part of the project records. The Engineer is expected to assume that all instructions are important and may be a future basis for further instructions or for a determination of equity. Instructions should be given only to authorized personnel of the Contractor and not to individual workers. Cooperation with the Contractor <u>does not ever</u> include project personnel acting as foreman or in a supervisory capacity for the Contractor.

Differences of opinion between the Contractor's supervisory personnel and those of the Department Inspectors are not uncommon regarding issues such as the interpretation of the specifications, quality of work, or whether work performed is a pay item or a required subsidiary to a pay item. The Resident or Project Engineer is expected to be sufficiently knowledgeable in these respects to arbitrate such controversies, and an attempt should be made to resolve these differences promptly and fairly within the scope of the contract. Failing to do so, the Resident or Project Engineer should refer the matter to the Engineer's immediate superior. Disposition made in any such controversy is to be recorded and made known to all parties concerned.

1.3 PROJECT RECORDS

1.3.1 Preparation For Contract Administration. Immediately after being assigned a project, the Resident Engineer should begin making preparations for administration of the contract.

The Resident Engineer and Assistants should thoroughly study the plans, specifications, and contract documents to determine whether any conflicts, problems, or changes can be anticipated due to existing field conditions. Any errors or changes to the contract found prior to letting should be forwarded to the Construction Division as soon as possible so these changes can be made to the contract prior to taking bids. All major findings should be discussed with the Assistant District Engineer - Construction before any action is taken.

If any potential problems of significant proportion are discovered, such as essential plan changes, the need for extra work, major quantity changes or poorly defined requirements relating to any items of work, immediate action should be taken to resolve or clarify the issue. In any event, the Resident

Engineer should know the Department's official position regarding these issues before they are presented at the pre-construction conference.

On occasion, it may be found that the plans or proposal contain some potentially controversial issues or other significant considerations. In such a situation, a preliminary conference involving Project, District, and Construction Division personnel and Federal Highway Administration officials, if necessary, should be held and the issues resolved. Such a conference should be held well in advance of the pre-construction conference so that the details and proposals decided on can be prepared for presentation at the pre-construction conference with the Contractor.

Before construction begins, the Resident Engineer should arrange an informal meeting with all project personnel so that they are briefed on the work related to the functions each will perform. Such a meeting will allow any questions regarding the work to be discussed and thereby increase personnel effectiveness.

Some of the items which could be covered at the meeting are the following:

1. Delegation of work and lines of authority for inspectors to be assigned to the project.
2. Employee's responsibilities and how they fit into the overall engineering supervision and inspection.
3. Frequency of tests and inspections. What to do when unacceptable work or improper methods or equipment are encountered on the job.
4. Legal relations and responsibility of employees toward the public, the Contractor, and visiting officials.
5. Regulations regarding fraudulent representations, misstatement of fact, false reporting, etc.
6. Documentation of procedures, quality and quantity control and record accounting practice.
7. Scope of the project and probable methods of proceeding.
8. Delegation of authority in SiteManager.

After the plans have been checked, any office or field books that may be prepared in advance should be set up for the project.

Administration of highway construction contracts is continually involving more and more paper work. The Resident Engineer should anticipate this and have a filing system set up for proper storage of project records and correspondence. The extent of the system will vary with the size of the project, but in all cases it should be adequate to keep project papers readily available for reference by project personnel, the Assistant District Engineer - Construction, Area Engineer, and Federal Highway Administration personnel. This file should be indexed into enough sections to separate the records by material, source, etc., as necessary for quick location. Sections will be cross-referenced, if necessary. The following is a suggested minimum project file assembly.

1. Miscellaneous Construction Correspondence
2. Bridges
3. Contractor's Correspondence and Payrolls.
   A. Labor Interviews (where applicable)
   B. Weekly Reports - Trainees (where applicable)
4. Right of Way
5. Utilities
6. Soils and Materials
7. Progress Reports
8. Test Reports
9. Quantity Adjustments and Supplemental Agreements
10. Estimates
11. Final Data
12. Sub-contracts and Rental Agreements
13. Contract Documents
14. Record Samples.

1.3.2 Keeping Project Records Up-To-Date. Subsections 105.03 and 106.03 of the Standard Specifications impose some obligations upon the Engineer which must be rigidly followed.

It shall be the responsibility of the Project Engineer to have project files complete for examination on a day-to-day basis. Accepted test reports, certifications, etc. under the provisions of Subsection 105.03 for materials and work must be kept up-to-date.

The Project Engineer's files must reflect, as the work progresses, whether or not all materials and work are in reasonably close conformity with contract requirements. If not, it is the Project Engineer's responsibility to have project files reflect such status. The Project Engineer must immediately initiate, through proper channels, actions taken or to be taken in accordance with the contract and the proper documentation of such actions taken.

The Project Engineer is expected to keep project records up-to-date and accurate should an inspection of the records be made, and to further expedite final acceptance and payment.

Most project records will be kept in SiteManager using the forms and layout format set out in the SiteManager modules. However, some projects may not be programmed in SiteManager and project records must be kept on Departmental forms or custom forms. The information shown in most of the illustrations of this manual are based on departmental forms and may vary slightly from those generated by SiteManager and other applications.

Section 110 of the Standard Specifications addresses the Contractor's requirements in regards to payrolls and wage rates. The Project Engineer or his/her designee shall thoroughly review all payrolls submitted by the Contractor with special emphasis given to the initial submission and when employees are added or change classifications. This review is to verify that the submitted wages rates are equal to or exceed the wages rates listed in the contract proposal.

1.3.3 Project Diary.

1.3.3.1 General. The term "diary" as used in engineering work has the primary definition as follows: "a record or events, transactions, or observations kept daily or at frequent intervals."

The Project Diary (Form CSD-120) is one of the most important records of any project. It should include a brief, factual, concise account of the activity of the day of all matters which are considered valuable as a permanent record.

The Project Engineer, or authorized representative, is to keep a daily diary on all projects and each daily entry is to be signed on the indicated line. Due to the importance of project diaries, it is essential that Project Engineers review diaries critically to be sure that they conform to the standards set forth hereinafter and that they are kept daily.

Diaries should be kept in such detail and manner that new personnel could take over the work at any time. Diaries must be complete enough so that the reader, who may never have been on the project but who is generally familiar with construction work, can form an accurate picture of each day's work after reading all diary entries for that date.

Diaries are usually read by reviewers as a means of familiarizing themselves with the project prior to actually beginning a review of the other records.

In the event of a claim, the project diary is the primary document concerning weather, progress, suitability and condition of equipment, acceptability of work completed, etc. Therefore, several suggestions relative to the contents to be entered in the diary are:

1. General weather conditions with temperatures or temperature range.

2. Orders and directives given the Contractor, differences with Contractor over work, quality of performance and decisions made.

3. Important discussions with the Contractor including agreements made, verbal instructions, and any objections or comments of the Contractor.

4. Official visitors and inspections.

5. Work or materials rejected and reasons therefore.

6. Record of dates of closing and opening the road and detours to traffic; dates of starting and completing major items of work; time of shutting down or resumption of work and explanations of the delays.

7. Work done by Contractor's and/or Subcontractor's forces during the day noting work performed by DBEs.

8. Record of locations of major items of work in progress, difficulties encountered and corrective actions taken.

9. Information and records pertinent to any time spent by the Contractor's or Subcontractor's personnel or equipment on disputable items of work, work which might qualify for additional

payment as extra work or for which the Contractor has requested additional payment contending that it is extra work, and especially any work which might be the basis of a claim. This information is necessary in supporting or denying additional compensation. Equipment used under situations listed in this paragraph should be specifically detailed to include brand, model number, horsepower rating, etc., so that accurate rental rates can be obtained.

10. Arrival and departure of major equipment.

11. Conditions of equipment and efficiency of Contractor’s operations; factors or conditions that might hinder the Contractor’s operations and cause delays.

12. An up-to-date inventory of Contractor's and/or Subcontractor's equipment and a list of the Contractor's and/or Subcontractor's personnel by classification.

13. Record of important phone calls.

14. Unusual conditions, if any, such as high water, bridge construction problems, slides, unsatisfactory subgrade or foundation conditions, detour conditions, the condition of construction signs and traffic control devices, etc. Care should be used when explaining hazardous conditions.

15. Progress of staking and surveys.

The diary is the property of the Department and shall be filed as a part of the project records. A good diary can provide valuable information and evidence in the event controversies arise. Personal information should not be entered in the project diary.

Although it is not necessary to make a daily diary entry of personnel by classification and major units of equipment used in the work every day, it is important that a daily entry be made which refers to a previous listing(s) and, as applicable, which would correct the original entry of personnel and equipment. It is usually easier to re-list personnel and equipment on each phase of the work periodically than to refer to the original listing(s) and make any subsequent changes. In other words, an appropriate entry should be made each day so that anyone reviewing the diary may determine accurately the number of personnel and major units of equipment being used on each phase of the work.

On major claims, force account work, or when major problems are encountered, the project diary may be supplemented with photographs or videotapes, at the discretion of the Engineer.

1.3.3.2 Specific Entries. The blanks to be completed at the top of Form CSD-120 are self-explanatory. The “Controlling Item” blank should be completed with the items that best fit the description stated in Subsection 101 of the Standard Specifications. Weather and soil condition records should be kept as accurately as possible.

The body of the project diary may be completed from the information submitted on the Inspector’s Daily Reports (Form CSD-121) and the Party Chief’s Daily Reports (Form CSD-603), and may also contain any other information the Project Engineer wishes to put in the permanent record of the project.

Facts pertaining to the Contractor's operations are to be listed in the main body of the form.

The words Engineering Activities should be entered directly beneath the record of Contractor's Operations. In this section of the diary, the Department personnel and their activities are to be listed. This section should show the name and activity of each employee who had time charged to the project this day. Vehicle numbers of State-owned vehicles used on the project are to be shown in this section. If any employee had personal vehicle mileage charged to the project, the notation (POV) should be shown by the employee's name. Recording individual employee's time and vehicle mileage is not required on the project diary.

The name and title of the person preparing the diary should be shown in the blanks in the lower left corner. The Project Engineer or the Project Engineer's designated representative shall sign the diary in the "Approved By" blank in the lower right corner.

It is preferable that the diary be prepared on a personal computer using software developed by the Department for diary preparation, but typing the diary is permissible.

The contents of the daily diary are to become a part of the records of the project and should be accurately and conscientiously prepared.

Corrections to the diary sheets are not permitted after the diary sheets have been signed and submitted. Any error discovered in a previously-submitted diary sheet shall be corrected by making an entry on the diary sheet the date the error is discovered indicating the correct information and the date of entry on which the error was made.

The diary is to be prepared on a daily basis beginning on the day listed in the contract for contract time to start, on the day the Contractor starts work, or on the day engineering expenses first occur, whichever is the earlier. The diary is to be kept through the day the final data is forwarded to the Final Plans Section for checking. <u>After</u> the final inspection has been made and the Contractor has been released either from maintenance or from maintenance except for plant establishment for growth and coverage, there is no need to post the diary on days no Contractor activities or engineering charges are made to the project. For landscaping and beautification projects that are inactive for a period of more than two (2) weeks, it will not be necessary to keep the diary during the inactive period. The absence of reports should be explained on the next day that an entry is required with a note as follows: "First activity or engineering charge to project since <u>(Date)</u>"; where "Date" is the last date activity or engineering charges occurred on the project. If additional engineering charges are made to the project after the final data has been forwarded, supplemental diary sheets showing only the dates involved are to be submitted.

More details on completing the daily diary are shown in Section 1.3.19, Progress Schedule and Contract Time.

1.3.3.3 SiteManager Daily Work Reports and Diary. The weather conditions should be placed in Daily Work Reports "DWR Info." tab at the top of the screen. Facts pertaining to the Contractor's operations are to be listed in the "Contractor Operation" remarks box on the Daily Work Report. Under the "Engineering Activities" in the remarks box, the department personnel and their activities are to be listed. Also provided in the remarks box are places to put information about soil conditions, rainfall/precipitation, accidents, and other remarks about the day's activity that should be documented daily.

The Contractor's personnel and equipment should be shown on the "Contractors" and "Contractor's Equip." tabs, respectively, which is on the Daily Work Report. MDOT personnel, their time worked, vehicle used, and mileage is to be documented under the "Daily Staff" tab. All work that is paid is to be documented under the "Work Items" tab.

The Project Engineer will then take all of the Daily Work Reports created for a day and create a Diary for that day. The Project Engineer is the only person with the authority to authorize or not authorize the Daily Work Reports and create the Diary.

The Daily Work Reports and the Diary is to contain all of the information listed in Section 1.3.3.1. The "Charge" tab on the Diary page is the place where time will be assessed for the contract. Any errors made in assessing time to the project can not be corrected on the Diary after the "Charge" tab has been saved. Any corrections are to be made under Diary Adjustments.

1.3.4 Inspector's Daily Report. Engineering personnel performing various inspection activities on a project are to submit daily reports covering the phase(s) of inspection to which they are assigned. These reports are to contain pertinent information, most of which will be transferred to the project diary and become a permanent historical record of the project. The Inspector's daily report is the means by which the Project Engineer and office staff are informed of the Contractor's activities and approximate quantities of work accomplished each day. The report may also serve as a source of approximate quantities for progress payments to the Contractor.

The blanks to be completed at the top of the front side of Form CSD-121 are self-explanatory. The portion of the report pertaining to Contractor's operations should contain at a minimum the following information:

1. Type(s) of work inspected.

2. Location of work by stations.

3. The daily quantities of pay items which can be reasonably estimated and are not covered by other daily reports. These would be items such as cubic yards of granular material, feet of pipe culverts, etc.

4. Arrival and/or departure of major pieces of equipment with a weekly re-listing of all equipment used in the operation.

5. Contractor's labor force.

6. Specific instructions given to Contractor's Superintendent or Foreman and reaction to instructions.

7. Official visits to the project by Central and District Office personnel.

8. Any condition(s) detrimental to the safe maintenance of traffic. This could include, but is not limited to, improper maintenance of the travelway, inadequate signing or other warning devices, insufficient number or incompetent flaggers, etc.

9. Any problem conditions regarding erosion control and siltation.

On the reverse side of the form, list the names and duties of all Department personnel under the direct supervision of the inspector who is preparing the report. Hours worked by personnel are to be reported to the whole hour and should be separated by project if more than one project is being supervised. Speedometer readings and mileage(s) for personal and/or state-owned vehicles should be shown on the bottom portion of the reverse side of the form in the appropriate blanks. The person preparing the report must also sign it. The report must be turned in to the Project Office daily and retained in the Project files.

1.3.5 Project Engineer's Affidavit. Upon completion of a construction project, the Project Engineer shall certify that the work performed on the project was in accordance with Final Plans, cross-sections and specifications. The Project Engineer shall include notarized Form CSD-601, Project Engineer's Affidavit Accompanying Final Estimate, in triplicate as part of the submission of final supporting data to the Final Plans Section of Contract Administration Division.

1.3.6 Project Modifications. Quantity Adjustments (Form CSD-081) are used to modify the proposal quantities due to changes caused by plan errors, omissions, field conditions, etc. Supplemental Agreements (Form CSD-720) are used to modify plans and specifications as required as construction progresses.

In SiteManager, supplemental agreements and quantity adjustments are both considered Change Orders. SiteManager is the way of approving and tracking change orders within the Department only. Change orders in SiteManager are to be done according to and using the forms provided in Sections 1.3.6.1 and 1.3.6.2 of the Construction Manual for approval outside of the Department (i.e. Contractors, FHWA). Fully executed copies of change orders should be scanned and attached into SiteManager.

In SiteManager, the Project Engineer can authorize the Project Manager to set up change orders in SiteManager. However, only the Project Engineer has the authority to approve the Change Order at the first (beginning) level of approval.

Change Orders in SiteManager should be as described in Sections 1.3.6.1 and 1.3.6.2 of the Construction Manual.

1.3.6.1 Quantity Adjustments. A quantity adjustment will be initiated by the Project Engineer, as necessary. Quantity adjustments are required for design changes (a quantity adjustment must accompany the required supplemental agreement), the addition of pay items (a quantity adjustment must accompany the required supplemental agreement), and for major changes in quantities.

Minor changes that may be considered field adjustments necessary to carry out the intent of the plans, such as adjusted pile lengths, minor adjustments of structures, and items of a similar nature ordinarily will not require Quantity Adjustments. If an accumulation of these minor changes become of such magnitude as to require a revised project agreement, they are to be combined and submitted on one Quantity Adjustment, the principal purpose of which is to increase or decrease the authorized cost of the project.

The Project Engineer will submit the original and one copy of the Quantity Adjustment to the District Engineer. The District Engineer shall have signature authority for the Department on all Quantity Adjustments. For quantity adjustments that do not accompany a supplemental agreement, the District Engineer, after approving the Quantity Adjustment, will make the following distribution:

Original: Central Records
Copies to: State Construction Engineer
Contract Administration Engineer
Assistant District Engineer - Construction
State Materials Engineer
Financial Management Director
Contractor
Project File
FHWA* (2)
* If applicable

For quantity adjustments that accompany supplemental agreements, distribution will be made in accordance with the supplemental agreement guidelines.

The following information will be required on the Quantity Adjustment Form CSD-081.

Item 1. Enter the Quantity Adjustment number in numerical sequence for the project. On Federal-aid projects, non-participating items, if occurring, will be submitted on a separate Quantity Adjustment from participating items and will bear the same numerical sequence as the number of the previously approved participating Quantity Adjustment but designated by the letter A, B, C, etc.; and boldly typed across the face of the Quantity Adjustment will be NON-PARTICIPATING.

Item 2. Enter the Project number.

Item 3. Enter the Date of submission of the Quantity Adjustment, by the Project Engineer.

Item 4. Enter the County.

Item 5. Enter in detail the stations, quantities, reasons, etc. that are proposed to be added or changed. Make every attempt for clarity and brevity but leave no doubt as to what is proposed and intended. <u>When a Quantity Adjustment requires the project agreement to be modified, the Project Engineer will prepare and submit a reworked project agreement estimate with the adjusted quantities including proper stations and pay items involved. The original reworked project agreement estimate must accompany the Quantity Adjustment requiring the modification.</u> Supplemental drawings, sketches, photographs, etc., may be attached.

Item 6. Enter the date and the amount of the current approved project agreement estimate.

Item 7. Enter the total of all previously approved Quantity Adjustment(s). Be sure to include all that have numbered sequences below this one; if previous ones are in the process of being approved, leave this item blank.

Item 8. Enter the total amount of this Quantity Adjustment.

Item 9. Enter the amount of the adjustment in construction engineering and contingencies. Normally, this item should be adjusted to compensate for increases made by this Quantity Adjustment and previous Quantity Adjustments, that being the purpose of the contingency item.

Item 10. When item 7 can be completed, enter the total adjusted cost of the project. In all cases where item 10 is greater than item 6, a modified project agreement estimate will be required. The Contract Administration Engineer will check the revised project estimate cost sheet prepared by the Project Engineer (see item 5 above) and submit the Quantity Adjustment to the FHWA for approval. This should seldom be required, but when required, the Project Engineer must submit, to accompany the Quantity Adjustment, a complete explanation as to why, if an over-run, the Project Engineer has been unable to administer the project within the engineering and contingency fund established. District Engineers will add their comments and justifications to the Project Engineer's statement. A decrease in this amount would normally be occasioned by errors in plans, elimination of pay items, substantial decrease in the engineering and contingency fund, etc. The modification of the project agreement in these cases would be done for the purpose of decreasing the expenditure authorization.

Items 6 through 10 should be calculated using the Quantity Adjustment Worksheet. This worksheet should be attached to the Quantity Adjustment. When a Quantity Adjustment is submitted on a State Project requiring additional funds (item 10 is greater than item 6), a "Request for Program Change for State Projects," Form CAD-684, must accompany the Quantity Adjustment for approval.

1.3.6.2 Supplemental Agreements. When items or work of a nature not covered on the original plans and in the proposal is required, a "Supplemental Agreement" must be executed with the Contractor. The supplemental agreement shall show the reasons therefore, the general nature of the work, the approximate quantities involved and prices to be paid by either unit prices or lump sum, as the case may be.

Depending on the amount of the Supplemental Agreement, the Supplemental Agreement can be one of four classes. The Districts may authorize Class I or Class II Supplemental Agreements, and the State Construction Engineer may authorize a Class IV Supplemental Agreement. However, the Transportation Commission must authorize Class III Supplemental Agreements.

The Districts shall be responsible for monitoring the cumulative value of all Supplemental Agreements to the original contract. The cumulative value of the Class I, Class II and Class IV Supplemental Agreements shall not exceed $100,000.00 for a particular contract. Should the cumulative value of the Class I, Class II and Class IV Supplemental Agreements approach $100,000.00 for a particular project, the District should notify the Construction Division by memorandum. The memorandum should include a request for Commission ratification and a copy of all Class I, Class II and Class IV Supplemental Agreements for the project that have not been previously ratified. The Construction

Division will furnish to the Assistant Chief Engineer – Field Operations the District's memorandum with attachments for inclusion on the Transportation Commission agenda. The Transportation Commission will then consider ratifying those Supplemental Agreements. Upon ratification, the project may then accumulate an additional $100,000.00 in Class I, Class II and Class IV Supplemental Agreements prior to repeating the above process. The District shall not initiate any further changes without the concurrence of the Transportation Commission.

When preparing a supplemental agreement on a federally funded project that contains both participating items and non-participating items, they must be separated and clearly identified on the supplemental agreement as Participating and Non-participating Items.

Class I Supplemental Agreement

Work of a minor nature that requires a Supplemental Agreement, such as engineering errors, quantity changes, minor work details, etc. may be authorized by the Resident or Project Engineer by a Class I Supplemental Agreement, providing the cost does not exceed $10,000.00. Design changes or specification changes not exceeding the $10,000 limit will be allowed with the verbal approval of the Assistant District Engineer - Construction and the State Construction Engineer and, when applicable, the Federal Highway Administration. The Resident or Project Engineer must consider safety in any decision involving a Class I Supplemental Agreement.

Prior to preparation of the Class I Supplemental Agreement, the Resident or Project Engineer must completely analyze the work to be done. It cannot be over emphasized that the Class I Supplemental Agreement must contain all facts relevant to the change being made. Careful consideration must be given to the value of making specification and special provision quotations, photographs, drawings, etc. a part of the agreement so that it may be more understandable to all parties concerned.

The District Engineer shall designate, in writing, the Resident or Project Engineer assigned to each project and authorized to execute the Class I Supplemental Agreement. When conditions arise which fall within the above stated limitations, the Resident or Project Engineer will prepare a Class I Supplemental Agreement defining the work to be performed. **On Non-Exempt Federal Aid Projects,** Federal Highway Administration (FHWA) approval must be obtained prior to distribution by submitting two copies to the FHWA. Upon execution, the FHWA will retain a copy for its records and return a signed copy to the sender. The sender must indicate their mail code on the original. Distribution of the Class I Supplemental Agreement will be made as follows:

Original: Central Records
Copies to: District Engineer
State Construction Engineer
Contract Administration Engineer
Financial Management Director
Contractor
Surety
Project Engineer
Other Divisions (when applicable)
FHWA (2 copies on Non-Exempt Fed'l-Aid and 1 copy on Exempt Fed'l Aid Projects)

The Class I Supplemental Agreement will be co-signed by the Contractor's authorized representative. The Contractor's representative authorized to execute a Class I Supplemental Agreement shall be designated as indicated in the Notice to Proceed.

Each Class I Supplemental Agreement will include the following information:

1. The project number and date of authorization.

2. If required, all Central Office contacts such as Materials Division, Construction Division, Roadway Design Division, Bridge Division, etc. shall be listed by name at the bottom of the form. Verbal approval from the District Engineer or the District Engineer's delegated representatives shall be shown.

3. The name of the Federal Highway Administration representative who grants verbal approval and the date of approval. (Non-Exempt Project Only)

The information given in the upper part of this Agreement shall contain the following information and shall be presented in a similar format of a Class II Supplemental Agreement:

1. Request: Stating in detail what change is proposed and the location of the proposed change.

2. Reason: Stating sound and factual reasons why the change should be made and how the project will benefit from the change.

3. Other: Such as "specification", "time limit", etc.

4. Estimate: Showing the cost or savings that will result from the proposed change.

If the funds for the approved Project Estimate are insufficient to cover the added work, the Project Estimate will be modified by the District in accordance with Section 1.3.6 of this manual. On 100% State funded maintenance projects, written approval by the District Engineer will be required prior to the approval of the Class I Supplemental Agreement.

The pay item, Minor Alterations to the Contract, will not be included on the plans or contract proposal. Minor alterations shall be defined as alterations to the contract that are not addressed in the standard specifications or supplements thereto. The pay item must be denoted by an S/A following the pay item number to signify addition by supplemental agreement. An individual alteration shall not exceed $10,000 and shall be entered on the monthly estimate.

Time extensions associated with a Class I Supplemental Agreement, specifically in accordance with the second paragraph of Subsection 108.06.1 of the Standard Specifications relative to adding work of such character that it requires more time than indicated by the money value, shall require the verbal approval of the Assistant District Engineer - Construction and the Construction Division. The District Engineer will also have to sign any Class I Supplemental Agreement involving a time extension.

Quantity Adjustments are not required with each Class I Supplemental Agreement. Quantity Adjustments associated with Class I Supplemental Agreements should be included either on Quantity

Adjustments submitted to adjust other bid items, or on the CSD-200 form. The District Engineer shall have signature authority for the Department on all Quantity Adjustments.

If the Central Office contact(s) does not agree with the District Engineer who initiated a change to a contract, it will be incumbent upon the individuals involved to resolve the issue or elevate it to the Chief Engineer for review and final resolution.

The Construction Division will furnish the Districts with a copy of the contract bid prices upon request.

Class II Supplemental Agreement

The District Engineer shall have the authority to enter into a Supplemental Agreement to a contract previously approved by the Transportation Commission if the Supplemental Agreement involves an additional expenditure not to exceed one hundred thousand dollars ($100,000.00). This Supplemental Agreement shall be identified as a Class II Supplemental Agreement and may include changes in specifications, design and/or establish new unit prices for the added work. Central Office contacts such as Materials Division, Construction Division, Roadway Design Division, Bridge Design Division, etc. may be made, but shall only be required for design changes or specification changes or any monetary changes greater than $25,000.00. Approval by the Federal Highway Administration will only be required on Non-Exempt Federal Aid Projects.

The Project Engineer shall initiate and prepare the request for Supplemental Agreement and shall submit it to the District Engineer along with recommendations for approval. The Contractor and the Contractor's Surety shall then sign the agreement and return it to the District Engineer for final approval. The District should then submit two copies to the FHWA on Non-Exempt Projects. Upon execution, the FHWA will retain a copy for their records and return a signed copy to the District for final distribution. Distribution of the Class II Supplemental Agreement will be made as follows:

Original: Central Records
Copies to: District Engineer
State Construction Engineer
Contract Administration Engineer
Financial Management Director
Contractor
Surety
Project Engineer
Other Divisions (when applicable)
FHWA (2 copies on Non-Exempt Fed'l-Aid and 1 copy on Exempt Fed'l Aid Projects)

Time extensions associated with a Class II Supplemental Agreement specifically in accordance with the second paragraph of Subsection 108.06.1 of the Standard Specifications relative to adding work of such character that it requires more time than indicated by the money value of the work added shall require verbal approval from the Assistant District Engineer - Construction and Construction Division.

Any pay item added by Class II Supplemental Agreement must be denoted by an S/A following the pay item to signify addition by Supplemental Agreement.

In case of emergency or when time is of the essence, the District Engineer shall have the authority to execute an Advance Authority for Contract Modification. Advance Authority will follow the process, through distribution, outlined above for a Class II Supplemental Agreement, except that the Contractor and the Surety are not required to sign and only verbal approval by FHWA is required. The advance authority is not a substitute for the Class II Supplemental Agreement. The Class II Supplemental Agreement must still be prepared and submitted as outlined above.

Quantity Adjustments are necessary with all Class II Supplemental Agreements. The District Engineer shall have signature authority for the Department on all Quantity Adjustments.

If the Central Office contact does not agree with the District Engineer who initiated a change to a contract, it will be incumbent upon the individuals involved to resolve the issue or elevate it to the Chief Engineer for review and final resolution.

The Construction Division will furnish the Districts with a copy of the contract bid prices upon request.

Class III Supplemental Agreement

The Transportation Commission shall have the sole authority to enter into a Supplemental Agreement to a contract previously approved by the Transportation Commission when the Supplemental Agreement involves an additional expenditure over one hundred thousand dollars ($100,000.00), or a time extension that is not directly related to a Class I, Class II or Class IV Supplemental Agreement. This Supplemental Agreement shall be identified as a Class III Supplemental Agreement and may include changes in specifications, design, contract time, and/or establish new unit prices for the added work. Central Office contacts such as Materials Division, Construction Division, Roadway Design Division, Bridge Design Division, etc. may be made, but shall only be required for design changes or specification changes. Approval by the Federal Highway Administration will only be required on Non-Exempt Federal Aid Projects.

The Project Engineer shall initiate and prepare the request for Supplemental Agreement and shall submit it to the District Engineer along with recommendations for approval. The Contractor and the Contractor's Surety shall then sign the agreement and return it to the District Engineer for approval and submission to the Construction Division for further processing. The Construction Division will submit two copies to the FHWA on Non-Exempt Projects. Upon execution, the FHWA will retain a copy for its records and return a signed copy to the Construction Division for further processing. The Construction Division will make arrangements for submission to the Transportation Commission. Distribution of the Class III Supplemental Agreement will be made as follows:

Original: Central Records
Copies to: District Engineer
State Construction Engineer
Contract Administration Engineer
Financial Management Director
Contractor
Surety
Project Engineer
Other Divisions (when applicable)

FHWA (2 copies on Non-Exempt Fed'l-Aid and 1 copy on Exempt Fed'l Aid Projects)

Any pay item added by a Class III Supplemental Agreement must be denoted by an S/A following the pay item to signify addition by Supplemental Agreement.

Quantity Adjustments are necessary with all Class III Supplemental Agreements. The District Engineer shall have signature authority for the Department on all Quantity Adjustments.

In case of emergency or when time is of the essence, the Mississippi Transportation Commission shall have the authority to execute an Advance Authority for Contract Modification. Advance Authority will follow the process, through distribution, outlined above for a Class III Supplemental Agreement, except that the Contractor and the Contractor's Surety are not required to sign and only verbal approval by FHWA is required. The Advance Authority is not a substitute for the Class III Supplemental Agreement. The Supplemental Agreement shall still be submitted as outlined above.

If the Central Office contact does not agree with the District Engineer who initiated a change to a contract, it will be incumbent upon the individuals involved to resolve the issue or elevate it to the Chief Engineer for review and final resolution.

The Construction Division will furnish the Districts with a copy of the contract bid prices upon request.

Class IV Supplemental Agreement

The State Construction Engineer shall have the authority to enter into a supplemental agreement to a contract awarded by the Transportation Commission. This supplemental agreement shall be identified as a Class IV Supplemental Agreement and may include changes in specifications, design, pay items and shall not exceed $100,000.00. The purpose of this Supplemental Agreement is to correct errors or omissions that were found in the contract or plans prior to receiving bids and after the addendum date to make corrections. Verbal approval from the FHWA will be required on all Non-Exempt projects.

The State Construction Engineer shall initiate and prepare the supplemental agreement and submit it to the Contract Administration Engineer. The Contract Administration Engineer shall submit the supplemental agreement to the Contractor along with the other contract documents. The Contractor and the Contractor's Surety shall sign the Supplemental Agreement and return it to the Contract Administration Engineer along with the other contract documents. The Construction Division shall submit two copies to the FHWA on Non-Exempt projects. The FHWA will retain a copy for their records and return a signed copy to the Construction Division. Distribution will be as follows:

Original: Central Records
Copies to: District Engineer
State Construction Engineer
Contract Administration Engineer
Financial Management Director
Contractor
Surety
Project Engineer
Other Divisions (when applicable)
FHWA (2 copies on Non-Exempt Fed'l-Aid and 1 copy on Exempt Fed'l Aid Projects)

Any Pay Item added by a Class IV Supplemental Agreement must be denoted by an S/A following the pay item to signify addition by supplemental agreement and must also include a quantity adjustment.

1.3.6.3 Advanced Authority. When time is critical, advanced authority may be given to allow work to begin before official approval of project modifications are obtained. Advanced authority should be submitted in one of two forms. The first form would be using the supplemental agreement form with the words “Advanced Authority” written above “Supplemental Agreement”. This form can be submitted without the Contractor or Contractor Surety signatures. The other form would be in a letter memo form requesting advanced authority. No signature is required for advanced authority to a Class I Supplemental Agreement. Advanced authority for a Class II Supplemental Agreement only requires the District Engineer’s signature, but the District may want the Project Engineer’s to also sign the request. Advanced authority for a Class III Supplemental Agreement only requires the District Engineer’s Project Engineers signature and must go before the Transportation Commission for approval. An example of a Class II Advanced Authority is shown in the Forms Section of this manual. Other classes would be similar.

1.3.6.4 Force Account Work. If added work can not be agreed upon between MDOT and the Contractor, the Project Engineer will submit a letter to the Executive Director requesting the work be performed by force account. The Executive Director will authorize in written the Project Engineer to precede with the work by force account. The Project Engineer will advise the Contractor by letter that the work will be performed by force account.

All extra work must be authorized PRIOR to proceeding with it, and every effort should be made to foresee extra work before it becomes an emergency. When possible to foresee such extra work, agreements for execution of and compensation for the work should be worked out with the Contractor, either on a unit price basis which requires the execution of a Supplemental Agreement or by Force Account when a unit price cannot be agreed upon. The latter requires a written Force Account Agreement, (Form CSD-001). These forms shall be executed by such parties and officials as indicated. Except in cases of emergencies, prior approval of a Supplemental Agreement or Force Account Agreement shall be obtained before any extra work is started. In case of an emergency, verbal authority confirmed by mail or e-mail shall be obtained from FHWA on non-exempt Federal-Aid projects, and the State Construction Engineer, Chief Engineer, or Executive Director before starting the work. Force Account Agreements covering emergency work shall be prepared at once and the EMERGENCY so indicated. The words “Emergency Work” shall be typed at the top of the page and the last sentence on the form modified to read, “The above proposal is hereby accepted for construction as verbally agreed to and authorized on (date).”

The Project Engineer should prepare an estimate of the quantities and submit it to the Contractor for unit prices or, if the extra work is to be by Force Account, the Contractor shall submit a schedule of labor rates, unit prices of materials, and equipment rental rates. The Contractor should be certain that all classes of labor, types and rating of equipment, and kinds and prices of material are included in the submission.

If there is any question about the use of certain labor, equipment and materials, it should be included in the submission.

Agreements for proposed force account work are to be submitted promptly with the Standard Supplemental Agreement (Form CSD-081). By prompt submission, a decision may be reached before the proposed work becomes an emergency.

If conditions require classes of labor, material or equipment not previously covered, a supplemental form should be submitted for approval.

One approved copy of Form CSD-001 is to accompany the force account statement (Form CSD-202) when submitted for payment. Submit one copy of Form CSD-202 for each copy of the Contractor's estimate. When submitting Form CSD-081 with Form CSD-001, the Project Engineer should explain the proposed work in detail. A plan of the work should accompany Form CSD-001. Force Account Agreements and records of such work must clearly isolate labor, materials, equipment, etc., from any work for which measurement and payment is already provided in the contract.

Force Account Statements (Form CSD-202) and supporting documents shall be submitted promptly with the next current monthly estimate after the work covered in the Agreement has been completed. This form states "... as per agreement previously entered into in writing...". This form should be completed as follows:

(1) Labor. Have the Contractor submit a time roll, preferably on a small sheet similar to our Time Report, showing names, classification, dates, hours worked, and rate per hour both for all labor and equipment used. The names of employees, classifications, dates worked, and rates must agree with the Contractor's payrolls. The hours shall represent the actual time devoted to the item of work. No claim may be made for a superintendent's time. Time and one-half or overtime may be allowed only when it is essential and to the Department's advantage. The Project Engineer shall add and sign the following certificate to the Contractor's time roll:

"I hereby certify that the foregoing has been checked against the Contractor's payrolls and find that the classification and rates as shown are correct; that the hours shown hereon represent the actual time devoted by the respective individuals in performing the authorized Force Account Work; and that the overtime shown was necessary to complete the work promptly and was to the advantage of the Department."

____________________________Project Engineer

When transferring labor charges from time rolls to Form CSD-202, total the number of hours worked by the various classifications of labor and the various rates and show on Form CSD-202 as follows:

Labor, Teams and Foreman

Number And Kind	Hours Worked	Hourly Rate	Amount
2 Foremen	17.5	8.00	$ 140.00
1 Sub-foreman	12.0	7.50	90.00
3 Skilled Laborers	32.0	7.50	240.00

2 Semi-Skilled Laborers	19.5	6.25	121.88
2 Semi-Skilled Laborers	20.0	6.00	120.00
14 Common Laborers	173.0	5.60	968.80

The rates shown for employees on Form CSD-202 shall NOT exceed those shown on Form CSD-001 (Force Account Agreement) although the Contractor may have to pay them a higher rate. The rates may not exceed those actually paid by the Contractor. Up to fifteen percent (15%) of the total wages paid is allowable to cover overhead, supervision and use of small tools and equipment.

(2) Materials. All materials claimed must be supported by invoices or sworn statement substantiating the quantities and prices claimed. In NO EVENT shall the prices claimed on Form CSD-202 exceed those agreed to on Form CSD-001; neither shall they exceed the prices shown by the supporting invoices or sworn statements. It is the Contractor's responsibility to ascertain the price of materials prior to entering into the agreement. All prices must exclude the credit allowed for returned material.

Where manufacturers, jobbers, or materials dealers, whether wholesale or retail, allow a discount on invoices for materials purchased if payment is made by a specified date or within a specified time, the discount shall be deducted from the invoice, even if the Contractor fails to take advantage of this discount.

Sales tax may be claimed by the Contractor on materials and freight provided the Contractor paid sales tax on these items. However, the 15% allowable on "Materials, Freight, and Handling" is to be charged on the net amount on invoices and NOT on the cost of materials or freight plus the sales tax.

(3) Rentals. The rates for equipment shown on Form CSD-202 shall not exceed that shown on Form CSD-001, which rate shall include fuel, oil, grease, etc., but not the operator. List on the time roll the hours each piece of equipment was used on the respective dates.

(4) Insurance. The rate for insurance shown on Form CSD-202 shall not exceed that agreed to on Form CSD-001; insurance is to be charged on the net amount of labor cost (not labor cost plus 15%).

(5) Extensions. When making extensions of Force Account Statements, ALL FRACTIONS of cents shall be rounded to the nearest cent ($0.01).

(6) Bond Premium and Contractor's Sales Tax. For property damage, liability, and workmen's compensation insurance premiums, unemployment insurance contributions and social security taxes on the force account work, the Contractor will be reimbursed actual cost only. The Contractor shall furnish satisfactory evidence of the rate or rates paid for the bond, insurance and tax.

(7) Profit. No line entry is available for profit. Markup on materials and labor is considered to the profit for Force Account Work.

On projects set up in Site Manager, Force Accounts are to be created and Force Account work is to be tracked on the Daily Work Report. The procedure listed above should be followed even when using Site Manager to track Force Account work.

1.3.7 Blank.

1.3.8 Claims. It is essential that policies and procedures for processing Contractor's objections to effects of acts or conditions which arise during construction and for processing Contractor's claims for additional compensation or adjustment to contact time be performed uniformly throughout the Department.

If the Contractor expresses objection to the effect of acts or conditions which arise during construction, the Project Engineer will review and evaluate these objections in full consideration of applicable provisions of the contract. The Project Engineer may request the participation of the Assistant District Engineer - Construction in this review and evaluation. A determination based on interpretations by the Project Engineer and Assistant District Engineer - Construction, if applicable, as to the contractual validity of the Contractor's objection will be made at the project level. The determination will be supported and documented in the project diary.

If the Contractor's objections are deemed to be contractually valid, appropriate corrective action is to be taken by the Project Engineer upon approval of such action by the District Engineer and State Construction Engineer and the appropriate representative of the Federal Highway Administration, if applicable. This corrective action may be the making of adjustments in the work which removes or alleviates the condition for which objection was expressed by the Contractor, or the making of necessary corrections by supplemental agreement as may be required for equitable contractual conclusion of the matter.

If the Contractor's objections are determined to be contractually invalid, the Project Engineer will advise the Contractor accordingly, in writing, setting forth the reasons therefore with copies of the transmittal furnished the District Engineer and the State Construction Engineer.

In case the Contractor continues to claim that additional compensation is due for work or materials not clearly covered in the contract or not ordered by the Engineer as extra work, or if the Contractor continues to claim that adjustment in contract time should be made because of any of the reasons provided for in the contract, the Contractor may elect to submit a claim setting forth objections to the effects of acts or conditions which the Contractor considers to have arisen during the construction that entitle the Contractor to additional compensation, or to an extension of contract time.

Claims by the Contractor for additional compensation, or for adjustment in contract time, must be based on provisions of the contract, and must be justified by facts that are supported by the project records.

The Contractor must submit the claim on the Department's form CSD-155, MDOT Notice of Claim Form. A copy of this form is in the "Forms Section" in the back of this manual.

When a claim is received from a Contractor at any engineering level other than that of the Project Engineer, it is to be immediately forwarded to the appropriate Project Engineer, for review against the project records.

If the claim has been presented in accordance with the provisions of Section 105 of the Standard Specifications, the Project Engineer is to carefully review the claim against the provisions of the contract and against the Project Engineer's records and make an appropriate recommendation on each part of the claim to the District Engineer.

In the event the Project Engineer finds the claim is not in reasonably close conformity with the requirements of the Specifications, the Project Engineer will so notify the Contractor, requesting supplemental data in writing, or returning the claim to the Contractor for resubmission in accordance with the Specifications. If after the Project Engineer has given such notification or has returned the claim to the Contractor for supplemental data, the Contractor fails to take the necessary corrective action in presenting the claim, the Project Engineer has no alternative but to submit the claim to the District Engineer with a recommendation that it be denied, setting forth the reasons therefore.

The District Engineer or the District Engineer's representative will make a thorough review of the claim and all matters related thereto. The claim will then be forwarded to the State Construction Engineer along with the written recommendations of the Project Engineer and the District Engineer.

The State Construction Engineer or the State Construction Engineers representative, after careful review and investigation of the claim, will make a full written report and recommendation to the Chief Engineer or the Chief Engineer's representative. The Chief Engineer, after careful review of all data submitted on the claim, will submit recommendations and all supporting data to the Executive Director for the final decision. The Executive Director will advise the Contractor in writing of the final decision with copies furnished to the Chief Engineer, the State Construction Engineer, the District Engineer, and the Project Engineer.

Should the Chief Engineer deny the Contractor's claim, no further action is required by the State; however, the Contractor has the right to request a hearing before the State Transportation Commission and/or the right of adjudication in the courts or before the Mississippi Transportation Arbitration Board. If the Executive Director's decision substantiates the validity of the Contractor's claim in whole or in part, then a supplemental agreement is to be prepared in conformity with the Executive Director's decision and approved by the Mississippi Transportation Commission prior to any allowance being made on any estimates as compensation to the Contractor for any additional monies or contract time.

In SiteManager, the Project Engineer is to enter all claims and disputes into SiteManager in the "Disputes/Claims" window. Only when the Project Engineer receives written documentation from the Contractor addressing a possible claim or a dispute, should the claim/dispute be entered into SiteManager. The Project Engineer is to update any important information and changes to the claim dispute.

1.3.9 Estimated Final Quantities and Materials Certification. Standard procedures for the collection and distribution of the Project Engineer's Statement of Estimated Final Quantities and Certified Tests of Materials (Form TMD-725) shall be performed as stated below. In order to expedite the materials certification process, there are several tasks that should be completed **throughout the duration** of the project in order to ensure that the TMD-725 is easily processed:

1. As materials are placed on a project, the Project Engineer should contact the District Materials

Engineer to discuss the materials associated with a contract. Every project has unique aspects that will require editing of the materials and frequencies associated to the contract's pay items. This materials editing process will help to minimize discrepancies on an estimate as a project progresses.

2. For SiteManager Projects, generate the Modified Sampling Checklist to help track testing progress. The Modified Sampling Checklist can be run at any time throughout the life of the project providing an update on project samples. For non-SiteManager projects, it is a good practice to develop a spreadsheet of the materials requiring testing throughout the course of a project so that critical testing requirements are not missed and sufficient sampling has been performed. For more information, refer to the TMD 20-04-00-000, the District Materials Engineer, or the Materials Division.

3. While it may be necessary to override some discrepancies during the course of a project, reoccurring materials discrepancies are a signal that the material and/or testing frequency of a pay item may need to be adjusted. The Project Engineer should contact the District Materials Engineer to resolve this type of issue.

4. Notify the District Materials Engineer upon completion of major items of work so that the District Materials Engineer may remove any test requirements for materials that are not to be used on the project.

Materials Certification. Statements on Form TMD-725 must be completed and properly distributed for issuance of the Certification of Materials and Tests, which is required before the work is officially accepted and final payment is made. Form TMD-725 can be generated in SiteManager.

The Project Engineer is to distribute Form TMD-725 prior to the final estimate. It is recommended that Form TMD-725 be submitted to the State Materials Engineer at the same time that the initial closing documents are submitted to Contract Administration for initial review following the final inspection. To monitor the project clearance process, the date of the final inspection, the date that Form TMD-725 is received by the Materials Division, and the date of the Final Estimate are tracked by CATS and/or SiteManager for better management of project closings. The statement of the estimated quantities is to be as accurate as possible when submitted to the State Materials Engineer.

Project Engineer's Procedures. To prevent unnecessary delay in obtaining project clearance, the Project Engineer is to comply with the following procedures:

1. Maintain a file for each project including the Modified Sampling Checklist and all supporting documents. For non SiteManager projects keep a listing of the quantity of materials tested for the project and the quantity of material shown on the most recent Contractor's monthly estimate. The Project Engineer must be sure that quantities are correct and follow-up on any variations within a reasonable period of time.

2. Have the required certificates and/or certified test reports in hand prior to allowing the materials to be incorporated into the project. Any work performed prior to approval of materials will be the sole responsibility of the Contractor. Any Certificate of Compliance or Certified Test Report which does not contain the information required by the Standard Specifications shall be promptly rejected. The Project Engineer shall strictly adhere to the

requirements of the Standard Specifications, particularly the requirement that "payment for work will not be made until proper certification has been received."

3. Address the corrective action taken regarding failing samples by notifying the District Materials Engineer, in writing, as soon as possible after receiving test results that indicate noncompliance with the specifications. SiteManager Template CPE 905 should be used to **document** project variations such as failing materials or insufficient testing and provide recommendations as to the disposition of the materials if they were placed the project.

4. For many items, a Project Engineer's certification serves as documentation for materials requested, tested and, accepted when the material is incorporated into the project. Refer to TMD 20-04-00-000 (contained in the *Inspector's Handbook)* to determine which materials require certification. Listed below are the current certification templates available in SiteManager for use by the Project Engineer:

TEMPLATE	FUNCTION
CPE 900	Previously Used Construction Signs
CPE 901r (Revised CPE 901)	Project Engineer Certification
CPE 902	Completion of Visual Inspection
CPE 903	Warranties and Guaranties Certification
CPE 905a (Revised CPE 905)	Materials Testing Variance
CPE 906	Acceptance of Small Quantities of Misc. Materials

5. Acceptance of materials used in the construction of project offices, maintenance buildings, shops, and additions and alterations to existing buildings should be in accordance with Section 4.1.3 of the Materials Division Inspection, Testing, and Certification Manual (MITCM).

6. The Project Engineer should generate, sign and submit for approval to the State Materials Engineer Form TMD-725. The SiteManager Form TMD-725 should have the "Total Rem." column cleared prior to submittal. Please note that any TMD-725's submitted with out this column being cleared will be returned for editing. A helpful tool for use when preparing Form TMD-725 is the Test Discrepancy Checklist (TSTKSCKL) available from the SiteManager Materials Process List. If there are variations on project materials, Form TMD-445 should be submitted to the District Materials Engineer.

7. Advise the Contractor, in writing, of the Materials Division's response to Form TMD-725 regarding any shortages of test reports, certificates, etc.

District Materials Engineer's Responsibilities. The District Materials Engineer (DME) shall assist the project engineer with the contract materials setup and maintenance for all SiteManager contracts. All pay items have a group of standard materials in SiteManager. Upon activation of a new contract in SiteManager, the DME must generate the materials for the project. The Outstanding Items List should be run before generation of the Contract Materials. The DME should contact the Materials Division to have materials associated to any new or existing contract pay items before the contact materials are generated. It is the DME's responsibility to ensure that materials that will not be used on a project are removed from appropriate contract pay item(s) and that the testing frequencies are adjusted in accordance with MDOT specifications and contract documents.

At closing, if there are any variations on a project, the DME will receive from the Project Engineer a signed Form TMD 445 (available in SiteManager). Upon completion of review of Form TMD 445, if the District Materials Engineer concurs the Project Engineer's disposition of the variations, the document shall be sign and submitted to the State Materials Engineer, as indicated in Subsection 4.1.1 of the Materials Division Inspection, Testing, and Certification Manual. The District Materials Engineer should also use the "Find Sample" report function in SiteManager or Reports available on the MDOT District 1 webpage to check for any outstanding unauthorized sample records on a project. All project samples should be authorized at project closing.

Material References. Listed Below is reference documents available at either the MDOT@Work intranet site or at www.GoMDOT.com under the Materials Division that provide helpful information for the materials certification process:

1 MDOT Inspectors Handbook
2 Materials Division Inspection, Testing, and Certification Manual (MITCM)
3 MDOT List of Approved Products and Producers/Suppliers
4 MDOT Field Manuals for Concrete and Hot Mix Asphalt
5 District 1 Materials Lab SiteManager Reports (District 1 MDOT@Work webpage)

Form TMD-725. Form TMD-725, Statement of Estimated Final Quantities and Certified Tests of Materials, is made a part of this manual for convenience and ready reference. Items requiring completion of this form are considered to be self-explanatory.

1.3.10 Permits and Utilities. Other Divisions S.O.P.s / Rules are related to the provisions of Subsection 107.04, Restoration of Surfaces Opened by Permit. They are as follows:

The below-listed Maintenance Division Rules should be consulted for information pertaining to permits for utilities, driveway and street connections, etc.:

941-7501-04001	Underground Utility Crossings
941-7501-04013	Driveway & Street Connections, Median Openings, Frontage Roads
941-7501-04015	Parallel Utility Lines and Overhead Crossing Encroachment Permits

Other Divisions S.O.P.s / Rules are related to Subsections 107.18 and 107.19. The below-listed Right of Way Division S.O.P.s should be consulted for information pertaining to utilities and right of way.

ROW-10-00-00-000	Right of Way - Utility
ROW-10-04-02-480	Monthly Utility Status Report
ROW-10-04-03-480	Monthly Utility Status Report, Form ROW-480

1.3.11 Payment For Laboratories. There are two conditions under which a Contractor is required to furnish laboratory space and utilities for the exclusive use of the Engineer in housing and using equipment necessary to carry on required tests. These conditions are:

1. When the Engineer undertakes to make inspection at the source of a material or product produced for the Contractor by a producer who is not a party to the contract for the pay item for which the material or product is produced.

   In such case, no payment is to be made for the required laboratory.

2. When a field laboratory is required by the Engineer, furnished by the Contractor, and used solely for housing and using equipment necessary to carry on required tests of materials.

   Under this condition, measurement and payment for the field laboratory is to be made under the provisions and requirements of Section 621 of the Standard Specifications.

In general, the Contractor will be required to provide one or more field laboratories on most, if not all, projects. Measurement and payment is to be made under the provisions and requirements of Section 621 of the Standard Specifications.

A laboratory at the plant of a producer from whom the Contractor purchases a product is not eligible for payment unless all of the following conditions are met:

1. The plant is not for the production of bituminous mixture(s) for the Contractor;

2. The laboratory of such a producer is adequate for plant inspections and tests, and meets the requirements for a field laboratory as set out in Section 621 of the Standard Specifications;

3. The Engineer determines that it is reasonable and practicable to use and does use such laboratory in lieu of requiring a field laboratory at some other location; and

4. The Contractor makes all the arrangements with the producer for the Engineer to have exclusive use of the facility and utilities as provided in Section 621 of the Standard Specifications.

Other laboratories required by the Engineer, furnished by the Contractor, and used as intended, will be measured for payment under the provisions and requirements of Section 621 of the Standard Specifications.

Duplication of payment will not be made to the same Contractor for concurrent use of the same laboratory for work under separate contracts. However, when all work for which a field laboratory was required under an earlier contract has been completed, the laboratory may be required and measured for payment under an incomplete project when its use is deemed to be necessary.

The Project or Resident Engineer having more than one (1) contract for work on projects in the same general vicinity by the same Contractor should consider suitability of combination use of the laboratory facilities. For example, if a Contractor should have a large project and one or more smaller projects in the same vicinity and the necessity for use of the laboratory begins at about the same time on the large project and one or more of the smaller projects, the laboratory should be required on the contract having the longer duration and should be used in combination, if practicable, with testing on the other project(s).

In the event a determination can be made during the field review phase that a field laboratory is not to be required and paid for, but will be furnished on the project by the Department, such determination should be made and the plans properly developed accordingly.

1.3.12 Safety. Since Contractor workers and MDOT inspectors are frequently exposed to the hazards of the traveling public, they need to be clearly visible at all times. The Code of Federal Regulations CFR 23 Part 634 final rule was adopted November 24, 2006 with an effective date of November 24, 2008. This rule requires that "All workers within the right-of-way of a Federal-Aid Highway who are exposed either to traffic (vehicles using the highway for the purposes of travel) or to construction equipment within the work area shall wear high-visibility safety apparel". High-visibility safety apparel is defined in the CFR as "personnel protective safety clothing that is intended to provide conspicuity during both daytime and nighttime usage, and that meets the Performance Class 2 or 3 requirements of the ANSI/ISEA 107-2004 publication entitled American National Standard for High-Visibility Safety Apparel and Headwear". All workers on Mississippi State Highway right-of-way shall comply with this Federal Regulation. Workers are defined by the CFR as "people on foot whose duties place them within the right-of way of a Federal-Aid Highway, such as highway construction and maintenance forces, survey crews, utility crews, responders to incidents within the highway right-of-way, and law enforcement personnel when directing traffic, investigating crashes, and handling lane closures, obstructed roadways, and disasters within the right-of-way of a Federal-Aid Highway".

1.3.12.1 Barricades, Warning Signs & Flaggers. The provisions and requirements for protection of the public by the Contractor of furnishing, installing and maintaining barricades, warning signs and devices and flaggers are set out in Subsection 107.10 of the Standard Specifications. It is the responsibility of the Resident Engineer to see that such protective devices are provided and properly positioned.

Subsection 107.10 of the Standard Specifications also requires that protective devices shall conform to the minimum requirements as set out in the MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES FOR STREETS AND HIGHWAYS, PART VI. The Resident Engineer may approve special safety devices proposed by the Contractor to protect the traveling public against special conditions or hazards, provided such devices are not in conflict with those specified in the contract, including the referenced Manual.

Due to the necessity of reconstructing or widening and resurfacing older roads, contracts require that all traffic be maintained through the project. For these projects, the Resident Engineer should give special consideration to preserving, replacing or substituting such protective devices which were in existence prior to the reconstruction.

For example, when an existing surfaced highway is to be widened and resurfaced, centerline stripes and no-passing stripes are obliterated by leveling courses or overall courses. Edge stripes are likewise obliterated. It is also necessary sometimes to remove or relocate informational signs in order to reconstruct the shoulders and upper slopes.

Prior to any portion of a no-passing stripe being obliterated by construction, DO NOT PASS and NO PASSING ZONE signs shall be placed at the beginning portion of the no-passing stripe, and a PASS WITH CARE sign placed at the end of the no-passing stripe. A sufficient number of such signs shall be provided, erected and maintained to properly mark the beginning and ending of all no passing zones for each direction of traffic.

The need for other signs or protective devices may exist for special situations depending upon the physical features of a given project and the sequence and nature of the Contractor's operations. Careful attention should be given to each such situation on all projects and the Contractor should be required to provide all protective devices that are essential to the convenience and safety of the public, as contemplated under the contract.

The Manual referred to above provides good coverage for most situations; however, the Traffic Engineering Division should be consulted for special situations or when some question arises as to the most effective protective devices to be used.

All applicable signs and other protective devices are to be maintained by the Contractor until their use is no longer needed and then immediately removed, or until replaced with permanent markings, signs or other devices; or unless otherwise provided until final acceptance of the project.

1.3.12.2 Forest Protection. The Department and the U.S.D.A. Forest Service have executed a "Memorandum of Understanding on Procedures Related to Highways Over National Forest Lands." Excerpts from the memorandum which are applicable to the Project Engineer and the Project Engineer's staff are as follows:

I. Pre-Design
   A. The State will:
      1. Notify the Forest Service at least 30 days prior to commencing location surveys for roads crossing National Forest land.

   B. The Forest Service will:
      1. Provide available data and information on such matters as land corner locations; property line boundaries, maps, and project access routes.

      2. Explain Forest Service and State responsibilities pertaining to fire prevention and suppression during project life.

      3. Review proposed requirements and limitations related to clearing survey lines and material source investigations as they affect Forest Service policies.

      4. Provide available data, information, concerns, and any mitigation measures necessary to minimize impacts to Potential Endangered and Threatened Species (PETS) within the project area.

II. Design
   A. The State will:
      1. Furnish the Forest Supervisor with two copies of the project preliminary design data as soon as available.

2. Invite the Forest Supervisor to go on the plans-in-hand field inspection. Notify Forest Supervisor of the date of inspection at least one week in advance.

B. The Forest Service will:
   1. Advise the State of Forest Service input resulting from plans-in-hand field inspection within seven days after the inspection.

III. Construction and Maintenance

A. The State will:
   a. Control construction under its contracts to assure work is in accordance with approved plans and agreements.

   b. Have the District Engineer contact the District Ranger for agreement prior to starting work under changed conditions which develop prior to or during construction on National Forest land.

   c. Utilize measures to control Invasive Species within the project area.

B. The Forest Service will:
   a. Consult only with the District Engineer or the District Engineer's designated representative on matters pertaining to project construction.

1.3.13 Opening Roads to Traffic. Prior to officially opening a section of road to traffic, adequate regulatory, warning, directional and informational signs and markers must be in place and operational. When not required in the contract, the Traffic Engineering Division will design and install the necessary signs and devices or supplement those required by contract.

It is the responsibility of the District Engineer to obtain permission from the Contractor for the Traffic Engineering Division sign crews to enter on the project and install signs and devices prior to the final acceptance or opening to traffic. At least thirty (30) days prior to the probable opening to traffic or release of the Contractor from maintenance of traffic, whichever is to occur first, the District Engineer is to provided in writing the estimated date of such occurrence and adequate evidence of the Contractor's permission for the State's sign crews to enter and perform the work as indicated.

The District Engineer's letter is to also contain all information necessary for the Traffic Engineering Division to organize and carry out the design, construction and installation of the necessary signs and devices and is to contain a statement as to the identity of the section(s) or all of the project(s) proposed to be opened. The letter is to be addressed to the Traffic Engineering Division with informational copies to the Assistant Chief Engineer - Field Operations, the Maintenance Division, Construction Division and affected District Maintenance personnel.

In cases when it is anticipated that a semi-final inspection or inspection for partial acceptance under the provisions of Subsection 105.16 of the Standard Specifications is to be made, or in cases when such preliminary inspections are not contemplated but a final inspection is to be made, the required notice is to be furnished at least thirty (30) days prior to the anticipated date of such field inspection. Upon completion of each field inspection, the District is to notify the Traffic Engineering Division as soon as possible by telephone or radio as to the inspection party's findings on the probability of the date on which all necessary signs and markings should be in place for opening to traffic.

For projects or sections requiring large amounts of materials and work to be performed by State forces in signing and marking, the thirty (30) day advance notice is to be increased commensurate with the amount of work to be performed.

In the event any conditions subsequently arise which would change the estimated date of opening or release, the Traffic Engineering Division is to be notified similarly.

All communications regarding the opening of a section of road to traffic are to be verified in writing with informational copies as indicated above.

The Traffic Engineering Division is to make every effort to have all necessary signs and markings in place and effective at the time of the contemplated opening of a section of road to traffic.

When such installations are completed, the State Traffic Engineer is to notify the District Engineer of such completion, with informational copies of the notification to the Assistant Chief Engineer-Operations, the State Construction Division, and the Maintenance Division.

Preferably one week prior to opening a section of roadway to traffic or anytime a major change in traffic alignment occurs, the Project Engineer will complete a form similar to the one titled "Road Opening and Traffic Change Notification Sheet" in the Forms Section of this manual and send it to the External Affairs Division. External Affairs Division will use this information to advise the public of changes in traffic conditions.

1.3.14 Blank

1.3.15 First Construction Report - Form CSD-201. Information pertaining to this form is in SiteManager. Therefore, this form is not required if the project is a SiteManager project. On projects that are not in SiteManager, this form will be required. No special instructions are required for completing the form. As soon as the Contractor arrives on the project, the First Construction Report is to be completed and mailed to the State Construction Engineer. Copies are to be furnished to those indicated on the form. The form is shown in the Forms Section of this manual.

1.3.16 Blank

1.3.17 Time Unit Assessment Report - Form CSD-760. This report is to be completed at the end of each estimate period for contracts with time units. Each report is to cover the same period as the estimate and is to list the time units assessed during the period. The form is shown in the Forms Section of this manual.

<u>Specific Instructions.</u>

The blanks for the period are to be filled in with the beginning and ending dates of the estimate period.

The blank by TOTAL TIME UNITS PREVIOUSLY ASSESSED is to be filled in with the number of total time units assessed at the end of the previous estimate period.

In the body of the report, the daily assessments of time units are to be shown. The form is designed to run from the twenty sixth of one month to the twenty fifth of the next month with blanks to be filled in for the applicable month.

The blank by TOTAL TIME UNITS ASSESSED DURING PERIOD is self-explanatory.

The sum of the TOTAL TIME UNITS PREVIOUSLY ASSESSED and the TOTAL TIME UNITS ASSESSED DURING PERIOD is to be entered in the blank by TOTAL TIME UNITS ASSESSED TO DATE. This total should match the total time units assessed that are recorded on the front of the daily diary with the same date as the estimate cut-off.

After completion, the report is to be signed by the Project Engineer and the original sent to the Contractor with copies distributed as indicated.

1.3.18 Preconstruction Conference. Preconstruction shall be held prior to commencing any work to discuss the future construction of each project. They can be held in the Project Engineer's office, the Contractor's office, on the project, or any other convenient place where an informal discussion of the work can be held. It will be the District's responsibility to schedule the conference and to send notices early enough in advance of the conference, to all parties, including the Contractor and the Contractor's associates, the Construction Division, the Right-of-Way Division - Utility Section, the Contract Administration Division - Contract Compliance Officer, the Office of Civil Rights, the Federal Highway Administration when applicable, all utility companies which are involved, and in the case of concrete paving projects, the Materials Division, in order that each may schedule a representative to be present.

At these conferences, technical information and special features of the project should be explained, including the construction progress schedules. In the event a proposed progress schedule other than the one furnished by the Department has not been submitted by the Contractor and approved by or on the day of the preconstruction conference, the Contractor should be notified that the schedule furnished by the Department is in effect in accordance with the provisions of the contract (see note below).

During the preconstruction conference, if construction staking is by MDOT, the sequence and manner of staking the work should be discussed and mutually agreed upon. The controlling features of material sources, any haul roads, land ownerships, and special drawings can be discussed. The type, number, and placing of construction signs, and the sequence and scope of the traffic control plan should be discussed and agreed upon. Any applicable permits, such as Department of Environmental Quality, Corp. of Engineers, etc., should be discussed. Any questions concerning utilities should be answered.

Any other special features of the project should be discussed. For special features of a particular project, consideration should be given to whether the Contractor is familiar with the type of work included in the contract or whether the Contractor has not been performing for the Department, work of the particular type called for in the contract. Any new or revised specifications or plan requirements included in the contract should be discussed in each instance.

Minutes of the conference are to be prepared and signed by the Resident or Project Engineer. The original, signed copy is to be retained in the project files and attached to the official diary sheet for that date and submitted with the final data. Copies of the minutes of the conference are to be furnished to the District Engineer, the State Construction Engineer, and the Contractor and to any other Division or party whose representative in attendance requests a copy of the minutes.

Upon receipt of the copy of the minutes by the District and Construction Division, a review should be made by the District and the Construction representatives present at the conference as to the adequacy of the minutes for coverage of the pertinent or special details discussed. If corrections or amendments are necessary, they should be discussed with the Project Engineer and appropriate entries made as a separate amendment to the initial minutes and attached thereto as “amendments” as of the relevant date.

The preconstruction conference and the record thereof should reflect a mutual understanding by all parties.

Note: The sentence referring to “schedule furnished by the Department” is applicable only to those contracts for which the Department has furnished the Contractor with a progress schedule in accordance with the provisions of the contract. In either case, the official progress schedule must include or have attached thereto the Contractor’s approved Schedule of Proposed Methods for the control of siltation and pollution, as provided for in the contract.

1.3.19 Progress Schedule and Contract Time.

General. The charging of contract time and subsequent assessment of liquidated damages under contracts is a very important matter to all parties concerned. A fair and uniform interpretation of the governing specifications has to be applied by the Project Engineer on a day-to-day basis. It is the intent of this section of the manual to explain the mechanics of the procedure in assessing contract time using time units. The Project Engineer should study very carefully all of the provisions for charging time as contained in the contract documents.

Construction Progress Schedule. The progress schedule is the key to charging contract time. Therefore, it is important that the schedule be realistic and as accurate as possible and kept up-to-date. The progress schedule prepared by the Department will be the controlling schedule unless the Contractor proposes to prepare and submit for approval and alternate schedule, in which case the Contractor should submit this proposed schedule as soon as possible. At the notification of the pre-construction conference, the Contractor should be informed to make an early submission of its own progress schedule, if it desires to submit one different from that prepared by the Department. If the Contractor submits an alternate progress schedule and it is approved by the Department, the alternate progress schedule will serve as the controlling schedule for the assessment of time. However, the controlling progress schedule, regardless of which party prepares it, should contain all contract pay items; grouped into the applicable controlling phases of work. Any remaining pay items, subject to the provisions of the specifications, should be grouped as “Miscellaneous”.

The Miscellaneous Phase will not be considered a controlling phase and will not be used in the assessment of time units except when it is shown on the progress schedule to be the only phase in progress, or if it includes items which constitute the only remaining work to be completed, such as mobilization at the beginning of contract time and clean-up or other incidental items at the end after all other controlling phases have been completed.

In all cases, each phase is to indicate by reference number the pay items(s) included in that phase.

As provided in the contract, at least one controlling phase of the work is to begin no later than the date of beginning of contract time. A proposed progress schedule which does not so indicate, or which shows a period in which no work is scheduled to be in progress prior to scheduled completion of all of the work, shall not to be approved.

If the progress schedule furnished by the Department is the official progress schedule, the Contractor must prepare, for approval by the Engineer, its proposed method of temporary and permanent erosion control measures as required elsewhere in the contract.

When the progress of the work lags more than 20 percent behind the approved progress schedule or when the schedule becomes unrealistic because soil and weather conditions have permitted work on some phases and not on others, the Construction Division will advise the Contractor in writing to submit a revised schedule for approval in order that the Engineer's daily assessment will be based on a more realistic schedule. The beginning date for the revisions on the schedule shall be the beginning date of the next report period after the submission. The revised progress schedule shall be accompanied by a written statement from the Contractor indicating any additional equipment, labor, materials, etc. to be assigned to the work to ensure completion within contract time. The total allowed time units shown on the revised progress schedule shall not exceed the total allowed time units in the original contract. Approval of the revised progress schedule shall in no way be construed as a waiver of the provisions of Subsection 108.07. In the event the Contractor does not submit an approvable revised progress schedule, the progress schedule in effect will continue to be used for the daily assessment of time units.

The Project Engineer is to examine the progress schedule for adequacy and conformity and will recommend approval or disapproval to the District Engineer. Satisfactory progress schedules meeting the requirements of the Specifications will be approved at the District level. If a progress schedule submitted by the Contractor is approved, the Project Engineer is to place the approved progress schedule in SiteManager.

The Contractor should be requested to submit four (4) copies of the proposed progress schedule which, upon approval, should be distributed to the Contractor, the District Engineer and the State Construction Engineer.

A proposed progress schedule which does not indicate minimum realistic requirements or is otherwise unsatisfactory, should be disapproved by the District.

The example progress schedule illustrates how controlling phases of work should be shown. Refer to the specifications for control and limitations.

Controlling Phases. Each controlling phase shown on the progress schedule will indicate by reference number, as taken from the bid sheets, all the contract items included in the phase. The total value of the contract items in each phase divided by the total number of time units allotted to the phase equals the average value per time unit (AVTU) for the phase. It is essential that the Project

Engineer thoroughly understands the concept of AVTUs because they constitute the basis on which proportional parts of time units are to be assessed. Use of AVTUs in assessing time units is illustrated on the example time assessment sheet. The Project Engineer must determine of whether a phase could or could not be worked on by the Contractor. The information to be recorded and computed is indicated on the example Daily Report of Time Unit Assessment, which will be printed on the back of Form CSD-120.

There may be instances when the progress schedule will properly show a skip (period of no planned activity) for a phase, in which case the specifications provide that the Average Value Per Time Unit will not be used for that phase during such period unless the Contractor actually works on the phase during such period or unless the phase(s) is (are) completed.

CSD-120

EXAMPLE

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
CONTRACT DIARY

Date: July 15, 2008 Day of Week: Tuesday Time Unit No.: 70.6

CONTRACT DIARY FOR PROJECT NO(S): STP-0001-02(003) / 123456301 Completion Date: ______
Route No: ______ County: ______
Temp.: 8 AM: 74 Weather A.M.: Fair Soil A.M.: Sat. Precipitation: 0.00
Noon: 80 Prev. Night: 0.00
5 PM: 86 P.M.: Fair P.M.: Sat. A.M.: 0.00
Time Not Assessed this day due to: PRIME CONTRACTOR: ______ P.M.: 0.00
Hours Worked: See Reverse

Continuous Number of Daylight Hours Possible to Work on the Controlling Phase(s)This Day: ______

Contractors Operations (Follow with description of Engineering Activities)

I. Assume that for this example soil conditions were unsatisfactory for grading operations during the A.M. but satisfactory during the P.M. and were satisfactory during the entire day for the other phases.

II. Refer to the example assessment form and note the following instructions for completing the reverse side of the diary:

(1) This is a list of all the controlling phases of work that should be in progress on the date shown. The phase numbers are as they are shown on the Progress Schedule.

(2) This is a plain language description of each phase; also from the Progress Schedule.

(3) This is the Average Value per Time Unit (AVTU) to the closest dollar for each of the phases shown. This value is determined by dividing the total value of all contract items in a phase by the total number of time units allotted to the phase.

(4) This is the AVTU total for all phases that should be in progress this day.

(5) This is the ratio of the individual AVTU to the total -- (3) ÷ (4). Sum of (5) should be 1.00.

(6) These columns are where the Project Engineer must exercise unbiased judgment when making entries. If soil and weather conditions are satisfactory for at least four consecutive hours prior to noon, enter an X under Sat. by each of the phases for which conditions were satisfactory for work. Otherwise enter an X under Uns.

(7) This column is self-explanatory, it is the hours actually worked on a phase. During the months of December, January and February this column should continue being completed.

(8) This is another column where the entry is dependent upon the Project Engineer's judgment. It shows the total number of productive hours that the Contractor could work on each phase. If the Contractor worked or could have worked eight hours or more on a phase, a maximum of eight hours will be shown as the productive hours available for that phase. Except in the case above, when the productive hours available are shown to be <u>less</u> than the hours worked, the Project Engineer should make a note of explanation on the front sheet of the diary.

Prepared by: ______ Approved by: ______
Title: ______

cc: (2) (District Engineer, State Construction Engineer)
(Original to be retained by Project Engineer for submission with the Final Estimate)

DAILY REPORT OF TIME UNIT ASSESSMENT

JULY 15, 2008

EXAMPLE

WORK PHASE (1) No.	(2) Description	(3) AVTU	Ratio to Daily Total (5)	(6) Work Conditions Sat.	Uns.	(7) Hours Worked	Productive Hours Available (8)	Adjusted Productive Hours (9)
2	Excavation	2,656	.45	X		4	4	1.8
5	Minor Drain. Struct., Etc.	2,214	.37	X		6	8	3.0
6	Box Bridge Items	828	.14	X		0	8	1.1
8	Erosion Control Items	238	.04	X		10	8	0.3
	Daily Total (4)	5936					(10)	6.2

÷ 8 = 0.7 * (11)

\+

Previously Assessed Time Units 69.9 (12)

=

Cumulative Time Units Assessed To Date 70.6 (13)

-Instructions Continued-

(9) This column shows the adjusted productive hours for each phase. The adjusted productive hours for each phase is determined by multiplying the ratio under (5) by the productive hours available shown under (8).

(10) This figure is the total Adjusted Productive Hours for the day (the sum of the Adjusted Productive Hours for each phase).

(11) This figure is the number of time units to charge for the day. It is the quotient of (10) ÷ 8.

*Round to nearest tenth

(12) & (13) The method of determining these entries needs no explanation. On all contracts, continue to show the cumulative assessed time units (13) until the date of the final inspection. This figure is to also be shown on the front side of the diary sheet by TIME UNIT NO.

III. Under some conditions, as set out in the contract, the daily assessment of time units is to be in accordance with the applicable column in Table of Time Units in the contract. When assessing time units according to the Table of Time Units, the time unit assessment for each calendar day should be listed to the third decimal place and the cumulative assessment shown to the third decimal place until the Project Engineer begins or resumes the daily assessment based on soil and weather conditions. Then, the cumulative assessment should be rounded to the nearest one-tenth time unit and subsequent daily assessments should be to the one-tenth time unit as set out in the specifications. In rounding cumulative assessments to one-tenth time units, numbers ending in x.x50 and below should be rounded down and those ending in x.x51 and above should be rounded up.

TABLE OF DAILY TIME UNIT ASSESSMENTS

Month	Column A	Column B	Column C	Column D
January	.161	.161	.194	.226
February	.179	.250	.286	.321
March	.290	.290	.355	.419
April	.433	.467	.467	.567
May	.548	.613	.613	.613
June	.633	.667	.733	.633
July	.677	.710	.742	.581
August	.677	.710	.742	.581
September	.667	.667	.733	.567
October	.484	.548	.548	.484
November	.333	.367	.367	.400
December	.161	.161	.129	.194

FORM CSD-610
Rev. 4/2006

PROGRESS SCHEDULE

PROJECT NUMBER STP-0001-02(003) / 123456301
COUNTY Hinds County

WORK PHASE NO.	WORK PHASE DESCRIPTION	REFERENCE NUMBERS	PHASE VALUE			NO.	AVTU
1	Miscellaneous	10	50,000	0	285	1	175
2	Excavation	20 - 60	581,724	5	224	2	2656
3	Granular Material & Prime	90, 100, 140, 150	178,770	79	135	3	3192
4	Pavement and Curb & Gutter	80, 120, 130, 400 - 420	561,178	90	224	4	4188
5	Minor Structures, etc.	70, 230 - 390, 630	250,185	22	135	5	2214
6	Box Bridges	650, 660	34,780	58	100	6	828
7	Surface Treatment	160 - 220	17,542	203	255	7	337
8	Erosion Control	530 - 620, 640	56,017	30	265	8	238
9	Pavement Markings	110, 430 - 520	48,593	245	275	9	1620

LET: January 22, 2008
NOA: February 12, 2008
NTP/BCT: March 3, 2008
T.U.: 285
Schedule: A

This Progress Schedule does not indicate breaks in the contract time during December, January, and February.
Per Section 108 of the Specifications, during the months of December, January, and February, time will only be assessed in the Miscellaneous Phase.

CSD-120

EXAMPLE

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
CONTRACT DIARY

Date: July 15, 2008 Day of Week: Tuesday Time Unit No.: 70.6

PROJECT NO(S): STP-0001-02(003) / 123456301

Temp.:	8 AM: 74	Weather A.M.:	Fair	Soil A.M.:	Sat.	Precipitation:	0.00
	Noon: 80					Prev. Night:	0.00
	5 PM: 86	P.M.:	Fair	P.M.:	Sat.	A.M.:	0.00

PRIME CONTRACTOR:______________________ P.M.: 0.00

Contractors Operations (Follow with description of Engineering Activities)

PHASE 2:
CONTRACTOR A: Hours worked, detailed description of work with station numbers, location left or right of centerline, personnel and equipment, etc.
CONTRACTOR B: Hours worked, detailed description of work with station numbers, location left or right of centerline, personnel and equipment, etc.

PHASE 5:
CONTRACTOR A: Hours worked, detailed description of work with station numbers, location left or right of centerline, personnel and equipment, etc.
CONTRACTOR C: Hours worked, detailed description of work with station numbers, location left or right of centerline, personnel and equipment, etc

PHASE 6:
CONTRACTOR C: Hours worked, detailed description of work with station numbers, location left or right of centerline, personnel and equipment, etc.

PHASE 8:
CONTRACTOR D: Hours worked, detailed description of work with station numbers, location left or right of centerline, personnel and equipment, etc.

NOTE:
Contractor's equipment shall be listed at a minimum of once a week and changes shall be noted as they occur. Equipment may be listed each day .

OPTIONAL: If a subcontractor completes a phase and moves off of the project, they may be removed from the diary until they return. Example: Erosion Control or Striping contractors who move in and out of the project.

ENGINEERING ACTIVITIES:
Complete description of activities, personnel, hours, and vehicles.

NOTES:
Any important instructions, conversations, or discussions with the Contractor, property owners, the public or supervisors should be documented.
Traffic accidents should be noted and pertinent information recorded, such as traffic control, weather and pavement conditions, Contractor's operations and location, but fault should not be assigned.
Visitors to the project such as district and central office personnel should be recognized.

Prepared by: ______________________ Approved by: ______________________
Title: ______________________

cc: (2) (District Engineer, State Construction Engineer)
(Original to be retained by Project Engineer for submission with the Final Estimate)

DAILY REPORT OF TIME UNIT ASSESSMENT

JULY 15, 2008
EXAMPLE

WORK PHASE (1) No.	(2) Description	(3) AVTU	Ratio to Daily Total (5)	(6) Work Conditions Sat.	Uns.	(7) Hours Worked	Productive Hours Available (8)	Adjusted Productive Hours (9)
2	Excavation	2,656	.45	X		4	4	1.8
5	Minor Drain. Struct., Etc.	2,214	.37	X		6	8	3.0
6	Box Bridge Items	828	.14	X		0	8	1.1
8	Erosion Control Items	238	.04	X		10	8	0.3
	Daily Total (4)	5936					(10)	6.2

÷ 8 = 0.7 * (11)
+
Previously Assessed Time Units 69.9 (12)
=
Cumulative Time Units Assessed To Date 70.6 (13)

NOTE: This area is a convenient place to keep track of the following contract time information:

CONTRACT TIME BEGINS: March 3, 2008
TOTAL CONTRACT TIME UNITS: 285

1.3.20 Percent of Elapsed Time. The Construction Division Area Engineer will determine which schedule of Time Units will be used to evaluate time for the contract. The calculations below are provided as an example of computing Percent Elapsed Time for contracts using time unit assessment. Percent elapsed time is based on time units in the table, not time units actually assessed.

For a contract using Column C in Subsection 108.06 of the Standard Specifications, and a Beginning of Contract Time date of March 9, 2005, and Total Time Units of 303; determine the Anticipated Percent Elapsed Time on September 5, 2005.

Available time units from Column C:

1.	January	6
2.	February	8
3.	March	11
4.	April	14
5.	May	19
6.	June	22
7.	July	23
8.	August	23
9.	September	22
10.	October	17
11.	November	11
12.	December	4

Time Units accessed thru March 31st = 8.1613

(8 ÷ 31) x 11 time units = 2.8387 time units available thru March 9th
11 time units - 4.2.8387 time units = 8.4613 time units available starting March 10th

Time Units accessed thru September 5th = 112.8280

April	14
May	19
June	22
July	23
August	23
	101 time units

Accumulated Time units thru August 31st = 8.1613 + 101 = 109.1613 time units
Time units for 5 days in September = (5 ÷ 30) x 22 time units = 3.6667 time units
Accumulated time units thru September 5th = 109.1613 + 3.6667 = 112.8280 time units

Anticipated Percent Elapsed Time on September 5th = 37.24%

$$\frac{\text{Time Units thru September 5}^{\text{th}}}{\text{Total Contract Time Units}} = \frac{112.8280}{303} = 0.3724$$

1.3.21 Final Report of Project Engineer - Form CSD-200. The recapitulation of final contract quantities shall be reported on Form CSD-200. This form is generated by the monthly estimate program at the completion of the construction project. The report has been modeled so that final quantities may be listed in the order that the pay items appear on the estimate sheets (CAD-002).

Also shown on Form CSD-200 is an overrun or underrun in final quantities. Should a final quantity vary more than plus or minus five percent (±5%) from the original quantity, including any Quantity Adjustments, and the monetary value of the quantity difference is more than plus or minus \$1,000.00, the item is marked with an asterisk in the right margin of the line containing that item. Any item that varies more than plus or minus \$25,000.00, regardless of the percent of change, is also marked with an asterisk. All items marked with an asterisk will require an explanation by the Project Engineer as to why the item overran or underran.

On the CSD-200 in SiteManager, an asterisk will appear with a pay item when the Final Quantity is 10% greater or less than the Original Amount or $10,000 greater or less than the Original Amount. Then, the Project Engineer, or the Project Manager authorized by the Project Engineer, is to create a Semi-Final Quantity Adjustment (Change Order). In the Semi-Final Quantity Adjustment, the Project Engineer is required to give an explanation of all the Pay Items on the CSD-200 that are marked with an asterisk. The Semi-Final Quantity Adjustment is to be approved by the Project Engineer. Once the Semi-Final Quantity Adjustment is approved, a new CSD-200 should be generated and submitted with other final data as directed in the previous paragraph.

If any changes are made to the quantities on the CSD-200, it may be necessary to create another Semi-Final Quantity Adjustment.

Two copies of the report with other final data shall be submitted to Final Plans Section of Contract Administration Division.

Form CSD-200 has been custom-designed to meet the needs of the Department and simplify the preparation and submittal of final quantities. No unauthorized modifications or changes will be allowed to the program, data files or print files.

1.3.22 Fuel and Material Price Adjustment. Applicable contracts contain a notice to bidders establishing the contract base prices for fuels and materials. Each month the Project Engineers will be furnished a base price list that will be effective for the current estimate period. If the difference between the contract base price and the monthly base price for fuel or any material incorporated into the work during the estimate period is greater than plus or minus five percent (±5%), an adjustment in compensation for fuel and/or the material will be made. The special provision states that adjustments in the costs of asphalt cements used in hot mix asphalt mixtures will be based on the theoretical gallon per ton of the mixtures. For converting theoretical pounds of asphalt to gallons, a unit weight of 8.43 pounds per gallon is to be used. The fuel adjustment for structures is to be based on one thousand dollar ($1,000.00) increments of completed work allowed. The contract value of all items pertaining to structures (structure excavation, piles, pipe culvert and end sections, concrete, reinforcement, etc.) is to be used in computing the fuel adjustment for structures.

Forms CSD-880 and CSD-881 may be used as worksheets for determining fuel and material price adjustments during an estimate period. Each monthly adjustment, if required by sufficient changes in base prices, is to be based on work actually performed during the estimate period or “Total Allowed to Date” minus “Previous Estimate.” The total adjustment for the estimate period is to be shown as a lump sum adjustment on the estimate recap sheet (CAD-001). Forms CSD-880 & 881 are in the Forms Section of this manual.

1.3.23 Final Adjustment for Fuel and Materials. Applicable contracts contain provisions pertaining to price adjustments for fuel and construction materials. They also provide provisions for a final price adjustment when there are differences between the final checked quantities and previously reported quantities of applicable items.

Form CSD-882 is a worksheet on which the final adjustment for all applicable items can be computed simultaneously. Fuel and asphalt requirements for all applicable items will be used in the computation even if there is no difference between the final checked and previously reported quantities.

The worksheet, Form CSD-882, on which the final adjustment is made, is to accompany the final estimate and the final price adjustment shown on the final Form CAD-001.

Forms CSD-882 & CAD-001 are in the Forms Section of this manual.

1.3.24 Recording of Measurement of Materials in Hauling Vehicles. All construction items hauled to the project in tons, gallons, pounds, or cubic yards of material in loose vehicular measurement (LVM) are to be measured in accordance with the following, except quantities of materials such as seeds, vegetative materials for mulch, fertilizers, etc. which are to be recorded by other methods as indicated in this manual for the particular item.

Project Office. One month prior to the initiation of the placement of materials on the project, the Project Engineer will request the Data Processing Center to furnish the haul ticket plates necessary for the control of material to be placed as per contract. The request will be for two (2) different types of haul ticket plates which are as follows:

1. Project Identification - The first plate will identify the Project Number, Contractor, and the County in which the project is located. (See Example)

2. Type of Material - The second plate will identify the specific type and specification number of materials to be placed on this project and the method to be used for measurement. (See Example)

The Project Engineer will request through the District Office, an imprinter(s) necessary to record the quantities of materials placed on the project.

Central Supply. The project office must request the number of haul tickets to be furnished by Central Supply.

Truck Measurements. All vehicles that are to haul material on a volume basis are to be measured and assigned a three-digit truck number. No number will be reassigned to another vehicle during the life of a project. Each time a new number is assigned to a vehicle, the vehicle must be re-measured and certified by the Project Engineer. After a number has been assigned to the vehicle, it will be placed on the vehicle in such a way as to be easily identified.

Where loose vehicle measurement (LVM) is used, the capacity will be computed to the nearest one-tenth cubic yard and given to the whole cubic yard. Variations below the rated capacity of less than one-tenth of a cubic yard will be treated as the next highest number. Example: A vehicle measurement of 9.9 cubic yards will be classified as 10 cubic yard vehicle. All less than this but greater than 8.9 cubic yards will be classified as a 9 cubic yard vehicle. The Contractor may increase the capacity by body modifications or by the addition of sideboards to the vehicle prior to the assignment of the truck number.

The vehicles will be loaded and judged in accordance with Sections 106.09, 108.05, and 109.01 of the Standard Specifications.

Information Systems Division. Upon receipt of the request from the Project Office for the haul ticket imprinter plates, the Information Systems Division will prepare the plates as requested and forward them to the Project Office.

Imprinters. The use of the imprinter method will be restricted to those items that are paid by the ton, cubic yard (LVM), and other volume or weight methods of payment where the quantity of material will justify their use. The imprinter is not to be used to supplement any procedure where tally count may be used, for example, in the determination of material placed from pits.

The haul tickets are numbered sequentially and are to be issued in sequential order at all times.

With the initiation of the placement of material each day, the Inspector assigned to the project will place in the imprinter the first plate identifying the Project Number, Contractor and County, followed by the second plate which identifies the pay item, name of material and type of material being placed on the project.

Volume Measurement. When recording volumes with the imprinter, the Inspector will ascertain that the truck is loaded sufficiently to meet the predetermined capacity. In such case, the Inspector will dial in the truck number and the pre-measured volume or quantity on the dials of the imprinter.

Weight Measurement. When recording weights with the imprinter, the net weight is to be dialed in for recording. The Inspector will write the gross and tare weights in the designated positions on the haul ticket.

Some projects may have materials that are to be measured by weight and approved electronic weighing system is furnished and utilized by the Contractor. In this case, as the information is completed on the haul ticket, the Inspector may omit the gross and tare weights if the weighing system shows the correct net weight on a dial indicator and prints the correct net weight on the haul ticket. In such case, the Inspector will observe the net weight on the dial indicator and compare the observed weight with the weight printed by the electronic printer and continue such observations and comparisons until the Engineer is fully satisfied as to the accuracy of the system. During this phase and periodically thereafter, the Engineer should make observations of the actual scale gross and tare weights at the scales and compare the net weight thus obtained with weights read from the dial indicator and the ticket print-outs.

In the event the observed net weight taken from the dial indicator or the scales differs from the net weight printed by the electronic printer by less than ten (10) lbs. for weights under 2000 lbs. or by less than twenty (20) lbs. for weights over 2,000 lbs., the net weight printed by the electronic printer is to be dialed into the imprinter as the net weight, and the cause for any variation should be established by the Contractor to the satisfaction of the Engineer.

In the event the variation is more than those indicated above, the Inspector is to write in actual scale gross and tare weights on the ticket and dial the computed net weight in the imprinter for recording in the normal manner, and disregard the electronic system until fully corrected and synchronized with proper scale weights and certified for accuracy in accordance with Section 401 of the Standard Specifications.

Dry Weight Basis. When recording weight such as stabilizer aggregate to be measured for payment by the ton dry weight basis, the gross, tare and net weights are to be recorded on the imprinter ticket in pounds.

Moisture samples for such material are to be taken at the point of weighing (Subsections 305.06 and 310.04 of the Standard Specifications) for determination of the moisture content.

Percent moisture is to be recorded on the imprinter ticket to the nearest one (1) decimal place and is to be shown on the last line under the column headed "Quantity."

The moisture content of the first moisture sample is to be used on each ticket until the second moisture content is determined. The second moisture content is to be used until the third is obtained, etc. (Several should be run as soon as practicable at the beginning of hauling or at a change of conditions). A log should be maintained in the Project files for each date and time of day a moisture determination is made.

The net wet weight is to be imprinted at the top of the ticket in the space where net weight is usually imprinted. The Contractor should be advised that the imprinted net weight is net wet weight and that pay weights (dry weight basis) are to be computed using the moisture content recorded. The Project Engineer will compute the conversion to net dry weight.

Conversion of the pounds net dry weight for subtotals and totals for monthly and final estimates will be made to the nearest one-hundredth (.01) of a ton.

Validation. After recording the haul ticket with the imprinter, the Inspector will then remove the document from the imprinter, sign it to show that it was loaded for the project, and remove the last copy for the Inspector's records. The original and first copy will be handed to the truck driver. The truck driver will carry the original and first copy to the Inspector at the point of placement of material on the project. If for any reason the load is unsatisfactory, it is to be returned to the source or otherwise disposed of and the haul ticket marked VOID over the recorded quantity in the upper right-hand corner of the ticket. Haul ticket documents are not to be corrected at the point of delivery.

When the material is placed on the project, the Inspector will sign both the original and first copy giving the copy to the truck driver and filing the original for tabulation of quantities.

For the purpose of determining the amount of material that has been placed in the natural boundaries of the contract, such as county lines and urban and municipal boundaries, the Project Engineer will indicate on each ticket, station numbers or any other acceptable system identification of sections as established on the contract estimate.

Determination Of Quantity. On a daily basis using the Department issued personal computer software, the Project Engineer will tabulate and verify quantities placed by pay item, project number, and section, if applicable.

The haul ticket tabulations will be used for determination of quantities for payment to the Contractor. At the discretion of the Project Engineer, one copy of the tabulation may be furnished to the Contractor.

When the project is finalized, the Project Engineer will submit to the Final Plans Engineer in Contract Administration Division, the original of the computer tabulation with any changes, additions, or deletions noted thereon, the quantity revised accordingly, and the original haul tickets. The Final Plans Engineer will review the tabulations, make spot checks, and verify final quantities.

Final Plans Engineer. The Final Plans Section of the Contract Administration Division may permit the use of other methods of recording when the quantity is not sufficient to justify the use of the imprinter or when approved equipment supplied and in operation by the Contractor is adequate.

<u>EXAMPLE: One Project - One County</u>

Project No.: STP-0059-03(023)/100556301

Contractor: Sam Finley, Inc.

County: Lauderdale

Material: 304-B
Granular Material, Class 5, Group D
Lbs

0000011
TRUCK NUMBER

789
STP-0059-03(023) / 100556
SAM FINLEY INC
LAUDERDALE COUNTY
PROJECT ID

304-B
GRAN MATL
CL 5 GPD
TON
PAY ITEM

0028552
QUANTITY

052105
DATE

LBS. ☒ GALS. ☐ CU. YD.. ☐ MSTRE ☐

GROSS 76920

TARE 30420

TEMP	TIME	CHECKED BY POINT OF LOADING:
°F	A.M. ☐ P.M. ☐	*John Doe*

TEMP	TIME	RECEIVED BY POINT OF DELIVERY:
°F	A.M. ☐ P.M. ☐	*James Doe*

POINT OF DELIVERY STATION:	TO STATION:	MSTRE CONTENT
		*0.058 **

REMARKS:
Moisture obtained at 1:15 P.M.

No. 333601

PROJECT ENGINEER'S ORIGINAL

EXAMPLE: One Project - Two Counties

Project No.: STP-0059-03(023)/100556301	Project No.: STP-0059-03(023)/100556302
Contractor: Sam Finley, Inc.	Contractor: Sam Finley, Inc.
County: Lauderdale	County: Kemper

Material: 211-B
Topsoil for Slope Treatment
Cubic Yard

0000010
TRUCK NUMBER

789

STP-0059-03(023) / 100556
SAM FINLEY INC
KEMPER
PROJECT ID

211-B
TOPSOIL FOR
SLOPE TRTMT
CU YD
PAY ITEM

0000005
QUANTITY

	052105 DATE	LBS. ☐ GALS. ☐ CU. YD.. ☒ MSTRE ☐	GROSS TARE

TEMP °F	TIME A.M. ☐ P.M. ☐	CHECKED BY POINT OF LOADING: *John Doe*
TEMP °F	TIME A.M. ☐ P.M. ☐	RECEIVED BY POINT OF DELIVERY: *James Doe*

POINT OF DELIVERY STATION: TO STATION: *178+00 RT* MSTRE CONTENT

REMARKS: **No.** 333615

PROJECT ENGINEER'S ORIGINAL

1.3.25 Whole Dollar Accounting for Progress Payments. Contractor estimates for a progress billing will be "dollar rounded" and the Contractor will be paid the "dollar rounded" amount.

Applicable forms: CAD-1, Contractors' Estimate Recap Sheet, and CAD-2, Contractors' Estimate.

1.3.26 -- Salvaged Materials. The Mississippi Department of Transportation (MDOT) does not require a salvage credit on either State Funded projects or Federal Aid projects for any unused construction materials, salvaged highway appurtenances, or other equipment or material for which the useful life is greater than one year. Any salvaged material may be hauled by contract requirements up to 30 miles from the project or the distance to the Contractor's yard / stockpile, whichever is greater.

For Reclaimed Asphalt Pavement (RAP), MDOT can retain 50% of the RAP or 10,000 tons, whichever is less, on a given project. Also, the Contractor's portion of the milled material will be claimed first. This does not mean it is automatic that RAP is to be retained on each contract. It is to be based on need. The quantity of RAP, up to the maximums of 50% or 10,000 tons, whichever is less, will be determined on a project by project basis. The District will advise Construction Division of the quantity of RAP desired to be retained in the scope of work or the plans.

Any other materials to be salvaged (i.e. guard rail, guard rail posts, etc.) should also be included in the scope of work submitted to Construction Division or in the plans. These materials must meet the hauling requirement of up to 30 miles from the project or the distance to the Contractor's yard / stockpile, whichever is greater.

CHAPTER 2
EARTHWORK AND ROADSIDE DEVELOPEMENT

2.1 Earthwork

A. General. The items of work discussed in this subdivision include those construction operations necessary to complete the roadbed to subgrade. The subgrade is the top surface of the design soil and is the surface upon which the base will be constructed. In the case of a project involving stage construction, the subgrade may be the top surface required by the contract. Such items as clearing and grubbing, removal of obstruction, excavation and embankment and the installation of minor drainage structures are usually considered in this category.

B. Structural Design of Highways. The construction of any highway consists of a number of correlated operations which must be integrated to produce a finished road. Each step has a definite effect on the quality of that road. In any type of construction, the preparation of the foundation is the first and one of the most important stages of the work. In the case of highways, grading and drainage make up the foundation and, irrespective of the care taken in succeeding phases of work, a durable highway cannot be attained if it has an unsatisfactory foundation or is inadequately drained.

   The basic concept of structural design of a roadbed is the selection from preliminary tests of the most suitable available materials and placing them most advantageously. Their grouping in horizontal layers under the pavement is such that the most benefit will be derived from the inherent qualities of each material.

C. Preliminary Checking of Plans and Outlining of Work. Prior to the start of work, the Project Engineer should go over the work indicated in the plans and note all conditions carefully as follows:

   1. Note topography, drainage, and the general characteristics of material to be handled.

   2. Check all rights-of-way. Note utility agreements and special agreements regarding right-of-way. Allow no encroachments on private property without permission. Allow no encroachments on public property. Discuss with adjacent property owners the exact location for ramps.

   3. Check all obstructions within the right-of-way which may interfere with construction. Make sure any obstructions are addressed in the contract documents and advise the Assistant District Engineer - Construction if obstructions are not covered in the contract.

   4. Check all existing drainage and structures, and proposed new structure sites.

   5. Investigate completely and report to the Assistant District Engineer - Construction any anticipated changes in plans which would require a change to the contract.

   6. Analyze the necessity for detours, signing, temporary structures or other means of traffic control during construction.

7. Make a complete inventory of all existing traffic signs and other traffic service devices as required in the contract.

D. Authority and Duties of Inspectors. Grading and drainage inspectors work under the supervision of the Project Engineer and are directly responsible to the Project Engineer in all matters pertaining to the work. To realize the importance of the Inspector's duties, the earthwork inspector needs only to recognize the fact that the greatest portion of road failures is due to deficiencies below subgrade elevation. Inspectors are authorized to inspect all work performed and materials furnished. Such inspection may extend to all or any part of the work. The inspector is not authorized to issue instructions contrary to the plans and specifications nor to act as foreman for the Contractor. The inspector should notify the Project Engineer at once of any changes affecting the quality of work or disagreement with the Contractor.

Inspectors must familiarize themselves with the plans, specifications, special provisions, staking procedures, the soil profile, the cross sections, the balance points and the proposed drainage features.

When the inspector is furnished transportation for the purpose of maximum coverage of a construction project, it does not mean that the inspecting duties can be performed from a vehicle. As an example, it is impossible to check a subgrade against blue tops from a vehicle. The so-called "road test" will never replace or duplicate work with hand level, cloth tape and six-foot rule. Inspectors should park their transportation vehicles outside the limits of the roadway construction activities and be on the job site at all times.

A chief grading and drainage inspector's responsibilities are divided into the several classifications:

1. Counsel with supervisors and the Contractor's representatives regarding specific procedures to be followed in relation to the abatement or prevention of siltation and pollution. See that the Erosion Control Plan, which was approved by the Engineer, is carried out during the construction operations.

2. If required in the specifications, inspect the Contractor's equipment for compliance.

3. Inspect clearing and grubbing; excavation or roadway cuts and/or drainage operations; and the construction of embankments.

4. Perform the sampling and testing, or notify the person responsible for the sampling and testing as required.

5. Keep daily records of work in progress and make required reports, including a complete, factual, legible report on Form CSD-121.

Subordinate assignments of some phases of the grading work to other personnel may be necessary due to the scope of the Contractor's operations. Each assignment must be made to personnel thoroughly knowledgeable in the phase of work to be inspected, or at least capable of receiving, understanding and carrying out instructions. Frequent counsel between such personnel and immediate supervisors should be conducted so the Project Engineer is confident that the inspector's duties are being properly performed.

2.2 Clearing and Grubbing.

2.2.1 General. Clearing and Grubbing must be completed in advance of any grading operations and accomplished in accordance with the provisions and requirements of Section 201 of the Standard Specifications, unless otherwise indicated in the contract. Much of the success of the project depends upon the proper performance of the clearing and grubbing operation. The final appearance of the project and the stability of cleared surfaces can be affected by improper procedures.

Clearing and grubbing is accomplished under a lump sum bid basis or under an area bid basis, and occasionally, by special provision, on a selective cutting bid basis. When the work is performed on a lump sum or area basis, the boundaries of all areas in which the Contractor will be required to perform the work should be clearly marked. When the work is performed by selective cutting of single trees, each tree to be cut should be plainly marked.

The Project Engineer should thoroughly study the plans, special provisions, right of way agreements, and preliminary reports for any special details concerning the clearing and grubbing. These details may consist of existing facilities to be protected or removed, arrangements for the disposal of merchantable timber, disposal arrangements which have been made, blasting information, etc. The Inspector in charge of clearing and grubbing work must be thoroughly familiar with all requirements of the contract that relate to this phase of the work.

It should always be remembered that if the contract does not include a pay item for removal and disposal of obstructions and salvageable materials such removal of structure and obstructions and salvaging all designated materials automatically become a part of and is included in the price bid for Clearing and Grubbing.

If the project or any part of the project is within the boundaries of a National or State Forest or Park, representatives of those organizations should be contacted prior to actual start of clearing and grubbing operations, as regulation other than those set forth by the Department may apply to areas within their boundaries. The Engineer should encourage visits from those agencies when they have certain jurisdiction over clearing operations and should do everything possible to ensure that the Contractor complies with their regulations.

Prior to the start of the work, the Project Engineer, the Inspector and the Contractor's designated superintendent should field check the project together in order to be in agreement as to the stake out control, as to any applicable requirements of special provisions and right of way agreements, and, in the case of clearing and grubbing on an area basis, the actual pay limits determined by the Department's personnel. At this time, the Contractor's planned operations should be fully discussed with particular attention being given to all pertinent requirements of the contract.

2.2.2 Protection and Preservation of Property. It is the Contractor's responsibility to protect certain features of the project that are not to be removed. These may consist of existing highway improvements, utility facilities, adjacent buildings, fences, trees, and shrubbery. The Contractor also has the responsibility for preventing or minimizing siltation and pollution set out in the provisions and requirements of Subsections 106.02 and 107.12 of the Standard Specifications, and other provisions of the contract.

Private or public property adjacent to the right of way, and all improvements thereon, must be continually protected from damage by the Contractor's equipment and any construction operations that are under way. When and where such damage is done by the Contractor's equipment and operations, it shall be the Contractor's sole responsibility to rebuild, repair or make good such damage or injury at no additional cost to the State.

The Department attempts to have all utilities removed and/or relocated prior to issuing the NTP, however, there are occasions when utilities are to be removed and/or relocated after construction operations have started. These locations should be restricted from the Contractor's operations in the contract documents. The Contractor should be kept informed as to progress of any removal or relocation so that the Contractor's operations can properly coordinate with the activities of the utility company involved.

All trees, shrubs, survey or historical markers, objects of historical or archeological value that are to be preserved or remain in place must be clearly marked and the Contractor made aware of their location. Trees and shrubs outside the clear zone which will not interfere with the use of the highway and its drainage system may be selected to remain in place and undamaged for their scenic, historical or other value. Necessary measures must be taken during the clearing and grubbing phase of the work to provide the required protection for trees and shrubs. Any tree surgery performed shall be in accordance with the requirements of Subsection 201.03.1.2 of the Standard Specifications.

2.2.3 Extent of Clearing and Grubbing. Clearing and grubbing on a lump sum basis includes all clearing and grubbing required between the right of way lines from the beginning to the end of the project, except sections which are specifically omitted on the plans or by special provisions, such as bridge sites covered by separate contract. Also included is the removal of all obstructions, structures, etc., which are not listed in the proposal by special pay items under "Removal of Obstructions" or similar items. When not otherwise specified, the area within the slope limits of cuts, fill ditches, right of way ditches and embankments and an additional 10 feet on each side shall be cleared of all trees (unless marked to remain), stumps, brush, including roots and other objectionable material, structures and obstructions. However, intermediate (approximate) construction limits of slope stake lines shown on the plans in no way limits the provisions of Section 201 of the Standard Specifications which provides that this work shall consist of clearing, grubbing, removing and disposing of all things within the limits of the right of way and easement areas acquired by the State for the construction of the project, except for such things as are designated to remain or be removed in accordance with other provisions of the contract. The Contractor may be required to clear and grub any area outside intermediate limits or lines within the limits of the right of way and all underbrush, stumps, obnoxious trees, plants, refuse and other undesirable matter within the right of way and adjoining construction easements. Material within areas designated for removal shall be disposed of in accordance with the provisions of Section 201 of the Standard Specifications. Stockpiling of surplus or reclaimed materials which impair the safe flow of traffic or detract from the appearance of the right of way, will not be permitted, excepting only those items shown on the plans or which may have been specifically authorized before construction began.

2.2.4 Removing Miscellaneous Structures. Miscellaneous structures to be removed under the clearing and grubbing item should, when practicable, be removed prior to grading operations; however, pavements, sidewalks and other similar items may often be removed more advantageously during excavation operations. Basements or cavities left by structure removal which require backfilling are to be backfilled and compacted in accordance with the provisions and requirements of Subsection 202.03 of the Standard Specifications.

2.2.5 Abandoning Wells. Wells within the right of way should be sealed. This sealing should be undertaken as an early operation to preclude the well becoming lost as other operations proceed. Methods for sealing wells under various circumstances will be set out on the plans or elsewhere in the contract.

2.2.6 Removing Signs and Other Traffic Control Devices. Where official traffic control signs or other devices are located within the construction limits and must be removed to clear construction, the Project Engineer should proceed in accordance with Section 2.1 of the manual.

2.2.7 Burning and Removal of Debris. The Contractor is to be advised that compliance with the State laws relative to the creation of fire hazards, setting fire to forest accidentally, or otherwise, is the Contractor’s responsibility. The Contractor is to exercise care in burning brush, trees or stumps and debris. Such burning, if done, must not be at locations adjacent to trees and shrubs selected to remain, and must comply with established air pollution regulations. No burning will be allowed on Interstate right-of-way.

Materials and debris which cannot be burned are to be removed from the right of way and disposed of in accordance with requirements of the specifications. There is a general tendency on the part of some Contractors to attempt to dispose of such material on property abutting the right of way. This will not be permitted except under the restrictions imposed in Subsection 201.03.2 of the Standard Specifications.

All roots not removed from heavily timbered areas before the start of grading operations must be removed from lifts of embankment materials as they are placed.

2.2.8 Records and Reports. In the case of clearing and grubbing on a lump sum basis, the project field notes should indicate the distances right and left of center line and that stakes or other markings are placed to define the limits of clearing and grubbing. In the case of clearing and grubbing on an area basis, the field notes will accurately indicate all measurements and information required to accurately compute final pay quantities for such work. All pay quantities allowed on progress and final estimates are to be supported by recorded data. Any appreciable changes from estimated plan quantities are to be noted and properly covered by approved quantity adjustments or supplemental agreements.

A daily record of events related to clearing and grubbing operations is to be reported on Form CSD-121.

NOTE: During inspections of clearing and grubbing operations is an excellent time to make observations and a record by station numbers of areas which appear to be unusually soft or spongy, or to contain other evidence of unsatisfactory materials, seeps, springs or other conditions which may require correction under the provisions of Subsection 203.03.8.2 of the Standard Specifications, or other necessary procedures in the preparation for grading operations. Any such observations should be called to the particular attention of the Project Engineer.

2.3 Excavation and Embankment.

2.3.1 General. The operations of excavating the roadway and borrow material, and the placing, compacting and finishing of the excavated material in the embankment or fills are among the most common operations in highway construction work. These operations are practically inseparable, since one operation is rarely carried on without the other; and inspecting and controlling them as a single grading operation is generally considered. The great bulk of the grade inspector's duties and responsibilities are the inspection and control of the excavation and embankment work of the grading operation.

The degree to which the Engineer or Inspector will be able to perform duties and meet responsibilities assigned in the supervision of excavation and embankment construction is dependent on the person's knowledge of the character, dimensions and details of the work to be done, and on the person's knowledge of directions, provisions and requirements contained in the contract relative to excavation and embankment construction. Prior to initiating inspection duties, the Engineer or Inspector should have acquired a thorough understanding of the geometrics of the designed roadway section, the construction stakes defining and controlling the limits of the work, the disposition of work to be performed and construction methods to be employed, the provisions and requirements of the contract relative to the quality of work required, the records and tests required, and the method of reporting on the quality of the work. The Engineer or Inspector in charge of earthwork operations must review the soil profile and attain a thorough knowledge of the cross-sections, typical section, planned drainage facilities and materials sources. The Inspector should also, have knowledge of the capabilities of various types of equipment used by the Contractor, the Contractor's plan of operations and the proposed method of proceeding with the work.

The Contractor's choice of equipment to perform earthwork operations depends on the nature of material being excavated, grade to be transversed, length of haul, working room, costs and availability of the equipment. The methods used in performing the construction and all equipment, tools and machinery used in executing the work is subject to the approval of the Engineer in accordance with the provisions of Subsection 108.05 of the Standard Specifications.

When specified in the contract, excavation and embankment construction is to conform to the applicable requirements of In-Grade Preparation as set out in Section 321 of the Standard Specifications.

2.3.2 Excavation Operations. Excavation will be classified as set out in Subsection 203 of the Standard Specifications. When sufficient clearing and grubbing has been done to efficiently start grading operations, inspections of the area should be made by the Engineer, or Inspector and if clearing and grubbing within the construction limits has been satisfactorily completed, and the prerequisite conditions of Subsection 203.03.1 of the Standard Specifications have been met, the Contractor should be given the authority to proceed with grading operations. Drainage conditions and requirements are to be carefully studied, slope stakes and other control layout stakes should be properly guarded and protected by the Contractor and the Contractor's equipment checked and approved. It is the intent of the specifications that all suitable material excavated in the grading of the given section of the roadway is to be used, to the extent required, in the construction of the embankments in that section. In order to utilize all desirable material in the construction of the embankments, all intersections, approaches and entrances should be graded at the time of excavating and grading the roadway. Frequent inspections will be necessary during the excavation operations to determine that the roadway, intersections, approaches, ditches and channels are excavated to the required grade, width and slopes. Cut ditches are to conform to the plan typical section and are to be finished to the full depth as specified. At the end of cuts, cut ditches should be turned away from embankments on contour lines. Drainage from cut ditches, or from any part of the roadway, should not be diverted onto property adjacent to the right of way except at natural drainage points, or until written agreement has been entered into with the owner of such adjacent property.

If channel changes are required on the project, the Project Engineer and Inspector should be thoroughly familiar with field conditions and plan requirements for such channel change construction. Proper disposition of channel excavation should be utilized in embankment construction where practicable, as provided in Subsection 203.01.5 of the Standard Specifications.

2.3.3 Unsuitable Materials. During the excavation operations, it is necessary at all times to observe the nature of the materials encountered. Undesirable soils, such as certain silts and clays which exhibit large changes in volume with varying water content, are usually unstable under varying moisture conditions, and should be used with discretion. It is essential that full consideration be given to making the best possible use of the soil material encountered in the excavation. However, the use of soils which may cause instability in the subgrade or embankment, or which may have some other detrimental effect, should be avoided where possible, unless adequately treated to make them satisfactory. Soils which are unsuitable in the upper portions of the subgrade may often be used in the bottom or center of the embankment where their detrimental effects will be minimized.

There will be soils encountered that are unstable in their natural state because of excessive moisture content. Many of these soils will respond to drainage improvements and mechanical manipulation to reduce the moisture content to render them suitable for use. Some soils, however, are unsuitable because of their natural composition and can cause instability in embankments or have some other detrimental effect. The Engineer or Inspector should not be hesitant about ordering the removal and disposal of material determined to be unsuitable. This is provided for in Subsections 203.03 and 321.03.3 of the Standard Specifications. The depth or removal will be that determined by the Engineer to be necessary. However, before a determination is made to waste sizable quantities of questionable soils, a thorough study should be made with District and Construction Division personnel to determine the feasibility of action.

2.3.4 Surplus Material. As soon as possible, the Engineer should reconcile preliminary quantity calculations and shrinkage factors with actual quantities and factors. Deviations may require wasting, adjustment in haul, grade, or typical section; e.g. flattening fill slopes. When there is no provision in the contract for disposal of surplus material, the Engineer should select disposal areas within the right of way if possible, which will not interfere with drainage, will improve the stability or appearance of the facility or would benefit future improvements. Unless otherwise indicated in the contract, surplus material so used should be compacted as for any other embankment material.

2.3.5 Embankment Construction. The specifications include general requirements with respect to preparation of all areas on which embankments are to be constructed. These requirements include satisfactory use or other disposal of unsuitable materials, preparation of area on which grasses or other vegetation exist, benching existing side hill slopes or embankment slopes which are to be widened, etc. The grading inspector should be thoroughly familiar with Subsection 203.03 of the Standard Specifications and any related special provisions of the contract.

The grading inspector will inspect the Contractor’s operations and procedures, as necessary, to obtain stability and the density specified. The inspection and control necessary will vary considerably depending on the requirements specified, the type of soil and ease of compaction, the moisture control necessary, weather conditions, the skill of the Contractor’s forces, numbers and types of equipment and other factors. Density tests are an aid to, and a verification of, the proper compaction of the finished embankment.

Experience shows that despite the good grading operations and proper compactive effort in the construction of embankments, there are a number of items which, if not carefully observed and specifically inspected, may result in settlement. These special attention areas are listed as follows:

1. Settlement or side slip may result on existing fill slopes or side hills if not properly benched. Careful inspection should be given to the matter of benching side hill slopes and existing embankment slopes to be widened, as indicated in the specifications.

2. Settlement may result at grade points if not undercut, backfilled, and compacted in accordance with Subsection 203.03.8.2 of the Standard Specifications.

3. Settlement in areas adjacent to, or over structures frequently occurs. Probably the most important inspection feature in this connection is the proper placement and compaction of material in the areas inaccessible to rollers and the compactive effort of the earth moving equipment. In most cases, this can be eliminated by close inspection of compaction by small mechanical tampers.

4. Compaction of backfills at bridge abutments, wings and retaining walls must be carefully performed. The slope of the existing ground should be stepped to prevent wedging action against the wall. Use material which will compact readily, if available. Silt or clay should not be used if sandy soils are available. During backfill operations, possible displacement of wing or abutment walls should be checked as the backfill progresses.

5. The grading inspector should be alert to possible damage to any drainage structure which the Contractor’s heavy equipment may cross or work over, and particularly to possible damage to pipe culverts with minimum fill heights over the structure. Check for displacement of alignment.

The grading inspector must insist on the construction of slopes conforming to typical cross section. The grading inspector should encourage the Contractor to maintain adequate roadway crown during construction to facilitate proper drainage.

On some projects, major shortages or overages may be encountered in the quantity of excavated material with respect to the requirements for construction of the embankments. This should be detected at the earliest possible time and a solution reached to correct the situation. One of the best ways to detect a shortage or overage in excavation is to note the amount of excavation hauled and length of haul as the work progresses with respect to the information indicated on the plan sheets.

Appreciable variations in plan sheets are an indication of trouble of some nature. The proper solution of such problems will vary, depending on the cause. It may be determined that the plan quantities are in error, that the shrinkage factor is varying appreciably from that indicated on the plans, the Contractor is not constructing the work to the required typical section, or other similar causes. If indications are that a shortage or overage is of an appreciable quantity, the Project Engineer, Assistant District Engineer - Construction and Construction Division personnel should seek the proper solution. Minor shortage or overages may be corrected on the project by minor grade changes or minor adjustments of the typical sections to bring the earthwork in balance. Any significant changes in the plans to correct the shortage or excess will require an approved Quantity Adjustment (Form CSD-081).

The specifications provide that material for roadway embankment shall be placed in horizontal layers not to exceed eight (8) inches uncompacted. However, the Contractor may be permitted to back dump an initial lift of only a sufficient depth to support hauling equipment when embankments are to be constructed over low swampy ground and provided the top of such “bridging” is three (3) feet or more below subgrade.

Supporting power of soils is directly affected by compaction. The lower the compaction the lower the supporting power at any given moisture content. Improperly compacted embankments will consolidate non-uniformly under traffic resulting in an uneven road surface. Soils vary widely in the amount of compactive effort necessary to reach a common degree of compaction. Care must be taken to see that uniform density is obtained throughout each fill rather than to have some areas compacted in excess of the density requirements while others are below requirements. Full width embankment construction is required by the specifications. This will assure more uniform density throughout the fill including the outer edges of the embankments. In order to achieve uniform density, it is essential that the moisture content be uniform. In most cases, the required density can be obtained with the least effort if the moisture content is close to the optimum obtained by the standard moisture-density test.

Soil as taken from cuts or borrow pits is usually too wet or too dry for compaction to maximum density. Therefore, the first operation is the preparation of the soil by adjusting the moisture content. Excess moisture can only be removed by evaporation. This can be speeded up by placing the soil on the fill in thin lifts and stirring occasionally with a blade or by making a few trips over the soil with a sheepfoot roller.

If the excavated soil is too dry or becomes too dry before the required density is obtained, the Contractor must be required to add moisture. This can be accomplished by sprinkling with proper and adequate water equipment and mixing on the grade with blades, disk-harrows or other equipment. In some cases, it may be advantageous to the Contractor and may provide a more uniform moisture content by applying water to the area to be excavated immediately prior to or at the time the material is being excavated.

2.3.6 Uniformity in Embankment Formation. The importance of uniformity in embankment construction cannot be over emphasized. Construction methods which ensure, to the extent economically feasible, uniformity of material, layer thickness, moisture content and compactive effort are vital in the accomplishment of embankment construction.

The proper breakdown of clods and bleeding of material is very essential in obtaining proper embankment consolidation. The use of disk plows, blade graders or similar equipment ordinarily will accomplish the desired results in most soils. Particular reference is made to the requirements for disk-harrowing and heavy blading of basement soils having variable characteristics and of design soils in the formation of embankments as set out in Subsection 203.03.8 of the Standard Specifications. When it is necessary to place unlike materials in the same embankment layer, care should be taken to use procedures and methods which will provide a satisfactory blend of these materials.

Proper routing of the Contractor's hauling equipment over the fill area is another essential operation in obtaining uniformity in the compacted area. Over compaction by continuous application of heavy loads in streaks or lanes is especially detrimental in some soils, particularly expansive clays, in that after the fill is constructed and upon moisture change, uneven pressures will develop and produce distortions. These may occur too late for correction and may even occur after the subsequent pavement is in place. Hauling with heavily loaded equipment should always be disbursed approximately uniformly over the entire roadway.

One of the main difficulties an inspector will encounter in the construction of embankments will be the tendency of most Contractors to haul material to the embankment sites at a rate greater than the processing equipment on the embankment can properly disburse, blend and uniformly compact the material.

The Inspector should carefully watch for such situations, and if necessary, the Project Engineer should not hesitate to require that either the rate of hauling be decreased or the amount of processing and compaction equipment be increased as necessary to result in each layer being properly processed and compacted before any material for the succeeding layer is placed.

2.3.7 Drainage. Water, either directly or as contributory factor, is often the cause of highway failures. It is therefore, essential that all work involving drainage is carried out carefully and accurately and in such a way that the design features are not impaired in construction, yet the flow lines and other features satisfactorily fit field conditions.

In cut sections or shallow fill sections, ditches are to be constructed to such grade that there will be no impounding of water with normal maintenance. This may require ditch grades which are independent of the roadway grade, or a special ditch. All of this should be anticipated before slope stakes are set. It may be necessary to gradually increase the slope stake constant in the direction of flow for cut sections in order that the foreslope of the cut may be extended downward to provide an increased gradient in the cut ditch. This is highly important in cuts having profile grades of less than about one percent (1%). This, of course, should be considered in the field review and design phase and is usually more economical than constructing paved inverts to increase the velocity sufficient to prevent siltation; however, these things are frequently overlooked in design and should be considered in the field prior to construction. Failure to do so almost always results in a poorer quality of highway, and a constant maintenance cost throughout the road life.

2.3.8 Finish Grading. It is considered good construction practice that the finish grading, in which the subgrade is shaped and trimmed to required lines and grade and the slope of cuts, fills, ditches and channels are trimmed and dressed to a neat and finished appearance, follow as closely as practicable with the rough grading. When in-grade preparation is specified in the contract, it is mandatory that finish grading be performed in accordance with the requirements of Section 321 of the Standard Specifications.

The finished graded section is to conform within the tolerances specified in the specifications. Particular attention is required to providing proper drainage to the rounding of slopes, to conformance to plan typical sections, to compacting and shaping of slopes and top six (6) inches of design soil, and to the neatness and completeness of the graded section. Where topsoiling is required, either in cut or fill sections, appropriate adjustment is to be made in the graded section such that the finished section after topsoiling will conform to the typical sections shown on the plans, within the tolerances specified.

A freshly graded and neatly dressed section of road is a beautiful thing, and if structurally sound should be a credit to the Inspector, and to the Contractor.

2.3.9 Documentation. In determining pay quantities for the Contractor's progress estimates, it is necessary that uniform and verifiable procedures be followed in estimating and documenting excavation quantities measured on an FM or FME basis.

A recommended method is for the Project Engineer on the estimate cut-off date to show on a set of plans, in the case of (FM), the cubic yards removed to date from each cut and, in the case of (FME), the cubic yards placed to date in each embankment. The totals of the yardages allowed for each cut or for each fill would be the total quantity allowed on the estimate. At the end of the next estimate period, a line can be drawn through the previous quantities and new quantities written in for the new estimate.

There are other acceptable methods for documenting these particular quantities but in all cases computations should be based upon plan quantities, or corrected plan quantities, and not upon conversion of LVM from load counts through the use of the eighty (80) percent conversion factor set out in Subsection 109.01 of the Standard Specifications which is intended for small quantities.

Whatever method of computation and documentation is used, the provisions of Chapter 9 apply and the following sentence is quoted for emphasis.

"However, regardless of whether the quantities are approximate or reasonably accurate, a documented record must be placed in the project files, and subject to review, of the method, procedure, and basis for determining any quantity which is allowed on partial estimates. The files should include documentation that clearly shows how quantities were measured and calculated".

2.4 Structure Excavation. It is essential that the foundation under a structure provide support as firm and as nearly uniform as possible under the entire bearing surface. Inspectors should ascertain to the best of their knowledge and ability that the foundation material will support the structure to be placed upon it without appreciable settlement. If the foundation material is spongy or pumping and cannot be stabilized by draining and drying, the Inspector should not hesitate to instruct the contractor to remove the unsatisfactory material and backfill with satisfactory material.

The completed foundation area is to be finished to the correct line, grade, and width. This may be checked by batterboards and stringline, stringlining off forms that have been set to correct line and grade, or by any other method determined by the Inspector to insure that the foundation has been properly finished.

Measurement for structure excavation is to be as set out in Subsection 206.04 of the Standard Specifications and documentation and computation should be as set out in Chapter 9 of the manual.

2.5 Fertilizing. It is essential that all sketches, measurements, and calculated areas along with type and rate of application of fertilizing items ordered be recorded and dated as a source document in an Erosion Control Field Book (ECFB) during application and be verified by the signature of the MDOT employee (inspector) making the order, measurement, calculation, etc. Such recordings and verifications are to be made in the ECFB, by area, as the work progresses at rates of application shown on the vegetation schedule in the plans or in the contract documents.

To implement the recording of all essential field information, the Engineer should prepare, ahead of actual work, sketches, dimensions, calculated areas, etc., in the ECFB in order that all pertinent data may be properly recorded in the ECFB during application.

Form CSD-203 in the ECFB should provide an up-to-date total of the quantities of each fertilizing item satisfactorily placed. Form CSD-203 is shown in the Forms Sections of this manual.

Fertilizer transferred from other projects in accordance with S.O.P. No. TMD-20-08-01-763 should be noted in the remarks section of form CSD-203 of the ECFB.

Each line of Form CSD-203 should represent an area of the roadside calculated in acres for the proper control of the application of fertilizing items. These calculated areas should not exceed approximately three (3) acres in size as required by Subsection 213.03 of the Standard Specifications. This will provide for the initially calculated areas to be used for the measurement and control of the application of all roadside development items, unless job conditions dictate otherwise. Any additional application of fertilizing items ordered and applied on previously vegetated areas shall be recorded in the same manner as for the initial application, with the words “Additional Application” indicated in the remarks column.

All fertilizing items ordered and applied for which a separate Pay Item is not included in the contract are to be recorded under the super-phosphate provisions with the type and rate indicated under 4(a.) or (b.) and the quantity included under the superphosphate column of form CSD-203 in the ECFB.

Fertilizing items shown in the ECFB are to be certified by the Project Engineer and submitted with the final plans after completion of the work.

2.6 Seeding. It is essential that all sketches, measurements, and calculated areas along with type and rate of application of seeds ordered be recorded and dated as a source document in Erosion Control Field Book (ECFB) during application and be verified by the signature of the MDOT employee (inspector) making the order, measurement, calculation, etc. Such recordings and verifications are to be made in the ECFB by area as the work progresses at rates of application shown on the vegetation schedule in the plans or in the contract documents.

To implement the recording of all essential field information, the Engineer should prepare, ahead of actual work, sketches, dimensions, calculated areas, etc., in the ECFB in order that all pertinent data may be properly recorded in the ECFB during application.

Form CSD-723 in the ECFB should provide an up-to-date total of the quantities of each type of seed satisfactorily placed. Form CSD-723 is shown in the Forms Sections of this manual.

Seeds transferred from other projects in accordance with S.O.P. No. TMD-20-08-01-763 should be noted in the remarks section of the report as meeting the requirements of the contract.

For those pre-tested seed failing to fall within the allowed tolerance for germination, the Contractor may elect to increase the rate of seeding to obtain the minimum specified germination. The calculated rate of the seed to provide the minimum germination percent is to be used to determine the ordered amount for each section (area). For each section, such ordered amount is to be entered in the ORDER column of Form CSD-723 for the type(s) of seeds planted. The calculated equivalent amount of seed meeting germination tolerance, required and placed on each section, is to be entered in the PAY column for the type(s) seeds being placed. The lot number for the seed(s) should be recorded in the LOT NO. column of the appropriate section. The percent germination of deficient seed (s) should be entered in the REMARKS column for each section.

Should the Contractor elect to plant post-tested seed(s), the amount of each type ordered and planted for a given section should be entered in the ORDER column of Form CSD-723, which amount should equal the amount calculated for the area if the seed met the requirements for germination. The PAY column should indicate the calculated amount for seed meeting the requirements for germination. Should the results of post-tested seed not be within the minus 5% tolerance, any additional seed ordered will be shown for the same area in the ORDER column on another line (or sheet) of Form CSD-723. The PAY column for this entry should be zero (0).

Form CSD-723 of the ECFB is to be certified by the Project Engineer and submitted with the final plans after completion of the work.

2.7 Mulching. It is essential that the necessary field data, measurements, and materials ordered by the Engineer be recorded and dated as a source document in an Erosion Control Field Book (ECFB) during application and be verified by the signature of the MDOT employee (inspector) making the order, measurement, etc. Such recordings and verification are to be made in the ECFB by the area as the work progresses, at the rates specified in the vegetation schedule in the plans or in the contract documents.

To implement the recording of all essential field information, the Engineer should prepare, ahead of actual work, sketches, dimensions, calculated areas, etc., in the ECFB in order that all penitent data may be properly recorded in the ECFB during application.

Form CSD-481 in the ECFB should provide an up-to-date total of the quantities of each mulching item satisfactorily placed. Form CSD-481 is shown in the Forms Sections of this manual.

Measurement for the weight of vegetative materials is to be made in accordance with the provisions of Subsection 215.04 of the Standard Specifications. The recorded field data should include the individual weights used to determine the average weight per bale for each delivery to the site and, for each area, a tally of the number of bales used from each delivery for which an average weight per bale has been determined.

Material transferred from other projects in accordance with S.O.P. No. TMD-10-00-01-763 should be explained in the ECFB in the remarks section of the Report Form.

All field data should be recorded as the work progresses so the Project Office records will provide an up-to-date and accurate tabulation of the quantities satisfactorily placed to date. Each such entry on Form CSD-481 in the ECFB is to be initialed by the person making the entry. Mulching quantities shown in the ECFB are to be certified by the Project Engineer and submitted with the final plans after completion of the work.

Additional instructions for filling out Form CSD-481 of the ECFB are on the last page of the form.

2.8 Grassing by the Acre. The MDOT inspector's responsibility for this type of work is generally the same as it is for those contracts with individual grassing pay items. Payment is based on an area planted rather than individual pay items. The inspector must monitor Contractor's operation and keep records to verify the quantities for ground preparation, fertilizers, and seed since there is a minimum application rate for these items. The inspector can keep this information on Departmental forms or custom forms as long as the pertinent information is recorded.

CHAPTER 3
BASES

3.1 Base Courses. The base course is the part of the roadway structure or cross-section which provides uniform and substantial support for the paved surface. This course transfers the traffic load from the pavement to the underlying subgrade without overtaxing the bearing capacity of the subgrade. It is essential, because of this important function, that the base course be constructed to provide strength and durability.

In order that the base course conform to the required grade, section, density and stability, it is essential that the prepared subgrade conform to the required grade, section, density and stability. High and low areas in the foundation will affect the thickness of the base. If soft, unstable or spongy areas are observed in the subgrade or the base course, they are to be examined, the cause determined and proper correction made before proceeding with the overlying course. If not corrected, these deficiencies are likely to be reflected in the next superimposed course(s). Correction of weak areas that are due to unsuitable material will require its removal and replacement with suitable material. Soft, spongy areas resulting from excess absorption of surface water may be corrected by aerating and recompacting.

To assure density and stability, samples are taken and tests run during production of the base course. Refer to the MDOT Inspector's Handbook for the correct sampling frequencies and methods for sampling and testing aggregates.

The base will usually be chemically treated. The specific type(s) will be designated on the typical section and are to be constructed in accordance with the appropriate specifications.

3.2 Granular Material Courses and Crushed Stone Base Courses. Granular and crushed stone base courses are used to provide a working platform for the pavement structure and can be shaped and compacted to a true plane. Section 321 of the Standard Specifications requires that the foundation be brought to the required grade and cross section. Since the crushed stone base course provides a channel to remove water, it is imperative that the impermeable foundation be true to grade and free from ruts or other irregularities which may trap water.

To facilitate and ensure uniform density throughout the course, the aggregates are placed and compacted in layers. If the required compacted depth of the base course exceeds eight inches (8"), the course shall be compacted in two or more layers of approximate equal thickness. Each layer shall be satisfactorily compacted before placing the next layer.

The course derives its load bearing and load distributing properties through the interlocking of the aggregate particles. The density of the course is directly related to the interlocking of aggregate particles. Construction operations will require handling and placing the aggregates in a manner to minimize segregation and manipulation.

Hauling operations over a previously placed layer must be done so that no contamination or intermixing of subgrade materials or rutting of the subgrade occurs at the edge of the previously placed layer.

Mixing and shaping operations cannot be neglected. If it is considered necessary to blend aggregates on the grade, sufficient shaping, mixing and compaction equipment must be on the job. If sufficient equipment is not on the job to properly mix and layout of the course, placing operations must be suspended or curtailed until the mixing and shaping operations are being satisfactorily performed. Excessive manipulation which could cause segregation should be avoided.

To ensure the constructed course will conform to the required thickness, the inspector should maintain an accurate check on the quantity of aggregates as placed. Methods of checking the placing of required quantities of aggregates may include: Deposit of each load within the measured distance computed for the spread of the load, load count of quantity required per station, or other method which will assure an even distribution of the required quantity. A tally of the quantity of placed aggregate should be kept by the inspector.

During compaction operations it should be determined by inspection that the moisture content is satisfactory, the necessary blading is performed to uniformly distribute and mix the material and remove depressions and other irregularities, the required density is obtained and the finished course conforms to the required grade, line, cross section and smoothness.

The course must be uniformly laid out and compacted from shoulder to shoulder. A water truck, specialized compaction unit and motor grader operated as a team by competent personnel are essential to a well mixed, thoroughly compacted, true and uniform base course.

Maintenance of previously-placed base cannot be neglected, and should take priority over placement of additional sections of the course. The Contractor is responsible for maintenance until the next course is placed.

3.3 Lime Treated Courses.

3.3.1 General. The treated subgrade (design soil) is not considered in most instances to be a portion of the pavement structure and does not permit a reduction in the thickness of superimposed courses.

3.3.2 Types of Lime for Soil Stabilization. The lime used in soil stabilization is either quicklime or hydrated lime. These types are usually referred to as high calcium or high magnesium (dolomitic) limes. This chemical lime is not to be confused with agricultural limestone or pulverized limestone used to sweeten, neutralize or reduce the acidity of the soil.

3.3.3 Chemical Effects of Lime on Clay Soils. There are several chemical reactions that take place simultaneously when lime is added to a clay soil but are difficult to separate and analyze due to lack of factual data. However, it has been generally accepted that three definite reactions take place and are understood to some degree. These chemical reactions fall into three categories which are base-exchange, cementation and carbonation.

3.3.4 Physical Effects of Lime on Clay Soils. As a result of the chemical reactions, certain physical properties of a soil containing clay are altered. Even though some disagreement exists due to lack of factual data or desirable criteria for comparison, it is generally agreed that lime influences the plasticity, volume change, grain size, strength and durability of a soil.

1. Plasticity - One of the most advantageous uses of lime is its ability to reduce the plasticity index of clay soils. This phenomenon is more commonly referred to than other changes in the physical properties of soil by lime treatment. The change in plasticity by the addition of lime is affected by changes in the plastic limit and liquid limits of a soil. The plastic limit of a soil is increase when additional amounts of lime are added to the soil.

   Generally, but not always, the liquid limit of soil decreases with increase quantities of lime. The liquid limit is generally decreased in the more plastic soils and increased in the less plastic soils. The increase in plastic limit, however, is usually sufficient to reduce the plasticity index regardless of whether the liquid limit increases or decreases.

2. Volume Change - Lime treatment of clay soils tends to reduce and minimize volume change that usually takes place in an untreated clay soil. As the lime content is increased, the plasticity is reduced, the shrinkage limit increases and the shrinkage ratio decreases. At the lime content where there is little change in plasticity index, there is little change in the shrinkage limit. The increased shrinkage limit results in less volume change of the soil when there is a gain or loss of moisture.

3. Grain Size - Clay particles tend to agglomerate or gather together when lime is added. The degree of agglomeration is affected mostly by the type of soil and lime content. The heavy plastic soils tend to agglomerate more than sandy or silty soils.

   The fine grain clay particles aggregate with the lime into larger particles and this improvement is reflected by a change in the soil classification.

4. Strength and Durability - There are many inter-related factors that influence the strength and durability of soil-lime mixtures. Some of the factors that affect the strength and durability of soil-lime mixture are the types of lime content, type of soil, compaction, density, temperature and curing.

3.3.5 Classes of Treatment. MDOT uses three classes of lime treatment stabilization: Class A, Class B, and Class C.

1. Class A. This treatment is specified for heavy clay soils and requires a double application of lime. It consists of spreading and incorporating the predetermined percentage of lime in two increments in the following sequence: spreading the predetermined percentage of lime, initially mixing with liberal amounts of water, sealing, mellowing from five to twenty days; & spreading the second increment of lime, final mixing, compacting, finishing sealing, and maintaining until covered by a subsequent course. The next subsequent course shall not be placed on the sealed course for at least seven (7) calendar days.

   The first application of lime preconditions the soil by reducing the plasticity index to a limit where pulverization will not be difficult when the second application is needed. The second application of lime increases the strength of the soil-lime mixture materially by cementation of the remaining unagglomerated clay particles.

2. Class B. This treatment is specified for heavy clays and consists of spreading and incorporating the predetermined percentage of lime, initially mixing with liberal amounts of

water, sealing and mellowing for five to twenty days; final mixing, compacting, finishing, sealing and maintaining until covered by a subsequent course, as described above under Class A.

3. Class C. This treatment is specified for plastic soils, AASHTO A-4 soils with a high group index and AASHTO A-6 soils with a low group index, and consists of spreading and incorporating the predetermined percentage of lime, mixing, compacting, finishing, sealing, and maintaining until covered by a subsequent course, as described above under Class A.

   Laboratory tests indicate that soils of this type achieve a much higher strength if compacted immediately after moist mixing.

3.3.6 Construction Methods.

1. Preparation of the Soil. All deleterious substances such as roots, stumps, grass turf and other vegetative material and aggregates larger than those that will not pass a 3-inch sieve, should be removed from the soil. Any soil considered to be unsuitable for stabilizing should be removed and replaced with suitable soil prior to treating.

2. Preparation of Roadbed. The roadbed is bladed and shaped to the required lines, grade and cross section within the permissible surface tolerances and compacted to the required density and stability prior to the application of lime. The roadbed should be firm and capable of supporting without displacement, the construction and compaction equipment. Unstable soil should be corrected prior to spreading lime.

   Soil-lime mixtures compacted at the same compactive effort as that of a raw soil, tend to resist compaction and will result in a lower dry unit weight. This phenomenon results in a “bulking” of the mixture above the grade at which the untreated soil was prepared. The raw soil on the roadbed should be prepared to or below theoretical grade to compensate for this differential in grade after final mixing and compaction, especially where a subsequent course is to be a cement treated course. The approximate anticipated “bulk” may be determined by a comparison of the dry unit weight of the untreated and treated soils. The condition is not prevalent or critical in plastic AASHTO A-4 soils with a high group index or plastic AASHTO A-6 soils with a low group index.

   Prior to treatment, the grade of the roadbed should be checked from grade stakes to insure proper grade control of the lime treated course.

3. Determining Rate of Spread. The amount of lime to be applied is furnished by Central Laboratory from the soil samples submitted and is expressed in pounds per inch per square yard, based on the actual dry unit weight of the soil to be treated.

   The original samples submitted to the Central Laboratory for test and design should represent soils of generally like characteristics. If soils are encountered on the project differing materially from those represented by samples, additional samples should be submitted to the Central Laboratory for determination if a different rate of application should be made.

The rate of application shall be computed by multiplying the number of pounds per inch of depth per square yard as specified in the Central Laboratory's Lime Design by specified depth to be treated.

Lime may be spread by dry application or slurry application. Dry lime should not be spread during windy conditions.

The application by both slurry and dry methods should be closely controlled by frequent checks. Lime in excess of the point of fixation should be avoided due to increase cost and the possible reduction in strength. The point of fixation is that point at which there is not further improvement in the soil, as determined by laboratory tests. Laboratory tests have indicated that quantities of lime above the point of fixation had an adverse effect on the strength of some soils.

4. Dry Application. The dry application is accomplished by the use of a mechanical spreader or by bag distribution. Careful control should be exercised in the application of the lime as the predetermined percentage of lime is determined or specified, based on obtaining a minimum CBR value. Many failures result from improper distribution of lime, particularly along the edges of treated courses. Distribution along the edges can be controlled either by "tight" blading the roadbed and constructing a small windrow of material along the edge or constructing a small furrow and windrow with the "heel" of a motor patrol blade. In both cases, particularly the latter, the raw material should be bladed well over into the section being processed prior to completion of processing to prevent the incorporation of untreated material when final mixed.

   Lime should be incorporated as soon as possible and no later than six hours to reduce the possibility of carbonation. Hydrated lime, calcium oxide (CaO) or calcium oxide and magnesium oxide (CaO+MgO) are manufactured by heating calcium carbonate ($CaCO_3$) or calcium carbonate and magnesium carbonate ($CaCO_3$+$MgCO_3$) and is a reversible equation. Hydrated lime ($Ca(OH)_2$) exposed to the elements of the air prior to mixing and compacting should be avoided as the calcium oxide (CaO) will combine with the carbon dioxide (CO_2) from the air and result in a weaker material; it also deters the cementing action.

5. Slurry Application. Slurry is prepared at approved locations away from commercial and industrial sites to prevent damage to such areas. The lime is proportioned with water by means of an agitator, blender or compressed air at a rate of no less than 30% dry solids by weight. Blending of the lime and water may be accomplished during or prior to loading into distributing truck tanks, but it is necessary to determine the amount of dry lime in each distributing truck tank to insure proper distribution. Distributing truck tanks should be equipped with circulating devices, mechanical agitators, pumps or compressed air to prevent an accumulation of lime sedimentation.

   The prepared roadbed is scarified or partially pulverized by means a rotary mixer or other approved equipment prior to distributing the lime slurry. The lime slurry is distributed on the prepared roadbed at the predetermined rate by successive passes over a measured area until the specified percentage of lime is obtained. After each successive pass of the distributing equipment, the slurry solution is incorporated into the soil by the use of a rotary mixer, disk or other approved equipment. Each lime slurry application should be incorporated immediately to prevent flow from the area on which originally deposited, thereby resulting in a non-uniformity of lime distribution.

6. Initial Mixing. The lime and soil is scarified by the use of a motor patrol grader and mixed with a disk, rotary mixer or other approved equipment with liberal amounts of water for a soil requiring a mellowing period, Class A and Class B treatment. Scarifying the soil prior to the application of lime by the dry method is permissible and may be advantageous during periods of unpredictable winds. During such periods, excessive dusting may be reduced by watering immediately after spreading and prior to scarifying. Excessive dusting should be carefully controlled at this stage to prevent loss of lime in solution along the edges and prevent the concentration of lime on grades and slopes.

   Scarifying and mixing should be controlled to provide a uniform depth with the crown of the undisturbed foundation course, and to conform as nearly as practicable to the finished course. The initial mixing should be for the required depth and width of the course to prevent the incorporation of treated material in the mixture at the time of final mixing. Mixing depth should be checked frequently from grade stakes by means of a stringlining to insure proper control of the mixing depth.

   Water should be applied uniformly on the entire area being processed. The mixing and water application should continue until a homogeneous mixture of soil, lime and water is obtained. Mixing the water into the soil should immediately follow each application of water to receive the maximum benefit on the area placed and prevent non-uniformity of lime and moisture content.

   Heavy clays receiving Class A and Class B treatment should be mixed at a moisture content of 15 or 20 percentage points above optimum moisture of the raw soil for maximum breakdown of clays under ideal temperature conditions.

   Liberal amounts of water are not difficult to incorporate by means of a disk harrow, or a disk harrow following a rotary mixer, if each application of water is incorporated immediately. The immediate incorporation of water should be controlled to prevent concentration of lime and the infiltration of water into the untreated expansive material when disk harrows are used.

   Application and incorporation of water in the above prescribed manner will produce a more uniform and homogeneous mixture, thereby resulting in a maximum reaction of lime on the clay particles and facilitate early final mixing and produce increased strength. At the completion of the initial mixing, the degree of breakdown or loaminess of soil can be detected by examination under the “hand method” prior to sealing for mellowing.

   The soil-lime mixture should be sealed with a light pneumatic roller or other approved equipment upon completion of the initial mixing to prevent the loss of moisture and carbonation of the lime. Lime has a very high affinity for water and enough moisture must be retained in the mixture to further the reaction and receive a maximum plasticity and volume change reduction. Soil-lime mixtures mixed with liberal amounts of water may be difficult to seal immediately upon completion of the initial mixing. In such cases, the mixture may be conditioned for sealing by back-dragging with a dozer, motor patrol grader or other suitable drag type equipment.

Clay soils require a mellowing period of five to twenty days, but generally, depending on the temperature and the degree of mixing and water application, the very expansive clays should mellow approximately 10 days prior to being remixed. A tendency to apply less water and to mellow for a minimum period in the late fall and early spring should be avoided due to the lack of desirable temperature conditions.

The proper amount of water on the initial mixing and proper mellowing period under proper temperature conditions are especially important to gain the design strength where the treated design soil is to become a part of the pavement structure. The pavement structure will be undersigned unless the treated course is processed under favorable conditions to obtain the strength upon which the design was predicated.

7. Final Mixing. After the soil-lime mixture has mellowed, the roadbed is bladed and reshaped to the required lines, grade, and cross section and remixed with a rotary mixer. Reshaping the initially mixed material to the required lines, grade, and cross section prior to remixing will produce a more uniform thickness and prevent the course from having variable thickness after shaping, compacting and finishing.

   It may be advantageous to reshape the soil-lime mixture to the approximate lines, grade, and cross section as soon as possible after the initial mixing, as some mixtures become difficult to reshape after the mellowing period.

   The final mixing depth should be controlled by checking with a stringline placed normal to centerline from grade stakes at 50-foot intervals.

   The mixing is to be continued until the mixture will meet the sieve tests as specified in the contract. During this final mixing, the moisture content should be checked frequently and water added and incorporated as necessary. Moisture content of optimum, or slightly above, will benefit the strength of the course by reacting with any available free lime to provide additional cementation of the soil particles.

8. Compaction. Compaction should begin immediately after the final mixing for Class A and Class B treatment and after the first mixing for Class C treatment. Uniform and continuous compaction should begin at the bottom and continue until the entire depth of the mixture is compacted to the required density.

   Sheepsfoot type rollers are primarily used during the initial compaction. Moisture, as required, should be added during the compaction to retain the mixture at the desired moisture content. Frequent checks on moisture content and the degree of compaction should be made to insure proper control.

   Compaction of soil-lime mixtures, as with the stabilization of any soil, is a very influential factor and is of paramount importance. The strength and durability of soil-lime mixtures greatly depends on the degree of densification. The maximum strength of a clay soil-lime mixture does not always occur at the point of maximum density. For practical field construction procedures, however, the optimum moisture content for maximum density at identical compactive efforts will produce the maximum strength. Generally, clay soil-lime mixtures should be compacted on the wet side of optimum moisture.

Lime treated courses failing to meet the density requirements should be reworked and recompacted immediately at the proper moisture content. Delayed subsequent compaction or delayed reworking of soil-lime mixtures will result in a breakdown of the cementing bond and should not be permitted unless available lime is present or additional lime is incorporated. At the stage of final compaction, a considerable quantity of the available lime has been consumed by chemical reactions and the strength of a soil-lime mixture will be adversely affected by delayed recompaction or reworking.

Compaction under ideal temperature conditions and proper moisture content will materially affect the ultimate strength and durability of a soil-lime mixture.

9. Finishing and Curing. The initially compacted mixture and any remaining mulch are bladed and shaped to the required lines, grade and cross section and compacted with pneumatic tire roller. The finished course should contain a uniform mixture of lime with a smooth, closely knit surface free from cracks, loose or segregated areas, and constructed by proper depth, width and surface requirements. Final compaction at the proper moisture content is of the utmost importance as lime mixtures are cemented together after the final compaction and not during the mellowing period or initial compaction.

   Curing is best accomplished during seasons of warm temperature and by prevention of moisture evaporation from within the compacted mixture. The evaporation of moisture can be prevented by applying water to the completed section; this is most essential for development of the maximum intended strength.

   Cracking and fluffing of lime treated courses are objectionable features of lime stabilization and can be detrimental. Cracking may result from the high volume change of the untreated underlying course, loss of moisture, internal shrinkage of the soil-lime mixture or heavy loads during the curing period. Small shrinkage cracks may be kneaded together by light applications of water and rolling with a light pneumatic roller during the curing period, and should be corrected before covering with a subsequent course.

   Fluffing is generally the result of soil-lime mixtures being cured without proper application of moisture during hot weather. The loose material resulting from improper segmentation of the entire course can be detrimental to the strength of the pavement structure.

   To minimize the most harmful effects of cracking and fluffing, each complete course shall be covered with a bituminous curing seal as soon as possible but no later than 24 hours after completion. The surface shall be sealed with one of the specified bituminous materials applied by a pressure distributor at the rate of 0.10 to 0.25 gallon per square yard or as directed by the Engineer. The bituminous material shall be heated or otherwise prepared to insure uniform distribution. Should the Contractor fail to seal the lime-fly ash course within the time specified, the Engineer will suspend all other work and withhold payment of the current estimate(s) until all damages resulting there from is corrected and the treated course is sealed.

A subsequent course shall not be placed on the sealed course for at least seven (7) calendar days. During this 7-day period, the treated course shall not be subjected to any type of traffic and equipment.

The Contractor shall maintain the treated course and the curing seal in a satisfactory condition until covered by a subsequent course. Protection shall include immediate repairs of any surface irregularities or other defects that may occur or develop. It shall be the Contractor's responsibility to control traffic and equipment loads to avoid damage and to guard against freezing of the treated material.

Soil-lime stabilization is severely restricted by climatic conditions and construction should be performed only in seasons of warm weather. The seasonal limits of lime treatment are set out in Specifications.

Durability of soil-lime mixtures are also affected by the length of time cured under ideal temperature prior to detrimental weathering. It is possible that a soil-lime mixture completed late in the season could develop satisfactory strength in short period of time before cold weather, but could fail during the first winter. Soil-lime mixtures completed late in the construction season should be adequately protected from freezing by a surfacing course or a course of granular material of sufficient thickness with sufficient fines to prevent the infiltration of water which increases the possibility of freezing. When the mixture is subjected to freezing, the bonds between soil-lime particles are broken and result in a permanent loss of strength. To receive the maximum benefit of soil-lime stabilization, early or middle season construction is necessary. Late season construction is not desirable, simply because the maximum value may not be received for the dollar paid.

10. Safety Precautions. Special precautions must be taken for the protection to the eyes and bodies of workers handling lime. Hydrated lime is relatively safe but may cause irritation to sensitive skin. Quicklime is highly caustic and is very dangerous in the presence of moisture. Even a small amount of perspiration on the skin will cause severe burns and is especially dangerous to the eyes. Workers should be properly instructed in first aid for treating injuries resulting from handling lime. Severe burns should immediately receive professional medical attention.

    Personnel handling lime should wear long sleeve shirts, safety glasses, respirators, close-fitting clothes and bathe as soon as practical after exposure.

3.3.7 Records and Reports. In addition to the required records of material tests and certifications, density and moisture records, the following records and reports are to be provided:

1. Keep pre-spread surface tolerance checks in bound notebook.

2. Complete Form TMD-125 for each section.

3. The Department’s prescribed delivery tickets are to be used for lime quantities.

4. Keep mixing depth checks in bound notebook and on TMD-125.

5. Keep tolerance checks of finished surface in bound notebook.

6. The inspector is to date and initial each sheet in bound notebooks on which recordings are made.

3.4 Cement Treated Courses.

3.4.1 General. Portland cement treatment may be specified for materials already in place or for newly processed materials. Processing already in place material normally involves road-mixing with either the multiple pass or single pass mixers. For processing new materials, mixing may be accomplished on the road using either the multiple pass or single pass mixers or a traveling plant, or at a central plant. The type of mixer used is usually optional with the Contractor. However, a specific type of mixer may be required as indicated in the contract by an application pay item designation.

Section 308 of the Standard Specifications describe the construction methods in detail. Attention is directed to certain operations which should be emphasized and to inspection procedures which are not normally included in the Standard Specifications.

Cement treated materials can be constructed properly only if the equipment and methods used in the work provide for the following:

1. Completion of the cement treatment for the section being processed within specified time limitations.

2. Uniform distribution of cement throughout the material being mixed.

3. Good pulverization and moisture control.

4. Proper compaction.

5. Adequate curing

The inspectors assigned to this type of construction should devote their efforts mainly to the accomplishment of these objectives.

3.4.2 Road-Mix. When the road mix method is used, it is important that the material-in-place under previous contract, or new materials, be properly prepared prior to spreading cement. This is important in order to make possible the proper proportions of cement, granular materials, and water, and in order to make it practicable to obtain the specified final cross section, grade, and desired thickness. Therefore, the requirements of the Standard Specifications should be thoroughly understood and closely followed in order to accomplish the desired results.

The work involved in treating granular material with cement should be started by laying out sections sufficiently short to leave no doubt that the work can be properly completed during the time available. As the work progresses, the length of section can be adjusted to fit the maximum capabilities of the equipment and personnel, and the available supply of materials.

The Standard Specifications contemplate that the Contractor will apply cement to the neat area to be treated as indicated in the contract, and will furnish and use mixing equipment such that the mixing operation will be performed to the neat lines indicated, within the tolerances allowed. To mix to a width greater or less is not to be allowed except as follows:

> The Engineer may permit the Contractor to mix to a width greater than that specified, including tolerances, only with the provision that the Contractor furnishes and applies, at no additional cost to the State, the additional cement necessary to provide the same application rate on the additional mixed width as required on the design width. It is the responsibility of the Project Engineer to insure that the Contractor follows these procedures and that an understanding, evidenced in writing by the Contractor, has been reached and recorded in the Project Files. In such case the computations for pay quantities of cement is to be made on a proportional basis that is the amount of cement of which payment is made is to be computed as follows:

$$C_p = C\,(Dw/Sw)$$

When: C_p = Cement for which payment is to be made.
C = Volume of cement spread less excess over 5%, if any.
Dw = Design Width
Sw = Spread Width

Soil-Cement-Water mixing for which payment is made is to be computed on the basis of design width.

At the discretion of the District or the Construction Division, the Project Engineer may be required to furnish additional copies of such basis for equipment approval.

The moisture content of the soil to be treated should be as nearly uniform as possible and should have a tendency to be on the dry side of optimum but should not be sufficiently dry to cause the washing of cement through the dry material into the subgrade upon application of the mixing water. During the mixing process, water added to reach the optimum moisture content should be applied, as required, through the mixer when using single-pass mixers, and in the necessary number of small increments, using pressurized equipment as specified, when using multiple-pass mixers. It may be desirable or even necessary to make intermediate moisture checks after dry mixing or partial mixing in order to know the amount of water that needs to be added to reach the optimum moisture content. It should be emphasized that uniform moisture content at the end of moist mixing is highly important, and every effort should be made to prevent moisture content in excess of optimum. Experience and research has shown that shrinkage cracking can be reduced by holding the moisture content to about 2% below optimum. For some soils, there is a tendency on the part of some Contractors to apply generous amounts of water to the mixture in order to facilitate compaction. This practice should not be permitted because of the resulting excess shrinkage cracking, and the probability of reduced strength of the treated course.

Bulk cement spreaders, which are used in the work, should be tested closely for their ability and proper setting to result in a uniform spread of the cement for the entire section being spread and, also, for uniformity of spread within the section. The Contractor should be required to make any initial adjustments and follow-up adjustments of the spreader as are necessary to achieve a uniform spread of the cement. Spread checks generally are made in two ways:

1. By making a square yard spot check. A three-foot square piece of canvas cloth is placed in the path of the spreader. After the spreader passes over the cloth, the cloth is carefully picked up such that the cement within the area of the cloth is collected and weighed. Better accuracy can be obtained using larger canvas cloth or special collecting frames.

2. For each linear distance of spread, a comparison is to be made between the actual weight of cement spread with the weight of cement which should have been spread at the specified cement content.

It is particularly difficult to add additional cement to a section on which insufficient cement has been placed. In order to achieve a uniform re-application over the entire area, critical equipment adjustments must be made, or other costly procedures followed. In no case should a second application of cement be attempted, except by the uniform application of an amount equivalent to the maximum deficiency at any one location applied over the entire area for which the deficient spread was made.

In the case a section is laid out for known amount of cement to be applied from a truck through the spreader and such known amount of cement fails to cover the entire area, additional cement is to be used to complete the spread at the required application and appropriate deductions made for the excess cement used, if applicable , above the allowable tolerance.

As indicated in the list of records to be kept as outlined herein below, a detailed record of the method of obtaining the correction of a deficient spread is to be made immediately after such correction. It should be pointed out that excess cement, including that applied to correct a minus deficiency, exceeding the five (5) percent allowable plus tolerance is to be deducted from measured quantities, and no payment made therefore.

For the reasons stated above, it is extremely important that the Contractor provide, adjust and regulate equipment such that the proper amounts of cement are applied upon initial application.

3.4.3 Central-Mix. On some projects, central plant mixers will be required. The Central Mixing Plant may be either the batch mixer or continuous mixer type, meeting the requirements of Subsection 308.03.2 of the Standard Specifications. Prior to beginning delivery of plant mixed materials to the road, plant facilities should be carefully checked to insure satisfactory proportioning and mixing is accomplished. Scales and meters for batch type plants should be tested for accuracy. For continuous flow-type plants, careful calibration should be made of all feeding and metering devices in order that all materials will be proportioned accurately. The mixer should be checked to determine that it is in good condition and will mix the materials satisfactorily. Water measuring devices should be checked for accuracy. Cement storage facilities should be checked to insure that protection is provided against moisture and weather. The storage facilities for all materials should be adequate to insure sufficient available materials for continuous production adequate to accomplish placement within the specified time limitations.

In proportioning the ingredients for the mixture in a central plant, the amounts of water and cement for the completed mixture are generally the same as for the completed road-mix. The amount of water to be added is that necessary for hydration of the cement and subsequent compaction , which, in general, is close to the optimum moisture content for compaction, but should never exceed the allowable tolerance above optimum moisture. The desirable time for addition of water in the Central Plant can be determined by observations and performance for the specific project, but practice indicates that there is some advantage in delaying the addition of water a couple of seconds to get the benefit from a limited amount of dry mixing of the cement and aggregates.

The addition of cement into the mixture in a uniform manner and in the desired amounts is always a cause for concern, since it has such an important bearing on the finished product and the cost thereof. Proportioning cement by weight in batch mixers is generally the most successful method of assuring that the required amounts are processed. The feeding of cement into continuous type mixers is generally performed with continuous flight augers or vane feeders. Due to the physical characteristics of cement relative to occupying varying volumes under different pressure conditions, it is difficult to be assured of an accurate delivery of the desired percentage. The more successful cement feeders now attempt to deliver cement from a constant head receiver in which the cement is agitated or other means to keep it in a uniform condition for delivery to the mixture. Calculations for proportioning of the ingredients should be similar to those used in design proportioning as set forth in Method of Test MT-9 (TMD-11-09-00-000), 5. (c).

Theoretically, cement is proportioned into the mixture by volume. Actually, control of the proportioning at the plant must be made considering weights of the ingredients converted to volume percentages required. Depending on the type of plant, procedures must be devised for determining the satisfactory rate or proportioning. In the case of batch plant, this is no problem. In the case of a continuous plant, a satisfactory method involves the intercepting of material for a known time increment from various feeders and determining the dry weights for each aggregate and then applying the calculations as indicated above.

In case of difficulty or question as to the actual proportions of the soil or soil-aggregate and cement in the mixture, a cement titration is available, which may be performed in a reasonable time to check the performance of mixing operation. This test can be performed in the Central Laboratory in accordance with AASHTO Designation: T 144 and provisions could be made for the performance of this test in other Department Laboratories.

It should be remembered that it is the obligation of the Contractor to provide equipment and to control the delivery of all ingredients to the mixer within the specified tolerances and the Engineer is not to take or inherit these responsibilities, but rather is to assist the Contractor in the calibration of the various feeders of the plant and make such checks as are necessary to insure uniform operation and control of the mixture.

The Standard Specifications require the trucks used for hauling cement treated mixture to the road be equipped with protective coverings to minimize the loss of moisture. Truck bodies and protective covers should be inspected for conformance with requirements before hauling is begun and periodically thereafter. The specifications require that Central Plant mixed cement treated material be placed by approved mechanical spreader(s) and the spreaders, rollers and all of the road equipment should be carefully inspected prior to approval for commencing the work.

3.4.4 Spreading, Compacting and Finishing. The Standard Specifications cover the details of these operations. Due to the effects of partial hydration of the cement during mixing and placing operations, the Specifications generally require that the Specified Density be something less than the Specified Density for similar untreated material.

The Specified Density stated in the Specifications is a percentage of the Standard Density of samples taken after completion of the mixing, molded and tested as provided in Method of Test MT-9 (TMD-11-09-00-000).

Molding of the test specimens should be correlated as nearly as possible with the road operations in order that the elapsed time between sampling and completion of the molding will correspond to the elapsed time between sampling and completion of the compaction on the road.

When placing fresh cement treated material against the vertical face of previously placed material as provided in the specifications, special care should be taken to secure good compaction next to the previously finished portion. Usually, it is better to finish the fresh mixture at the joint slightly higher and trim it to grade during the "tight-blading" finishing operations. Joints finished low usually cannot be satisfactorily corrected.

Most of the cement treated courses in the past and some still are shaped and finished by blading with a motor grader. Probably due to the time limitations and the nature of the work, smooth riding surfaces built to line, grade, and section are difficult to obtain. If a treated course is not properly constructed from the start, it is next to impossible to correct the errors or faults without tearing everything out and starting over.

Too much emphasis cannot be placed on checking the grade and section at and between the bluetops as treated course is being finished. This is a responsibility of the Contractor and must be verified by the Department's personnel by appropriate recorded measurements.

Fortunately, on projects where electronically controlled fine grading equipment is used, the problems of finishing the section are diminished; however, attention is invited to the fact that cutting and filling with any type of machine in final surface finishing does not give desirable results because a thin layer of filled material usually cannot be satisfactorily bonded to the underlying material. It is desirable that the course be so constructed that the "tight-blading" should be clipping the surface of the course at all points. It is the Contractor's responsibility to prepare the compacted surface of the course prior to "tight-blading" in such a manner that satisfactory final clipping can be performed without wasting more than the very minimum amount of treated material.

3.4.5 Curing. It is very important that the newly constructed cement treated course be kept moist for the specified curing period. The curing seal is to be placed as soon as deemed practicable after final surface finishing and, until the curing seal is applied, the surface of the treated course must not be allowed to dry out. The curing seal, after application, shall be maintained and protected by the Contractor as required in the Specifications.

3.4.6 Records and Reports. In addition to the required records of material tests and certifications for the component materials in the cement treated course, the following construction records and reports are to be provided:

GENERAL

1. Complete Form TMD-128 for each section.

2. If initial cement spread is deficient by more than the tolerance allowed, indicate on Form TMD-128, in detail, the procedure used to bring the spread within tolerance.

3. The Department's prescribed delivery tickets are to be used for cement quantity.

4. The inspector is to initial and date each sheet on which recordings are made in bound notebooks on a daily basis.

5. Recordings of calculations for tests made are to be preserved for future reference.

6. For records only, reports or bound notebook records are to be kept for curing agent.

7. Records or Deviation from Specified Values to be maintained currently.

8. Originals or copies of all records are to be maintained on the project site or in the project files at all times.

9. Record any unusual incident which might be a key to an abnormal condition or possible future behavior of the finished work.

BEFORE SPREADING CEMENT

1. Keep density record - TMD-200.

2. Keep surface tolerance checks in bound notebook.

3. Keep longitudinal surface tolerance checks, if required, in bound notebook.

4. Keep results of moisture checks in bound notebook.

AT THE COMPLETION OF MIXING

1. Keep moisture checks as indicated above.

2. Keep results of pulverization tests in bound notebook and Form TMD-128. Also keep computations for tests as indicated above for moisture check.

AT THE COMPLETION COMPACTION AND FINISHING

1. Keep record of density - Form TMD-200.

2. Keep surface tolerance checks in bond notebook.

3. Keep longitudinal surface tolerance checks, if required, in bound notebook.

4. Keep width tolerance record on Form TMD-200.

5. Keep thickness tolerance checks in bound notebook and Form TMD-128.

3.5 Lime-Fly Ash Treated Courses.

3.5.1 General. This type construction consists of treating a course with fly ash and lime, all in accordance with the requirements of the Specifications.

3.5.2 Construction Requirements. The first phase of this work is to mix the soil and fly ash by spreading fly ash over a scarified area of soil or soil-aggregate, followed by lightly disking or mixing the materials prior to spreading the lime. Fly ash is to be applied as set out in Subsection 311.03.4.1 of the Standard Specifications. Lime is then incorporated into the soil/fly ash course with sufficient water to allow the mixture to be uniformly mixed and immediately compacted to required density. No mellowing period is required or allowed with lime-fly ash courses. The course is to be shaped, compacted and finished in accordance with the provisions and requirements of Subsection 311.03.7 of the Standard Specifications. The finished course shall be cured and maintained in accordance with the requirements on Subsection 311.03.8 of the Standard Specifications.

3.5.3 Records And Reports. All checks, records, and reports are to be as set out in this manual and reported on Form TMD-125. A copy of this form is in the "Forms Section" in the back of this manual.

3.6 Shoulders. Shoulders are defined as that portion of the roadway adjoining the traveled way that is constructed for emergency use, for the accommodation for parked vehicles, and for lateral support of the base and pavement courses. For a graphic delineation of the limits of shoulders, vertically and horizontally, see Figure 1 at the end of Section 101 of the Standard Specifications.

One of the most important functions of the wide shoulders being constructed on today's modern highways is their contribution to the safety of the traveling public.

Materials for shoulder construction will, in most instances, be determined by availability and the class of highway under construction. Shoulders are usually constructed of compacted granular materials, mechanically stabilized, or cement stabilized granular materials. On heavily traveled high type roads, the surface of the shoulder may be paved with a surface treatment or hot mix asphalt.

The design of the shoulder will be shown on the plans and is to be finished to the widths and slopes shown on the typical section(s) and the applicable Super Elevation Standard Drawing. Setting shoulder blue tops will help insure that the shoulders are finished to the correct slope(s) and width(s).

To provide the maximum degree of safety on projects where traffic is being maintained and to obtain a properly constructed shoulder, the provisions of Subsection 320.03, Construction Details, of the Standard Specifications and/or any applicable Special Provisions should be followed closely.

3.7 In-Grade Preparation. In order that the contract requirements pertaining to In-Grade Preparation be properly carried out, it is essential that the Engineer and inspector(s) carefully read and understand the referenced sections of the Standard Specifications, and all applicable Notices to Bidders and Special Provisions.

Particular attention should be paid to the Subsections pertaining to tolerances for the various courses in order that adequate checks may be made and documented before permitting the Contractor to proceed with subsequent courses or phases of work. For example, all finishing of the subgrade must be completed and checked before proceeding to the sub-base course.

In-grade preparation is defined as the work required to prepare (blade, shape, scarify, disk, mix, compact) the existing material to specification requirements prior to placement of the subsequent layer. In-grade preparation, whether or not measured for separate payment, will be required whenever a subsequent course is placed on design soil. Separate measurement and payment will be made only on full depth paving projects where the grading has been completed on a separate project, and measurement will be made only for the lane(s) which was graded on the earlier contract.

CHAPTER 4
BITUMINOUS PAVEMENTS

4.1 General. Bituminous pavements comprise a large percentage of our State's Highway System. They provide a cost effective and easily maintainable flexible pavement.

Vigilant inspection is required by the Contractor, the inspectors and laboratory personnel throughout each phase of its production, laying and rolling.

Through the use of a Quality Management Program, the Contractor has full responsibility for quality management and maintaining a quality control system that will furnish reasonable assurance that the mixtures and all component materials incorporated in the work conform to contract requirements. The Contractor has the responsibility for the initial determination and all subsequent adjustments in proportioning materials used to produce the specified mixture. Adjustments to plant operation and spreading and compaction procedures shall be made immediately when results indicate that they are necessary. The Contractor has to provide certified asphalt technicians to perform all necessary tests, data analysis, correction, etc. to assure that the Department is getting an acceptable product.

The MDOT plant technician's function is to assure the quality of the bituminous mixture through assurance testing. The MDOT plant technician is to make tests to check the quality of mixture in order to maintain compliance with the job-mix formula. The MDOT plant inspector is to record and/or sign the individual truck tickets which show the weights and mix temperature. The MDOT paving inspector's duties include checking layout ahead of paving, checking equipment for compliance with specifications and checking each detail of receiving, dumping, spreading, compacting and finishing, as required in the specifications. Particular attention should be directed to the mix because many deficiencies in the quality of mix can be detected before the mixture is actually placed. The construction of joints and appearance of the mat require continuous observation by the inspector.

Surface smoothness and good riding qualities of a pavement can be attained only by hard work and strict attention to small details on the part of the project personnel. They should continually study the conditions peculiar to the job and strive to obtain the smoothest surface possible.

A smooth riding pavement costs no more than an unsightly poor surface, but it does require constant, careful inspection of all details of construction to obtain the desired results.

Persons involved with any phase of bituminous pavement construction should familiarize themselves of the contents of the latest version of the MDOT Hot Mix Asphalt Field Manual and the U. S. Corps of Engineers Hot-Mix Asphalt Paving Handbook.

4.2 Asphalt Pavements. Asphalt pavements are bid as Warm Mix Asphalt (WMA) or Hot Mix Asphalt (HMA). Generally, all the requires for both kinds of mixes are the same. Differences are addressed in the contract documents. For the most part, Subsection 401.03.10, Spreading and Finishing, of the Standard Specifications carries adequate detail requirements for the spreading and finishing of asphalt pavement courses, and such details are here affirmed by reference thereto.

It is basically desirable that asphalt pavements be spread and compacted for the full width of the course in a single operation. The reason for this is that circumstances sometimes make this accomplishment unreasonable. When possible, in the absence of a full width paver, more than one(1) paver operating in echelon is very desirable.

It must be remembered that it is the duty of the paving inspector, in addition to inspection of the construction operation, to inspect and approve each unit of equipment as to its conformance with the requirements set out in the contract. An appropriate check list is a convenient way of documenting inspection for such characteristics. Form CSD-325 provides a standard for recording and reporting the inspection of asphalt laydown equipment.

The responsibility for providing equipment which produces the desired results is that of the Contractor. However, it is important that the Paving Inspector involved with the placement of asphalt courses have some working knowledge of the mechanical processes of the particular paver being used. Some information is included here for that purpose.

Several types and makes of pavers are used, and all of them may be capable of providing satisfactory surface finishes. The various types of paving machines differ primarily in the methods used in striking off, compacting and smoothing the surface.

The inspector should be familiar with the mechanical features of the type of paver to be used on the job in order that an intelligent appraisal of the condition and adjustment of the machine can be made. Handbooks and literature containing the various details and the operating instructions are available from the manufacturer. The inspector may be interested in obtaining copies of these instructions from the Contractor or the manufacturer.

Paving machines using the tamping bar and fixed screed principles require rather precise adjustments of clearances and movements. The size shape, length of the stroke and extension of the stroke of the tamper bar below the screed are critical factors in obtaining proper compaction. The condition of the screed plate and its adjustment for crown are very important in achieving a smooth, uniform surface. The clearance between the tamper bar and leading edge of the screed must be checked for proper adjustment. The speed of the engine, which drives the tamper bar must be checked to determine if the tamper bar is operated at the correct number of strokes per minute. With the paving machines using a transverse oscillating screed to strike off the mix, followed by a vibrating screed plate which compacts and smoothes the mix, it is essential that the oscillating screed is free of excessive play and is correctly adjusted for crown and tilt. For best results, the vibrator on the screed plate must be operating at the correct frequency.

Machines using an electrically vibrated screed to strike off, compact, and smooth the mix must be checked to insure that all vibrators are set to deliver vibrations of equal amplitude. The screed plate should be checked for signs of excessive wear, and the engine speed determined to insure correct adjustment of the governor. The immobile foot in front of the screed, which serves to push the mixture under the screed and assists the screed in striking off, should be checked for proper height.

On all track-laying machines, correct adjustment of the track linkage is essential for a smooth operation. A poorly adjusted track, or a badly worn one, can produce an uneven, “choppy” pavement surface. Observations of the machine in motion will usually detect any defects in the track of the drive mechanism.

Some pavers are suspended on rubber tire wheels. With these machines, all pneumatic tires must be inflated to the correct pressure, and the chain drives must be examined to insure that chains are adjusted properly, without excessive slack.

4.2.1 Asphalt Pavement Material Requirements. Primarily, quality considerations for asphalt pavements are permeability, density, durability and, in the top surface lift, adequate prolonged skid resistant characteristics. The contract documents should be reviewed carefully for aggregate requirements.

4.2.2 Asphalt Pavement Surface Requirements. Surface requirements are set out in the specifications to insure satisfactory grade, crown slope, thickness and smoothness.

The specifications require that immediately after screeding of any course and prior to roller compaction of courses of plant mix, it shall be the responsibility of the Contractor to check the surface for conformance to these surface requirements and to adjust inequalities at that time that are necessary to produce a finished surface within the tolerances specified for the particular course.

There is a natural tendency on the part of some inspectors to make measurements on the surface of uncompacted or partially compacted courses of mixture in order to be helpful to the Contractor. If the Contractor uses the inspector's measurements as a basis for manipulation of the mixture, any errors, omissions or misjudgements made by the inspector might be reflected in the Contractor's operations. The inspector's observations of the Contractor's required progress measurements and manipulations could be informative, but in no case should the inspector actually make these measurements for use by the Contractor.

After compaction, sections of courses found by the Engineer to be exceeding the allowable tolerances shall be corrected by the method provided in the specifications at no additional cost to the State.

On all pavement projects, the inspector must make and record a sufficient number of measurements after final compaction of the mixture to determine necessary corrections and to reflect conformance to surface requirements. These measurements are to be taken in accordance with Section 403 of the specifications.

Even though normally required on paving projects, grade stakes or other grade reference points and maximum deviation from grade and cross-section may not be required on all projects. On widening and overlay projects, the specifications allow variances in the maximum deviation from grade depending on the particular type of construction involved in the project. When only one intermediate lift is required, or when only a leveling and surface lift is required, or when only a surface lift is required, allowances are different than those required on full depth construction projects. The Project Engineer and Paving Inspector should review the requirements of the contract, especially Subsection 403.03.2, Surface Tolerances.

The above inspection procedures are considered necessary for high quality construction. Full cooperation and effort in maintaining high quality inspection procedures is anticipated.

Day to day records of individual measurements made after final compaction are to be used to determine necessary corrections of deficiencies in the course being laid, and then must reflect that corrective action has been taken or that action is necessary under the provisions of Subsection 105.03 of the Standard Specifications to determine the appropriate correction, adjustment or replacement.

A summary of the record checks made on the completed surface of each course after correction of deficiencies must be available at the time of the final inspection indicating that the work performed is in reasonably close conformity with the requirements of the specification.

The summary of these record checks are to be kept current for each completed course, and available for inspection in the project office.

4.2.3 Control and Workmanship of Asphalt Pavements.

A. Know Your Job and the Plans and Specifications. One of the first things the bituminous paving inspector and any assistants should do is to make themselves completely familiar with all applicable portions of the plans and specifications for the particular job. If not present at any pre-construction or pre-paving meetings, become familiar with comments, questions, agreements, etc. that may have been discussed at these meetings.

B. The Plant. The specifications provide in considerable details the requirements for individual units of equipment and combined plant operation for the plant to be used to produce the bituminous mixture.

The quality of the finished bituminous pavement will be reflected by the degree of conformance with these specification requirements for the plant equipment and operation.

Most modern day plants are efficient when properly assembled and operated, and recently much more emphasis has been placed on the qualities of performance being the responsibility of the Contractor.

C. Transporting Mixed Materials. The asphalt mixture is, of course, transported from the Central Mixing Plant to spreading operations by trucks. Before any material is loaded into the trucks at the plant, the plant inspector should have determined that the vehicles meet the requirements of Subsection 401.03.3 of the Standard Specifications.

In spite of the fact that each truck should be equipped with a cover, the problem of temperature control of the mixed material may become acute because of the distance hauled, time lost because of equipment breakdown, and the ambient temperature. Any mixture arriving at the job site at a temperature below that permitted in the specifications is to be rejected.

D. The Paver. There are many types of pavers used in placing asphalt mixtures. Some of the new modern pavers are extremely sophisticated; however, pavers which are in good working order and properly operated should be capable of producing satisfactory results.

E. On the Grade. The mere fact of an inspector's presence at the site of the paving operation may help a little, for a while.

1. Taking Part. The inspector should always be alert to see that good practices are followed by the construction crew and workmanship is not sub-standard. Each little detail of workmanship in itself may seem insignificant but when all the details are added together, they assume considerable magnitude. It is attention to each of these seemingly minor details that can make the difference between a good job and a superior job.

2. Checking of Equipment. Prior to beginning the paving operation, the paving inspector, together with the Project Engineer, if possible, should review with the Contractor's superintendent the equipment to be used and the condition of the equipment.

3. Weighing and Verification. The bituminous mixture is weighed at the plant. A haul ticket is to be made out, delivered to the paving inspector and validated and processed in accordance with this manual.

   The haul tickets are to be collected by the inspector as each load of material is delivered to the paver. Handing of the tickets to a Contractor employee for accumulation and passing to the inspector later in groups is not to be permitted. The inspector must validate (sign) haul tickets for each vehicle before the material is incorporated in the work.

4. Importance of Grade. The paving inspector should reference Subsection 401.03.6 of the Standard Specifications regarding surface preparation prior to placement of the bituminous mixture.

   The inspector should also make certain that the surface upon which the asphaltic paving is to be placed is within the specified tolerances for grade and section. The smoothness of the finished riding surface is dependent to a large degree on the smoothness of each of the preceding courses.

5. Spreading the Mixture. The Contractor is to establish the rate of spread such that the compacted course will be within specified tolerances and check to see that the compacted course is in compliance.

   Spreading temperatures are to conform to the Specifications and should be high enough to provide suitable workability for placement and to allow sufficient time for proper compaction prior to cooling.

   The use of a motor grader for spreading can be permitted only in areas inaccessible to a paving machine or for preliminary leveling and correcting irregularities in an existing base or surface prior to placing the first overall course of asphaltic concrete.

   In machine spreading of bituminous mixture, if any unsatisfactory mechanical conditions exist in the paving equipment being used, the quality of the finish course will suffer. If a condition exists in a paver that is causing difficulty in the spread, the difficulty will usually be magnified or aggravated with higher paving speeds. In either case remedial action should be taken immediately upon discovery.

6. Automatic Screed Control. Most Contractors have pavers equipped with an automatic screed control device. This device is designed to maintain desired grade and slope by raising or lowering, automatically, the pivot points of the screed arms to control the screed angle of attack. The elevation is controlled by reference independent of the tractor unit of the paver, which may be a stringline, a traveling ski or a matching shoe on uncompacted material when pavers are operated in tandem.

   The five main components of an automatic screed control are the sensor, pendulum, control box, command panel, and motors or cylinders to change the screed tilt, automatically compensating of road surface irregularities. The automatic screed control device was designed to improve “gradeline” smoothness and “sway” in cross-section.

   When an approved profile averaging device is permissible under the contract, it shall be a device capable of working in conjunction with a taut string or wire set to grade, or ski-type device with extreme contact points at least 30 feet apart. Approved non-contacting type profile averaging devices are laser type ski devices with at least four referencing mobile stations at a minimum length of 24 feet, or an approved equal.

   The matching shoe is designed to match a previously laid uncompacted mat and can also be used in conjunction with an approved profile averaging device to match a gutter grade, when slope control is not specified, providing the gutter grade is satisfactory. Remember that the paver will only lay to the accuracy of the reference. It will not correct any errors in the reference.

F. Rolling of Asphaltic Pavements. Proper and adequate rolling is one of the secrets of successful asphalt paving. Different mixes may require considerably different levels of compactive effort and thus different compaction equipment and rolling patterns. Different types or combinations of rollers may be needed to achieve a required level of density. At the option of the Contractor, a rolling pattern may be established at the start of the particular paving project using one or more roller test strips.

G. Surface Smoothness. After compaction, surface checks are to be made and recorded in field books to insure conformance with the requirements of the contract for grade, typical section, and surface smoothness.

   If any corrections are indicated by such surface checks, they must be made and documented prior to placing the subsequent layers, or by approved grade raise(s). In each case, the corrections in the surface of the course are to be made in accordance with the specifications.

H. General Clean-Up at Completion of Paving. During the course of paving operations there normally are small scattered piles of material deposited at intervals along the roadway. Also, at the end of each day’s operation the laydown machine will usually be cleaned in an area within the right of way. These deposits of unused material and other debris scattered along the project should be removed and disposed of as directed by the Engineer as soon as possible after the completion of the paving operation.

It must be remembered that unauthorized surplus or wasted material in any appreciable quantity must be measured in a manner determined by the Engineer to be reasonably accurate, documented in the inspector's field notebook and Form CSD-121, and deducted from measured quantities.

4.2.4 Inspection Report for Asphalt Laydown Equipment. Prior to beginning the laydown operation on the project, the paving inspector and the Contractor's representative shall inspect the Contractor's equipment. The paving inspector shall record the results of this inspection on Form CSD-325. It is important that any action taken by the inspector toward correction of any equipment deficiencies and/or rejection of any equipment be documented.

Form CSD-325, in the Forms Section of this manual, is to be completed and signed by the paving inspector and reviewed and signed by the Project Engineer. This form is to be updated as necessary when equipment is removed and/or added to the project.

4.3 Maintained Asphalt Pavements. Unlike normal asphalt pavement, the MDOT inspector has limited responsibilities when the contract requires maintained asphalt pavement. The inspector will report the Contractor's daily activities for the daily diary, monitor the Contractor's traffic control plan, closely monitor the operations of the profilograph and perform other duties as directed by the Engineer.

The Contractor's responsibilities are defined in the special provisions for Maintained Asphalt Pavement in the contract proposal.

4.4 Cold Bituminous Pavements.

General. The cold bituminous asphaltic concrete is a mixture similar to the hot/warm asphaltic concrete except that the asphaltic material and additives, when required, are of such nature that the mixture may be transported, stockpiled, and laid cold. This type of mixture is most commonly used for pavement repair work but can be used as a resurfacing course over an existing pavement. Ordinarily, when the quantities are sufficient to warrant setting up a plant on the project, hot/warm mix asphalt will be specified. Cold laid mixes are generally not as water tight as hot laid mixes.

Materials. Material requirements are addressed in Subsections 404.02 of the Standard Specifications.

1. Mineral Aggregate. The mineral aggregates should be handled and stockpiled in the same manner as the hot/warm mix aggregates.

2. Bituminous Material. The liquid bituminous material should be of the type that will remain fluid at air temperature sufficiently long enough to permit completion of the construction operations.

Design. The gradation of the aggregate and the percent asphalt must conform to the requirements of the job-mix formula.

Plant Operations. Generally, the plant operations for the cold bituminous pavements are the same as for the hot/warm bituminous pavements except for the drying and mixing operations.

The temperature of the mineral aggregate at the mixer must be considerably lower for the cold mix. The mixing temperature limits are usually set forth in the specifications. These temperature limits must be strictly observed to insure a mixture that will remain in a workable condition from the time it is mixed until it is incorporated in the pavement. The temperature may be controlled by heating and drying the aggregate, and then cooling back to the required temperature; or by controlling the heat and rate of flow of the aggregate through the plant so that the aggregate will arrive at the mixer properly dried and at the specific temperature.

The sequence of introducing the aggregate and the bituminous material, and approved primer or water, if specified, into the mixer, and the length of the mixing period should be such that a uniform and workable mixture conforming to the Job Mix Formula is produced.

Road Operations. The road operations for the cold laid mixtures are the same as for the hot/warm bituminous pavement except as discussed below.

The specifications permit spreading cold bituminous mixtures with a motor grader. When a motor grader is to be used for spreading, the mixture is to be dumped and windrowed in accordance with Subsection 404.03.6 of the Standard Specifications.

When the mixture is ready for spreading, it shall be uniformly windrowed, spread, finished, and compacted in the same manner as the hot/warm mix pavement. No succeeding course is to be applied until the mixture has cured sufficiently as required by the plans and specifications.

Records and Reports. Daily entries should be made in the Inspector's Daily Report (Form CSD-121) describing locations received from the Project Engineer, instructions given to the Contractor, unusual conditions, and other items of interest.

Applicable work sheets, forms, and reports should be maintained and submitted as for hot/warm mix asphalts.

4.5 Tack Coats and Prime Coats.

4.5.1 Tack Coats. A tack coat consists of bituminous material applied at a specified rate per square yard upon an existing pavement surface to increase bond between existing surface and new surface. If tack coat coverage is too heavy, the tack coat may bleed through the subsequent layer or act as a lubricant between the two surfaces and cause the top surface to slip under the rollers. If the tack coat is not adequate, the surface course will not bond properly and may slip under the roller, causing waving, checking or cracking.

Just before applying tack coat, the surface to be coated must be swept to remove all dirt, or other objectionable material which might prevent proper bonding of resurfacing material to existing surface. The roadway surface must be dry and the ambient temperature must not be below that specified for the course to be placed. A light application of asphalt for tack coat is usually placed by a rapidly moving distributor. When shown as a separate pay item, material in the distributor must be measured by use of the calibrated dip stick both before and after each application. The distributor should be in level position when checked. Also, the temperature of asphalt should be recorded at the beginning of each shot. By determining the area over which material has been placed and correcting the volume of asphalt to 60°F, the application rate per square yard is computed and number of gallons used can be determined for payment.

In the event the tack coat is applied by a fast moving distributor, there may be a fine spray of bitumen that could speck or spot cars if opposing traffic is permitted to continue during application. For this reason, all traffic should, if at all practicable, be halted by flaggers during the few minutes that application is being made on one-half the roadway.

Responsibility for the length of tack coat applied in advance of resurfacing placement rests with the Contractor. However, it should be brought to the Contractor's attention, that a "Live" tack will be required at the time of placing resurfacing mixture. When traffic or other conditions are such that the length or time of application have reduced the effectiveness of tack, it is the Contractor's obligation to rejuvenate the tack at no additional cost to the State.

4.5.2 Prime Coats. A prime coat consists of a low viscosity bituminous material applied at a specified rate per square yard directly upon the surface of a base course which is to receive some type of bituminous wearing surface. Its purpose is to penetrate the existing surface, to coat and bond any loose mineral particles to the surface, to provide a dust free surface for subsequent bituminous applications, and to promote adhesion between the base and a subsequent bituminous treatment.

Before a base is primed, it is to be checked for smoothness and compliance with typical cross-section. Immediately before a prime coat is applied, the surface of the base should be cleaned of foreign material and free from excess loose fines. Penetration will be more rapid and complete if the surface is slightly moist. Free water should not be on the surface nor should the base contain a considerable amount of moisture.

The optimum quantity of prime is a variable. It depends on such factors as the type of base material, amount of fines, texture of surface, and moisture content of the base. Although an application rate used for estimating purposes will usually be shown in the contract, it is the responsibility of the Engineer in the field to determine an optimum rate, depending on the nature of the base, between 0.15 and 0.50 gallons per square yard. The rate is generally set by knowledge of the optimum quantity on other bases of similar nature and characteristics. If the contract requires that traffic be maintained, the prime coat is to be blotted with sand-clay or other friable material. The Contractor is responsible for maintaining the primed surface in satisfactory condition through the curing period and until covered by a subsequent layer or course. The curing time for the prime coat is very important if the prime material is a cut-back asphalt. The prime material contains a petroleum solvent and "cures" when the solvent evaporates and leaves only asphalt. If a "green" prime is covered, it is likely that it will "bleed" through the overlying course.

Certain limitations have been established by Standard Specifications to control priming operations. Prime material must not be applied:

1. When the air temperature is below 60°F.

2. During the period between October 15 and March 1, unless specific authority is given by the Chief Engineer under the provisions of Subsection 105.01 of the Standard Specifications.

3. When weather or soil conditions prevent proper placement and retention of the material.

4.6 Bituminous Surface Treatment.

1. **General**. Bituminous surface treatment consists of applying a bituminous material, at a specified rate per square yard, and immediately placing a single, uniform application of aggregate on the bituminous material. The aggregate is promptly embedded in the bituminous material by rolling. The surface treatments may consist of a single or double application of bituminous material and aggregate. They are usually applied to a prepared non-asphaltic base and are for the purpose of waterproofing the base and protecting it from the abrasive action of traffic. In a single surface treatment, the treatment consists of only one application of a seal aggregate spread uniformly over the bituminous material. In a double surface treatment, the first treatment of "mat" consists of coarse cover aggregate spread uniformly on the bituminous material. The second treatment consists of applying bituminous material to the "mat" and then spreading seal cover aggregate.

2. **Materials**. All materials must be inspected and tested for compliance with the requirements of the applicable Specifications prior to their use.

   Aggregate will usually be tested and approved at the source. Surface treatment inspectors should assure themselves that the necessary tests have been performed. If the material has been shipped without being tested, the inspector should notify the District Materials Engineer so that the material can be sampled, tested and the necessary test reports issued.

   The inspector should inspect each load of coarse aggregate visually for cleanliness and segregation even though the material is being delivered from tested stock. Extremely dirty or dusty stone should not be used until the results of a retest by the Testing Division are known. Dust prevents proper adherence between the asphalt and the aggregate.

3. **Weather Limitations**. An important factor which must be considered when constructing penetration type surface is the weather. Construction operations should not proceed when the existing surface is wet, when it is foggy, raining or threatening rain, or when the air temperature is below 75°F for asphalt cements and 60°F for emulsified or cut-back asphalts. Between November 1 and March 1 special authorization is required to place bituminous materials for surface treatment. Refer Subsection 410.03.2 of the Standard Specifications for more details.

4. **Equipment**. The equipment required for surface treatments is listed in Subsection 410.03.3 of the Standard Specifications. The inspector should ascertain that all required equipment is on the project and in proper working order before seal or surface treatment operations begin.

5. **Construction Methods**. The construction operations are very important in surface treatment work. Even the most precise planning and design will be of no value if the construction operations are not properly carried out, such as:

a. Clean the Surface. The existing surface should be thoroughly cleaned with a rotary power broom to remove dirt and dust.

b. Traffic Control. Traffic control is essential to the construction of this type surface. Traffic must be controlled in such a manner that interruption and damage to the work will be avoided, that construction personnel will be protected and that the traffic itself will be protected from hazards created by construction operations.

c. Application of Bituminous Material. Just prior to the application of the bituminous material, the quantity of material in the distributor tank should be determined using charts and devices provided by the Contractor. For this determination the distributor should be parked with the tank in a level position. After application to the bituminous material has been made, the quantity of material remaining in the distributor should be determined.

The pay quantity of bituminous material is to be based on the volume in gallons at 60°F. Therefore, the actual temperature of the material in the tank must be determined. The latest version of the Material Division Inspection, Testing, and Certification Manual contains volume correction factors for bituminous material at various temperatures. The factor obtained from the applicable table multiplied by the gallons measured will yield the actual gallons used at 60°F.

Due to the fact that bituminous materials cool rapidly, the distribution of the material should be coordinated with the spreading of the cover aggregate. The time lapse between the distribution of the bituminous material and the application of the cover aggregate should be kept to an absolute minimum in order to obtain greater coating action and hence better bond with aggregate.

The transverse joints on surface treatments should be carefully made so that they will not be rough and unsightly. This can be done successfully by starting and stopping each application of bituminous material and cover aggregate on a sheet of building paper.

The longitudinal joints for surface treatments which are not placed to the full width of the roadway in a single pass should also be carefully controlled. Since it is not practical to use building paper on these joints, it is considered better to have a slight buildup due to overlapping the adjacent passes than to have a gap in the surface.

The length of "shot" to be made depends both on the capacity of the distributor and the volume of the aggregate trucks available. Assume for example:

3 - 10 cu. yd. trucks
1200 gallon distributor
Seal aggregate to be applied at 0.27 cu. ft. per sq. yd.
Asphalt cement to be applied at 0.30 gal. per sq. yd.
Temperature of A.C. 350°F.
Width of Application - 24 feet or 2.67 sq. yd. per ft.

3 x 10 x 27 / 0.27 = 3,000 sq. yd. aggregate available
3,000 / 2.67 = 1,124 ft. shot with aggregate controlling

1,124 x 2.67 x 0.30 = 900 gal. A.C. at 60°F
900 / 0.904 = approximately 1,000 gal. at 350°F.
OK to make 1,124 ft. shot

d. Application of Cover Aggregate. The application of the cover aggregate should be scheduled so that the time lapse before the bituminous material is covered will be the absolute minimum. Care should be exercised in the spreading of the aggregate so that it is spread to a depth of approximately one particle thickness. Since excess aggregate will not adhere to the bituminous material the rate of application should be carefully evaluated. The desired uniform rate of application can be obtained by using an aggregate spreader. If the spreader has been properly adjusted and if it is operated at constant speed, seldom should there be a reason for spreading any cover aggregate by hand.

e. Rolling. The rolling operation should immediately follow the application of the aggregate material in order to embed the particles while the bituminous material is still soft and tacky. The operation should begin at the outside edge of the surface and progress toward the center. Rolling should be discontinued when the bituminous material has set or hardened.

f. Excess Cover Aggregate. When placing surface treatments in half widths, the loose aggregate should be removed from along the longitudinal joint before the adjacent lane is surfaced.

Usually there will be some loose aggregate particles on a new surface after the rolling operation has been completed. It is recommended that this loose aggregate should be broomed off in the cool part of the morning when the bituminous material is hard and the bonded aggregate particles will not be disturbed.

6. **Records**. It is essential that the necessary field data, calibrations, measurements and material spreads ordered by the Engineer and applied be recorded, dated, and verified by the signature of the employee (Inspector or Engineer) making the order, calibration, measurement, etc. This data is to be recorded either by the imprinter ticket system (or approved modified ticket system) or in bound field notebooks, as applicable. Such recordings and verification are required as the work progresses. Entries are to be made by area as rates of application are determined.

Form CSD-724 includes the quantities and application rates of aggregates used in bituminous surface treatments. It is self-explained by the wordings at the top of each column. Form CSD-724 is in the Forms Section of this manual.

Source information for cover aggregates is to be recorded by the ticket system and recorded as final data on Form CSD-724.

Bituminous materials are to be recorded in bound field notebooks as source documents, and tabulated on Form CSD-724 as final data.

The ticket numbers for each load of cover aggregate for a “shot” are to be recorded in the field notebook, along with the record of asphalt measurements, in order that the quantity can be identified with the “shot” when recording on Form CSD-724.

To implement the recording of source data for bituminous materials, and identification of cover aggregate, the Engineer should prepare, ahead of actual work, columnar headings, sketches, dimensions, calculated areas, etc., in a bound field notebook in order that all pertinent data may be properly recorded during application, for transfer to Form CSD-724.

Material transferred from other projects in SiteManager should be explained in the field notebook and the remarks section of the report form.

All pertinent data from the inspector’s field notebooks should be posted periodically, at the earliest practicable time, on Form CSD-724 such that the Project Office records will provide an up-to-date and accurate tabulation of the quantities satisfactorily placed to date. Each such entry on Form CSD-724 is to be initialed by the person making the entry. The original copies of the report (CSD-724) are to be certified by the Project Engineer and maintained in the project files as each sheet is completed, and are also to be submitted with the final plans after completion of the work.

Separate reports should be completed for each grade of bituminous material and each type of aggregate used. That is:

(a) Separate reports for prime material.

(b) Separate reports for asphalt cement and coarse cover aggregate.

(c) Separate reports for asphalt cement and seal aggregate.

Distribution: Original - to be submitted with final quantities data.
Copy - District Engineer
Copy - Project Office File

4.7 Reclaimed Asphalt Pavement (RAP). MDOT can retain 50% of the RAP or 10,000 tons, whichever is less, on a given project. Also, the Contractor’s portion of the milled material will be claimed first. This does not mean it is automatic tat RAP is to be retained on each contract. It is to be based on need. The quantity of RAP, up to the maximum of 50% or 10,000 tons, whichever is less, will be determined on a project by project basis. The District will advise Construction Division of the quantity of RAP desired to be retained in the scope of work or the plans.

CHAPTER 5
RIGID PAVEMENTS

5.1 Portland Cement Concrete Pavement.

5.1.1 General. This work shall consist of a pavement composed of portland cement concrete, with or without reinforcement as specified, constructed on a prepared subgrade or base course in accordance with these specifications and in reasonably close conformity with the lines, grades, thickness, and typical cross sections shown on the plans or established by the Engineer.

The types of pavement are plain or non-reinforced, conventional or reinforced (RCP) with welded wire fabric (mesh) with joints, or continuously reinforced (CRCP). The latter type is reinforced with deformed steel bars or extra heavy welded wire fabric.

The pavement will be constructed of air-entrained concrete of the dimensions indicated on plans and in the contract documents.

Concrete is a designed combination of sand, gravel, crushed rock, or other aggregates held together by a hardened paste of cement and water. When mixed thoroughly, these ingredients make a plastic mass, which can be cast or molded to a desired size or shape. Upon hydration of the cement by water, concrete becomes stone-like in strength and hardness.

With proper design, mixing and placing, concrete of almost any strength may be obtained and which may be used for almost any purpose. However, there is still some concrete which, through carelessness or ignorance in its manufacture and placement, fails to give the service that should be expected of it. It is the responsibility of those in charge of construction work to make sure that concrete is of uniformly good quality. The extra care and efforts required to achieve this objective are small in relation to the benefits. Good Engineering dictates acceptance of the best when the best is procurable at no extra cost. This axiom is especially true of concrete for the best costs usually no more than mediocre. All that is required to achieve the best is an understanding of the basic principles of making good concrete and close attention to proven practices during construction. Improved practices and techniques have added greatly to our ability to produce good concrete, and a modern formula for successful concrete production must include common sense, good judgment, and vigilance.

Concrete is sold and accepted on the basis of certain specified qualities, such as cement factor, consistency, strength, etc. It is of the utmost importance, therefore, that standard procedures, based on experience and found reliable, be used from securing the sample through all phases of determining and reporting test results. The importance of sampling should be apparent. If a sample is really representative, and if test specimens are made and handled properly, then test results may be considered to reflect the quality of the concrete. On the other hand, samples which are carelessly taken cannot yield reliable results no matter how well the tests are made. The exercise of informed judgment in selecting samples is indispensable. This holds true not only for concrete but for sampling and testing all the materials that will ultimately be used in making concrete.

Accepted methods for sampling, molding, curing, and testing concrete and its related materials are set out in the Material Division Inspection, Testing, and Certification Manual, as well as AASHTO and ASTM Standards.

Listed below are some terms pertaining to concrete and their definitions:

Cement Factor - A value to show the quantity of cement used per unit volume of concrete. Example - 1.00 C.F. denotes one barrel or four bags cement per cubic yard concrete; 1.50 C.F. denotes 1 1/2 barrels or six bags cement per cubic yard of concrete, etc.

Fineness Modulus (F.M.) - An empirical factor obtained by adding the total percentages of aggregate retained on the Nos. 100, 50, 30, 16, 8, 4, 3/8", 3/4", 1 1/2", and 3" sieves and dividing the sum by 100.

Specific Gravity - The ratio of the weight of a volume of some substance to the weight of an equal volume of substance, usually water, taken as a standard or unit. Example - concrete gravel having a specific gravity of 2.50 means that a cubic foot (solid volume) of this gravel is 2 1/2 times as heavy as a cubic foot of water.

Water Cement Ratio - The ratio of the total weight of water used, including free moisture in the aggregate, to the weight of cementitious material.

Slump Test - A test showing the vertical subsidence, or fall, of fresh concrete from a given height. (The procedure for making this test and its significance are explained elsewhere).

Concrete Cylinder - A specimen, normally six inches (6”) in diameter and 12 inches in height, made of concrete that is used in construction, and tested for compressive strength. For concrete mixtures with a maximum aggregate sizes equal to or less than one inch (1”), a specimen four-inch (4”) in diameter and eight inches (8”) in height is allowed.

Sand - A fine granular material resulting from the natural or mechanical disintegration of rock. Depending on its use, material may be classed as sand if it passes 3/8 inch, No. 4 or No. 10 sieve.

Gravel - The granular, pebbly material, usually retained on a No. 8 sieve, resulting from the natural disintegration of rock.

5.1.2 Construction Requirements. The procedures as established by this Construction Manual will deal primarily with central batching and slip-form continuously reinforced pavement. Refer to Material Division Inspection, Testing, and Certification Manual and Form TMD-123 pertaining to central batching operations and instructions for completing daily reports. Occasionally a Contractor may elect to use form type construction and mixers at the site. In these cases, consult the Department’s Training Manuals for Inspectors and Technicians. These manuals contain excellent information and have been distributed to every project office.

The subgrade or base at the form line must be at the proper grade and carefully checked to insure a smooth riding surface and the proper thickness of pavement. The results of the final pavement will depend largely on the smoothness of the grade on which it is placed.

Once the base material is approved for line, grade, and thickness, the formless pavement will be placed with either an electronically controlled paver which may or may not ride on the subgrade or a paver that rides directly on the subgrade and depends upon the trueness of the subgrade for its final grade. In the latter case it is imperative that the grade on which the paver tracks ride be at the precise grade specified.

The plant inspector and the paving inspector on the road should synchronize their watches at the beginning of the day so that there will be no mistake or misunderstanding in enforcing the delivery time requirements of the specifications. Before commencing the paving operations, there should be no doubt that the Contractor has enough trucks and the haul distance is short enough that the time interval between delivery loads will not exceed twenty minutes, or fifteen minutes if temperatures above 90°F are expected. Delivery trucks, should be checked for conformity with the Specifications and should be free of accumulations of set concrete. Set concrete must not be allowed to get into fresh concrete that is to be deposited on the grade.

Review the plans sufficiently in advance to determine the locations of key way or tie bars and super elevation so the Contractor is alerted to these requirements, and a suggested method of keeping everyone informed is to place stakes showing the beginning and ending stations.

The inspector's review of the plans, the applicable parts of the Standard Specifications and any Special Provisions concerning the different features of the surged, reinforcing steel and curing prior to starting, will eliminate many problems and the inspector will be alerted to the requirements necessary for a satisfactory finish.

It is important to continuously check the condition of the reinforcing steel ahead of the slipform paver and the line and edge slump while the pavement is being placed. If the Contractor is unable to maintain satisfactory line and grade during paving operations, the Project Engineer should be contacted immediately and the Contractor required to cease operations until suitable means are provided to maintain acceptable line and grade. Edge slump can be controlled by using uniform mix with low slump, proper adjustment of the edge plates on the slipform paving forms and finishers working the edge within the length of the trailing pavement forms instead of behind the forms.

The concrete should be deposited uniformly on the grade to prevent segregation during placing. Any foreign material is to be removed and the concrete finished to the proper cross section as fast as possible to prevent presetting of the concrete.

If occasional excessive edge slump over that permitted by the Specifications is evident, either wood planks or metal forms should be placed against the pavement immediately and the pavement brought to the proper grade. Metal forms usually work better than wood planks as they will lock together and will not cause variations in the pavement edge. Corrective measures should be taken immediately to prevent a recurrence of excessive edge slump.

Be sure that split header boards are being used on continuously reinforced pavement so that the reinforcing steel may be extended past the header board at the proper elevation. Notice that in the CRCP Standards additional reinforcing bars are required at each construction joint and that there is a minimum distance from the laps of the steel where a construction joint may be placed. The inspector should insist that the Contractor provide and use a portable vibrator for vibrating the concrete next to the construction joint when making the joint and also when starting the subsequent placement. The internal vibrators on the slipform paver will not cover this area. Failures on continuously reinforced pavement are usually the result of lack of proper consolidation or improper placement of the reinforcement at the construction joints.

Be sure there are provisions made prior to starting formless paving to take care of any sudden showers that may occur. It is very disheartening to see formless pavement that has been left uncovered and unprotected during a hard summer shower. The Contractor should have sufficient burlap or other covering material and side forms are on the job to cover such emergencies. This should discuss with the Contractor or paving superintendent in advance.

Curing of concrete pavement is intended primarily to protect the slab against rapid drying and loss of strength and should follow as soon as possible after finishing operation. Liquid membrane or polyethylene sheeting is normally used as curing agents. See the specifications for protective measures to take during cold weather curing. Liquid membrane curing compound can be applied closely behind the finishing, while polyethylene sheeting and other acceptable curing methods must be delayed until the concrete has hardened sufficiently to allow placement without marring the surface. Improper application of liquid membrane curing compound can also mar the surface. The nozzle on the spray machine must be adjusted to produce a fine spray and not an erratic stream or drops, and be operated at a distance from the concrete that will eliminate marking of the surface. Curing compounds require agitation, before and during use, and the compound should be thoroughly mixed before the machine begins application. The exposed sides of the slabs are to receive the same cure as the top and special attention should be given to insure that this is carried out. When polyethylene sheeting is used for curing, be sure that the surface has hardened sufficiently before applying the sheeting so that the surface texture will not be damaged.

It is important that straightedging be started as soon as possible to determine if the pavement surface is out of tolerance and adjustments in the procedures need be made. It is advisable that if polyethylene sheeting is the curing medium, the Contractor be notified far enough in advance of straightedging so that extra men will be available to roll and re-roll the sheeting.

Whatever method of curing is used, the Inspector should insure that it is properly maintained for the specified curing period.

Thin pavement is not desired. It is necessary that the subgrade be checked accurately by the use of a scratch template or stringline and level, if necessary, to insure that the thickness of pavement specified is being constructed. Specifications require a penalty for thin pavement, but with proper inspection, the penalty can be held to a minimum. On continuously reinforced pavement, the percentage of steel in concrete has been accurately determined and it is not desirable to have thin pavement or excessively thick pavement as the percentage of steel is correspondingly increased or decreased depending on the pavement thickness. Proper checking and correction of grade deficiencies in advance of paving will keep the slab thickness and steel percentage within acceptable tolerances of that shown on the plans.

As the pavement placing progresses with the equipment properly set and the mix adjusted to give satisfactory performance, the main duties will be to continually check the reinforcing steel ahead of the slipform paver, the grade and slope of the pavement behind the slipform paver and to see that the curing medium is applied as soon as practicable.

5.1.3 Equipment Requirements. It is the intent of the specifications that an adequate number of bins or compartments be provided to contain each specified aggregate and that a hopper or hoppers be provided to contain the properly weighed aggregate(s) prior to discharge into the mixer. It is also intended that each aggregate component be introduced into the composite by a separate weighing. This, of course, is accomplished in some plants by multiple weigh beams attached to the same weigh hopper or by springless dial indicators with suitable markers on the same dial which may be set to mark the position of the indicator for the pre-determined loads for the weighing hopper. In other plants, separate beams or dials are attached to individual weigh boxes for weighing and temporary storage of the weighed increment of each separate aggregate.

Either of the above two arrangements are considered to be satisfactory under the specification.

Of course, any approved equipment is only tentatively approved subject to continuous satisfactory actual performance.

Attention is directed to the second paragraph, and particularly, to the first sentence of the third paragraph of Subsection 108.05 of the Standard Specifications. The efficiency of the equipment is measured by actual performance, and in the event excess materials or deficient amounts of materials are weighed into the weigh box(es), satisfactory methods for removal of the excess or adding the deficient amount are to be provided, or the equipment changed or improved as indicated in Subsection 108.05 of the Standard Specifications.

5.2 Maintained Portland Cement Concrete Pavements. Unlike normal concrete pavement, the MDOT inspector has limited responsibilities when the contract requires maintained portland cement concrete pavement. The inspector will report the Contractor's daily activities for the daily diary, monitor the Contractor's traffic control plan, closely monitor the operations of the profilograph and perform other duties as directed by the Engineer.

The Contractor's responsibilities are defined in the special provisions for Maintained Portland Cement Concrete Pavement in the contract proposal.

5.3 Bridge End Pavement. This item is a more heavily reinforced slab constructed at the ends of bridges when shown on the plans. All requirements of Section 501 of the Standard Specifications for cement concrete pavement apply to bridge end pavement, except where otherwise set out in Subsection 502.03.2 of the Standard Specifications, special provisions, or on the plans.

Screeding and finishing are normally by hand methods and the inspector should ascertain that the screed is in good condition and in the correct alignment. In the event the concrete pavement is not in place adjacent to site of the bridge end slab, the bridge end pavement is to be screened from a correctly set temporary header. This header must be constructed of heavy material of sufficient strength and so anchored as to withstand the screeding action. The grade stakes for setting the header should be very carefully and accurately set, and should be checked immediately before their use in setting the header.

Screeding is to be longitudinal, with the header, or pavement in place, and the finished bridge end as gauges.

5.4 Pressure Grouting Concrete Pavements. Widening and overlaying existing concrete pavements with bituminous surfacing are expensive operations.

Overlaying on existing concrete pavement will within itself provide some protection to the underlying concrete pavement, and the base upon which it is placed, from the infiltration of surface water. However, individual slabs which are "pumping" before overlay will probably continue to pump under heavy loads after overlaying, unless they have been stabilized at least to the extent that the voids underneath the slabs are substantially filled. Of course, when the slabs continue to pump the purpose of the overlay is soon defeated.

Although it is desirable that water-obstructing shoulder material be removed and replaced with pervious materials, experience has shown that a reasonably satisfactory overlay of concrete pavement can be achieved in most cases, provided pumping is stopped and voids are filled with materials resistant to erosion or other detrimental action by water.

Experience has shown that such stabilization can be attained by the proper use of pressure grouting with a cement-soil mixture.

Varied experiences have evolved from variations in application of pressure grouting and allied work. Results obtained on successful pressure grouting jobs appear to follow a pattern of effort on the part of field personnel and the Contractor to be liberal with the application of minimum standard basic principles for pressure grouting work.

It is known that considerable effort, time, and money has been expended in the past, with some ungratifying results to "mudjack" distorted and pumping concrete pavements into a desirable traffic facility. Most of these attempts were made to correct a problem entirely different from that now involved in the construction of widening and overlay projects. Most "mudjacking" was done under traffic with traffic continuing to use the jacked sections immediately behind the pumping operations. More depth of grout was usually employed under the slab because of "raising" the deformed slabs to some desirable grade, insufficient time was allowed, in most cases, for the grout to set and the resulting "mudjacked" slabs were not provided the additional stabilizing and waterproofing effect of a dense graded hot mix pavement overlay.

The major difference between "mudjacking" and pressure grouting, however, is that in pressure grouting no attempt is made to "raise" a slab, but merely to stabilize the slab in its present vertical position. Pressure grouting acts as a foundation for a new pavement. To raise a slab involves an entirely different set of complications and techniques not involved in pressure grouting. The leveling of grout stabilized slabs is, of course, accomplished with hot mix asphalt pavement.

Sufficient experience has been obtained and observed for the Department to adopt the policies and procedures, as set out herein, for minimum basic requirements for stabilizing existing concrete pavements.

Pretesting. All existing concrete pavements, with or without a previous overlay, which are moving, are to be tested under favorable testing conditions to determine and identify slabs which are moving, or to document from such testing that no slabs are moving under prescribed conditions and loads.

Prior to Plan Preparation. There are at least two successful ways to make these preliminary tests.

1. During or after a rainy and preferably cool period, knowledgeable personnel should walk the project slowly and in its entirety, and locate slabs and joints that are obviously moving under heavy loading conditions. These are usually easily located by observing mud or water that is being or has been pumped from beneath the slabs and from observed movement of the slabs under heavy loads.

   Each slab or major section of slab so detected should be marked and its location recorded in a log. During this walking survey of slabs, also locate and determine the area of any slabs that are too badly broken to be stabilized. This information should also be logged in a field book. Keep in mind that a slab, which is not broken into small pieces, can be stabilized and will provide a more desirable base after stabilization than an intermittent short section of deep flexible base, and at much less cost.

2. In the event the erratic scheduling of projects to be overlaid prevents the determination of moving slabs as indicated in the preceding Paragraph No. 1, predetermination can be made in a very short time by the use of properly loaded equipment, traveling at or near walking speeds, with proper observations and recordings made. The District Maintenance Engineer may be able to furnish a loaded single axle truck and driver to assist the Project personnel, a considerable savings can be accomplished by eliminating the pre-rolling item from the contract. This type to investigation should be made preferably following a rain(s), and in any case, in the early morning hours before the air temperature has reached 80º F., or late in the afternoon after the air temperature has gone below about 65º F. It has been observed that under higher temperature conditions, the expansion of the slabs have resulted in some mechanical locking at the longitudinal and transverse joints and cracks, and that a false assumption will result under such conditions.

The equipment to be used in this predetermination shall be, as a minimum, a truck having a single rear axle, with the rear axle loaded to the maximum, legal load for a tandem axle for the road being tested.

The above indicated load is to be considered minimum. Heavier loads will make it easier to determine moving slabs, and should be permitted, or required, if less than favorable conditions exist for testing slab movement. However, extreme care and good judgment must be exercised in the selection of the proper load to be applied in order to assure effective determination of unstable slabs, but without inflicting damage to stable portions of the pavement structure. Under conditions of high water table or after prolonged periods of wet weather which would indicate saturated conditions of subgrade soils, or other similar conditions, any increase in the load over the minimum indicated above should be dependent upon the severity of such conditions. In no case should the single axle be loaded in excess of 25 tons.

Under either of the two procedures indicated above, slabs should be identified in the field as they are checked, in such a manner that they may later be located from a log made. It is impossible to know exactly where holes should be drilled in order to stabilize a slab, but the hole location pattern developed as a typical minimum requirement for Pressure Grouting has been proven by research to produce good results; therefore, this method for marking these slabs with sufficient permanency is coding each one with spray paint, or different colors of spray paint, so as to record in the log the location and condition of the slabs. For example, the slab and the log should identify where pumping is occurring, that is, at the edge, at the lead end of the slab with respect the direction of traffic, or at both ends of the slab, or combinations thereof. Also include in the identification and the log, any slabs which obviously are broken into pieces to the extent that the slab cannot be stabilized; such information is necessary in order to provide a reasonably accurate quantity of removal and replacement. In this connection, it has been stated that the capabilities of Pressure Grouting has reached a point such that almost any slab broken into too many small pieces would become excessive, and results might be somewhat doubtful. Also, in this connection, it has been observed that the removal of slabs and the replacement of these individual slabs with flexible materials have not consistently resulted in satisfactory riding qualities, presumably because of the intermittent stability and consolidation differential between rigid materials and flexible materials and their effect on underlying flexible materials.

A complete log of the moving and seriously broken slabs is to be made as the testing progresses, with each condition coded or otherwise identified, such that the completed log fully represents the results of the testing. A copy of the log is to be furnished to the Roadway Design Division prior to plan preparation.

Pressure Grouting is Specialized Work. It is essential that bidders be provided with a reasonably accurate estimate of quantities involved in order that the bidder may know, when bidding, how to distribute costs for this specialized work. Otherwise, the bidder must inflate prices in order to take the gamble.

The Roadway Design Division will use the log of pumping and broken slabs to determine estimated quantities of slab removal, if any, and will apply the standard minimum basic hole spacing requirements in determining the number of holes and estimating quantities for other allied pay items. The Area Engineer of the Construction Division and the representative of the Roadway Design Division will use the log for field and plan review purposes.

Pre-Rolling Under the Contract. Occasionally, the contract will contain an item for pre-rolling. In most cases the item of pre-rolling will not be included in the contract when an adequate test rolling procedure has been accomplished prior to pressure grouting. Where the item of pre-rolling is included in the contract or where the contract requires that the Contractor pre-roll as a part of another item, or where the Contractor elects to and is permitted to pre-roll for personal information, proceed as follows:

Using the Contractor’s equipment, as specified in the contract or as indicated hereinabove, locate any moving slabs that might have been missed during the original testing. The equipment used should be loaded in accordance with the governing specifications and operated at walking speeds. Competent inspectors paying close attention to the operation should detect, mark, and make a log, similar to that indicated above, of any moving slabs or other changed conditions that had not been previously determined. Determinations during this pre-rolling should be made similar to those indicated herein for earlier determinations and should supplement such earlier determinations.

Once a slab is detected as moving, it should never be considered at some subsequent date as not moving, and should be pressure grouted. As indicated earlier, it is desirable that testing of the road for moving slabs should be made during the most adverse wet and cool periods. During such period, a slab may be detected as moving, but under drier and warmer conditions, the slab may not be moving. There is no reasonable way in which the conditions causing the movement during cool, wet weather could permanently correct themselves and, therefore, the slab would pump again under similar or worse conditions.

All pre-rolling should be performed on the entire project before Pressure Grouting operations are begun.

In the event pre-rolling, performed under the contract, indicates any change in quantities of Pressure Grouting or slab removal of more than 25% from that shown in the contract, the Assistant District Engineer - Construction is to be notified immediately and approval obtained prior to proceeding with the Pressure Grouting or slab removal, as the case may be.

Pressure Grouting. Before commencement of grouting operations, the inspector should thoroughly check the Contractor's equipment for compliance with the specifications and as to its apparent working order. All materials used in the grout mixture should be checked by the inspector to verify that they are in compliance with the specifications. The Contractor should be informed as to the exact proportions of materials to be used in the grout mixture. Before mixing operations start, the sand box or hopper mounted above the conveyor belt will need to be calibrated in order to measure the exact sand-cement ratio in the mixture. This can easily be done by using the one (1) cubic foot box provided by the Contractor for this purpose.

An inspector should be stationed in such a location that the Inspector can see the exact proportions of materials being mixed as specified in the contract or as directed by the Engineer. After adequate holes have been drilled to insure an uninterrupted pumping operation and the Contractor is ready otherwise, an initial batch should be mixed and the consistency of the grout checked as outlined below.

Remember that the calcium chloride is to be in solution with the mixing water before incorporation with the cement and sand.

The specifications require that the Contractor furnish a grout flowcone and stopwatch for the Engineer's use in determining consistency of the mix. It is the Contractor's responsibility to maintain the consistency of the grout mixture in accordance with the specified time of efflux (in seconds) for a particular material. A flowcone check should be made by the inspector after the Contractor has satisfactorily mixed the initial batch and as many times as is necessary during batching and pumping operations. It is very important that the consistency of the mixture be controlled as indicated by flowcone measurements. Research and tests reveal that variable amounts of water in the mixture have more effect on the shrinkage, time of initial and final set, strength, etc. than any other factor. The grout mixture can be too stiff and cause "stooling", but the probability of "stooling" has been overemphasized in the past.

During the grouting of a hole, the pumping of grout should continue until the grout extrudes from a joint, crack, adjacent hole, side of the slab, shoulder or slope, or until the slab starts to rise. In watching for the extrusion of grout, be sure that any water that was beneath the slab has been pushed out ahead of the grout mixture. In other words, continue pumping until any liquid or semi-liquid that has been expelled from beneath the slab has approximately the same consistency as the grout mixture. Holes should be plugged immediately after the removal of the discharge hose so that back pressure will not force the grout through the hole. Grout wasted by the Contractor caused by leaking equipment, plugged lines and hoses, careless operation, grout left in mixing tank, etc. will not be included for payment.

After grouting all holes in a slab, traffic should continue to be detoured around the slab and the Contractor's equipment kept off the slab for the minimum period indicated in the contract, or in the event no minimum period is indicated in the contract, for as long as is considered to be reasonable, but in no case less than three (3) hours to allow the grout mixture to set and harden sufficiently to prevent displacement.

After the time period indicated in the contract, proof-rolling and re-grouting should be carried out as necessary and in accordance with the terms of the contract. Research and tests have shown that less re-grouting will be required if the proper consistency is maintained in the grout mix.

For record purposes, slabs should be drawn at a convenient scale in a bound field book and location of holes shown accordingly. Number of holes, dates, and inspector's initials shown on each page. For information purposes, a different symbol for holes for each grouting should be used, such as:

X - First grouting

O - Second grouting

$ - Third Grouting

¢ - Fourth Grouting

T - Fifth grouting

NOTES

1. Every reasonable safety precaution should be taken during test rolling and pressure grouting. Elements of equipment operating under pressure should be in such condition and so used as to eliminate the probability of blow-outs. Tires, wheels, rims, etc. on loaded rolling as to withstand the imposed loads without the danger of failure.

2. Plugs driven into the top of a grouted hole to prevent the escape of grout should remain in place as long as necessary to prevent such escape. However, any portion of a plug protruding above the surface of the pavement must be removed or the plugs removed before traffic is allowed on the grouted slab.

CHAPTER 6
INCIDENTAL CONSTRUCTION

Incidental Construction, Division 600 in the Standard Specifications, includes a wide variety of items that are used on Department construction projects. Many of these items are broad in scope and are commonly used on most types of projects. Many other items are specialized and are used on specific types of projects. Requirements for incidental construction items are well described in the Standard Specifications. This chapter supplements the Standard Specifications by providing discussion of some of the broader construction practices.

6.1 Structural Concrete. Structural concrete will typically be governed by Section 804 of the Standard Specifications. Occasionally, projects will have structural concrete items such as inlets, junction boxes, curb and gutter, etc. and no major structures such as box culverts or box bridges. On these projects, if the total cubic yards of structural concrete are less than 200, a Special Provision (Section 907) will be included in the contract that will delete and replace Section 804, the provisions for Concrete Quality Control / Quality Assurance of the Standard Specifications. The procedures indicated in this section of the manual are intended to be used on those projects.

6.1.1 Batching, Mixing, Transporting, Placing and Finishing Concrete. Upon advice from the Contractor as to the source of aggregates, the Resident Engineer should furnish this information to the Central Laboratory and request a mix design for the class(es) of concrete specified in the contract. Also, a sample of the mixing water should be tested and approved before production starts. See the Material Division Inspection, Testing, and Certification Manual for more information.

A. <u>Batching</u>. In order to assure that the approved design mixture is consistently batched, the plant inspector should assemble and check information on batch weights of the required ingredients, and should observe the scales as the ingredients are weighted into the batch.

   Scales for ready mix plants are required to be checked and certified in accordance with Section 804 of the Standard Specifications. Certification and checks shall be performed by a scale calibration company and monitored by a District representative. The calibration procedure will be documented on Form TMD-324, or a copy of the company's calibration report will be obtained.

   Rechecking and recertifying of scales should be required when balancing or sensitivity checks indicate the need, or at any time the Project Engineer is not satisfied as to the accuracy of the scales.

   A few of the larger ready mix plants may move the cement from the bin to the scale by blowing the cement. Certain blower systems, if not properly designed, will result in erroneous scale readings. If a plant is conveying cement by this method, the accuracy of the method must be checked. This is done by requiring a batch quantity of cement to be blown into the scales but no other materials added. If there is no change in scale reading after a 10 minute waiting period, the blower operation for introduction of the cement for that plant may be accepted as satisfactory. This check should be made periodically of the plant operation if the work extends over a considerable period of time. If the check reveals an inaccuracy in the blower method, the Project Engineer should notify the plant manager and the Contractor promptly. After adjustments are made, a recheck must be made to confirm the accuracy of the operation.

B. Mixing.

1. Mixing at Site. Before concreting operations are begun, check the mixer drum for leaks, excessively worn blades, presence of hardened concrete, and the condition of the discharge chute. Insist that all defects be corrected satisfactorily before permitting use of equipment. Check the speed of the drum to determine that it is within the limits of the manufacturer. The mixer should be provided with a name plate by the manufacturer stating the capacity of the mixer. No charge should exceed this stated capacity.

The condition of the skip should permit complete discharging without loss, and it should be kept raised long enough to discharge all material into the drum.

If the mixer is to be idle for more than (1) hour, it should be thoroughly cleaned.

2. Truck Mixing. If a commercial plant is being used, check that it has been inspected and approved by the District Laboratory within the past six months.

A representative of the District will inspect all transit mix trucks and any unsatisfactory conditions will be corrected before permitting their use. The following items will be checked:

a. The truck should have a legible plate supplied by the manufacturer showing the capacity of the mixer drum.

b. The calibration of the water-discharge mechanism should be plainly marked.

c. Check all water valves for leaks.

d. Check the mixer drum for leaks, excessively worn blades, and clogging with hardened concrete.

e. Check the water tank for leaks

f. Check that the revolution counters are working properly. The specifications require that each batch be mixed for at least seventy (70) and not more than one-hundred (100) revolutions at mixing speed.

g. Complete Form TMD-765 (Ticket for Truck Mixed Concrete) for each batch. The batching inspector is to complete and sign the top part of the ticket and to record the reading of the revolution counter at the beginning, and end of the mixing cycle if the cycle is completed before leaving the plant. Also show if additional water and how much is to be added at the delivery site. If the batch is mixed in transit, the reading at the end of the mix cycle is to be entered by the placement inspector who is to also complete and sign the bottom portion of the ticket.

C. Forms. Before placing any concrete, the forms must be completely checked for conformance with the plans and specifications, and all irregularities corrected. They should be checked for ease of removal without injury to the concrete.

Any element of the forms, such as chamfer strips or other light decorative forming, likely to warp or distort from moisture absorbed from the concrete should be waterproofed with shellac, or equivalent, or thoroughly soaked with water immediately prior to placing of concrete.

All sawdust, dirt, and other foreign material, including ponded water, must be removed from within the forms before placing any concrete in the forms. If the forms are too deep to permit easy removal at the top, an opening should be left at the bottom through which this material can be removed. This opening must be closed and made mortar tight after the forms have been cleaned.

If forms are to be oiled, they should be oiled before placing of reinforcing steel to avoid splattering of oil on steel.

D. Handling and Placing Concrete. First check that the mixture is within the specified slump range.

During the placing of the concrete, watch the consistency of the concrete and the methods of spreading and working. See that segregation is avoided, that the finished product is well consolidated, and that the monolithic mass is free from surface cavities resulting from the trapping of air and water along the forms. Careful spading of the concrete along vertical forms will usually release the air and water bubbles. "Sand streaking" must also be avoided. This is usually the result of leaky forms permitting the escape of cement paste. Forms should be watched closely and any leak discovered must be caulked immediately.

Concrete should not be dumped indiscriminately through the reinforcement, nor should it be deposited continuously at one point and forced to flow for considerable distances. Start at one point and work from that point by dumping the succeeding batches in such a way that the concrete will flow along and under the reinforcement and will be vibrated into the preceding batch.

Concrete must be vibrated and spaded immediately upon dumping. The vibrator should be applied to the concrete systematically at short intervals so that the vibrated areas of concrete overlap. The vibrator should be inserted to the full depth of the concrete being placed and into any previously placed concrete which has not taken its initial set.

E. Removal of Forms. The specifications state the minimum time the forms must remain in place for different types of structures if test cylinders are not used as a guide.

Keep an accurate day by day record of weather conditions including high and low temperatures as a guide in determining when the falsework maybe safely struck if test cylinders are not used as a control. When test cylinders are used to determine the time to remove the forms, they should be made and cured in the same manner as job control cylinders.

Any honeycomb or damaged areas noted upon removal of the forms should be repaired by removing all improperly bonded aggregate and filling the cavity with grout made from the same cement used in the mix.

F. Curing of Concrete. The proper curing of concrete requires the proper control of three major factors: Humidity, temperature, and protection against disturbance. The concrete should be kept under conditions of humidity and temperature that will produce a uniform hydration of the cement at the fastest economical and practical rate. The specifications require that, unless high-early strength cement is used, all concrete shall be kept continuously moist for a minimum period of seven days. Frequent inspections of curing concrete should be made to see that it is kept moist.

Temperature control is rarely used until the ambient temperature is below, or is expected to drop below, 40ºF.

For temperature below 40ºF, protection and/or artificial heat must be provided. If salamanders or other producers of dry heat are used, the surface of the concrete must be kept continuously moist. If steam is used, it must be supersaturated. It is very important that the rate of temperature change and the maximum temperature be kept within the specification limits.

While the concrete is curing, it must be subject to no disturbances or loads. Concrete that is disturbed or loaded while partially hydrated may be irreparably damaged.

G. Finishing Concrete Surfaces. The various classes of surface finishes are described in detail in the specifications. The following items in the specifications will need special attention:

1. Surfaces to be patched must be kept saturated with water for at least three (3) hours immediately before patching.

2. For concrete surfaces requiring a rubbed finish, rubbing is to begin as soon as the forms can be safely removed without danger of injuring the concrete. The surfaces should be thoroughly saturated with water for at least three hours immediately before rubbing begins, and kept saturated during rubbing operations.

6.1.2 Check List. A suggested check list for inspectors of concrete box culverts and minor structures is as follows:

A. Storage of Materials. Steel and cement must be properly stored and protected from the weather.

B. Location of Structure.

1. Check on location as to stationing, barrel length compared to roadway cross section, skew and flow lines.

2. Check survey stakes for proper information.

3. Check invert elevations in relation to stream bed.

C. Excavation and Foundation Exploration.

1. Record the data necessary to compute excavation quantities.

2. Foundation material should be uniform for the entire length of the structure. Where unsuitable materials are encountered special treatment may be needed. In these instances, notify the Project Engineer.

3. Provide for bypass of drainage.

D. Forming.

1. Form dimensions must be checked.

2. Forms must be well built, with tight joints and smooth surfaces.

3. Forms must be oiled or wetted before use.

E. Mixing and Placing Concrete.

1. Concrete must be accurately batched and delivered in accordance with the applicable Specifications

2. Required finishing tools must be on hand.

3. Reinforcing steel must be tied and secured in proper position before concrete placement.

4. Be sure all spacers are removed as placement progresses.

5. Finish concrete to neatlines.

6. Provide the proper curing environment for the fresh concrete.

7. Make the necessary additional test cylinders if the Contractor plans to remove forms or backfill the culvert before the prescribed time has elapsed.

8. If curing compound is used, be sure it is thoroughly mixed and properly applied.

9. Make job control test cylinders according to Materials Division schedule.

F. Removal of Forms

1. Require tie-bar holes and honeycomb to be patched as soon as possible after form removal.

2. Enforce Specifications in regard to time or compressive strengths for form removal.

G. Reports

1. Keep in a bound field notebook an accurate record of dates and concrete placed.

2. Keep record of key dimension checks made.

3. Use SiteManager to complete Form TMD-124. See the Concrete Field Manual for more information.

6.2 Bedding For Pipe. Strict enforcement of all specification requirements of the installation of drainage conduits is to be maintained to provide dependable and serviceable drainage structures. Each stated requirement is important. Failure to comply with one, or more, of these requirements may cause failure in the structure, or decrease the efficiency of the installation.

Particular attention is to be given to providing a stable foundation for the structure, and it shall be the responsibility of the Project Engineer to insure that the Contractor provides bedding for pipe in accordance with the requirements and provisions of Subsections 603.03 of the Standard Specifications, and Standard Drawing for the type bedding specified.

6.3 Maintenance of Traffic. Prior to the start of any construction, all signs, barricades, etc. shown on the DETAILS OF CONSTRUCTION SIGNING in the plans should be in place. It should be remembered that the DETAIL OF CONSTRUCTION SIGNING shows only the <u>minimum</u> requirements and in no way relieves the Contractors of their responsibility for all signing and their duty to see that signs or devices are erected and maintained as are deemed necessary to safeguard the traveling public.

Before starting an operation that will change the flow of traffic or require different traffic control, the superintendent should discuss the proposed maintenance and construction signing with the Project Engineer. The specifications and the <u>Manual on Uniform Traffic Control Devices for Streets and Highways</u> cover the requirements and should be frequently consulted.

It is the Project Engineer's responsibility to insure that the Contractor maintains and properly protects all construction signs necessary to properly warn and safeguard the traveling public. The signs on the project should be frequently checked and the Contractor required to re-adjust or replace any signs which have been knocked down or damaged.

The safety and convenience of residents along the project must be provided for by the Contractor. He should make proper and timely notification to local residents before making interruptions of their access. This works to everyone's advantage as residents are most cooperative when they are notified and understand what is to happen. Often the Contractor learns of some important considerations such as sickness, funerals or some scheduled delivery so that the interruption to access can be timed for the least interference.

When Maintenance of Traffic requires the construction of detours, run-arounds, etc., the plans and special provisions should be checked very closely to determine which, if any, items are to be paid for as direct bid items and which are to be included in this lump sum price bid for Maintenance of Traffic.

The percentage of the contract lump sum price bid for Maintenance of Traffic to be allowed on the monthly estimate will be determined by the percentage of the combined total monetary value of all other bid items allowed on the same monthly estimate.

6.4 Traffic Control Plan Report - Form CSD-761. As referenced in SOP No. ADM-31-01-00-000, this form is to be completed by the Responsible Person assigned to monitor and administer the Traffic Control Plan for a project. The report is to be made on a frequency of at least once a week. If discrepancies are noted, the contractor's superintendent is to be immediately notified, and the report is to continue on a daily frequency until all discrepancies are corrected. Form CSD-761 is in the Forms Section of this manual.

6.5 Salvaged Guard Rail. The District will address the quantity of guard rail, guard rail posts, etc. desired to be retained in the scope of work submitted to Construction Division or in the plans. These materials must meet the hauling requirement of up to 30 miles from the project or the distance to the Contractor's yard / stockpile, whichever is greater.

CHAPTER 7
MATERIALS AND TESTING

7.1 General. Materials inspecting, sampling, and testing is an important part of the inspector's daily responsibilities. Materials that are incorporated into the work will be inspected, sampled, and tested in accordance with the Standard Specifications, Plans, the Materials Division Inspection, Testing, and Certification Manual, the Field Manual For Hot Mix Asphalt (HMA), and the Inspector's Handbook. Persons involved with materials and testing should review the above documents as to the importance of compliance with sampling and testing frequencies and receipt of material certification reports, including coverage prior to payment.

The inspector should be familiar with specifications, manuals, and handbooks referenced above.

7.2 Random Sampling. As stipulated in Subsection 700.04 of the Standard Specifications, samples in each lot to be evaluated for acceptance under the statistically based acceptance plan are to be taken by a pre-determined random sampling pattern.

The random sampling table shown below, and also shown in the Tables and Charts Section of this manual, consists of two hundred an eighty (280) pairs of random numbers which can to be used in determining location of samples. Each number is to be considered as a decimal fraction of 1,000. For any lot consisting of an area of work, the random numbers are to be taken from the table in pairs. Many electronic calculators have a random number generator which also can be used to generate random numbers.

The two numbers of each pair are to be used to determine coordinates of the sample within the area, measured from a reference point located at one corner of the area. The first, or left, number is to be used as the fraction of the length and the second number is to be used as the fraction of the width.

For example, a section of a course twenty-eight (28) feet wide and nine hundred, seventy-five (975) feet long, extending from Station 450+00 to Station 459+75 is to be tested by the random sampling method. A pair of random decimal numbers is selected without bias from any block, such as the second pair in the block at the intersection of column 2 and brace 5. By multiplying by the decimal fractions as indicated above, the coordinates, in feet, of the sample location would be 176 for length, and 17 for width. Assuming the construction to be progressing from the beginning of project toward the end of project, the sampling location would then be Station 451+76, 17 feet from the left edge.

The sampling points should always be located from the left edge of construction regardless of the direction of construction with reference to station numbers. For the purpose of practicality, all computations involving relatively large areas should be rounded off to the nearest foot.

It is understood that the location of the test may be moved for good cause within the square yard; the center of which is the coordinate location, such as in the case of edges, boundary line, joints and surface texture affecting testing equipment seating, etc. In the event it is necessary to move the location of the test site outside of the square yard indicated above, the reason for such location should be documented.

The set of random numbers may also be used for lineal random sampling such as in distance, time, number of trucks, etc., where width or depth is not involved. In such case, merely use the first decimal fraction of the pair and disregard the second decimal fraction. Likewise, the set of random numbers may be used for random sampling in three (3) dimensions merely by using the first decimal fraction for the first dimension, the second decimal fraction for the second dimension and the first decimal fraction of the next pair for the third dimension.

RANDOM SAMPLING TABLE

	Random Numbers													
	1		2		3		4		5		6		7	
	815	722	048	964	248	826	665	147	767	147	133	870	796	957
	296	205	680	264	469	208	897	815	866	126	922	571	804	252
1	007	573	390	664	846	400	328	613	989	960	647	645	960	982
	053	042	256	264	444	440	379	639	457	661	754	665	346	904
	919	264	641	943	267	259	399	222	715	645	914	424	078	696
	005	047	879	773	422	351	740	995	818	426	438	766	620	766
	007	698	627	561	863	880	762	360	846	931	760	658	779	880
2	690	657	958	552	189	273	265	086	408	599	298	801	127	485
	259	579	298	886	679	487	189	822	654	697	336	542	859	035
	097	834	735	129	308	183	282	357	059	416	349	378	389	880
	915	425	279	301	040	863	298	997	555	848	290	092	796	732
	179	563	909	491	200	599	061	205	180	020	737	835	361	427
3	465	185	188	496	023	510	206	587	281	154	569	533	205	873
	921	896	948	781	846	828	099	254	441	484	255	212	355	204
	145	627	356	812	396	473	568	563	616	495	896	201	774	180
	984	075	333	642	016	924	669	984	048	455	465	041	468	457
	349	639	887	827	344	170	875	408	324	700	706	888	777	693
4	700	282	394	464	232	534	949	258	699	948	196	728	001	667
	539	549	069	672	683	829	113	428	802	882	473	466	065	978
	760	295	409	073	587	257	229	800	399	961	411	142	606	595
	907	522	839	299	658	388	504	837	556	143	317	573	562	415
	643	674	333	319	148	244	597	923	974	892	359	041	237	519
5	089	003	316	253	616	340	812	356	568	693	483	455	785	817
	950	683	935	707	105	045	764	543	023	172	288	147	627	922
	156	104	204	383	911	219	595	816	271	482	467	229	322	856
	164	818	041	533	794	214	830	923	366	312	596	917	727	023
	186	819	055	919	047	130	976	248	947	064	350	048	867	982
6	731	351	474	876	990	710	888	710	187	202	231	729	351	430
	574	167	231	493	450	331	125	410	807	453	448	125	989	912
	304	839	237	144	150	457	227	197	099	743	686	304	707	254
	166	350	859	982	323	523	168	692	827	384	738	325	419	444
	967	202	425	789	053	221	243	542	350	196	110	914	603	197
7	389	642	143	826	665	441	006	355	359	191	633	296	033	598
	316	763	174	533	441	644	647	753	765	316	126	330	603	923
	789	194	236	278	479	025	376	208	721	393	348	089	850	878
	039	333	570	742	634	173	628	399	056	912	688	255	388	469
	744	332	439	101	899	156	528	738	731	886	889	744	518	993
8	090	009	207	954	926	454	095	888	165	511	793	975	162	660
	422	124	870	142	209	045	645	313	860	294	476	059	524	168
	161	080	265	417	819	656	742	563	000	671	775	706	287	341

CHAPTER 8
BRIDGES AND STRUCTURES

8.1 Bridges and Structures - General. The construction of bridges and structures is more specialized than most other phases of highway construction. Construction operations and inspection are more complicated because of the work and because of the means by which the work must be accomplished. A bridge site is seldom a convenient place to build anything, let alone a structure requiring a fair degree of precision in its location. Many bridge construction operations depend heavily upon the skills of individual workmen for their successful accomplishment. When assigned a project that includes bridges or other structures, the Project Engineer and Inspector should at the first opportunity, make a thorough study of the Plans, Special Provisions, Supplemental Specifications, and the Sections of the Standard Specifications relating to the work under the contract. Review the Plans for possible errors in quantities and elevations. Check for conformance between dimensions given and elevations shown. Inspect the structure site and determine if conditions are as depicted on the Plans or whether some changes may have taken place since the original survey was made. This investigation may indicate that the structure should be shifted slightly from the exact stationing shown on the Plans to better fit existing conditions. There may be no latitude for a shift in position such as in the case of a grade separation structure, but there is sometimes considerable opportunity to shift drainage structures.

Location. The Engineer should see that the structures are located in such a position as to provide for the most efficient drainage. In some cases, it may be advisable to change the location of culverts if a careful survey of the drainage system indicates that this should be done. The life of a road depends to a large extent upon proper drainage, and care should be taken to see that the drainage system is properly designed and constructed in every detail.

If the culvert, as indicated in the Plans, appears to be improperly located, inadequate or excessive in size, or if it is definitely not adapted to the location specified, the proper change should be initiated by the Project Engineer through the District.

Staking. When bridge staking is performed by MDOT, the Project Engineer or Inspector should review the staking with the Contractor and make sure that the Contractor understands the meaning and significance of all stakes before work begins. The responsibility for the preservation of stakes is the Contractor's and the Contractor should be advised accordingly.

When the contract provides a pay item for staking by the Contractor, MDOT will furnish bench marks and baseline reference points as per Section 699 of the Standard Specifications. Even though the Engineer is required by the Specifications to furnish the Contractor with only centerline and benchmarks, the Bridge Inspector should cooperate with the Contractor in establishing lines and elevations necessary for the proper prosecution of the work, but it should be clearly understood that in so doing the bridge inspector is not relieving the Contractor of any responsibility for such lines and grades.

Inspection. The Project Engineer is to see that the construction work on each structure or portion of the structure is thoroughly inspected. The Inspector should check all the forms for line, elevation, plumbness, spacing, quality, bracing, strength, etc., before any concrete is ordered, mixed, or placed. Prior to their incorporation into the work, all materials should be inspected at their point of storage or manufacture. Usually test reports or certifications are received in the Project Engineer's Office before the materials arrive on the job site. In this instance, it is necessary to check the material markings, such as lot number or tag number, against the test report and also to visually inspect the material to insure against damage or deterioration between time of test and time of use.

Occasionally, materials arrive on the job site prior to testing. In this instance, samples should be taken and forwarded to the laboratory for testing. The procedures for this sampling are covered in other sections of this manual and the Specifications.

No material is to be incorporated in the work unless it has been tested and accepted by the laboratory and visually approved on the job by the Engineer. Although an Inspector may be given specific authorization to inspect certain work and enforce the requirements of the Plans and Specifications, the limitation of the Inspector's authority must be known. The problem usually arises as to when an Inspector can and cannot make the decisions that are required to be made. The case may occur where work is in progress and a questionable application of a specification requirement arises. If an immediate decision is required, the Inspector should render such a decision if the Inspector judges the intent of the specification requirement to clearly warrant a reasonable interpretation. The decision should then be confirmed by the Project Engineer at the earliest opportunity. The Inspector should, however, initially take such matters to the Project Engineer for interpretation if time permits.

The Inspectors should have a thorough understanding of accepted procedures for keeping field notebooks, diaries, records, and reports to assure proper documentation. The Inspectors will probably be required to make out all of these reports as they may be the only person to observe a particular phase of construction and thereby be the only ones qualified to give an accurate account of the information that is required for the records. Each Inspector is to keep a personal diary, Form CSD-121, listing unusual occurrence and all construction work accomplished by the Contractor in order that all significant items will be included in the project diary.

Safety. The Inspector should keep well informed as to the safety practices that are required during any construction work. The Inspector should always be alert to any possible personal danger, as well as danger to the Contractor's forces and the public. Following is a partial list of items that the Inspector should be familiar with to insure the safe completion of any construction project:

1. Be familiar with the Plans as to the location of underground facilities such as water lines, gas lines, communication lines, etc., so that construction can proceed without danger of damaging these facilities.

2. Be familiar with safety practices while working around the various kinds of construction equipment to include an observation of overhead clearances to prevent damage to power lines, telephone lines, etc.

3. Be familiar with the safety precautions involved in the various construction methods and practices, such as cofferdam construction, movement and storage of material, steel erection, concreting operations, demolition and dismantling of structures, etc.

4. Observe that adequate warning signs and barricades are used.

5. Be familiar with the proper requirements to insure the safety of the structure, such as not overloading concrete that has not reached its desired strength.

6. Remember to wear a hard hat, safety vest and other safety equipment, as required.

7. The inspector should be familiar with the Prime or Subcontractor's Safety Officer(s).

8.2 Foundation Excavation. Before the foundation excavation is begun, adequate elevations or cross-sections of the site must be obtained, from which the quantity of excavation can be accurately determined.

Normally the excavation is carried to the elevation shown on the plans, but if any doubt exists as to the stability of a foundation when this elevation is reached, the Project Engineer should be contacted at once for consultation and instructions. The Specifications provide for extra depth excavation if this action is considered necessary.

Ground water is often encountered above the desired foundation elevation. This water must be prevented from saturating the foundation soils. One way of preventing saturation is by constructing sumps in the excavation. These serve as receptacles for excess water and expedite pumping operations. All sumps should be located outside the footing forms and other precautions taken to insure that water flow will not wash the cement from freshly placed concrete (See Subsection 801.03.6).

Cofferdam. A Cofferdam is a structure, usually of a temporary nature, constructed for the purpose of keeping water and earth out of the excavation area. Normally a cofferdam is placed before excavation begins. A simple type of cofferdam is a box-like enclosure of sheet piling within which the excavation is made, pumped dry, and the foundation constructed.

If the excavation within a cofferdam is to be of sufficient depth to create the possibility of a hazard or if any condition exists which might contribute to a dangerous situation, the Contractor should be requested to submit, for approval, drawings showing the proposed method of cofferdam construction. Drawings must be signed by a Registered Professional Engineer with appropriate expertise. This is required of the Contractor by the specifications, when so requested by the Engineer. Submission of the drawings and approval by the Engineer does not relieve the Contractor of any responsibility under the contract and this should be understood.

Cofferdams must be of sufficient size to accommodate the necessary form work, drainage details such as sumps, clearance for battered piles and clearance for minor deviations that occur in the installation of the walls.

Shoring. Shoring refers to temporary support of the side of an excavation. It is a wall type structure constructed of wood and/or steel and is installed as the excavation proceeds. Although the Contractor is responsible for the adequacy of shoring used, any seemingly unsafe condition should be brought to the attention of the Project Engineer. On some projects when the shoring is complicated and detailed, the plans may require the shoring to be designed and signed by a Registered Professional Engineer with appropriate expertise.

Removal Of Bottom Heave. Generally, the excavation will be completed to the bottom of the foundation prior to driving of any permanent piles. Any heaving of the bottom caused by pile driving is to be removed upon completion of driving and the bottom finished for the placement of concrete thereon. There should not be any additional payment for removal of bottom heave.

Measurement And Payment. Measurement of and payment for Foundation Excavation is to be in accordance with the provisions of Subsections 801.04 and 801.05 of the Standard Specifications.

In the sketches and computations submitted for checking for final payment, show only that portion of Foundation Excavation within the “pay lines.” Usually, these lines will be 18 inches (typical) outside the neat lines of the footing. Original ground elevation and/or graded elevations at specific locations and the elevations of notable irregularities should be recorded in the sketches.

The actual elevation of the bottom of the footing should be recorded along with the vertical dimensions used and the calculations necessary to compute Foundation Excavation.

Any abnormal conditions encountered during excavation should be noted in detail in the diary.

8.3 Piling Bearing Value. Pile bearing is usually determined using either the drop hammer method, Pile Driving Analyzer (PDA) Monitoring or by static load tests.

Drop Hammer Method. When this method is used, the pilings are driven in the ground with a steam, air or diesel hammer. Marks are made on the piling in one-foot increments. The number of blows it takes to drive the piling is counted. This information along with other information about the hammer is entered into pile hammer formulas and the bearing of the pile is determined.

PDA Monitoring. When this method is used, the Department will install special instrumentation on the pile and the information will be recorded as the piling is driven into the ground. From the collected information, the bearing capacity, pile driving stresses, pile integrity and other information can be determined.

Static Load Tests. When this method is used, a static load is applied to an in-place piling. The Contractor will furnish the measuring frame and jacks and the Department will furnish the dials and load cells. The test will be performed in accordance with specific AASHTO and ASTM test methods. As a general rule, when the total top settlement of the piling is greater than one(1) or one and one half (1½) inch(es), depending on the type and length of piling, the piling is considered a failure. Final determination of failure is dependent on the decision made by the Bridge Engineer.

The above test methods address bearing determination of conventional piles. In some cases, drilled shafts are constructed in lieu of driving conventional piling. Load testing of drilled shafts requires special instrumentation. General requirements for this method of testing are set out in the Standard Specification. The Contractor is required to submit a plan for load testing drilled shafts for approval by the State Geotechnical Engineer prior to stating work.

Should there be any question as to the procedures to be followed, or cost considerations, the loading information, behavior information and recommendations should be routed through channels to the Construction Division. The Construction Division, with recommendations if necessary of the

Bridge Division, the Materials Division and District Engineer, will determine procedures to be followed and whether or not contract modifications are indicated.

With the rapid changes in today's technology, advanced methods of determining pile bearing are being developed. The Project Engineer and Bridge Inspector should familiarize themselves with contract requirements relating to loading tests.

8.4 Curing Concrete. Careful attention is to be given to the proper curing and protection of concrete in conformity with the requirements of Subsection 804.03.17 of the Standard Specifications, or as this specification may be modified by Special Provision. Concrete surfaces are to be protected from conditions causing premature drying by strict enforcement of the methods specified. When wetted burlap is used, it shall be of the specified thickness and the surface of the concrete is to be kept thoroughly moist for the period of time indicated.

Particular attention is to be given in maintaining the proper moist condition when wetted burlap or other satisfactory material is used as a protective covering in the curing and protection of concrete surfaces, where such covering must necessarily be partially tented over reinforcing steel, or other projections, or may be subject to flapping or other conditions under which the curing material might not be in intimate contact with the concrete surface.

Sound practices must be devised and used to prevent drying of the concrete surfaces during the specified curing period.

8.5 Reinforcing Steel. This applies to all construction projects where a listing of the reinforcing steel is furnished by the steel manufacturer and the listing is to be verified, corrected and used in computations of quantities for final payment.

At the completion of a project, the Project Engineer will furnish the Final Plans Engineer with a certified listing of accumulated steel quantities for final payment.

The procedure for obtaining a certified listing will be as follows:

1. The Project Engineer will check manufacturer's list, make any needed changes and verify the use of the listed reinforcement in the structure(s).

2. The Project Engineer will verify, using departmental issued personal computer software, quantities placed. This should be broken down into individual project numbers, structure numbers, station number, etc.

3. The Project Engineer will check computer listings against the manufacturer's bar list and certify that all bars, their lengths and number used are correct. If any errors are encountered the Project Engineer will make corrections on the computer listings, certify that all bars, their lengths and numbers as revised, are correct.

4. When the project is finalized, the Project Engineer will submit to the Final Plans Engineer, a computer listing with any changes, additions or deletions noted thereon, the quantity revised accordingly and the original steel documents. The Final Plans Engineer will review the listings, make spot checks, and verify final quantity.

CHAPTER 9
ESTIMATES, MONTHLY AND FINAL, WITH SUPPORTING DATA

9.1 General. This section establishes uniform minimum requirements for keeping systematic and accurate records essential to work performed and computation of amounts earned.

On a day-to-day basis during construction of the project, systematic and accurate notes, sketches and other records are to be maintained as a basis for payments so that, as the work is completed, factually supported progress payments can be made and there will not be any delay in forwarding final plans of completed work and the final estimate to the Central Office after all work has been completed.

If the instructions contained in this manual or related S.O.P.s conflict with any provision of the contract, the provisions of the contract will control. The procedures for proper record keeping can usually be found in the Standard Specifications, the contract documents contained in the Contractor's proposal, or in other S.O.P.s.

Each Pay Item in the contract carries a "Method of Measurement." If any conflict arises, the Contract Administration Engineer should be contacted by e-mail, or other written correspondence.

THE TIME TO START WORK ON THE FINAL PLANS COINCIDES WITH THE TIME THE FIRST ACTIVITY IS PERFORMED.

Preparation of the project diary must commence on the first day engineering salaries and expenses are charged. Field notes are records that become part of the data supporting the Final Estimate.

Write down each day's conditions and events as they occur. Data for the final plans should be completed as the work on the project progresses. Complete and up-to-date records are required for proper construction management.

All measurements and bases of payment are to be in strict accordance with the Standard Specifications unless superseded by Supplemental Specifications, Plans, Special Provision(s), Notice(s) to Bidders or Supplemental Agreements. (Reference Subsection 105.04 of the Standard Specifications for ascending order of controlling documents).

Supporting data for the final estimate, where practical, should be submitted in a three-ring binder. Roadway and bridge items should be in separate folders. The roadway items should be separated. There should be a "Quantity Sheet" for each pay item, **<u>signed by the Project Engineer</u>**, in the order the pay item appears in the CSD-200 stating the pay item, description, and the final quantity. The computations and supporting data, where practical, should be placed in the binder immediately following the quantity page. Data that cannot be put in the binder, such as field books and computer print outs, should be placed in envelopes, clearly stating the pay item and the final quantity. These envelopes should be numbered for identification purposes. All data not in the binder should be referenced on pages immediately following the quantity page.

A quantity sheet, signed by the Project Engineer, should be submitted for each pay item including lump sum pay items and items with a zero (0) quantity.

For uniformity regarding decimals for listing quantities in the final reports and final estimates, the table in Section 9.4, B, Section 100, C of this section of the manual should be used.

All sketches, computations, and reports should show where the data was obtained. For example: If the data was obtained from the plans, indicate the plan sheet number. If the data was obtained from a table, include the book or SOP, the page number, and the table as appropriate. Clearly identify the location so that a person not familiar with the procedures or area could locate the data.

When quantities are computed by GEOPAK, electronic data should be submitted in accordance with Section 9.4, D, 1 of this section of the manual, or the MDOT Survey Manual.

Forms available on the Contract Administration website may be used for computation of quantities. However, when an item is measured by conventional means and computed by electronic spreadsheets or programs, the field books or other recorded documentation of this data should be submitted. Do not just submit the spreadsheets. It must be shown where the input data was obtained. Quantities should be measured in accordance with the MDOT Specifications. If there is a conflict between these instructions and the Specifications, the Specifications will govern. See Section 9.4, D, 2 of this section of the manual for more information.

9.2 Monthly Payment(s). Subsection 109.06 of the Standard Specifications provides the conditions under which a partial (monthly) estimate is to be made as a basis for progress payment to the Contractor. Subsection 109.06.2 provides the basis upon which advance payments may be made as progress payments for certain stored or stockpiled non-perishable materials.

Monthly estimates will be submitted for payment on the CAD-001 & CAD-002, using the FMS Contractors Estimate Program or by Site Manager. Contractor cut-off dates and submission dates will be established by other S.O.P.s or by the Contract Administration Engineer. Fuel adjustments will not be computed after the month in which the Contractor completes all physical work on the project.

Monthly estimates should <u>not</u> be based on work <u>anticipated</u> to be performed, but shall be made on the basis of work which, on the day prescribed for making the estimate, has actually been satisfactorily performed.

In preparing partial estimates, the Project Engineer must exercise good judgment on those contract items where, due to the nature of the work, the quantities allowed will only be approximate. On other contract items, the Project Engineer will be able to determine reasonably accurate quantities (subject to re-check) to be allowed on partial estimates. <u>However, regardless of whether the quantities are approximate or reasonably accurate, a documented record must be placed in the project files, subject to review of the method, procedure, and basis for determining any quantity which is allowed on partial estimates.</u> <u>THE FILES SHOULD INCLUDE DOCUMENTATION THAT CLEARLY SHOW HOW QUANTITIES WERE MEASURED AND CALCULATED.</u>

While generating a Site Manager monthly estimate, Site Manager may create a list of discrepancies (lack of payrolls, lack of material testing, overruns, etc.), which will not allow the estimate to be generated until those discrepancies are addressed. The Project Manager, at the request of the Project Engineer, has the option to “Override” the discrepancies and address them at a later time. However, the Project Engineer/Manager should make all possible efforts to address all discrepancies listed. If the Project Engineer/Manager chooses the “Override” option, an acceptable reason is to be given. The Project Engineer should understand that if the “Override” option is chosen, that the estimate can be rejected at a higher level of approval due to an unacceptable reason.

9.3 Partial Final Payments. If the Contractor’s work has been completed and circumstances beyond the Project Engineer’s control delay completion of the final estimate, a current estimate should be submitted, using checked final quantities and such other estimated quantities that are conservative in nature, without overpayment to the Contractor.

9.4 Final Payment.

A. General. Do not submit the final data to Contract Administration Division until all work has been satisfactorily completed, except for growth of grass.

Final data must be submitted as soon as possible after release of maintenance on the project. Thirty (30) days is considered ample time for completing the final data on the basis that data has been accumulated, calculated, and posted as items of work are completed during construction.

From the beginning of the project, all final and supporting data should be readily legible and accurate.

B. Supporting Data. Supporting data for each project should include the following: (If there is more than one binder for roadway design items, include an index, indicating the contents of each binder)

1. One (1) set of ½-scale final construction plans. Changes should be made to the plans to reflect the project as-built conditions, using permanent red ink. Each sheet should be signed in the upper right-hand corner by the Project Engineer, using black ink. This should be his/her original signature. Facsimile stamps should not be used for any official purpose. All final quantities should be listed on the summary of quantities sheet if practical. If not, request an exception from final plans.

2. Computations of earth work quantities. Data as set forth in the MDOT Survey Manual.

3. All **ORIGINAL** imprinter and Contractor tickets and an approved computer ticket printout. All ticket computer programs should be the latest program approved by the Financial Management Division.

4. All original bar lists, sketches, computations, charts, reports, computerized computation forms, and any other data required to support the final quantities. Use approved programs like Microsoft Office, Microstation, or GEOPAK. Contact Final Plans before you use other programs.

5. One (1) signed copy of the CAD-97 (Approved Hot Mix Asphalt Design to be Used When Determining Percent of Asphalt for Fuel Adjustments).

6. One (1) signed copy of the CAD-12, (Report of Deductions and Incentive Payment for Final Estimates).

7. Two (2) signed copies of the CSD-200, with the overrun/underrun statements. (See Section 9.4, D, 4 of this section of the manual, and pages 3-2 through 3-13 of "Engineering Technician's Guide, FINAL ESTIMATES").

8. All original field notes.

9. Three (3) signed and notarized copies of the Project Engineer's Affidavit.

10. One (1) signed copy of the check off sheet. See the example forms at the end of this SOP for more information.

11. One (1) proposal.

Section 100 - General Provisions

a. Contract Modification. Modifications to quantities, pay items, time, etc. can be made with quantity adjustments, supplemental agreements and force account work. Project modifications are discussed in Chapter 1 of this manual.

b. Conversion Factors.

(1) Small volumes designated for payment by "Final Measure" (F.M.) may be measured loose in the vehicle (L.V.M.) and converted to contract measurement by multiplying the loose measure by 0.80. See Subsection 109.01 of the Standard Specifications. Small volumes designated for payment by "Loose Vehicle Measure" (L.V.M.) may be measured by the average end area method and converted to contract measurement by multiplying the F.M. volume by 1.25. See Subsection 109.01 of the Standard Specifications

(2) Volumes designated for payment by FME may be measured in its original position by the average end area method and multiply the FM measure by 90 percent. Small volumes of surplus, excess excavation or other small volumes of excavation which are impractical to measure by the average end area method but are designated to be measured by FME may be measured LVM and multiply the loose measure by 72 percent.

(3) When requested by the Contractor and approved by the Engineer in writing, materials specified to be measured by volume may be weighed and such weights converted to the unit of volume indicated in the contract, or materials specified to be measured by weight may be measured by volume and such volume converted to the unit of weight indicated in the contract. Factors for conversion from weight measurement to volume measurement or from volume measurement to weight measurement, will be determined by the Engineer and shall be agreed to by the Contractor in writing before such method of measurement of pay quantities is used.

c. Decimals. The following table is to be used for rounding of units for construction items using English and Metric units. If there is any difference between this table, and the MDOT plans or specifications, the MDOT plans or specifications will govern.

In order to have uniformity regarding decimals for listing quantities in the Final Reports and Final Estimates, please conform to the following table. Computations should be carried an additional decimal point for each item but rounded off as listed below when recorded in the Final Report or Final Estimate).

ITEM		**UNITS**
Additional Construction Signs	0.1	square foot
Aggregate (Cover and Stabilizer)		cubic yard
Bituminous Material		gallon
Bridge End Pavement	0.1	square yard
Bridge Railing	0.1	foot
Castings and Gratings		pound
Cement	0.1	barrel
		ton
Cleaning & Filling Joints		foot
Clearing and Grubbing	0.001	percent
Clearing and Grubbing	0.001	acre
Cold Milling		square yard
Cold Milling		ton
Cold Milling		cubic yard
Concrete Median Barrier	0.1	foot
Concrete (Structural)	0.01	cubic yard
Concrete Cl. "C" (Paved Ditch, etc.)	0.1	cubic yard
Curb and Curb & Gutter		foot
Crushed Stone	0.1	ton
Ditch Liner		square yard
Driveways and Sidewalks	0.1	square yard
Embankment		cubic yard
Erosion Checks		bale
Excavation (L.V.M. or FM)		cubic yard
Excavation (Rock)		cubic yard
Excavation (Structure or Foundation)	0.1	cubic yard
Expansion Joints		foot
Fence		foot
Fertilizers (Agricultural Limestone)	0.1	ton
Fertilizers	0.01	ton
Filter Material		ton
Filter Material	0.1	cubic yard
Fine Sand for Pressure Grouting	0.1	cubic yard
Flowable Fill	0.01	cubic yard
Fly Ash	0.1	ton
Geotextile Fabric		square yard
Granular Material		cubic yard
Granular Material		ton
Ground Preparation		square yard
Guard Rail		foot

Haul of Excavation		station yard
Insect Pest Control	0.1	acre
In-Grade Modification	0.001	mile,
	0.1	station or
		square yard
In-Grade Preparation	0.001	mile
Lime	0.1	ton
Masonry	0.1	cubic yard or
	0.01	mile
Milling		square yard
Milling		cubic yard
Milling		ton
Mixing (Soil-Cement, Soil-Lime, etc.)		square yard
Pavement (Concrete)	0.1	square yard
Pavement (Hot Plant Mix)	0.1	ton
Piling	0.1	foot
Pipe (Clay, Conc., V.C.)		foot (Multiple of Joints)
Pipe (Corrugated Metal)		foot
Price Adjustment Factors	0.01	percent (0.0001)
Rejuvenating Agent	0.1	gallon
Removal Items		square yard
Removal Items		cubic yard
Removal Items		foot
Riprap		square yard
Riprap	0.1	ton
Rubblizing Concrete		square yard
Sawing and Sealing Transverse Joints		foot
Seeding		pound
Seeding	0.01	acre
Seedlings	0.001	thousand
Select Material for Undercut	0.1	cubic yard
Sign Post	0.1	foot
Signs	0.1	square foot
Silicone Sealed Joints		foot
Silt Fence		foot
Slurry Seal		square yard
Soil Reinforcing Mat		square yard
Solid Sod and Sprigging		square yard
Spray Finish on Bridge		square yard
Steel (Reinforcement and Structure)		pound
Stripe (Continuous and Detail)		foot
Stripe (Continuous)	0.001	mile
Stripe (Continuous)		foot
Stripe (Legend)	0.1	square foot
Stripe (Legend)		foot
Stripe (Skip)	0.001	mile
Stripe (Skip)		foot
Timber	0.001	MBM

Topsoil for Slope Treatment .... square yard
Topsoil for Slope Treatment .... cubic yard
Vegetative Material for Mulch ....0.1 ton
Water..0.1 M/gallon
Other Items Not Shown ....0.001 Unit*

* If it is not practical to round an unlisted item to 0.001 unit, request an exception from Final Plans.

Section 200 - Earthwork Items

a. Clearing and Grubbing

(1) Lump Sum Basis - No computations are necessary for this item unless an increase or decrease was made in the project right of way after the contract was awarded. If a change is made to the right-of-way area after the contract is awarded, it will be necessary to make an adjustment in the payment for this item. In the event the contract carries a pay item for Clearing and Grubbing, Area Basis, the increase or decrease in payment is to be made by computing the area of the change and multiplying by the unit price bid, Area Basis.

If there is no unit price bid, Area Basis, it will be necessary to compute an increase or decrease in the Lump Sum measurement as provided for in Subsection 201.04.2 of the Standard Specifications.

The Roadway Design Division, upon request, will furnish the Project Engineer the total area to be cleared and grubbed within the right-of-way limits of the original plans. Add or subtract any increases or decreases in area of the right-of-way to be cleared and grubbed. This result is then divided by the original area, carrying the percentage to three decimal places (i.e., 101.337% or 98.663%). The lump sum price bid will then be adjusted by multiplying by this percentage.

(2) Area Basis. On an additional sheet, plot the gross areas of all areas involving payment for Clearing and Grubbing, Area Basis, including any adjustment as indicated above. Within each area, shade the area actually cleared and grubbed of small and large trees, giving relevant dimensions and angles or bearings. Show computations beside each area and indicate the net acreage within each shaded area. These areas may be computed using electronic recording and computing in accordance with Section 9.4, D, 1 of this manual.

b. Removal of Structures and Obstructions. When payment is to be made on a unit basis (S.Y., L.F., etc.), all pertinent information (date, station, dimensions, inspector's initials, etc.) is to be recorded in a bound field book and submitted with other final data.

c. Excavation and Embankment.

For items measured by LVM, see Section 9.4, D, 3 of this section of the manual.

For items measured and computed by electronic methods, see The MDOT Survey Manual.

For excavation items measured by conventional methods, submit field books or other recorded data that clearly show location, sketches, measurements and calculations. If the measurement data is complicated and not easy to check, include supplemental sheets to simplify the measurement.

(1) Final Measurement (FM). All three-dimensional measurements for FM payment not included in cross-sections, such as measurements for ramps, undercuts, culverts, etc., should be shown separately but included in the final quantity.

(2) Borrow Excavation (FME) In making such measurement, the volume of embankment above the natural ground line displaced by structures should not be included in FME measurement. However, in the interest of simplification, and considering reasonable capabilities for accuracy of determination of small volumes of earthwork, applicable portions of structures shall not be deducted.

Measurements and computations for deductions for structures should be shown separately and deducted from final quantities.

d. Haul. When the plans and proposal provide for haul of excavation measured as plan haul distance (P.H.D.), the final quantity for Haul of Excavation will be adjusted proportionately to the increase or decrease in the total excavation quantity determined from final cross-sectional measurement of accepted work.

$$\frac{\textbf{Actual Excavation x Planned Haul}}{\textbf{Planned Excavation}} = \textbf{Paid Haul}$$

For any other situations, contact Final Plans for submission requirements.

e. Structure Excavation. Electronic spreadsheets may be used (See Section 9.4, D, 2 of this section of the manual). However, the field notes that have the data, sketches and location (Station Limitations) recorded on these forms must be included. The data used as input to these forms should be in a format that can be easily checked to insure that the correct data is entered on the forms.

If you do not use the electronic spreadsheets, the applicable tables at the end of this S.O.P. shall be used to determine quantities for payment of Structure Excavation. To facilitate final checking, the excavation quantities are to be listed in tabular form as in the following example:

TABULATION OF STRUCTURE EXCAVATION - PIPE CULVERTS

Station	Size	Standard	No. Lines	Table No.	Length	Avg cut to F.L. Pipe	U.S.	D.S.	Cu. Yds. Str.
10+26	30”	3130	2	1,4	96’	2.1	0.8	0.2	46.6 (1)
29+13	51”x31”	D-FE-2	1	7	60’	1.5	0.0	0.3	28.7 (2)

(1) Sta. 10 + 26
Pipe - [96 - (2 x 2.61)] x 0.17 x (2.10 + 0.27) = 36.58

U.S. - 3.66 (0.8 + 0.27 + 0.5)	=	5.75
D.S. - 3.66 (0.2 + 0.27 + 0.5)	=	3.55
Toewalls - 2 x 0.33	=	0.66
		46.54 = 46.5 C.Y. Str.

(2) Sta. 29 + 13

Pipe - 60 x 0.23 x (1.50 + 0.38)	=	25.94
U.S. - 2.46 x (0.00 + 0.38)	=	0.93
D.S. - 2.46 x (0.30 + 0.38)	=	1.67
D.S. - Toewall	=	0.13
		28.67 = 28.7 C.Y. Str.

TABULATION OF STRUCTURE EXCAVATION - BOX CULVERTS

Station	Size & Standard(s)	Length	Table No.	Average Cut to F.L. Barrel	U.S.	D.S.	Cu. Yds. Str.
50+00	IBS-10x6, ISK-30-4W	822'	30	1.2	1.3	1.1	159.30 (3)

(3) Sta. 50 + 100

Barrel - 82.2 x 0.49 x (1.2 + 0.79)	=	80.16
U.S. H'Wall - 21.79 x (1.3 + 0.58)	=	40.97
D.S. H'Wall - 21.79 x (1.1 + 0.58)	=	36.61
Toewalls - 2 x 0.78	=	1.56
		159.30 = 159.3 C.Y. Str.

Structure excavation is not allowed for Inlets. One (1) extra foot is added to the pipe length to determine the quantity where the pipe enters the inlet. For example, if 20 feet measured length of pipe is connected on each end to two inlets, then one foot is added to each end of the pipe length, for 22 feet of structure excavation. If the 20 feet measured length of pipe were connected to an inlet on one end and a concrete end section on the other end, only one extra foot would be added for 21 feet of structure excavation, because the one extra foot on the F.E.S. end is included in the factor for the F.E.S.

Section 210 - Roadside Development.

Prior to performing Roadside Development items, the Project Engineer should prepare or have prepared bound field notebooks such that all source information required to be recorded may be properly and systematically entered into the book to serve as final data or to be transferred to required forms for final data. Any additional field data should be placed in bound field books and retained in the project files for inspection until final payment to the Contractor has been made. Should a question arise during checking of the final quantities, the Final Plans Section may request the bound field book, in which case the Project Engineer will submit such field book(s) as a supplement to the final data. Certain other field notebooks, as indicated for the respective items, are required to be submitted as final data.

a. Topsoil and Sod Mulch. If Topsoil or Sod Mulch is to be measured by the cubic yard (LVM), reference Section 9.4, D, 3 of this section of the manual. However, any excess topsoil placed, computed in accordance with the requirements of Subsection 211.03.4 of the Standard Specifications, is to be deducted as specified. If topsoil is specified by the square yard, actual measurements of each area and depth are to be recorded in a bound field notebook(s) and areas computed and shown thereon. Area and depths are to be computed in accordance with Subsection 211.03.4 of the Standard Specifications and deductions made, if any, as provided therein. Field books containing all measurements, capacities and computations, all tickets, and computer listings are to be submitted as final data.

b. Ground Preparation, Sprigging, and Solid Sodding. Actual measurements of these areas are to be recorded in the pre-printed MDOT Erosion Control Field Books. Field books are to be submitted as final data.

c. Fertilizer. Record of fertilizers are to be kept in accordance with Section 2.6 of this manual.

Agricultural Limestone is to be weighed in tons on a commercial scale or other scale approved by the Project Engineer.

d. Seed. The records of seed of each type required and used are to be made in accordance with Section 2.7 of the manual. In weighing seeds specified to be paid for by the pound and for determination of distribution of application, suitable scales are to be used for weighing these small quantities. Truck scales are not suitable for weighing such small quantities. The Project Engineer should insure that seeds are weighed by competent personnel on scales that are accurate and approved by the Engineer. Periodic checks of such scales by testing with known weights in the range of use should be made and entries made in the bound field book as to such scale checks. Use of weights listed on commercial bags of seed is acceptable.

e. Vegetative and Bituminous Materials for Mulch. Each truck load of vegetative material should be weighed on approved scales provided by the Contractor or approved commercial scales. An average weight per bale may be determined by either of the following two methods:

(1) The net weight of the mulch on the truck may be divided by the number of bales on the truck to establish an average weight per bale to be used in determining the quantity applied; or

(2) A sample of approximately ten (10) bales designated at random by the Engineer or inspector may be taken and weighed collectively or individually and the total weight divided by the number of bales in the sample to obtain an average weight to the nearest pound per bale to be used for the truckload from which the sample was taken.

In either case, all bales received in that particular truckload must be isolated until used and the average weight per bale applied thereto.

The total net weight of each load of material and the average weight per bale are to be recorded by date and time in the bound field book, along with other data as required in Section 2.8 of the manual.

To verify the amount of vegetative material used from the truck, one of the following methods should be used:

(a) Keep the truck under surveillance until all of the material is used;

(b) Actually count and record in the field book the bales as they are used; or

(c) Count and record the number of bales on the truck before beginning each application and the number of bales left on the truck each time it leaves the application site.

Measurement of bituminous material for mulch is to be made as for other bituminous materials. The original of Form CSD-481 is to be submitted as final data.

f. Paved Ditches. Location, sketches of typical section(s), lengths and computation are to be entered in a field book, signed and submitted as final data.

g. Miscellaneous Items. All field books, tickets, sketches, computations, etc., necessary to substantiate final measurement, as set out in the contract for miscellaneous items are to be signed and submitted as final data.

Section 300 - Bases

a. Granular Courses, Stabilizer Aggregates, Stone Base, etc. For items paid by the ton, the weight is recorded on either Contractor-generated tickets or MDOT imprinter tickets. The tickets should be input daily into SiteManager. A print out for each day, indicating the daily weight total, should be wrapped around the original copy of the tickets for that day. When the project is complete, the original tickets and a complete print out should be submitted to Final Plans.

For Items paid by LVM, reference Section 9.4, D, 3 of this section of the manual.

b. Lime, Portland Cement, Lime-Cement and Lime-Fly Ash Treated Courses.

(1) The procedure to be used for the measurement of lime and cement is explained in Section 1.3.25 of the manual. In addition, in any section, if the spread of cement or lime exceeds the 5% allowable tolerance, the amount to be deducted should be shown beside the quantities for the applicable ticket number(s) on the computer listing. The adjusted total of the computer listing should then equal the total of the net amounts for pay shown on the daily reports, Form TMD-125 or Form TMD-128.

(2) In addition to the imprinter tickets and the computer listings(s), the original copies of Form TMD-125 (Daily Report of Lime Stabilization) and Form TMD-128 (Daily Report of Cement Stabilization) must be submitted as final data. Each Daily Report should have attached to it all the imprinter tickets for lime or cement used that day, with a corresponding adding machine tape showing the total ticket quantity. Forms TMD-125 or TMD-128 must be completely filled out and signed by the Inspector. The Contractor is not entitled to payment for material wasted outside of the spreading limits by contending that it should be allowed under the five (5) percent spreading tolerance permitted within the spreading limits.

Excess material due to waste or over-application, or both, must be determined and deducted for each section such that the daily reports will show the net amount for payment.

The Project Office will check the TMD-725 calculations by entering the data into the electronic forms. See Section 9.4, D, 2 of this section of the manual for more information.

(3) The area to be processed must be determined before the lime or cement is spread on a section. This area is necessary so that the correct amount of lime or cement can be ordered and for the mixing item for which the Contractor is to be paid. Thus, irregular areas must also be measured and computed before the spread of lime or cement begins.

The areas of irregular sections may be computed by applicable mathematical formulae or methods. Sketches and computations of areas are also to be submitted as final data. If the Project Engineer desires, areas may be computed using electronic and computing equipment in accordance with Section 9.4, D, 1 of this section of the manual where a large number of complicated irregular areas are involved. A recap of all areas for payment should accompany the other final data. A convenient method for making this recap would be to identify each sketch on which computations are made for the respective areas and each of the other computations by prominent number, and on the recap merely list the area numbers in order and the area, with appropriate totals. This would eliminate duplicating the identification of each area.

c. <u>In-Grade Modification, Mechanically Stabilized Courses and In-Grade Preparation.</u>

(1) For measurements by the square yard: The areas for square yard can be measured by tape, with the dimensions and station limitations recorded on a sketch on the right-hand side of a field book. Calculations should be recorded on the left-hand side of the field book.

(2) For items to be measured by the station or mile, see Subsection 305.04 of the Standard Specifications for In-Grade Modification and Subsection 321.04 of the Standard Specifications for In-Grade Preparation.

(3) For stabilizer aggregates by volume, reference Section 9.4, D, 3 of this section of the manual for more information.

(4) For stabilizer aggregates by weight, the weight is recorded on either Contractor-generated tickets or MDOT imprinter tickets. The tickets should be input daily into the latest ticket program, which first must be approved by the Information Systems Division. A print-out for each day, indicating the daily weight total, should be wrapped around the original copy of the tickets for that day. When the project is complete, all the original tickets with the complete print out should be submitted to Final Plans.

(5) Although a contract will seldom contain a requirement for local stabilizer aggregates measured by the cubic yard, original position measurement, computations and submission of final data are to be made in the same manner as excavation.

<u>Section 400 - Hot Mix Pavements</u>

a. <u>Hot Mix Asphalt Courses.</u> Hot mix asphalt courses are normally measured for payment on a weight (ton) basis. The weight is recorded on either Contractor-generated tickets or MDOT imprinter tickets. The tickets should be input daily into SiteManager. A print-out for each day, indicating the daily weight total, should be wrapped around the original copy of the tickets for that day. When the project is complete, all the original tickets with the complete print-out should be submitted to Final Plans.

b. Surface Treatments. Cover and seal aggregates will be measured for payment in accordance with Section 1.3.24 of the manual. The quantity of aggregate spread for each shot of asphalt cement should be recorded on Form CSD-724. The quantity for payment cannot exceed the quantity ordered plus five (5) percent for regular areas, or plus fifteen (15) percent for irregular areas where hand spraying is required (see Subsection 410.04 of the Standard Specifications).

   Liquid asphaltic materials or tars will be measured for payment by the gallon. Unless otherwise indicated, the distributor tank measurement will be used. Temperature corrections are to be made in accordance with Subsection 702.02 of the Standard Specifications. Tables for conversion will be available from the Materials Engineer.

   Measurements and volume determinations are to be recorded on Form CSD-724, Surface Treatment - Report of Materials Applied.

   The Contractor is required to have the distributor calibrated by an agency and in a manner approved by the Department of Transportation. Prior to a distributor being used on the project, the Engineer must determine that the distributor is properly calibrated as evidenced by an approved calibration chart identified for the particular distributor. The Standard Specifications provide that under certain conditions, MDOT may perform the calibration. S.O.P. No. TMD-20-00-00-000 sets forth conditions for calibration by MDOT.

   Forms CSD-724 are to be completed for all bituminous materials when paid for on a gallon basis. The original copies of Form CSD-724 are to be submitted with the final data.

   The certified chart furnished for a distributor is based on the unit at the time the calibration was made. Any subsequent change or alteration made in the unit which would change the “liquid level” or calibrated capacity of the distributor tank will void the original calibration, and the distributor must be calibrated before further use.

   When any doubt exists as to the capacity of the distributor, it should be checked for total capacity. If the total capacity is not within reasonably close conformity with that shown on the calibration sheet for the unit, the distributor must be completely recalibrated.

   If surface treatment is to be measured and paid for on a square yard basis, measurement and documentation should be as set out in the paragraphs pertaining to mixing areas for lime or cement treatment.

Section 500 - Rigid Pavement.

a. Concrete Pavement and Bridge End Pavement. These items are usually measured and paid for on a square yard basis. Electronic measuring and computing as set forth in Section 9.4, D, 1 of this section of the manual may be used to a considerable advantage where a large number of irregular areas are involved.

The second paragraph of Subsection 109.01 of the Standard Specifications provides controlling dimensions for making measurements for computation of areas.

If coring reveals that portions of the completed pavement are deficient by more than 0.2 inches, but not more than 1.0 inch for the plan thickness, an adjustment in the unit price must be made in accordance with Subsections 501.05.2 of the Standard Specifications. In addition, if any core indicates a deficiency of more than one (1) inch, the area of such deficient thickness must be carefully determined as provided and, unless pavement in such area is removed and replaced with pavement meeting all of the requirements of the contract, such area deficient by more than 1.0 inch must be accurately computed for no payment. The Engineer must work closely with the coring crew to make these determinations. All sketches, computations, and recap sheets are to be submitted as final data.

b. Expansion Joints and Lug Anchors. Expansion joints and lug anchors are to be measured and paid for by the linear foot. Field books showing the locations and lengths of each joint and lug anchor should be submitted as final data.

Section 600 - Incidental Construction.

a. Structural Concrete. Some of the Standard Plans have the following note: "The quantities shown will be used as the basis for final payment unless this plan is modified." If applicable, these quantities will be used to determine final pay quantities.

The electronic spreadsheets from the MDOT CONTRACT ADMINISTRATION Web Site may be used for computation of quantities. If the quantities are computed by electronic spreadsheets or programs, the field books or other recorded documentation of this data should be submitted so that the data in the field books can be easily correlated with the data in the spreadsheets.

If the electronic spreadsheets are not used, quantities may be computed using the standard sheets in the plans for box culverts normal to the centerline and for structural concrete, minor structures. For skewed box culverts, use the tables at the end of this section of the manual.

For special design concrete structures, submit a drawing and calculations unless the plans state that the quantities shown may be used for final payment. The drawing and calculations should be made easy to check.

b. Reinforcement. Input the data from the bar list into the latest computer tabulation program for reinforcing steel approved by the Information System Division. The Information System Division will provide input instructions. Some of the Standard Plans have the following note: "The quantities shown will be used as the basis for final payment unless this plan is modified." If applicable, these quantities will be used to determine final pay quantities.

Submit the original bar list with the computer print when submitting the final data.

c. Pipe Culverts, Storm Drains, and Underdrains. These items will be measured by the linear foot as set out in Subsections 603.04 and 605.04 of the Standard Specifications. The locations and lengths of each type and size of pipe are to be shown on the final plans. Field books showing this information and date or installation and initials of the inspector who witnessed the installation should be submitted as final data.

d. Sidewalks and Concrete Driveways. These items will be measured for payment by the square yard. Quantities will be supported by accompanying sketches and computations where necessary. Sidewalks should be listed by station limits, showing the number of square yards in each section. Driveways should be listed by station and the square yard.

e. Curb, Gutter, and Curb and Gutter. The sketches and other information for curb & gutters and concrete barriers may be recorded in a standard field book and computed by using conventional methods.

   The electronic spread sheet (CAD-290) from the MDOT CONTRACT ADMINISTRATION Web Site Final Plans Quantity Menu may be used to tabulate curb & gutter and concrete barriers quantities. If the electronic spreadsheets are used, the field books or other recorded documentation of the data used for input to these spreadsheets should also be submitted. It must be shown where the input data was obtained. The field books or other recorded documentation of this data should be arranged in a manner such that the data in the field books can be easily correlated with the data in the spreadsheets.

f. Brick Masonry. This is to be measured by the cubic yard or by the thousand (M). If measured by the cubic yard, mortar joints are to be included in the volume. If applicable, Standard Plans will be used for determination of quantities. Submit sketches and computations as final data. Also, submit invoices for brick if measurement is by the thousand (M), accounting for any brick shown on the invoices and not used in the work.

g. Right-of-Way Markers. On the final plans, check (X) in permanent red ink those markers placed in accordance with the plans. No sketches are required for right-of-way markers.

h. Pressure Grouting Items. These items will be measured in accordance with Subsection 512.04 of the Standard Specifications. The number and location of holes are to be recorded in a bound field book. The Project Engineer, or the inspector, should devise systematic methods for accurately determining quantities of materials for which pay items are included in the contract depending upon specific procedures permitted to be used by the Contractor in the manufacture of the grout. This is necessary so that the composition of the grout can be controlled and correct measurements recorded for payment. Tickets should be written for materials measured L.V.M., with computations to verify the L.V.M. measurement. Measurement of other ingredients of the grout mixture are to be made in accordance with the controlling specifications and adequately recorded in a bound field book. Field books, tickets, and computations are to be submitted as final data.

i. Traffic Stripe. Measurements showing station limits and lengths of each type stripe should be submitted as final data. Sketches should be provided for all striping items except striping items that run parallel to the roadway.

j. Miscellaneous Items. All field books, tickets, sketches, computations, invoices, statements, etc., necessary to substantiate final measurement as set out in the Specifications should be signed and submitted as final data.

<u>Section 700 - Materials And Tests</u>.

a. <u>General</u>. The various sections of Division 700 of the Standard Specifications must be closely coordinated with the applicable sections of the general provisions and construction sections.

From time to time, field personnel should review Subsection 700.01 and the other subsections referred therein.

All field personnel should be thoroughly familiar with the glossary of terms and definitions described in Subsection 700.02 of the Standard Specifications, particularly the terms “Frame”, “Increment”, “Lot”, “Sample”, “Specified Value”, “Test Portion”, “Test Result”, “Test Value”, “Unit of Deviation”, and ”Verification Test.” Sometimes the term “Test Result” has been incorrectly used as “Test Value” and vice versa. These terms are NOT interchangeable and should be used only as defined in the Glossary of Terms.

b. <u>Statistically Based Acceptance Plan</u>. Subsection 700.04 of the Standard Specifications provides quantitative values for the determination of reasonably close conformity and, supplemented by certain special provisions contained in the contract, provides a formula for an automatic price adjustment of work or materials beyond reasonably close conformity. Field personnel should be thoroughly familiar with this subsection of the Specifications, and it should be used precisely as stated in the Standard Specifications and other contract documents.

The last paragraph of Subsection 700.04 of the Standard Specifications is important in the determination of reasonably close conformity in cases where quantitative values have not been set up for such determination.

<u>Section 800 - Bridge And Structures</u>.

a. <u>Excavation</u>. Measurement and payment shall be as set out in Subsections 801.04 and 801.05 of the Standard Specifications. Sufficient measurement of depths of each excavation are to be made to determine an accurate average depth to be used in final computations. Sketches and computations are to be submitted as final data.

b. <u>Piling and Loading Tests</u>. Forms TMD-500 and TMD-601, as applicable, and TMD-203 are to be submitted as final data for bearing piles. Number, dimensions, and computations of areas are to be submitted as final data for sheet piling.

Forms TMD-760 and TMD-761, as applicable, are to be submitted as final data for test piles.

Form TMD-440 is to be submitted as final data for conventional load tests.

c. <u>Concrete</u>. Upon request, the Bridge Engineer will furnish computations of quantities of bridge concrete. If no modifications are made in the bridge details and if the Project Engineer does not have reason to re-compute the quantities, the computations and quantities furnished by the Bridge Engineer should be submitted as final data. If modifications were made, or the fillets or build-ups over beams vary from those indicated on the plans, sketches, dimensions, and computations of such authorized changes and the adjusted final quantities are to be attached to the computations from the Bridge Engineer and submitted as final data.

d. Reinforcement. Input the data from the bar list into the latest computer tabulation program for reinforcing steel approved by the Information System Division. The Information System Division will provide input instructions.

e. Structural Steel. Structural steel is to be measured for payment in accordance with Subsection 810.63 of the Standard Specifications. Upon request, the Bridge Division will furnish structural steel computations under the same provisions as for concrete herein above, which list of shapes, plates, etc. and computations of weights or authorized modifications thereof are to be submitted as final data.

f. Steel Grid Flooring. Sketches showing dimensions and computations are to be submitted as final data.

g. Railing. Submit a tabulation of rail lengths according to nominal measurements shown on the span details, between beginning and ending of railing at abutments, as indicated on the plans.

h. Beams. The length shown on the plans for each particular beam will be used as a basis for final measurement for payment. Tabulations of these lengths should be submitted as final data.

i.. Timber. Timber is to be measured for payment in thousand (M) board feet, nominal dimensions:

$$\left(\frac{W'' \times D''}{12} \right) \times L'$$

A tabulation showing nominal dimensions, lengths, and board feet should be submitted as final data.

j. Slope Paving and Concrete Riprap in Bags. These items are to be measured for payment by the theoretical yield and the number of bags of cement used, based on batch count and the cement factor of the design mix. Unless otherwise provided in the contract, other methods of measurement are not acceptable.

k. Miscellaneous Items. Final quantities for miscellaneous items not otherwise indicated herein are to be supported by field books, tickets, sketches, statements, invoices, etc., necessary to substantiate final measurement, as set out in the specifications, and which are to be submitted as final data.

C. Preparation of Final Plans of Completed Work. A ½-scale set of prints bearing the stamp "FINAL PLANS OF COMPLETED WORK" will be mailed to the Project Engineer along with other copies of construction plans. These plans MUST be kept neat since they are the permanent records showing how the project was constructed.

The data shown on the Final Plans must agree with that recorded on Form CSD-200 and the quantities on the Final Estimate Forms (S.O.P. CAD-06-05-02-001).

1. Title and Layout Sheet.

    a. The names of the Contractor and the District Engineer, the Project Engineer's signature, the date work started, and the date work accepted are to be recorded in the hand-stamped block near the upper right-hand corner. If final data is submitted before final acceptance of the project, leave blank the space for: "Date Work Accepted."

    b. Project data such as equations and length shown on the left-hand side of the sheet are to be corrected to conform to actual construction.

2. Quantity Sheet. Under the heading "Recapitulation of Quantities," in the column designated as Final Quantities, list the total final quantities for the project. If any items were added after construction was begun, show the items and quantities. DO NOT REDRAW THE QUANTITY SHEET. NOTE: An (X) is to be drawn across all other boxes listing individual structures, as the details on these items are to be shown on the plan profile sheets and in the Final Report.

3. Typical Section Sheets. Retain the typical section sheets in the assembly, indicating any authorized changes.

4. Plan and Profile Sheets.

    (a) Plot actual finished centerline elevations and indicate the grade line and final elevations using permanent red ink for all types of projects. The final elevations need only be shown at even stations, P.V.C.s, P.V.I.s and P.V.T.s and in addition at +50s on vertical curves of paving projects. Revise the percent of grade if changed from the original.

    It will not be necessary to take final profile elevations on surface treatment and pavement projects on which the granular material has been placed on previous contracts, and which have been constructed in accordance with the plans, provided a statement is added on each plan profile sheet to the effect that "the final profile grade as constructed conforms very closely to the theoretical grade, except where final profile grade elevations have been noted on this sheet."

    (b) Check or correct (permanent red ink) the flow line, (giving upstream and downstream elevation) station, size, length, and type of drainage structure actually constructed.

    Structures that were not built are to be crossed (XXX) out, with an appropriate explanation. When locations of structures and ramps are changed, use black ink to plot the new location indicating direction of flow at structures.

    (c) Check or correct (permanent red ink) all Bench Mark locations and elevations and equations.

    (d) Check (permanent red ink) all R.O.W. markers that were placed according to the original plans, cross out the ones that were shifted and with black ink plot the new location with correct station and distance from centerline.

(e) Plot all changes in alignment. (permanent red ink).

(f) The Project Engineer's signature is required in the upper right-hand corner of each sheet of the final plans.

D. References.

1. Electronic Recording of Areas. The following instructions are to be used when measuring horizontal areas with electronic recording instruments and making computations using GEOPAK DESIGN AND COMPUTATION MANAGER:

   Data measured using electronic recording instruments should be downloaded into the computer.

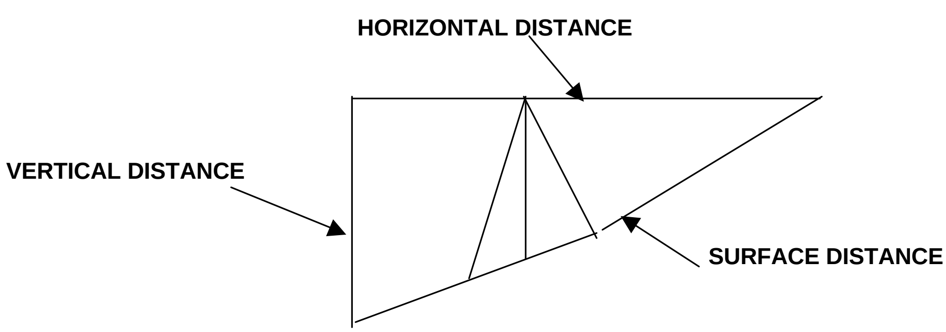
   Set Design Computation Manager to **Item Report**. When computations are completed, output files generated by the D&C Manager should be saved with a **.out** extension. Once you compute, you cannot use these file names again or the previous data will be overwritten. Edit the *.out file in the header area by typing in the following:

   Final Quantities
   Project Number:
   County:
   Project Engineer:

   Save the file. The Project Engineer should sign the printout of the file.

   Send the ***.dgn, *.gpk, *.asc,** and ***.out** files to the Contract Administration Server. Create a directory under the PROJECTS directory. Use your project number for the name of this directory. E-mail the Final Plans CAD coordinator when you finish placing all of your information in your directory. If practical, place these files on a diskette and submit them with your final data.

   Do not use horizontal distances when specifications require surface measurements.



NOTE: SEE ROADWAY DESIGN WEBSITE FOR ADDITIONAL INFORMATION

2. Electronic Final Quantities Work Sheet. The electronic forms that can be downloaded from the Contract Administration Website, may be used for computing final quantities.

   If the electronic forms are used, the field books or other recorded documentation of the data used for input to these spreadsheets should also be submitted. You must show where the input data was obtained. The field books or other recorded documentation of this data should be arranged in a manner that the data in the field books can be easily correlated with the data in the spreadsheets.

   When using these programs, send an electronic diskette and the hard copy of the spreadsheet. If the program is too large to put on a disk, send the electronic form to the Contract Administration Server.

   When sending electronic data to the Contract Administration Server, create a directory under the Projects Directory and use your project number for the name of the directory. Inform the Final Plans CAD Coordinator when you have completed placing all required information in the project directory.

3. LVM Measurements. The latest computer program approved by the Information Systems Division should be used for computing final pay for items paid by LVM.

   Tickets should be input into the computer program for LVM measurements on a daily basis. The day's tickets should be placed in numerical sequence in ascending order. The day's computer printout should be wrapped around tickets for that day.

   The tickets and the computer printout for the pay item should be submitted with the final data.

   All LVM vehicle and water tank measurements, together with volume computations, are to be furnished to the Final Plans Section along with other final data. The truck measurement computer forms, downloaded from CAD, may be used for truck volume computations.

   If the electronic spreadsheets are used, the field books or other recorded documentation of the data used for input to these spreadsheets should also be submitted. You must show where the input data was obtained. The field books or other recorded documentation of this data should be arranged in a manner that the data in the field books can be easily correlated with the data put into the spreadsheets.

    4. Overrun/Underrun Statement. Overrun/underrun statements are required on the CSD-200 for all pay items that have an overrun or underrun of more than five percent (5%) and a cost of more than $1,000.00. These pay items are noted by a double asterisk (**).

       The purpose of an overrun/underrun statement is to find why there is a difference in the estimated and actual amount and make corrections toward improved performance.

       The reasons stated for the overrun/underrun of a pay item should be factual and worded so that MDOT can determine a reason for the difference and attempt to correct it. Contract Administration will review the justification for any overrun or underrun, forward any relevant comments to the applicable Division, coordinate any corrections to be made, and submit recommendations to the appropriate District Office or Division.

Events may happen that are beyond the control of MDOT. These events should be recorded and, while possibly no action will be taken, the majority of large overruns and underruns may be reduced.

INDEX TO FINAL QUANTITIES DATA

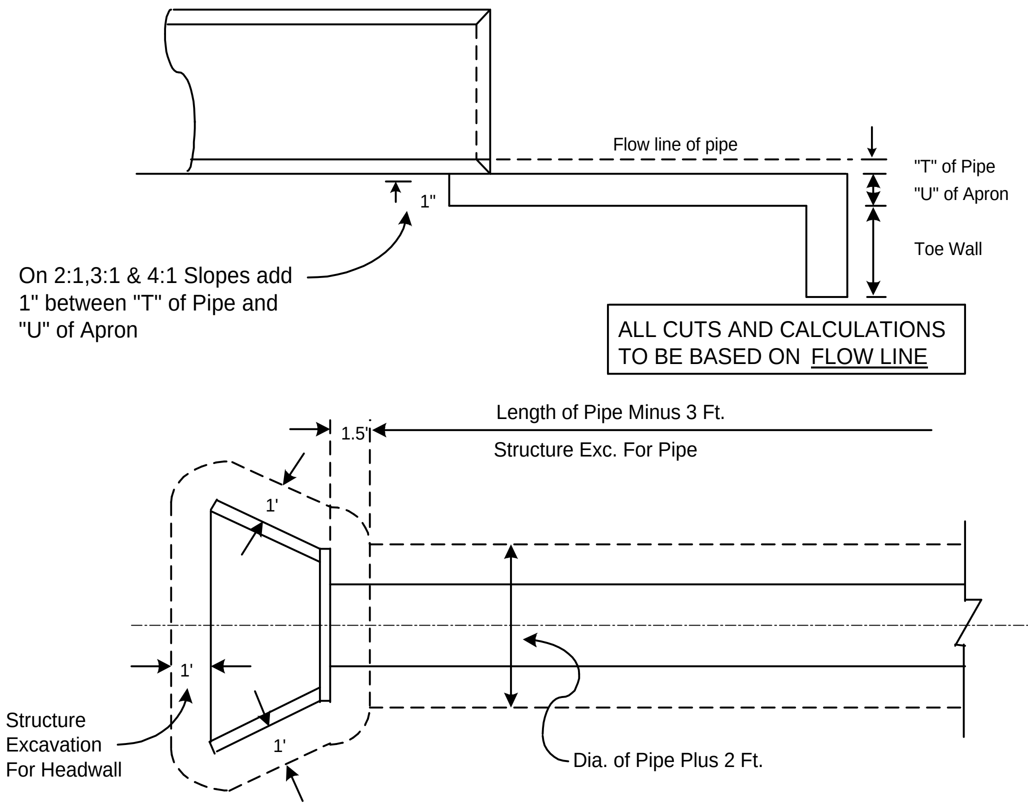
STRUCTURE EXCAVATION FOR HEADWALLS, PIPE CULVERTS, BOX CULVERTS, AND MINOR STRUCTURES

CONCRETE FOR SKEWED BOX CULVERTS
LENGTH 40’

LENGTH 150’

STRUCTURE EXCAVATION FOR PIPE AND HEADWALLS
General

2:1, 3:1, AND 4:1 SLOPES



SKETCH SHOWING LIMITS FOR COMPUTING
STRUCTURE EXCAVATION

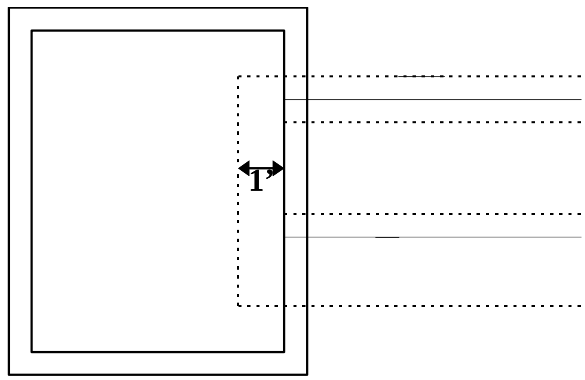
EXAMPLE: 48’ - 30’ single line pipe culvert (Standard HW-2100). From field observations the average cut to flow line is as follows:

Pipe 2.3 ft., upstream headwall 2.1 ft., downstream headwall 1.8 ft.

From Table 2:
Str.Exc.=(48-3) (0.17)(2.57)+(2.39 x 2.95)+(2.39x2.95)+(0.26x2) = 33.56
Pay 33.6 Cu. Yds.

Figure 1

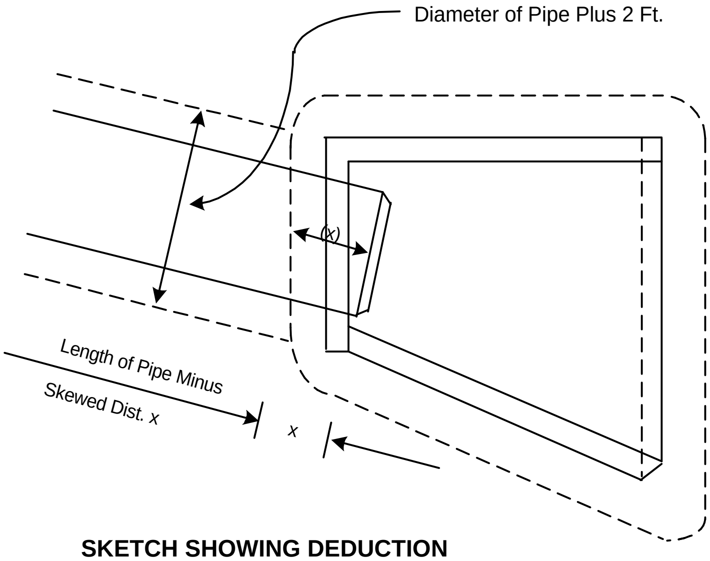
STRUCTURE EXCAVATION WHERE A PIPE ENTERS AN INLET



Since payment for structure excavation is not made for inlets, when pipe(s) go into an inlet, add one foot to the length of the pipe as long as the size of the inlet permits. Where more than one pipe goes into an inlet, do not compute volume for any overlapping.

NOTE: The quantities shown in the following tables are correct and will be used on the final estimate as the basis of payment, unless authorized modifications are made. Use same shell thickness for Class III and Class IV Pipe.

Figure 1 - (Cont'd.)



Note: The distances (x) shown in the above table are to be deducted from all special design skewed pipe culvert lengths when calculating structure excavation.

The distance (x) was computed with "U" as listed on the standard Headwalls 2:1 slopes. Where "U" is different from this standard the distance (x) must be computed.

SKETCH SHOWING DEDUCTION FOR SKEWED PIPE WITH HEADWALLS.

DEDUCTIONS EACH END FOR SKEWED PIPES
(WITH HEADWALLS)

SIZE	0º SKEW	SKEW 15º (x)	SKEW 30º(x)	SKEW 45º (x)
15”	1.50’	1.77’	2.19’	2.91’
18”	1.50’	1.80’	2.26’	3.04’
24”	1.50’	1.88’	2.43’	3.33’
30”	1.50’	1.96’	2.61	3.64’
36”	1.50’	2.04’	2.76’	3.92’
42”	1.50’	2.11’	2.93’	4.20’
48”	1.50	2.19’	3.10’	4.50’
54”	1.50’	2.28’	3.30’	4.83’
60”	1.50’	2.36’	3.46’	5.12
66”	1.54’	2.48’	3.68’	5.47’
72”	1.58’	2.60’	3.90’	5.82’
84”	1.67’	2.84	4.33’	6.52’

Example: 48’ - 30”, 45º Skew, Single Line Pipe Culvert, 2:1 Slope
From field determinations, the average cut to flow line is as follows:
Pipe 2.3 Ft.; U.S. Headwall 2.1 Ft.; D.S. headwall 1.8’. From
[(48-7.28)0.17] 2.57 + (3.21 x 2.95) + (3.21 x 2.65) + (2 x 0.37) = 36.51 C.Y.
Pay 36.5 Cu. Yds.

See Table 7 for Deduction for Skewed Arch Pipes (With Headwalls)

TABLE 1

STRUCTURE EXCAVATION (ONE FT. DEPTH)
FOR PIPE CULVERT 2:1 SLOPES

		HW-2100 0º - 15º SKEW								
		SINGLE LINE			DOUBLE LINE			TRIPLE LINE		
"T"	PIPE SIZE	Cu.Yds. per Ft. of Pipe	Cu.Yds. One Hdwl.	Cu.Yds. One toe wall	Cu.Yds. per Ft. of Pipe	Cu.Yds. One Hdwl.	Cu.Yds. One toe wall	Cu.Yds. per Ft. of Pipe	Cu.Yds. One Hdwl.	Cu.Yds. One Toe wall
2"	15"	.12	1.23	.15	.22	1.72	.22	.31	2.20	.29
2"	18"	.13	1.44	.18	.23	2.02	.24	.34	2.60	.32
2½"	24"	.15	1.92	.22	.27	2.72	.30	.40	3.52	.40
3¼"	30"	.17	2.39	.26	.33	3.50	.37	.49	4.62	.49
3½"	36"	.19	2.93	.30	.37	4.39	.43	.56	5.85	.57
4"	42"	.20	3.50	.34	.42	5.34	.49	.64	7.18	.65
4½"	48"	.22	4.16	.38	.47	6.45	.55	.72	8.74	.74
5½"	54"	.24	4.85	.42	.52	7.64	.62	.81	10.43	.83
6"	60"	.26	5.69	.46	.57	9.04	.67	.89	12.40	.92
6½"	66"	.28	6.78	.49	.62	10.83	.75	.97	14.88	1.01
7"	72"	.30	7.67	.51	.67	12.35	.79	1.05	17.02	1.08
8"	84"	.33	9.62	.55	.77	15.67	.88	1.21	21.75	1.21
HW-2130 30º SKEW										
2"	15"	.12	1.27	.16	.22	1.83	.24	.31	2.39	.33
2"	18"	.13	1.48	.18	.23	2.15	.27	.34	2.81	.36
2½"	24"	.15	1.97	.22	.27	2.90	.33	.40	3.82	.44
3¼"	30"	.17	2.46	.26	.33	3.75	.40	.49	5.03	.54
3½"	36"	.19	3.02	.30	.37	4.70	.46	.56	6.39	.63
4"	42"	.20	3.60	.34	.42	5.73	.53	.64	7.86	.72
4½"	48"	.22	4.28	.38	.47	6.93	.60	.72	9.57	.81
5½"	54"	.24	5.00	.42	.52	8.23	.67	.81	11.45	.91
6"	60"	.26	5.87	.46	.57	9.75	.73	89	13.63	1.00
6½"	66"	.28	6.99	.49	.62	11.66	.78	.97	16.34	1.07
7"	72"	.30	7.92	.51	.67	13.32	.82	1.05	18.72	1.13
8"	84"	.33	9.94	.55	.77	16.94	.89	1.21	23.94	1.22
HW-2145 45º SKEW										
2"	15"	.12	1.62	.22	.22	2.31	.32	.31	3.00	.42
2"	18"	.13	2.16	.25	.23	2.98	.36	.34	3.79	.47
2½''	24"	.15	2.54	.32	.27	3.67	.45	.40	4.81	.59
3¼"	30"	.17	3.21	.37	.33	4.78	.54	.49	6.35	.71
3½"	36"	.19	3.97	.43	.37	6.03	.63	.56	8.10	.83
4"	42"	.20	4.76	.49	.42	7.37	.72	.64	9.98	.95
4½"	48"	.22	5.70	.54	.47	8.94	.81	.72	12.18	1.07
5½"	54"	.24	6.68	.60	.52	10.63	.90	.81	14.58	1.20
6"	60"	.26	7.87	.67	.57	12.62	1.00	.89	17.37	1.34
6½"	66"	.28	9.42	.72	.62	15.14	1.09	.97	20.87	1.45
7"	72"	.30	10.68	.75	.67	17.29	1.15	1.05	23.90	1.55
8"	84"	.33	13.44	.81	.77	22.01	1.27	1.21	30.58	1.74

TABLE 2

STRUCTURE EXCAVATION (ONE FT. DEPTH)
FOR PIPE CULVERT 3:1 SLOPES

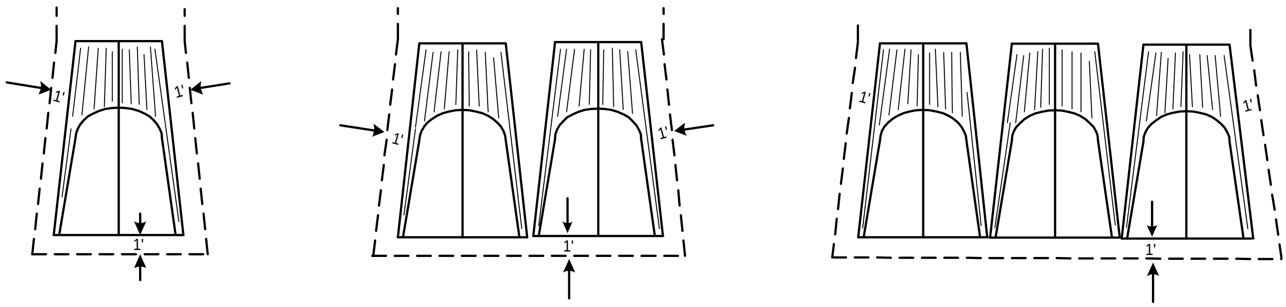
		HW-3100 0º - 15º SKEW								
		SINGLE LINE			DOUBLE LINE			TRIPLE LINE		
"T"	PIPE SIZE	Cu.Yds. per Ft. of Pipe	Cu. Yds. One Hdwl.	Cu.Yds. One toe wall	Cu.Yds. per Ft. of Pipe	Cu.Yds. One Hdwl.	Cu.Yds. One toe wall	Cu.Yds. per Ft. of Pipe	Cu.Yds. One Hdwl.	Cu.Yds. One toe wall
2"	15"	.12	1.53	.16	.22	2.14	.23	.31	2.75	.30
2"	18"	.13	1.81	.18	.23	2.54	.26	.34	3.28	.34
2½"	24"	.15	2.45	.22	.27	3.51	.32	.40	4.55	.41
3¼"	30"	.17	3.10	.26	.33	4.57	.38	.49	6.04	.50
3½"	36"	.19	3.84	.30	.37	5.79	.44	.56	7.75	.58
4"	42"	.20	4.62	.33	.42	7.11	.49	.64	9.61	.66
4½"	48"	.22	5.54	.37	.47	8.67	.56	.72	11.79	.75
5½"	54"	.24	6.50	.41	.52	10.33	.62	.81	14.17	.84
6"	60"	.26	7.68	.45	.57	12.32	.69	.89	16.97	.96
6½"	66"	.28	9.21	.49	.62	14.84	.75	.97	20.47	.99
7"	72"	.30	10.46	.51	.67	16.98	.78	1.05	23.51	1.04
8"	84"	.33	13.19	.54	.77	21.70	.83	1.21	30.21	1.12
HW - 3130 30º SKEW										
2"	15"	.12	1.76	.20	.22	2.46	.28	.31	3.17	.37
2"	18"	.13	2.10	.23	.23	2.95	.32	.34	3.79	.41
2½"	24"	.15	2.89	.28	.27	4.10	.39	.40	5.30	.50
3¼"	30"	.17	3.66	.33	.33	5.36	.47	.49	7.05	.61
3½"	36"	.19	4.57	.38	.37	6.82	.54	.56	9.08	.77
4"	42"	.20	5.52	.43	.42	8.40	.62	.64	11.28	.81
4½"	48"	.22	6.64	.48	.47	10.25	.70	.72	13.86	.91
5½"	54"	.24	7.81	.53	.52	12.24	.78	.81	16.66	1.02
6"	60"	.26	9.26	.58	.57	14.62	.85	.89	19.99	1.13
6½"	66"	.28	11.14	.62	.62	17.64	.92	.97	24.14	1.20
7"	72"	.30	12.66	.65	.67	20.20	.96	1.05	27.73	1.27
8"	84"	.33	15.99	.70	.77	25.82	1.04	1.21	35.65	1.38
HW - 3145 45º SKEW										
2"	15"	.12	2.29	.29	.22	3.15	.39	.31	4.02	.49
2"	18"	.13	2.76	.31	.23	3.80	.42	.34	4.84	.53
2½"	24"	.15	3.86	.40	.27	5.34	.53	.40	6.81	.67
3¼"	30"	.17	5.17	.47	.33	7.25	.64	.49	9.32	.81
3½"	36"	.19	6.23	.55	.37	9.00	.75	.56	11.76	.95
4"	42"	.20	7.57	.61	.42	11.10	.84	.64	14.63	1.08
4½"	48"	.22	9.16	.70	.47	13.58	.97	.72	17.99	1.23
5½"	54"	.24	10.81	.76	.52	16.23	1.07	.81	21.65	1.37
6"	60"	.26	12.87	.86	.57	19.44	1.19	.89	26.00	1.53
6½"	66"	.28	15.56	.93	.62	23.52	1.29	.97	31.49	1.64
7"	72"	.30	17.71	.97	.67	26.94	1.35	1.05	36.17	1.72
8"	84"	.33	22.41	1.05	.77	34.44	1.46	1.21	46.47	1.88

TABLE 3

STRUCTURE EXCAVATION (ONE FT. DEPTH)
FOR PIPE CULVERT 4:1 SLOPES

		HW-4100 0º - 15º SKEW								
		SINGLE LINE			DOUBLE LINE			TRIPLE LINE		
"T"	PIPE SIZE	Cu.Yds. per Ft. of Pipe	Cu. Yds. One Hdwl.	Cu.Yds. One toe wall	Cu.Yds per Ft. of Pipe	Cu.Yds. One Hdwl.	Cu.Yds. One toe wall	Cu.Yds per Ft of Pipe	Cu.Yds. One Hdwl.	Cu.Yds. One toe wall
2"	15"	.12	1.98	.19	.22	2.71	.26	.31	3.45	.33
2"	18"	.13	2.38	.21	.23	3.27	.29	.34	4.16	.37
2½"	24"	.15	3.30	.26	.27	4.59	.35	.40	5.87	.45
3¼"	30"	.17	4.21	.30	.33	6.04	.42	.49	7.87	.54
3½"	36"	.19	5.29	.35	.37	7.74	.49	.56	10.19	.63
4"	42"	.20	6.40	.39	.42	9.54	.55	.64	12.68	.72
4½"	48"	.22	7.74	.44	.47	11.70	.63	.72	15.66	.82
5½"	54"	.24	9.13	.48	.52	14.00	.69	.81	18.88	.91
6"	60"	.26	10.85	.53	.57	16.78	.76	.89	22.71	1.00
6½"	66"	.28	13.10	.58	.62	20.32	.82	.97	27.53	1.08
7"	72"	.30	14.91	.60	.67	23.29	.87	1.05	31.67	1.13
8"	84"	.33	18.87	.65	.77	31.00	.94	1.21	40.78	1.23
		HW-4130 30º SKEW								
2"	15"	.12	2.32	.23	.22	3.17	.31	.31	4.01	.40
2"	18"	.13	2.80	.26	.23	3.83	.35	.34	4.86	.44
2½"	24"	.15	3.94	.33	.27	5.43	.44	.40	6.91	.55
3¼"	30"	.17	5.05	.38	.33	7.16	.52	.49	9.27	.66
3½"	36"	.19	6.38	.44	.37	9.20	.60	.56	12.03	.77
4"	42"	.20	7.76	.50	.42	11.39	.69	.64	15.02	.88
4½"	48"	.22	9.41	.56	.47	13.98	.77	.72	18.55	.98
5½"	54"	.24	11.12	.62	.52	16.75	.87	.81	22.38	1.11
6"	60"	.26	13.27	.68	.57	20.11	.95	.89	26.97	1.23
6½"	66"	.28	16.07	.74	.62	24.40	1.04	.97	32.74	1.33
7"	72"	.30	18.30	.77	.67	27.97	1.08	1.05	37.66	1.39
8"	84"	.33	23.20	.83	.77	35.85	1.17	1.21	48.51	1.51
		HW-4145 45º SKEW								
2"	15"	.12	3.10	.35	.22	4.14	.45	.31	5.18	.55
2"	18"	.13	3.80	.40	.23	5.06	.51	.34	6.33	.62
2½"	24"	.15	5.42	.50	.27	7.24	.63	.40	9.06	.77
3¼"	30"	.17	7.02	.59	.33	9.60	.76	.49	12.18	.93
3½"	36"	.19	8.95	.68	.37	12.41	.88	.56	15.87	1.08
4"	42"	.20	10.93	.77	.42	15.38	1.00	.64	19.82	1.24
4½"	48"	.22	13.34	.86	.47	18.94	1.13	.72	24.53	1.39
5½"	54"	.24	15.81	.95	.52	22.70	1.25	.81	29.60	1.55
6"	60"	.26	18.94	1.06	.57	27.32	1.39	.89	35.71	1.73
6½"	66"	.28	23.05	1.15	.62	33.25	1.51	.97	43.46	1.86
7"	72"	.30	26.28	1.21	.67	38.13	1.59	1.05	49.97	1.96
8"	84"	.33	33.38	1.28	.77	48.87	1.69	1.21	64.36	2.11

TABLE 4



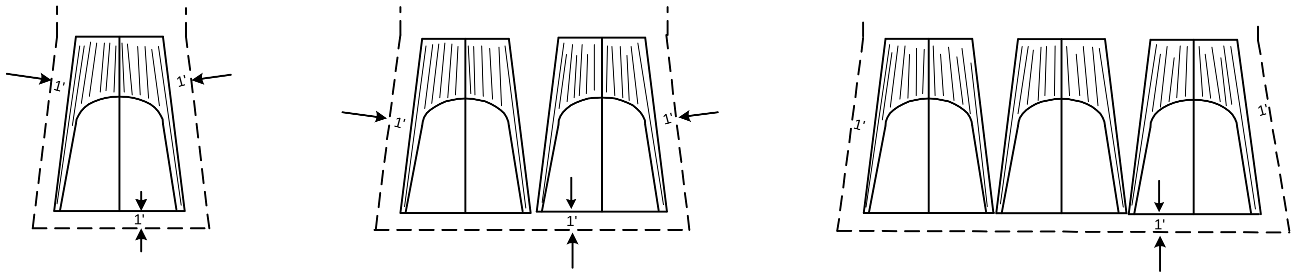
SKETCH SHOWING LIMITS FOR
STRUCTURE EXCAVATION FOR FLARED END PIPE

STRUCTURE EXCAVATION (ONE FT. DEPTH)
FOR FLARED END CULVERT PIPE - FE-1

Round-Pipe		Single Line			Double Line			Triple Line		
Size	"T" of Pipe	Cu.Yds. Per FES	Cu.Yds. Per Ft. Bbl.	Cu.Yds. per Toewall	Cu.Yds. Double FES	Cu.Yds. Per Ft. Bbl.	Cu.Yds. per Toewall	Cu.Yds. Triple FES	Cu.Yds. Per Ft. Bbl.	Cu.Yds. Per Toewall
15	.19	1.04	.12	.06	1.84	.23	.11	2.64	.35	.17
18	.21	1.11	.13	.06	2.01	.26	.13	2.91	.38	.19
24	.25	1.33	.15	.08	2.52	.31	.17	3.72	.48	.25
30	.29	1.53	.17	.10	3.01	.37	.21	4.49	.58	.31
36	.33	2.21	.19	.12	4.47	.43	.25	6.73	.68	.37
42	.38	2.38	.20	.13	4.84	.47	.27	7.31	.74	.40
48	.42	2.55	.22	.15	5.21	.51	.29	7.87	.80	.44
54	.46	2.76	.24	.16	5.67	.55	.31	8.59	.86	.47
60	.50	2.94	.26	.17	6.05	.59	.33	9.16	.93	.50
66	.54	3.11	.28	.18	6.42	.63	.35	9.73	.99	.53
72	.58	3.28	.30	.19	6.79	.67	.38	10.30	1.05	.56

NOTE: Quantities for End Section DO NOT include toe wall.
The quantities shown in Table 5 are correct and will be used on the final estimate as the basis of payment unless authorized modifications are made.

TABLE 5



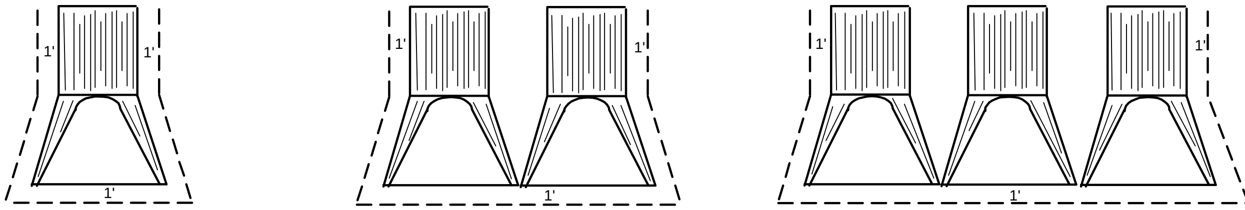
SKETCH SHOWING LIMITS FOR
STRUCTURE EXCAVATION FOR FLARED END PIPE.

STRUCTURE EXCAVATION (ONE FT. DEPTH)
FOR FLARED END ARCH PIPE - FE-1A Type 1

		Single Line			Double Line			Triple Line		
Size	"T" of FES	Cu.Yds. Per FES	Cu.Yds. Per Ft. Bbl.	Cu.Yds. per Toewall	Cu.Yds. Double FES	Cu.Yds. Per Ft. Bbl.	Cu.Yds. per Toewall	Cu.Yds. Triple FES	Cu.Yds. Per Ft. Bbl.	Cu.Yds. Per Toewall
22 x 13	.21	1.14	.14	.06	2.03	.27	.13	2.92	.40	.19
29 x 19	.25	1.35	.16	.08	2.52	.33	.17	3.68	.50	.25
36 x 23	.29	1.56	.19	.10	3.00	.39	.21	4.45	.60	.31
44 x 27	.33	2.28	.21	.12	4.50	.46	.25	6.72	.70	.37
51 x 31	.38	2.46	.23	.13	4.88	.50	.27	7.30	.77	.40
58 x 36	.42	2.64	.25	.15	5.25	.54	.29	7.87	.83	.44
65 x 40	.46	2.82	.27	.16	5.63	.59	.31	8.43	.90	.47
73 x 45	.50	3.01	.30	.17	6.01	.63	.33	9.01	.97	.50
88 x 54	.58	3.69	.35	.21	7.54	.76	.41	11.40	1.17	.62

Note: Quantities for End Section DO NOT include toe wall.
The quantities shown in Table 6 are correct and will be used on the final estimate as the basis of payment unless authorized modifications are made.

TABLE 6



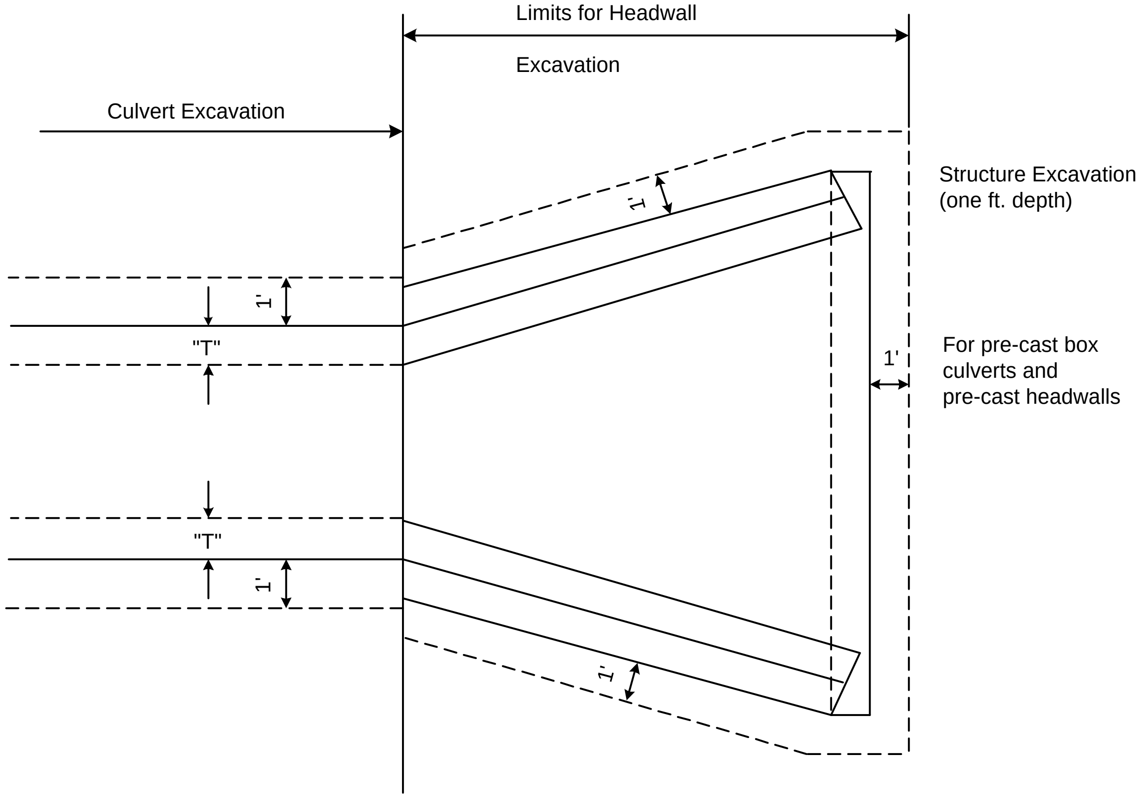
SKETCH SHOWING LIMITS FOR
STRUCTURE EXCAVATION FOR FLARED END PIPE.

STRUCTURE EXCAVATION (ONE FT. DEPTH)
FOR FLARED END ARCH PIPE - FE-1A Type II

		Single Line			Double Line			Triple Line		
Size	“T” of FES	Cu.Yds. Per FES	Cu.Yds. Per Ft. Bbl.	Cu.Yds. per Toewall	Cu.Yds. Double FES	Cu.Yds. Per Ft. Bbl.	Cu.Yds. per Toewall	Cu.Yds. Triple FES	Cu.Yds.Per Ft. Bbl.	Cu.Yds. Per Toewall
22 x 13	.21	1.06	.14	.06	1.95	.27	.13	2.84	.40	.19
29 x 19	29	1.28	.16	.08	2.47	.33	.17	3.67	.50	.25
36 x 23	.33	1.87	.19	.10	3.76	.39	.21	5.66	.60	.31
44 x 27	.38	2.16	.21	.13	4.42	.46	.25	6.68	.71	.38
51 x 31	.38	2.34	.23	.13	4.77	.50	.27	7.20	.77	.40
58 x 36	.42	2.53	.25	.15	5.15	.54	.29	7.78	.83	.44
65 x 40	.46	2.72	.27	.16	5.54	.59	.31	8.36	.90	.47
73 x 45	.50	2.92	.30	.17	5.94	.63	.33	8.95	.97	.50

Note: Quantities for End Section DO NOT include toe wall.
The quantities shown in Table 6a are correct and will be used on the final estimate as the basis of payment unless authorized modifications are made.

TABLE 6A



SKETCH SHOWING LIMITS FOR STRUCTURE EXCAVATION
FOR PRE-CAST BOX CULVERTS AND PRE-CAST HEADWALLS

STRUCTURE EXCAVATION (ONE FT. DEPTH)
FOR PRE-CAST BOX CULVERTS AND PRE-CAST HEADWALLS

Size	"T" of Box	Cu.Yds. Per Ft. of Bbl.	Cu.Yds. Per Headwall	Cu. Yds. per Toewall
6 x 4	8"	0.35	5.06	0.25
8 x 4	8"	0.42	5.73	0.28
10 x 4	10"	0.51	6.40	0.32
6 x 5	8"	0.35	5.06	0.25
8 x 5	8"	0.42	5.73	0.28
10 x 5	10"	0.51	6.40	0.32
6 x 6	8"	0.35	8.03	0.30
8 x 6	8"	0.42	9.00	0.33
10 x 6	10"	0.51	9.96	0.36
8 x 8	8"	0.42	12.70	0.38
10 x 8	10"	0.51	13.95	0.41

NOTE: Quantities shown are correct and will be used as basis for payment unless authorized modifications are made.

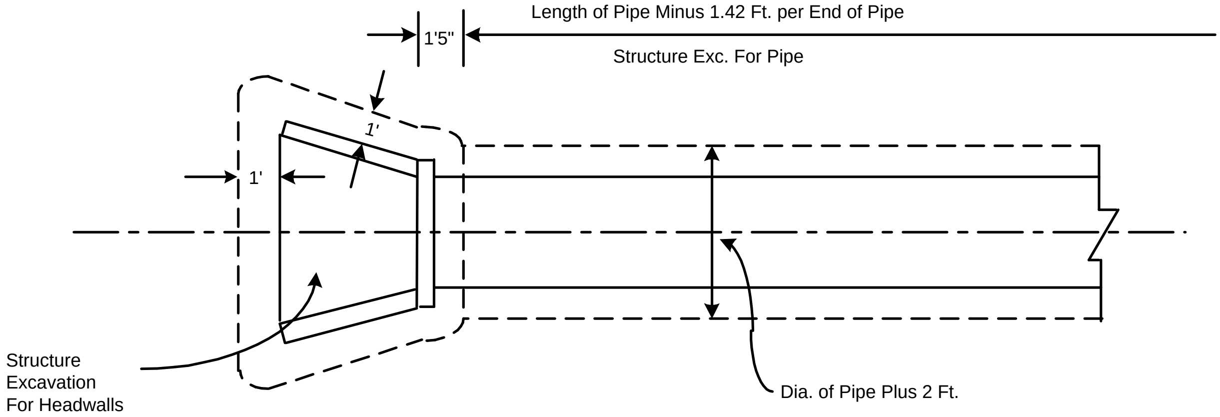
TABLE 6-B

The deductions shown below were determined similarly to those for round pipes in Table 1.

DEDUCTION EACH END FOR SKEWED ARCH PIPE CULVERTS
(WITH HEADWALLS)

SIZE	0ºSKEW	15º SKEW	30º SKEW
22 X 13	1.42	1.77	2.29
29 X 19	1.42	1.86	2.47
36 X 23	1.42	1.95	2.67
44 X 27	1.42	2.05	2.80
51 X 31	1.42	2.14	3.08
58 X 36	1.42	2.24	3.29
65 X 40	1.42	2.32	3.48
73 X 45	1.42	2.42	3.69
88 X 54	1.42	2.61	4.08

TABLE 7



STRUCTURE EXCAVATION (ONE FT. DEPTH)
CONCRETE ARCH PIPE CULVERT

	SINGLE LINE			DOUBLE LINE			TRIPLE LINE		
PIPE SIZE	Cu.Yds. Per Ft. of Pipe	Cu.Yds. One Hdwl.	Cu.Yds. One toe wall	Cu.Yds. Per Ft. of Pipe	Cu.Yds. One Hwdl.	Cu.Yds. One toe wall	Cu.Yds. Per Ft. of Pipe	Cu.Yds. One Hwdl	Cu.Yds. One toe wall
	STANDARD - 2:1 SLOPES HWA 2100								
22” x 13”	0.14	1.28	0.18	0.26	1.87	0.28	0.38	2.46	0.37
29” x 19”	0.16	1.66	0.23	0.31	2.47	0.34	0.45	3.29	0.46
36” x 23”	0.19	2.05	0.26	0.35	3.08	0.40	0.52	4.10	0.53
44” x 27”	0.21	2.52	0.30	0.42	3.90	0.47	0.62	5.28	0.63
51” x 31”	0.23	2.98	0.34	0.46	4.64	0.52	0.69	6.30	0.71
58” x 36”	0.25	3.57	0.38	0.52	5.66	0.60	0.78	7.75	0.81
65” x 40”	0.27	4.09	0.42	0.57	6.58	0.66	0.87	9.07	0.89
73” x 45”	0.30	4.80	0.46	0.64	7.82	0.73	0.97	10.857	1.00
88” x 54”	0.35	6.14	0.54	0.74	10.16	0.86	1.14	14.17	1.17
	STANDARD - 4:1 SLOPES HWA 4100								
22” x 13”	0.14	1.88	0.20	0.26	2.73	0.30	0.38	3.57	0.39
29” x 19”	0.16	2.76	0.26	0.31	4.01	0.37	0.45	5.27	0.48
36” x 23”	0.19	3.31	0.29	0.35	4.90	0.42	0.52	6.46	0.56
44” x 27”	0.21	4.13	0.34	0.42	6.29	0.50	0.62	8.45	0.66
51” x 31”	0.23	5.06	0.38	0.46	7.75	0.56	0.69	10.44	0.75
58” x 36”	0.25	6.19	0.43	0.52	9.64	0.64	0.78	13.09	0.85
65” x 40”	0.27	7.26	0.47	0.57	11.46	0.71	0.87	15.67	0.95
73” x 45”	0.30	8.64	0.52	0.64	13.81	0.79	0.97	18.97	1.05
88” x 54”	0.35	11.42	0.61	0.74	18.42	0.92	1.14	25.44	1.24

TABLE 8

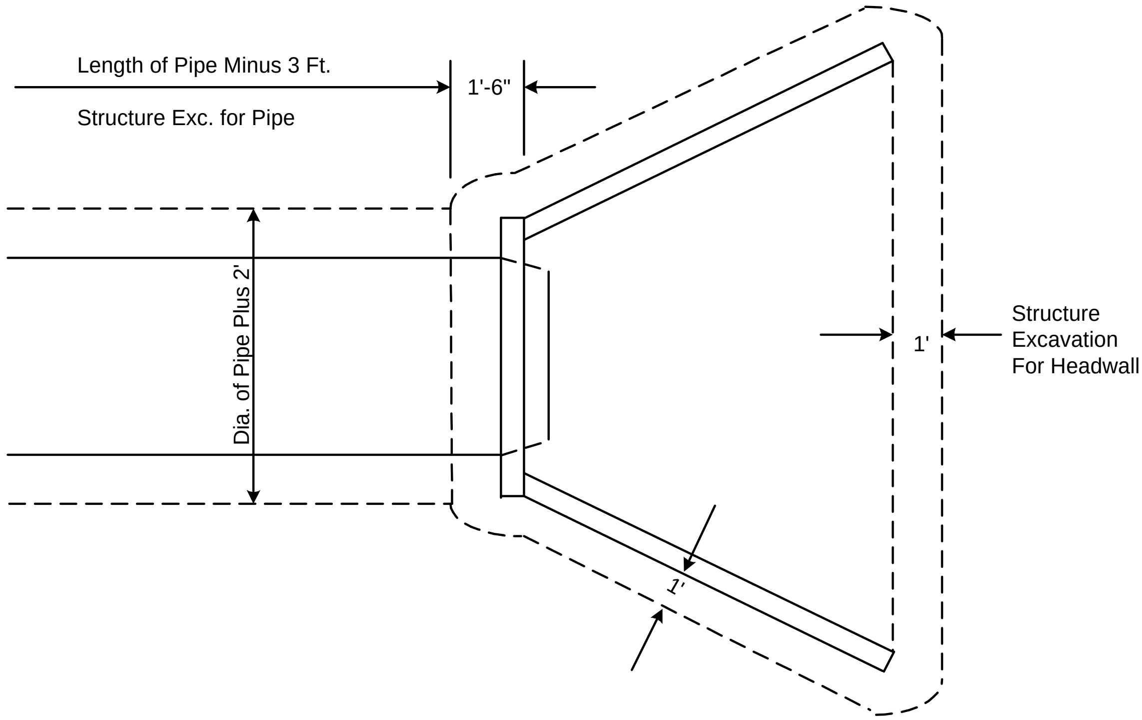
STRUCTURE EXCAV. (ONE FT. DEPTH) CONC. ARCH PIPE CULVERT CONTINUED:

	SINGLE LINE			DOUBLE LINE					
PIPE SIZE	Cu.Yds Per Ft. of Pipe	Cu.Yds One Hdwl.	Cu.Yds One toe wall	Cu.Yds. Per Ft. of Pipe	Cu.Yds. One Hwdl.	Cu.Yds. One toe wall	Cu.Yds. Per Ft. of Pipe	Cu.Yds. One Hwdl	Cu.Yds. One toe wall
30º SKEW - 2:1 SLOPES HWA 2130									
22” x 13”	0.14	1.34	0.19	0.26	2.02	0.30			
29” x 19”	0.16	1.71	0.23	0.31	2.63	0.36			
36” x 23”	0.19	2.14	0.27	0.35	3.33	0.42			
44” x 27”	0.21	2.64	0.31	0.42	4.24	0.50			
51” x 31”	0.23	3.12	0.35	0.46	4.99	0.56			
58” x 36”	0.25	3.75	0.39	0.52	6.17	0.63			
65” x 40”	0.27	4.31	0.43	0.57	7.20	0.70			
73” X 45”	0.30	5.05	0.47	0.64	8.55	0.78			
88” X 54”	0.35	6.46	0.55	0.74	11.09	0.91			
30º SKEW - 4:1 SLOPES HWA 4130									
22” x 13”	0.14	2.19	0.25	0.26	3.17	0.36			
29” x 19”	0.16	3.26	0.32	0.31	4.71	0.45			
36” x 23”	0.19	3.92	0.36	0.35	5.76	0.52			
44” x 27”	0.21	4.91	0.42	0.42	7.41	0.61			
51” x 31”	0.23	6.05	0.48	0.46	9.16	0.69			
58” x 36”	0.25	7.43	0.54	0.52	11.41	0.78			
65” x 40”	0.27	8.74	0.59	0.57	13.59	0.87			
73” x 45”	0.30	10.43	0.66	0.64	16.39	0.96			
88” x 54	0.35	13.83	0.77	0.74	21.93	1.13			

NOTE: The quantities shown in Table are correct and will be used unless authorized modifications are made.

EXAMPLE: 48’ of 36” X 23” Single Line Culvert. From field observations, the average cut to flow line is as follows:
Pipe 1.3 Ft., Upstream Headwall 1.7 Ft., Downstream Headwall 1.6 Ft.
From Table: Structure Excavation = (48 - 2.84)0.19+1.59 + (2.05 x 2.57) + (2.05 + 2.47) + (2 x 0.26) = 24.49 C.Y.
Pay 24.5 Cu. Yds.

Table 8 - Continued



SKETCH SHOWING LIMITS FOR
STRUCTURE EXCAVATION FOR PIPE CATTLE PASS

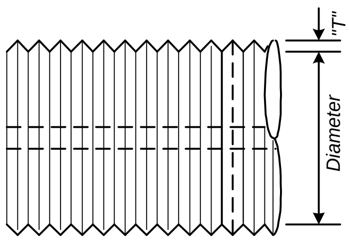
STRUCTURE EXCAVATION FOR REINFORCED
CONCRETE PIPE CATTLE PASS (ONE FT. DEPTH)

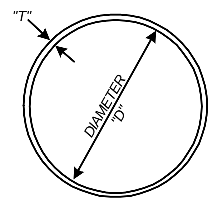
PIPE SIZE	CU.YDS. per Ft. of Pipe	CU.YDS. One Headwall	CU.YDS. One Toewall	
48” x 72”	.22	6.49	.48	CP-1
		30º SKEW		
48” X 72”	.22	6.57	.47	CP-1S

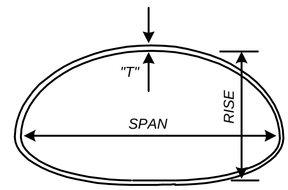
2:1 Slope

NOTE: The quantities shown in Table are correct and will be used unless authorized modifications are made.

TABLE 9





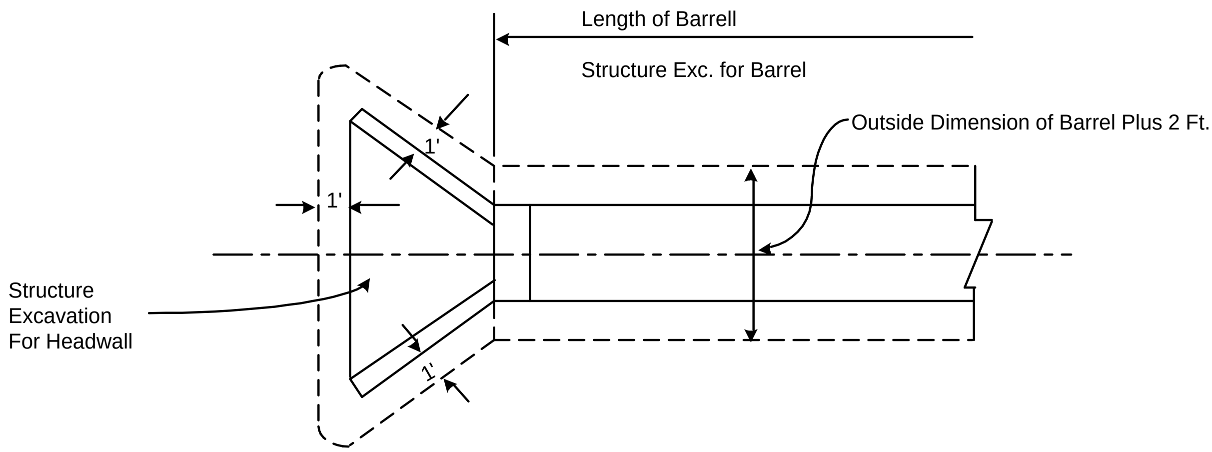


STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR
CORRUGATED STEEL PIPE AND F. E. S.

SINGLE LINE (STD. PIPE)				SINGLE LINE (ARCH PIPE)			
PIPE SIZE (IN.)	"T" (FT.)	CU.YD. PER FT. OF PIPE	CU.YD. PER F.E.S.	PIPE SIZE (IN.)	"T" (FT.)	CU.YD. PER FT. OF PIPE	CU.YD. PER F.E.S.
15	0.04	0.12	0.52	18x11	0.04	0.13	0.44
18	0.04	0.13	0.65	22x13	0.04	0.14	0.54
24	0.04	0.15	0.95	25x16	0.04	0.15	0.67
30	0.04	0.17	1.31	29x18	0.04	0.16	0.81
36	0.08	0.19	1.70	36x22	0.08	0.19	1.07
42	0.08	0.20	2.15	43x27	0.08	0.21	1.42
48	0.08	0.22	2.57	50x31	0.08	0.23	1.75
54	0.08	0.24	2.96	58x36	0.08	0.25	2.24
60	0.08	0.26	3.28	65x40	0.08	0.27	2.65
66	0.08	0.28	3.44	72x44	0.08	0.30	3.09
72	0.08	0.30	3.59	79x49	0.08	0.32	3.31
78	0.08	0.31	3.74	85x54	0.08	0.34	3.51
84	0.08	0.33	3.90				

NOTE: If Corrugated Steel Structural Plate Pipe (not to be confused with the above pipe) is used, Structure Excavation will be determined using "T" as "4" regardless of pipe size, which starts at 60" and may be as large as 252" for round pipe and starting at 6'-1" x 4'-7" to as large as 20'-7" x 13'-2" for arch pipe.

TABLE 10



SKETCH SHOWING LIMITS FOR COMPUTING
STRUCTURE EXCAVATION

STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR IBS & IBD
AND BS & BD SERIES BOX CULVERTS 2:1 SLOPE

BS-2					BS-3				
SIZE	"T"	Cu.Yds. per Ft. of Bbl.	Cu.Yds. One Hdwl.	Cu.Yds. (1) Const.	SIZE	"T"	Cu. Yds. per Ft. of Bbl.	Cu.Yds. One Hdwl.	Cu.Yds. (1) Const.
2 x 2	6"	0.19	1.46	0.20	3 x 3	6½"	0.22	2.49	0.28
3 x 2	6½"	0.22	1.65	0.23	4 x 3	7	0.26	2.74	0.31
4 x 2	7"	0.26	1.84	0.25	5 x 3	7½"	0.30	2.99	0.34
5 x 2	7½"	0.30	2.03	0.28	6 x 3	8"	0.34	3.24	0.36
6 x 2	8"	0.33	2.22	0.31	7 x 3	8"	0.37	3.49	0.39
7 x 2	8"	0.37	2.40	0.34	8 x 3	8½"	0.41	3.74	0.42
8 x 2	8"	0.42	2.59	0.37	9 x 3	9"	0.45	3.99	0.45
IBS-4-2W & BS-4					IBS-5-2W & BS-5				
4 x 4	6½"	0.26	3.71	0.36	5 x 5	7"	0.30	4.95	0.43
5 x4	7½"	0.30	4.02	0.39	6 x 5	7½"	0.34	5.31	0.46
6 x4	7½"	0.34	4.33	0.42	7 x5	8"	0.38	5.67	0.49
7 x 4	8"	0.37	4.65	0.44	8 x 5	8½"	0.41	6.04	0.51
8 x 4	8½"	0.41	4.96	0.47	9 x 5	9"	0.45	6.40	0.54
9 x 4	9"	0.45	5.27	0.50	10 x 5	9½"	0.49	6.76	0.57
10 x 4	9½"	0.48	5.58	0.53	12 x 5	10	0.56	7.48	0.63

TABLE 20

STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR IBS & IBD AND BS & BD SERIES BOX CULVERTS - CONTINUED: 2:1 SLOPE

SIZE	"T"	Cu. Yds. per Ft. of Bbl.	Cu.Yds. One Hdwl.	Cu.Yds. (1) Const.
IBS-6-2W & BS-6				
4 x 6	7”	0.27	6.54	0.45
6 x 6	7½“	0.34	7.46	0.51
8 x 6	8½“	0.42	8.37	0.56
10 x 6	9½“	0.49	9.28	0.61
12 x 6	10½“	0.57	10.19	0.66
14 x 6	1’0”	0.65	11.10	0.72
16 x 6	1”1”	0.73	12.01	0.77
18 x 6	1’2”	0.81	12.92	0.82
20 x 6	1’3”	0.90	13.83	0.87
IBS-10-2W & BS-10				
10 x 10	10”	0.51	15.60	3.72
12 x 10	11”	0.58	16.90	3.94
14 x 10	1’0”	0.65	18.21	4.17
16 x 10	1’1”	0.73	19.51	4.43
18 x 10	1’2”	0.81	20.81	4.70
20 x 10	1’3”	0.91	22.11	4.99
22 x 10	1’4½“	0.98	23.42	5.33
IBD-4-2W & BD-4				
8 x 4	7”	0.43	5.11	0.48
10 x 4	7½“	0.50	5.74	0.54
12 x 4	8”	0.57	6.36	0.60
16 x 4	9”	0.73	7.60	0.71
20 x 4	10”	0.88	8.88	0.82
24 x 4	11½“	1.03	10.13	0.93
IBD-6-2W & BD-6				
12 x 6	8½“	0.58	10.43	0.69
16 x 6	9½“	0.74	12.27	0.79
20 x 6	10”	0.88	14.09	0.90
24 x 6	11½“	1.03	15.91	1.00
28 x 6	1’1”	1.19	17.77	1.11
32 x 6	1’2½	1.34	19.61	1.21
IBD-10-2W & BD-10				
20 x 10	11½“	0.90	22.63	4.79
24 x 10	1’0½“	1.05	25.23	5.25
28 x 10	1’1½“	1.20	27.87	5.75
32 x 10	1’3”	1.36	30.50	6.32
36 x 10	1’4½“	1.51	33.16	6.93

SIZE	"T"	Cu.Yds. per Ft. of Bbl.	Cu.Yds. One Hdwl.	Cu.Yds. (1) Const.
IBS-8-2W & BS-8				
8 x 8	9”	0.42	11.79	1.07
10 x 8	9½“	0.49	12.94	1.25
12 x 8	10½“	0.57	14.09	1.45
14 x 8	1’0”	0.64	15.24	1.69
16 x 8	1’1”	0.72	16.39	1.92
18 x 8	1’2”	0.79	17.55	2.17
20 x 8	1’3”	0.90	18.69	2.43
IBS-12-2W & BS-12				
12 x 12	11½“	0.59	20.58	5.34
14 x 12	1’0”	0.66	22.07	5.56
16 x 12	1’1”	0.73	23.56	5.82
18 x 12	1’2”	0.81	25.05	6.09
20 x 12	1’3”	0.90	26.54	6.37
22 x 12	1’4½“	0.98	28.03	6.72
24 x 12	1’6”	1.06	29.52	7.04
IBD-5-2W & BD-5				
10 x 5	7½“	0.50	6.94	0.58
12 x 5	8”	0.58	7.67	0.64
16 x 5	9”	0.73	9.12	0.75
20 x 5	10”	0.88	10.58	0.87
24 x 5	11½“	1.03	12.04	1.00
28 x 5	1’1”	1.19	13.50	1.09
IBD-8-2W & BD-8				
16 x 8	10”	0.74	16.77	1.78
20 x 8	11”	0.92	19.10	2.17
24 x 8	1’0½“	1.05	21.42	2.63
28 x 8	1’1½“	1.19	23.72	3.06
32 x 8	1’2½“	1.35	26.04	3.54
IBD-12 2W & BD-12				
24 x 12	1’1”	1.07	30.20	6.66
28 x 12	1’2”	1.21	33.18	7.15
32 x 12	1’3½“	1.37	36.20	7.74
36 x 12	1’5”	1.52	39.21	8.35
40 x 12	1’6”	1.67	42.20	8.93

TABLE 20 -CONTINUED

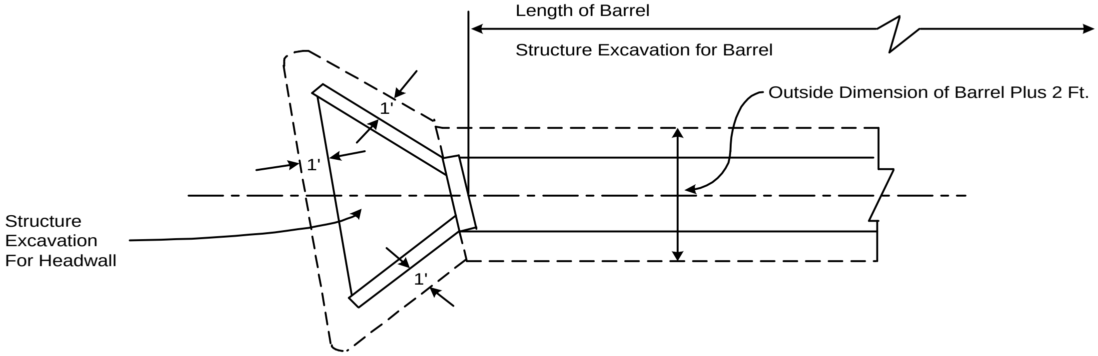
STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR STATE STANDARD IBS AND IBD AND BS & BD SERIES BOX CULVERTS - CONTINUED: 2:1 SLOPE

(1) NOTE: The constant quantity includes the toe wall in all instances, the auxiliary slab under end of barrel, and thickened apron where applicable.

NOTE: The quantities shown in the above table are correct and will be used on the final estimate as the basis of payment, unless authorized modifications are made.

EXAMPLE: 33.5’ of 8’ X 6’ Box Culvert (St. Std. BS-6). From Field Observations the average cut to flow line is as follows:
Barrel 1.7 Ft., Upstream Headwall 1.9 Ft., Downstream Headwall 1.3 Ft.
From Table: Structure Excavation=(33.5 x 0.42 x 2.41)+(8.37 x 2.48)+(8.37x1.88)+(0.56 x 2) = 71.53 Cu.Yds.
Pay 71.5 Cu.Yds.

Table 20 - Continued:



SKETCH SHOWING LIMITS FOR COMPUTING
STRUCTURE EXCAVATION

STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR IBS &
IBD and BS & BD SERIES BOX CULVERTS - 15º SKEW (2:1 Slope)
FOR STANDARD ISK-15-2W FOR IBS & IBD SERIES

BS-2				BS-3			
SIZE	Cu.Yds. per Ft. of Barrel	Cu.Yds. One Headwall	Cu.Yds. (1) Constant	SIZE	Cu.Yds. per Ft. of Barrel	Cu.Yds. One Headwall	Cu.Yds. (1) Constant
2 x2	0.19	1.47	0.20	3 x 3	0.22	2.51	0.30
3 x 2	0.22	1.65	0.22	4 x 3	0.26	2.76	0.33
4 x 2	0.26	1.84	0.25	5 x 3	0.30	3.01	0.36
5 x 2	0.30	2.02	0.28	6 x 3	0.34	3.26	0.38
6 x 2	0.33	2.21	0.31	7 x 3	0.37	3.51	0.41
7 x 2	0.37	2.39	0.34	8 x 3	0.41	3.76	0.44
8 x 2	0.42	2.58	0.37	9 x 3	0.45	4.01	0.47
BS-4				BS-5			
4 x 4	0.26	3.80	0.39	5 x 5	0.30	5.09	0.46
5 x 4	0.30	4.11	0.41	6 x 5	0.34	5.45	0.49
6 x 4	0.34	4.42	0.44	7 x 5	0.38	5.81	0.52
7 x 4	0.37	4.73	0.47	8 x 5	0.41	6.18	0.55
8 x 4	0.41	5.05	0.50	9 x 5	0.45	6.54	0.58
9 x 4	0.45	5.36	0.53	10 x 5	0.49	6.91	0.60
10 x 4	0.48	5.68	0.56	12 x 5	0.56	7.64	0.66
BS-6				BS-8			
4 x 6	0.27	6.76	0.50	8 x 8	0.42	12.14	1.17
6 x 6	0.34	7.68	0.55	10 x 8	0.49	13.30	1.35
8 x 6	0.42	8.60	0.60	12 x 8	0.57	14.47	1.56
10 x 6	0.49	9.52	0.66	14 x 8	0.64	15.63	1.81
12 x 6	0.57	10.44	0.71	16 x 8	0.72	16.79	2.10
14 x 6	0.65	11.36	0.77	18 x 8	0.79	17.96	2.30
16 x 6	0.73	12.28	0.82	20 x 8	0.90	19.12	2.56
18 x 6	0.81	13.20	0.88				
20 x 6	0.90	14.12	0.93				

TABLE 21

STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR IBS & IBD AND BS & BD SERIES
BOX CULVERTS - 15º SKEW - CONTINUED: (2:1 Slope)

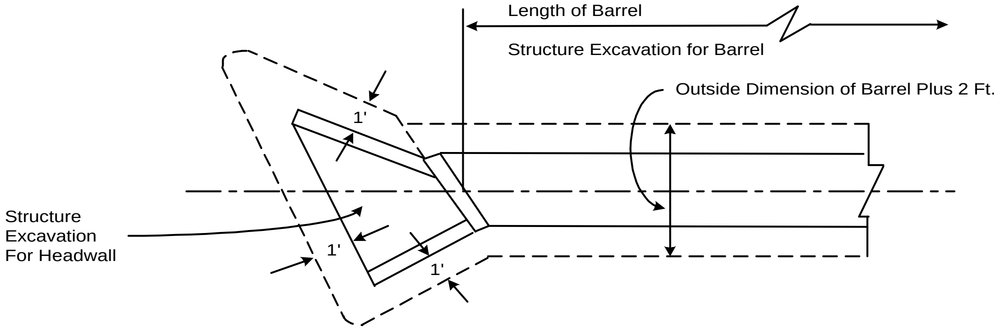
SIZE	Cu.Yds. per Ft. of Barrel	Cu.Yds. One Headwall	Cu.Yds. (1) Constant	SIZE	Cu.Yds. per Ft. of Barrel	Cu.Yds. One Headwall	Cu.Yds. (1) Constant	
BS-10				BS-12				
10 x 10	0.51	16.03	3.79	12 x 12	0.59	21.15	5.56	
12 x 10	0.58	17.34	4.02	14 x 12	0.66	22.66	5.78	
14 x 10	0.65	18.66	4.26	16 x 12	0.73	24.17	6.04	
16 x 10	0.73	19.97	4.53	18 x 12	0.81	25.67	6.31	
18 x 10	0.81	21.29	4.81	20 x 12	0.90	27.18	6.60	
20 x 10	0.91	22.61	5.10	22 x 12	0.98	28.69	6.94	
22 x 10	0.98	23.92	5.44	24 x 12	1.06	30.20	7.31	
BD-4				BD-5				
8 x 4	0.43	5.21	0.51	10 x 5	0.50	7.09	0.62	
10 x 4	0.50	5.83	0.57	12 x 5	0.58	7.83	0.68	
12 x 4	0.57	6.46	0.63	16 x 5	0.73	9.29	0.79	
16 x 4	0.73	7.72	0.75	20 x 5	0.88	10.76	0.91	
20 x 4	0.88	8.99	0.86	24 x 5	1.03	12.23	1.02	
24 x 4	1.03	10.24	0.98	28 x 5	1.19	13.71	1.14	
BD-6				BD-8				
12 x 6	0.58	10.71	0.73	16 x 8	0.74	17.18	1.90	
16 x 6	0.74	12.57	0.84	20 x 8	0.92	19.53	2.30	
20 x 6	0.88	14.41	0.95	24 x 8	1.05	21.88	2.78	
24 x 6	1.03	16.25	1.06	28 x 8	1.19	24.21	3.23	
28 x 6	1.19	18.12	1.17	32 x 8	1.35	26.56	3.71	
32 x 6	1.34	19.98	1.28					
BD-10				BD-12				
20 x 10	0.90	23.13	4.90	24 x 12	1.07	30.89	6.95	
24 x 10	1.05	25.76	5.37	28 x 12	1.21	33.90	7.46	
28 x 10	1.20	28.38	5.88	32 x 12	1.37	36.95	8.05	
32 x 10	1.36	31.08	6.47	36 x 12	1.52	40.00	8.69	
36 x 10	1.51	33.77	7.11	40 x 12	1.67	43.01	9.29	

(1) NOTE: The constant quantity includes the tow wall in all instances, the auxiliary slab under end of barrel and thickened apron where applicable.

NOTE: The quantities shown are correct and will be used on the final estimate as the basis of payment, unless authorized modifications are made.

EXAMPLE: 37.8’ of 20’ X 5’ Box Culvert (St. Std. BD-5). From Field Observations the average cut to flow line is as follows:
Barrel 1.9 Ft., Upstream Headwall 2.1 Ft., Downstream Headwall 1.5 Ft.
From Table: Structure Excavation = (37.8 x 0.88 x 2.73)+(10.76 x 2.60)+
(10.76 x 2.00)+(0.91x2) = 142.14 Cu.Yds.
Pay 142.1 Cu.Yds.

Table 21 - Continued:



SKETCH SHOWING LIMITS FOR COMPUTING
STRUCTURE EXCAVATION

STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR IBS & IBD and BS & BD SERIES BOX CULVERTS - 30º SKEW (2:1 Slope)
FOR STANDARD ISK-30-2W FOR IBS & IBD SERIES

SIZE	Cu.Yds. per Ft. of Barrel	Cu.Yds. One Headwall	Cu.Yds. (1) Constant	SIZE	Cu.Yds. per Ft. of Barrel	Cu.Yds. One Headwall	Cu.Yds. (1) Constant
BS-2				BS-3			
2 x2	0.19	1.45	0.20	3 x 3	0.22	2.44	0.27
3 x 2	0.22	1.65	0.23	4 x 3	0.26	2.72	0.31
4 x 2	0.26	1.86	0.26	5 x 3	0.30	2.99	0.34
5 x 2	0.30	2.07	0.29	6 x 3	0.34	3.27	0.37
6 x 2	0.33	2.27	0.32	7 x 3	0.37	3.55	0.40
7 x 2	0.37	2.48	0.36	8 x 3	0.41	3.83	0.44
8 x 2	0.42	2.68	0.39	9 x 3	0.45	4.10	0.47
BS-4				BS-5			
4 x 4	0.26	3.67	0.35	5 x 5	0.30	4.92	0.42
5 x 4	0.30	4.02	0.39	6 x 5	0.34	5.33	0.45
6 x 4	0.34	4.37	0.42	7 x 5	0.38	5.73	0.49
7 x 4	0.37	4.72	0.45	8 x 5	0.41	6.14	0.52
8 x 4	0.41	5.07	0.48	9 x 5	0.45	6.55	0.55
9 x 4	0.45	5.42	0.51	10 x 5	0.49	6.95	0.58
10 x 4	0.48	5.77	0.55	12 x 5	0.56	7.76	0.65
BS-6				BS-8			
4 x 6	0.27	6.35	0.44	8 x 8	0.42	11.68	1.20
6 x 6	0.34	7.38	0.50	10 x 8	0.49	12.97	1.40
8 x 6	0.42	8.41	0.56	12 x 8	0.57	14.27	1.63
10 x 6	0.49	9.43	0.62	14 x 8	0.64	15.56	1.90
12 x 6	0.57	10.46	0.68	16 x 8	0.72	16.86	2.17
14 x 6	0.65	11.48	0.74	18 x 8	0.79	18.16	2.45
16 x 6	0.73	12.51	0.80	20 x 8	0.90	19.45	2.75
18 x 6	0.81	13.54	0.86				
20 x 6	0.90	14.56	0.92				

TABLE 22

STRUCTURE EXCAVATION (ONE FT DEPTH) FOR IBS & IBD AND BS & BD SERIES BOX CULVERTS - 30º SKEW - CONTINUED: (2:1 Slope)

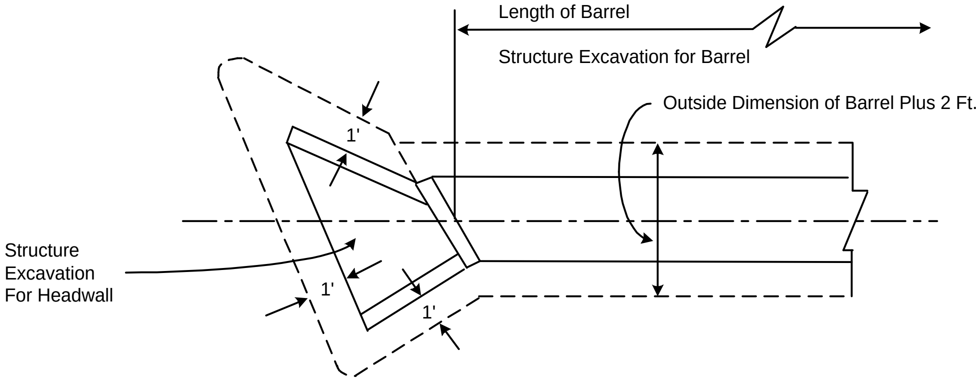
SIZE	Cu.Yds. per Ft. of Barrel	Cu.Yds. One Headwall	Cu.Yds. (1) Constant	SIZE	Cu.Yds. per Ft. of Barrel	Cu.Yds. One Headwall	Cu.Yds. (1) Constant
BS-10				BS-12			
10 x 10	0.51	15.50	3.79	12 x 12	0.59	20.48	5.55
12 x 10	0.58	16.97	4.04	14 x 12	0.66	22.16	5.79
14 x 10	0.65	18.43	4.31	16 x 12	0.73	23.84	6.08
16 x 10	0.73	19.90	4.61	18 x 12	0.81	25.52	6.39
18 x 10	0.81	21.37	4.92	20 x 12	0.90	27.20	6.71
20 x 10	0.91	22.84	5.25	22 x 12	0.98	28.88	7.05
22 x 10	0.98	24.30	5.62	24 x 12	1.06	30.57	7.50
BD-4				BD-5			
8 x 4	0.43	5.25	0.50	10 x 5	0.50	7.16	0.60
10 x 4	0.50	5.94	0.56	12 x 5	0.58	7.98	0.67
12 x 4	0.57	6.64	0.63	16 x 5	0.73	9.61	0.79
16 x 4	0.73	8.05	0.76	20 x 5	0.88	11.25	0.92
20 x 4	0.88	9.46	0.88	24 x 5	1.03	12.89	1.05
24 x 4	1.03	10.86	1.01	28 x 5	1.19	14.53	1.18
BD-6				BD-8			
12 x 6	0.58	10.76	0.70	16 x 8	0.74	17.29	2.01
16 x 6	0.74	12.83	0.82	20 x 8	0.92	19.91	2.46
20 x 6	0.88	14.88	0.94	24 x 8	1.05	22.53	2.99
24 x 6	1.03	16.93	1.06	28 x 8	1.19	25.13	3.49
28 x 6	1.19	19.03	1.19	32 x 8	1.35	27.75	4.03
32 x 6	1.34	21.10	1.31				
BD-10				BD-12			
20 x 10	0.90	23.42	5.02	24 x 12	1.07	31.34	7.06
24 x 10	1.05	26.35	5.55	28 x 12	1.21	34.70	7.65
28 x 10	1.20	29.32	6.16	32 x 12	1.37	38.10	8.33
32 x 10	1.36	32.28	6.78	36 x 12	1.52	41.49	9.04
36 x 10	1.51	35.28	7.49	40 x 12	1.67	44.86	9.71

(1) NOTE: The constant quantity includes the toe wall in all instances, the auxiliary slab under end of barrel and thickened apron where applicable.

NOTE: The quantities shown in above table are correct and will be used on the final estimate as the basis of payment, unless authorized modifications are made.

EXAMPLE: 42.4’ of 12’ X 6’ Box Culvert (St. Stds. BS-6 & SK-30). From Field Observations, the average cut to flow line is as follows:
Barrel 2.4 Ft., Upstream Headwall 2.6 Ft.; Downstream headwall 1.8 Ft.
From Table:
Str.Exc.=(42.4x0.57x3.28)+(10.46x3.18)+(10.46x2.38)+(0.68x2)=138.78 C.Y.
Pay 138.8 Cu.Yds.

Table 22 - Continued:



SKETCH SHOWING LIMITS FOR COMPUTING
STRUCTURE EXCAVATION

STRUCTURE EXCAVATION (ONE FT. DEPTH FOR IBS & IBD
AND BS & BD SERIES BOX CULVERTS - 45º SKEW
FOR STANDARD ISK-45-2W FOR IBS & IBD SERIES 2:1 SLOPE

SIZE	Cu.Yds. per Ft. of Barrel	Cu.Yds. One Headwall	Cu.Yds. (1) Constant	SIZE	Cu.Yds. per Ft. of Barrel	Cu.Yds. One Headwall	Cu.Yds. (1) Constant
BS-2				BS-3			
2 x2	0.19	1.97	0.29	3 x 3	0.22	3.36	0.41
3 x 2	0.22	2.22	0.33	4 x 3	0.26	3.70	0.45
4 x 2	0.26	2.47	0.37	5 x 3	0.30	4.04	0.49
5 x 2	0.30	2.73	0.41	6 x 3	0.34	4.38	0.53
6 x 2	0.33	2.98	0.45	7 x 3	0.37	4.72	0.57
7 x 2	0.37	3.23	0.49	8 x 3	0.41	5.06	0.61
8 x 2	0.42	3.49	0.53	9 x 3	0.45	5.40	0.65
IBS & BS-4				IBS & BS-5			
4 x 4	0.26	5.11	0.53	5 x 5	0.30	6.86	0.63
5 x 4	0.30	5.54	0.57	6 x 5	0.34	7.36	0.67
6 x 4	0.34	5.96	0.61	7 x 5	0.38	7.86	0.71
7 x 4	0.37	6.39	0.65	8 x 5	0.41	8.35	0.75
8 x 4	0.41	6.82	0.69	9 x 5	0.45	8.85	0.79
9 x 4	0.45	7.25	0.73	10 x 5	0.49	9.35	0.83
10 x 4	0.48	7.68	0.77	12 x 5	0.56	10.34	0.91
IBS & BS-6				IBS & BS-8			
4 x 6	0.27	9.11	0.68	8 x 8	0.42	16.44	1.67
6 x 6	0.34	10.37	0.75	10 x 8	0.49	18.03	1.91
8 x 6	0.42	11.63	0.83	12 x 8	0.57	19.62	2.19
10 x 6	0.49	12.89	0.90	14 x 8	0.64	21.21	2.53
12 x 6	0.57	14.14	0.98	16 x 8	0.72	22.79	2.86
14 x 6	0.65	15.41	1.05	18 x 8	0.79	24.38	3.21
16 x 6	0.73	16.66	1.12	20 x 8	0.90	25.97	3.57
18 x 6	0.81	17.91	1.20				
20 x 6	0.90	19.17	1.27				

TABLE 23

STRUCTURE EXCAV. (ONE FT. DEPTH) FOR IBS &IBD AND BS&BD SERIES
BOX CULVERTS - 45° SKEW - CONTINUED: 2:1 SLOPE

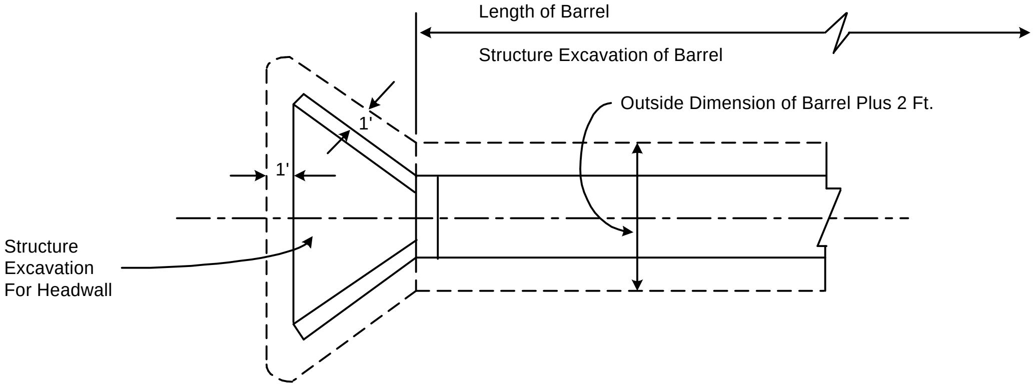
SIZE	Cu.Yds. per Ft. of Barrel	Cu.Yds. One Headwall	Cu.Yds. (1) Constant	SIZE	Cu.Yds. per Ft. of Barrel	Cu.Yds. One Headwall	Cu.Yds. (1) Constant
IBS & BS-10				IBS & BS-12			
10 x 10	0.51	21.70	4.93	12 x 12	0.59	28.66	7.19
12 x 10	0.58	23.50	5.25	14 x 12	0.66	30.72	7.49
14 x 10	0.65	25.30	5.58	16 x 12	0.73	32.78	7.85
16 x 10	0.73	27.10	5.94	18 x 12	0.81	34.84	8.23
18 x 10	0.81	28.89	6.32	20 x 12	0.90	36.90	8.62
20 x 10	0.91	30.69	6.72	22 x 12	0.98	38.96	9.09
22 x 10	0.98	32.49	7.19	24 x 12	1.06	41.02	9.58
IBD & BD-4				IBD & BD-5			
8 x 4	0.43	7.03	0.71	10 x 5	0.50	9.60	0.85
10 x 4	0.50	7.89	0.78	12 x 5	0.58	10.61	0.93
12 x 4	0.57	8.74	0.86	16 x 5	0.73	12.60	1.09
16 x 4	0.73	10.47	1.02	20 x 5	0.88	14.61	1.25
20 x 4	0.88	12.20	1.18	24 x 5	1.03	16.62	1.40
24 x 4	1.03	13.91	1.34	28 x 5	1.19	18.64	1.56
IBD & BD-6				IBD & BD-8			
12 x 6	0.58	14.51	1.00	16 x 8	0.74	23.32	2.66
16 x 6	0.74	17.05	1.15	20 x 8	0.92	26.53	3.21
20 x 6	0.88	19.56	1.30	24 x 8	1.05	29.74	3.86
24 x 6	1.03	22.08	1.44	28 x 8	1.19	32.92	4.47
28 x 6	1.19	24.64	1.60	32 x 8	1.35	36.13	5.14
32 x 6	1.34	27.18	1.75				
IBD & BD-10				IBD & BD-12			
20 x 10	0.90	31.40	6.44	24 x 12	1.07	41.96	9.09
24 x 10	1.05	35.00	7.09	28 x 12	1.21	46.08	9.79
28 x 10	1.20	38.63	7.79	32 x 12	1.37	50.25	10.60
32 x 10	1.36	42.27	8.60	36 x 12	1.52	54.41	11.48
36 x 10	1.51	45.94	9.47	40 x 12	1.67	58.53	12.29

(1) NOTE: The constant quantity includes the toe wall in all instances, the auxiliary slab under end of Barrel and thickened apron where applicable.

NOTE: The quantities shown in above Table are correct and will be used on the final Estimate as the basis of payment, unless authorized modifications are made.

EXAMPLE: 47.2’ of 10’ x 8’ Box Culvert (St. Stds. BS-8 & SK-45). From Field observations the average cut to flow line is as follows:
Barrel 2.1 ft., Upstream Headwall 2.4 Ft., Downstream Headwall 1.6 Ft.
From Table: Str. Exc.=(47.2x0.49x2.89)+(18.03x3.11)+(18.03x2.31)+(1.91x2)
= 168.38 Cu.Yds.
Pay 168.4 Cu. Yds.

Table 23 - Continued:



SKETCH SHOWING LIMITS FOR COMPUTING
STRUCTURE EXCAVATION

STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR IBS & IBD
AND BS & BD SERIES BOX CULVERTS (3:1 SLOPE)
FOR STANDARDS IWS-3 & IWD-3 FOR IBS & IBD SERIES 2:1 SLOPE

SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.	SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.
BS-4					BS-5				
4 x 4	0.26	5.46	0.36	0.36	5 x 5	0.30	7.26	0.43	0.43
5 x 4	0.30	5.93	0.39	0.39	6 x 5	0.34	7.81	0.46	0.46
6 x 4	0.34	6.39	0.42	0.42	7 x 5	0.38	8.35	0.49	0.49
7 x 4	0.37	6.86	0.45	0.45	8 x 5	0.41	8.89	0.52	0.52
8 x 4	0.41	7.33	0.48	0.48	9 x 5	0.45	9.44	0.54	0.54
9 x 4	0.45	7.80	0.50	0.50	10 x 5	0.49	9.98	0.57	0.57
10 x 4	0.48	8.27	0.53	0.53	12 x 5	0.56	11.07	0.63	0.63
IBS & BS-6					IBS & BS-8				
4 x 6	0.27	9.51	0.46	0.46	8 x 8	0.42	17.15	1.07	1.07
6 x 6	0.34	10.88	0.51	0.51	10 x 8	0.49	18.87	1.25	1.25
8 x 6	0.42	12.25	0.56	0.56	12 x 8	0.57	20.59	1.44	1.44
10 x 6	0.49	13.61	0.61	0.61	14 x 8	0.64	22.31	1.69	1.69
12 x 6	0.57	14.98	0.67	0.67	16 x 8	0.72	24.04	1.92	1.92
14 x 6	0.65	16.35	0.72	0.72	18 x 8	0.79	25.76	2.17	2.17
16 x 6	0.73	17.71	0.77	0.77	20 x 8	0.90	27.48	2.43	2.43
18 x 6	0.81	19.08	0.82	0.82					
20 x 6	0.90	20.45	0.88	0.88					
IBS & BS-10					IBW & BS-12				
10x10	0.51	22.67	4.58	4.58	12x12	0.59	29.88	6.67	6.67
12x10	0.58	24.62	4.82	4.82	14x12	0.66	32.11	6.89	6.89
14x10	0.65	26.57	5.06	5.06	16x12	0.73	34.33	7.14	7.14
16x10	0.73	28.51	5.31	5.31	18x12	0.81	36.56	7.41	7.41
18x10	0.81	30.46	5.59	5.59	20x12	0.90	38.79	7.69	7.69
20x10	0.91	32.41	5.88	5.88	22x12	0.98	41.01	8.03	8.03
22x10	0.98	34.36	6.21	6.21	24x12	1.06	43.24	8.38	8.38

TABLE 24

STRUCTURE EXCAV. (ONE FT. DEPTH) FOR IBS & IBD AND BS & BD SERIES
BOX CULVERTS
(3:1 SLOPE) - CONTINUED:

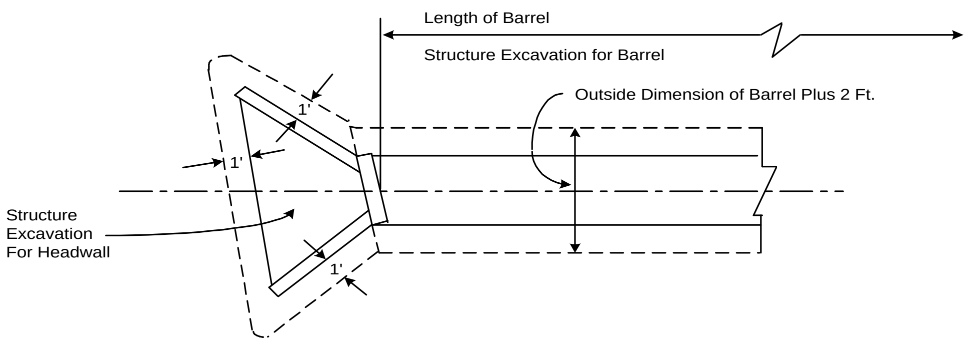
SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.	SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.
IBD & BD-4					IBD & BD-5				
8x4	0.43	7.57	0.49	0.49	10x5	0.50	10.25	0.59	0.59
10x4	0.50	8.51	0.55	0.55	12x5	0.58	11.36	0.64	0.64
12x4	0.57	9.45	0.60	0.60	16x5	0.73	13.54	0.75	0.75
16x4	0.73	11.34	0.71	0.71	20x5	0.88	15.73	0.87	0.87
20x4	0.88	13.24	0.83	0.83	24x5	1.03	17.93	0.98	0.98
24x4	1.03	15.11	0.94	0.94	28x5	1.19	20.12	1.09	1.09
IBD & BD-6					IBD & BD-8				
12x6	0.58	15.38	0.68	0.68	16x8	0.74	24.61	1.78	1.78
16x6	0.74	18.14	0.79	0.79	20x8	0.92	28.09	2.17	2.17
20x6	0.88	20.87	0.89	0.89	24x8	1.05	31.57	2.62	2.62
24x6	1.03	23.61	1.00	1.00	28x8	1.19	35.01	3.06	3.06
28x6	1.19	26.40	1.11	1.11	32x8	1.35	38.49	3.53	3.53
32x6	1.34	29.16	1.21	1.21					
IBD & BD-10					IBD & BD-12				
20x10	0.90	33.18	5.96	5.67	24x12	1.07	44.26	8.35	8.02
24x10	1.05	37.07	6.41	6.12	28x12	1.21	48.71	8.84	8.51
28x10	1.20	41.01	6.91	6.62	32x12	1.37	53.21	9.42	9.09
32x10	1.36	44.94	7.48	7.19	36x12	1.52	57.71	10.04	9.70
36x10	1.51	48.92	8.10	7.81	40x12	1.67	62.17	10.62	10.28

(1) NOTE: The constant quantity includes the tow wall in all instances, the auxiliary slab under end of barrel, thickened apron where applicable, and center extension wall thickened apron on upstream headwall.

NOTE: The quantities shown in above table are correct and will be used on the final estimate as the basis of payment, unless authorized modifications are made.

EXAMPLE: 33.5’ of 8’ x 6’ Box Culvert (St. Std. BS-6). From Field Observation the average cut to flow line is as follows:
Barrel 1.7 ft., Upstream Headwall 1.9 ft., Downstream Headwall 1.3 Ft.
From Table: Str.Exc.=(33.5x0.42x2.41)+(12.25x2.48)+(12.25x1.88)+(0.56x2)
= 88.44 Cu. Yds.
Pay 88.4 Cu.Yds.

Table 24 - Continued:



SKETCH SHOWING LIMITS FOR COMPUTING
STRUCTURE EXCAVATION

STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR IBS & IBD AND BS & BD SERIES BOX CULVERTS-15ºSKEW (3:1 SLOPE) FOR STANDARD ISK-15-3W FOR IBS & IBD SERIES

SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.	SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.
BS-4					BS-5				
4x4	0.26	5.65	0.39	0.39	5x5	0.30	7.54	0.46	0.46
5x4	0.30	6.13	0.42	0.42	6x5	0.34	8.10	0.49	0.49
6x4	0.34	6.61	0.45	0.45	7x5	0.38	8.65	0.52	0.52
7x4	0.37	7.09	0.48	0.48	8x5	0.41	9.21	0.55	0.55
8x4	0.41	7.57	0.50	0.50	9x5	0.45	9.77	0.58	0.58
9x4	0.45	8.05	0.53	0.53	10x5	0.49	10.32	0.61	0.61
10x4	0.48	8.53	0.56	0.56	12x5	0.56	11.43	0.66	0.66
IBS & BS-6					IBS & BS-8				
4x6	0.27	9.91	0.49	0.49	8x8	0.42	17.83	1.16	1.16
6x6	0.34	11.31	0.54	0.54	10x8	0.49	19.59	1.34	1.34
8x6	0.42	12.71	0.60	0.60	12x8	0.57	21.35	1.55	1.55
10x6	0.49	14.11	0.65	0.65	14x8	0.64	23.12	1.80	1.80
12x6	0.57	15.51	0.71	0.71	16x8	0.72	24.88	2.04	2.04
14x6	0.65	16.91	0.76	0.76	18x8	0.79	26.64	2.30	2.30
16x6	0.73	18.31	0.82	0.82	20x8	0.90	28.41	2.57	2.57
18x6	0.81	19.70	0.87	0.87					
20x6	0.90	21.10	0.92	0.92					
IBS & BS-10					IBS & BS-12				
10x10	0.51	23.53	4.81	4.81	12x12	0.59	31.03	7.00	7.00
12x10	0.58	25.52	5.07	5.07	14x12	0.66	33.31	7.23	7.23
14x10	0.65	27.52	5.31	5.31	16x12	0.73	35.59	7.48	7.48
16x10	0.73	29.51	5.58	5.58	18x12	0.81	37.87	7.75	7.75
18x10	0.81	31.50	5.86	5.86	20x12	0.90	40.15	8.03	8.03
20x10	0.91	33.50	6.16	6.16	22x12	0.98	42.43	8.37	8.37
22x10	0.98	35.49	6.50	6.50	24x12	1.06	44.71	8.72	8.72

TABLE 25

STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR IBS AND IBD & BS & BD SERIES BOX CULVERTS
15º SKEW (3:1 SLOPE) - CONTINUED:

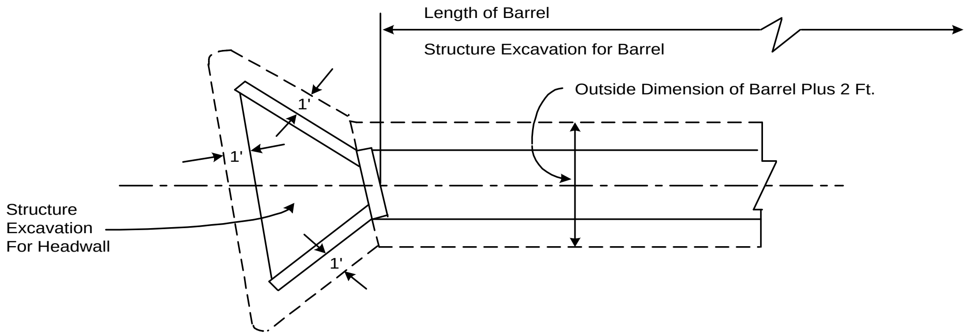
SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.	SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.
IBD & BD-4					IBD & BD-5				
8x4	0.43	7.81	0.52	0.52	10x5	0.50	10.60	0.62	0.62
10x4	0.50	8.77	0.58	0.58	12x5	0.58	11.73	0.68	0.68
12x4	0.57	9.73	0.63	0.63	16x5	0.73	13.96	0.79	0.79
16x4	0.73	11.66	0.75	0.75	20x5	0.88	16.20	0.91	0.91
20x4	0.88	13.60	0.87	0.87	24x5	1.03	18.45	1.03	1.03
24x4	1.03	15.52	0.98	0.98	28x5	1.19	20.70	1.14	1.14
IBD & BD-6					IBD & BD-8				
12x6	0.58	15.92	0.72	0.72	16x8	0.74	25.47	1.89	1.89
16x6	0.74	18.74	0.83	0.83	20x8	0.92	29.03	2.29	2.29
20x6	0.88	21.54	0.94	0.94	24x8	1.05	32.59	2.77	2.77
24x6	1.03	24.34	1.05	1.05	28x8	1.19	36.12	3.22	3.22
28x6	1.19	27.20	1.16	1.16	32x8	1.35	39.68	3.71	3.71
32x6	1.34	30.02	1.27	1.27					
IBD & BD-10					IBD & BD-12				
20x10	0.90	34.29	6.20	5.91	24x12	1.07	45.76	8.72	8.39
24x10	1.05	38.27	6.70	6.41	28x12	1.21	50.32	9.24	8.90
28x10	1.20	42.30	7.21	6.92	32x12	1.37	54.93	9.84	9.50
32x10	1.36	46.33	7.81	7.52	36x12	1.52	59.54	10.48	10.15
36x10	1.51	50.40	8.45	8.16	40x12	1.67	64.10	11.08	10.74

(1) NOTE: The auxiliary quantity includes the tow wall in all instances, the auxiliary slab under end of barrel, and thickened apron on upstream headwall.

NOTE: The quantities shown in above table are correct and will be used on the final estimate as the basis of payment unless authorized modifications are made.

EXAMPLE: 46’ of 10’ x 8’ Box Culvert (St.Std.BS-8). From Field Observations the average cut to flow line is as follows:
Barrel 1.8 ft., Upstream Headwall 1.7 ft., Downstream Headwall 1.2 ft.
From Table: Structure Excavation= (46x0.49 x 2.59)+(19.59x1.91)+(1.34x2)
= 145.69 Cu.Yds.
Pay 145.7 Cu.Yds.

TABLE 25 - Continued:



SKETCH SHOWING LIMITS FOR COMPUTING
STRUCTURE EXCAVATION

STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR IBS & IBD AND
BS & BD SERIES BOX CULVERT - 30º SKEW (3:1 SLOPE)
FOR STANDARD ISK-30-3W FOR IBS & IBD SERIES

SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.	SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.
BS-4					BS-5				
4x4	0.26	6.13	0.42	0.42	5x5	0.30	8.18	0.50	0.50
5x4	0.30	6.67	0.45	0.45	6x5	0.34	8.80	0.53	0.53
6x4	0.34	7.20	0.48	0.48	7x5	0.38	9.42	0.56	0.56
7x4	0.37	7.74	0.51	0.51	8x5	0.41	10.04	0.59	0.59
8x4	0.41	8.27	0.55	0.55	9x5	0.45	10.66	0.62	0.62
9x4	0.45	8.81	0.58	0.58	10x5	0.49	11.28	0.66	0.66
10x4	0.48	9.34	0.61	0.61	12x5	0.56	12.52	0.72	0.72
IBS & BS-6					IBS & BS-8				
4x6	0.27	10.69	0.52	0.52	8x8	0.42	19.34	1.30	1.30
6x6	0.34	12.26	0.58	0.58	10x8	0.49	21.31	1.50	1.50
8x6	0.42	13.82	0.64	0.64	12x8	0.57	23.28	1.73	1.73
10x6	0.49	15.38	0.70	0.70	14x8	0.64	25.25	2.01	2.01
12x6	0.57	16.94	0.77	0.77	16x8	0.72	27.21	2.29	2.29
14x6	0.65	18.50	0.83	0.83	18x8	0.79	29.18	2.57	2.57
16x6	0.73	20.06	0.89	0.89	20x8	0.90	31.15	2.88	2.88
18x6	0.81	21.62	0.95	0.95					
20x6	0.90	23.18	1.01	1.01					
IBS & BS - 10					IBS & BS -12				
10x10	0.51	25.56	5.31	5.31	12x12	0.59	33.71	7.69	7.69
12x10	0.58	27.78	5.58	5.58	14x12	0.66	36.26	7.94	7.94
14x10	0.65	30.00	5.85	5.85	16x12	0.73	38.80	8.23	8.23
16x10	0.73	32.23	6.16	6.16	18x12	0.81	41.35	8.55	8.55
18x10	0.81	34.45	6.47	6.47	20x12	0.90	43.89	8.88	8.88
20x10	0.91	36.68	6.81	6.81	22x12	0.98	46.44	9.27	9.27
22x10	0.98	38.90	7.20	7.20	24x12	1.06	48.98	9.69	9.69

TABLE 26

STRUCTURE EXCAV (ONE FT. DEPTH) FOR IBS & IBD & BS & BD SERIES BOX CULVERT
30º SKEW (3:1 SLOPE) - CONTINUED:

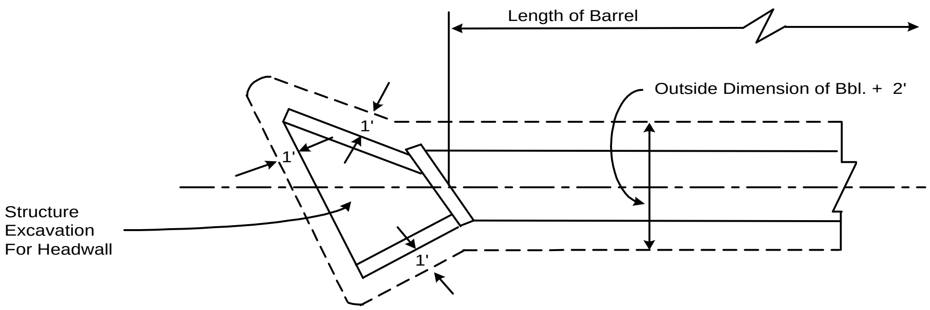
SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.	SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.
IBD & BD-4					IBD & BD-5				
8x4	0.43	8.54	0.56	0.56	10x5	0.50	11.59	0.67	0.67
10x4	0.50	9.61	0.63	0.63	12x5	0.58	12.86	0.74	0.74
12x4	0.57	10.68	0.69	0.69	16x5	0.73	15.34	0.87	0.87
16x4	0.73	12.84	0.82	0.82	20x5	0.88	17.85	0.99	0.99
20x4	0.88	15.00	0.95	0.95	24x5	1.03	20.35	1.12	1.12
24x4	1.03	17.14	1.08	1.08	28x5	1.19	22.86	1.25	1.25
IBD & BD-6					IBD & BD-8				
12x6	0.58	17.40	0.78	0.78	16x8	0.74	27.87	2.11	2.11
16x6	0.74	20.55	0.91	0.91	20x8	0.92	31.85	2.56	2.56
20x6	0.88	23.67	1.03	1.03	24x8	1.05	35.82	3.09	3.09
24x6	1.03	26.80	1.15	1.15	28x8	1.19	39.76	3.60	3.60
28x6	1.19	29.98	1.27	1.27	32x8	1.35	43.74	4.15	4.15
32x6	1.34	33.14	1.39	1.39					
IBD & BD-10					IBD & BD-12				
20x10	0.90	37.56	6.82	6.53	24x12	1.07	50.15	9.58	9.25
24x10	1.05	42.01	7.38	7.09	28x12	1.21	55.24	10.15	9.82
28x10	1.20	46.50	7.95	7.66	32x12	1.37	60.38	10.83	10.49
32x10	1.36	51.00	8.62	8.33	35x12	1.52	65.53	11.55	11.21
36x10	1.51	55.54	9.34	9.05	40x12	1.67	70.62	12.22	11.88

(1) NOTE: The constant quantity includes the toe wall in all instances, the auxiliary slab under end of barrel, thickened apron where applicable, and center extension wall thickened apron on upstream headwall.

NOTE: The quantities shown in above table are correct and will be used on the final estimate as the basis of payment unless authorized modifications are made.

EXAMPLE: 128’ of 8’ X 6’ Box Culvert (St. Std. BS-6). From Field Observations the average cut to flow line is as follows:
Barrel 1.7 ft., Upstream Headwall 1.6 Ft., Downstream Headwall 1.3 ft.
From Table: Str. Exc.= (128 x 0.42 x 41)+(13.82x2.18)+(13.82x1.88)+(0.64x2) = 186.95 Cu. Yds.
Pay 187.0 Cu. Yds.

Table 26 - Continued:



SKETCH SHOWING LIMITS FOR COMPUTING
STRUCTURE EXCAVATION

STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR IBS & IBD AND
BS & BD SERIES BOX CULVERTS-45º SKEW (3:1 SLOPE)
FOR STANDARD ISK-45-3W FOR IBS & IBD SERIES

SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.	SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.
BS-4					BS-5				
4x4	0.26	7.67	0.53	0.53	5x5	0.30	10.25	0.63	0.63
5x4	0.30	8.33	0.57	0.57	6x5	0.34	11.01	0.67	0.67
6x4	0.34	8.98	0.61	0.61	7x5	0.38	11.77	0.71	0.71
7x4	0.37	9.64	0.65	0.65	8x5	0.41	12.53	0.75	0.75
8x4	0.41	10.29	0.69	0.69	9x5	0.45	13.29	0.79	0.79
9x4	0.45	10.95	0.73	0.73	10x5	0.49	14.04	0.83	0.83
10x4	0.48	11.60	0.77	0.77	12x5	0.56	15.56	0.90	0.90
IBS & BS-6					IBS & BS-8				
4x6	0.27	13.48	0.67	0.67	8x8	0.42	24.29	1.65	1.65
6x6	0.34	15.39	0.74	0.74	10x8	0.49	26.70	1.90	1.90
8x6	0.42	17.30	0.82	0.82	12x8	0.57	29.11	2.18	2.18
10x6	0.49	19.21	0.89	0.89	14x8	0.64	31.52	2.53	2.53
12x6	0.57	21.12	0.96	0.96	16x8	0.72	33.93	2.87	2.87
14x6	0.65	23.03	1.04	1.04	18x8	0.79	36.34	3.22	3.22
16x6	0.73	24.95	1.11	1.11	20x8	0.90	38.75	3.60	3.60
18x6	0.81	26.86	1.19	1.19					
20x6	0.90	28.77	1.26	1.26					
IBS & BS - 10					IBS & BS -12				
10x10	0.51	32.09	6.56	6.56	12x12	0.59	42.31	9.48	9.48
12x10	0.58	34.81	6.89	6.89	14x12	0.66	45.43	9.79	9.79
14x10	0.65	37.53	7.22	7.22	16x12	0.73	48.55	10.14	10.14
16x10	0.73	40.26	7.59	7.59	18x12	0.81	51.66	10.53	10.53
18x10	0.81	42.98	7.98	7.98	20x12	0.90	54.78	10.94	10.94
20x10	0.91	45.70	8.40	8.40	22x12	0.98	57.89	11.42	11.42
22x10	0.98	48.43	8.87	8.87	24x12	1.06	61.01	11.93	11.93

TABLE 27

STRUCTURE EXCAV (ONE FT. DEPTH) FOR IBS & IBD AND BS & BD SERIES BOXCULVERTS - 45º SKEW (3:1 SLOPE) - CONTINUED:

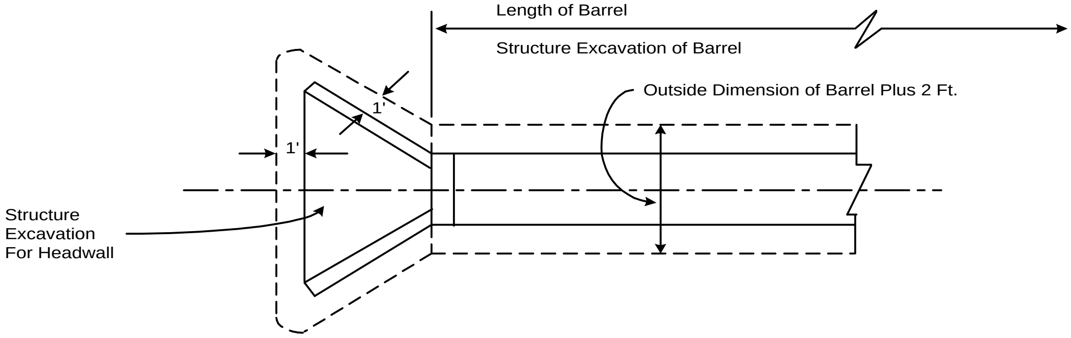
SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.	SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.
IBD & BD-4					IBD & BD-5				
8x4	0.43	10.62	0.71	0.71	10x5	0.50	14.42	0.85	0.85
10x4	0.50	11.93	0.79	0.79	12x5	0.58	15.97	0.93	0.93
12x4	0.57	12.24	0.87	0.87	16x5	0.73	19.01	1.08	1.08
16x4	0.73	15.88	1.02	1.02	20x5	0.88	22.08	1.24	1.24
20x4	0.88	18.53	1.18	1.18	24x5	1.03	25.15	1.40	1.40
24x4	1.03	21.15	1.34	1.34	28x5	1.19	28.22	1.56	1.56
IBD & BD-6					IBD & BD-8				
12x6	0.58	21.68	0.99	0.99	16x8	0.74	34.73	2.65	2.65
16x6	0.74	25.54	1.14	1.14	20x8	0.92	39.60	3.21	3.21
20x6	0.88	29.36	1.29	1.29	24x8	1.05	44.47	3.86	3.86
24x6	1.03	33.18	1.43	1.43	28x8	1.19	49.28	4.48	4.48
28x6	1.19	37.09	1.59	1.59	32x8	1.35	54.16	5.15	5.15
32x6	1.34	40.95	1.73	1.73					
IBD & BD-10					IBD & BD-12				
20x10	0.90	46.78	8.36	8.07	24x12	1.07	62.44	11.72	11.39
24x10	1.05	52.23	9.02	8.74	28x12	1.21	68.67	12.42	12.09
28x10	1.20	57.73	9.73	9.44	32x12	1.37	74.97	13.25	12.90
32x10	1.36	63.24	10.55	10.26	36x12	1.52	81.26	14.13	13.80
36x10	1.51	68.80	11.43	11.14	40x12	1.67	87.50	14.96	14.60

(1) NOTE: The constant quantity includes the tow wall in all instances, the auxiliary slab under end of barrel, thickened apron where applicable and center extension wall thickened apron or upstream headwall.

NOTE: The quantities shown in above table are correct and will be used on the final estimate as the basis of payment unless authorized modifications are made.

EXAMPLE: 86’ of 6 x 4 Box Culvert (St. Std. BS-4). From Field Observations the average cut to flow line is as follows:
Barrel 1.4 Ft., Upstream Headwall 1.3 Ft., Downstream Headwall 1.5 Ft.
From Table: Str.Exc.(86x0.34x2.03)+(8.98x1.80)+(8.98x2.00)+(0.61x2) =
94.70 Cu. Yds.
Pay 94.7 Cu. Yds.

Table 27 - Continued



SKETCH SHOWING LIMITS FOR COMPUTING
STRUCTURE EXCAVATION

STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR IBS & IBD AND
BS & BD SERIES BOX CULVERTS - (4:1 SLOPE)
FOR STANDARDS IWS-4 AND IWD-4 FOR IBS & IBD SERIES

SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.	SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.
BS-4					BS-5				
4x4	0.26	7.16	0.37	0.37	5x5	0.30	9.54	0.43	0.43
5x4	0.30	7.78	0.39	0.39	6x5	0.34	10.26	0.46	0.46
6x4	0.34	8.40	0.42	0.42	7x5	0.38	10.98	0.49	0.49
7x4	0.37	9.02	0.45	0.45	8x5	0.41	11.70	0.52	0.52
8x4	0.41	9.65	0.48	0.48	9x5	0.45	12.42	0.54	0.54
9x4	0.45	10.27	0.51	0.51	10x5	0.49	13.14	0.57	0.57
10x4	0.48	10.89	0.53	0.53	12x5	0.56	14.58	0.63	0.63
IBS & BS-6					IBS & BS-8				
4x6	0.27	12.47	0.46	0.46	8x8	0.42	22.52	1.07	1.07
6x6	0.34	14.28	0.51	0.51	10x8	0.49	24.80	1.24	1.24
8x6	0.42	16.09	0.56	0.56	12x8	0.57	27.09	1.44	1.44
10x6	0.49	17.91	0.61	0.61	14x8	0.64	29.37	1.68	1.68
12x6	0.57	19.72	0.67	0.67	16x8	0.72	31.66	1.92	1.92
14x6	0.65	21.54	0.72	0.72	18x8	0.79	33.95	2.16	2.16
16x6	0.73	23.35	0.77	0.77	20x8	0.90	36.23	2.42	2.42
18x6	0.81	25.16	0.82	0.82					
20x6	0.90	26.98	0.88	0.88					
IBS & BS - 10					IBS & BS -12				
10x10	0.51	29.77	5.50	5.50	12x12	0.59	39.25	8.11	8.11
12x10	0.58	32.35	5.73	5.73	14x12	0.66	42.21	8.32	8.32
14x10	0.65	34.93	5.97	5.97	16x12	0.73	45.16	8.57	8.57
16x10	0.73	37.52	6.23	6.23	18x12	0.81	48.12	8.84	8.84
18x10	0.81	40.10	6.50	6.50	20x12	0.90	51.08	9.13	9.13
20x10	0.91	42.68	6.79	6.79	22x12	0.98	54.03	9.46	9.46
22x10	0.98	45.27	7.12	7.12	24x12	1.06	56.99	9.82	9.82

TABLE 28

STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR IBS & IBD AND BS & BD SERIES BOX CULVERTS - (4:1 SLOPE) - CONTINUED:

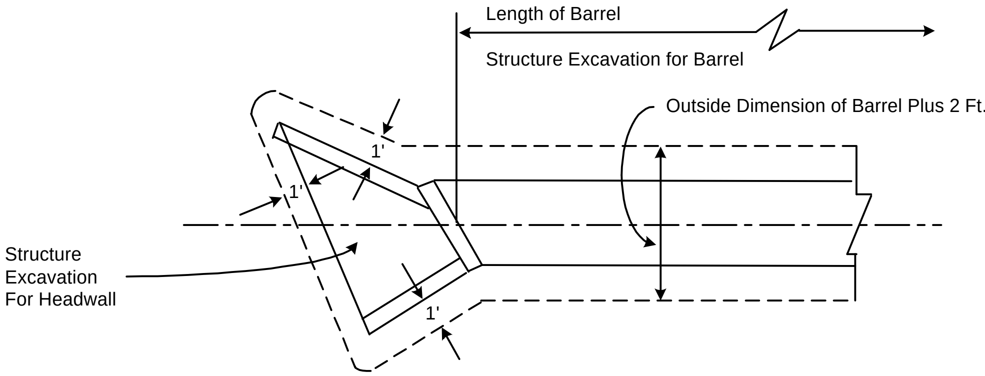
SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.	SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.
IBD & BD-4					IBD & BD-5				
8x4	0.43	9.96	0.49	0.49	10x5	0.50	13.50	0.59	0.59
10x4	0.50	11.20	0.55	0.55	12x5	0.58	14.97	0.64	0.64
12x4	0.57	12.44	0.60	0.60	16x5	0.73	17.85	0.75	0.75
16x4	0.73	14.96	0.71	0.71	20x5	0.88	20.77	0.87	0.87
20x4	0.88	17.48	0.83	0.83	24x5	1.03	23.68	0.98	0.98
22x4	1.03	19.96	0.94	0.94	28x5	1.19	26.60	1.09	1.09
IBD & BD-6					IBD & BD-8				
12x6	0.58	20.25	0.68	0.68	16x8	0.74	32.42	1.78	1.78
16x6	0.74	23.92	0.79	0.79	20x8	0.92	37.04	2.17	2.17
20x6	0.88	27.54	0.89	0.89	24x8	1.05	41.66	2.62	2.62
24x6	1.03	31.17	1.00	1.00	28x8	1.19	46.23	3.05	3.05
28x6	1.19	34.87	1.11	1.11	32x8	1.35	50.84	3.53	3.53
32x6	1.34	38.54	1.21	1.21					
IBD & BD-10					IBD & BD-12				
20x10	0.90	43.71	6.86	6.58	24x12	1.07	58.34	9.79	9.45
24x10	1.05	48.88	7.32	7.03	28x12	1.21	64.26	10.28	9.94
28x10	1.20	54.10	7.81	7.52	32x12	1.37	70.23	10.85	10.52
32x10	1.36	59.32	8.38	8.10	36X12	1.52	76.20	11.47	11.14
36x10	1.51	64.60	9.01	8.72	40x12	1.67	82.11	12.05	11.71

(1) NOTE: The constant quantity includes the toe wall in all instances, the auxiliary slab under end of barrel, thickened apron where applicable and center extension wall thickened apron on upstream headwall.

NOTE: The quantities shown in above table are correct and will be used on the final estimate as the basis of payment unless authorized modifications are made.

EXAMPLE: 33.5’ of - 8’ x 6’ Box Culvert (St. Std. BS-6). From Field Observation the average cut to flow line is as follows:
Barrel 1.7 Ft., Upstream Headwall 1.9 Ft., Downstream Headwall 1.3 Ft.
From Table: Str. Exc. (33.5 x 0.42 x 2.41) + (16.09 x 2.48) + (16.09 x 1.88) + (0.56 x 2) = 105.18 Cu. Yds.
Pay 105.2 Cu. Yds.

TABLE 28 - Continued:



SKETCH SHOWING LIMITS FOR COMPUTING
STRUCTURE EXCAVATION

STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR IBS & IBD AND
BS & BD SERIES BOX CULVERTS - 15º SKEW (4:1 SLOPE)
FOR STANDARD ISK-15-4W FOR IBS & IBD SERIES

SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.	SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.
BS-4					BS-5				
4x4	0.26	7.44	0.39	0.39	5x5	0.30	9.94	0.46	0.46
5x4	0.30	8.08	0.42	0.42	6x5	0.34	10.68	0.49	0.49
6x4	0.34	8.72	0.45	0.45	7x5	0.38	11.42	0.52	0.52
7x4	0.37	9.36	0.48	0.48	8x5	0.41	12.16	0.55	0.55
8x4	0.41	10.00	0.51	0.51	9x5	0.45	12.90	0.58	0.58
9x4	0.45	10.64	0.53	0.53	10x5	0.49	13.64	0.61	0.61
10x4	0.48	11.28	0.56	0.56	12x5	0.56	15.12	0.66	0.66
IBS & BS-6					IBS & BS-8				
4x6	0.27	13.04	0.49	0.49	8x8	0.42	23.50	1.16	1.16
6x6	0.34	14.90	0.54	0.54	10x8	0.49	25.86	1.34	1.34
8x6	0.42	16.77	0.60	0.60	12x8	0.57	28.20	1.54	1.54
10x6	0.49	18.63	0.65	0.65	14x8	0.64	30.56	1.79	1.79
12x6	0.57	20.50	0.71	0.71	16x8	0.72	32.91	2.04	2.04
14x6	0.65	22.37	0.76	0.76	18x8	0.79	35.26	2.29	2.29
16x6	0.73	24.23	0.81	0.81	20x8	0.90	37.61	2.57	2.57
18x6	0.81	26.10	0.87	0.87					
20x6	0.90	27.96	0.92	0.92					
IBS & BS - 10					IBS & BS -12				
10x10	0.51	31.03	5.75	5.75	12x12	0.59	40.91	8.47	8.47
12x10	0.58	33.69	6.01	6.01	14x12	0.66	43.95	8.70	8.70
14x10	0.65	36.35	6.25	6.25	16x12	0.73	46.99	8.95	8.95
16x10	0.73	39.01	6.52	6.52	18x12	0.81	50.03	9.23	9.23
18x10	0.81	41.67	6.80	6.80	20x12	0.90	53.07	9.53	9.53
20x10	0.91	44.32	7.10	7.10	22x12	0.98	56.11	9.88	9.88
22x10	0.98	46.98	7.45	7.45	24x12	1.06	59.15	10.25	10.25

TABLE 29

STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR IBS & IBD AND BS & BD SERIES BOX CULVERTS - 15º SKEW (4:1 SLOPE) CONTINUED:

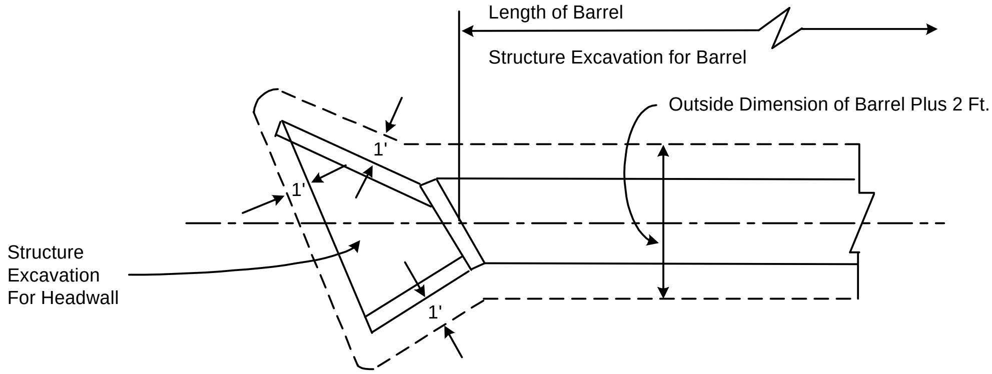
SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.	SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.
IBD & BD-4					IBD & BD-5				
8x4	0.43	10.32	0.52	0.52	10x5	0.50	14.01	0.62	0.62
10x4	0.50	11.60	0.58	0.58	12x5	0.58	15.52	0.68	0.68
12x4	0.57	12.88	0.63	0.63	16x5	0.73	18.49	0.79	0.79
16x4	0.73	15.46	0.75	0.75	20x5	0.88	21.48	0.91	0.91
20x4	0.88	18.04	0.87	0.87	24x5	1.03	24.48	1.03	1.03
24x4	1.03	20.60	0.98	0.98	28x5	1.19	27.47	1.14	1.14
IBD & BD-6					IBD & BD-8				
12x6	0.58	21.04	0.72	0.72	16x8	0.74	33.69	1.89	1.89
16x6	0.74	24.81	0.83	0.83	20x8	0.92	38.43	2.29	2.29
20x6	0.88	28.54	0.94	0.94	24x8	1.05	43.19	2.76	2.76
24x6	1.03	32.27	1.05	1.05	28x8	1.19	47.89	3.22	3.22
28x6	1.19	36.08	1.16	1.16	32x8	1.35	52.64	3.70	3.70
32x6	1.34	39.85	1.27	1.27					
IBD & BD-10					IBD & BD-12				
20x10	0.90	45.37	7.17	6.88	24x12	1.07	60.54	10.20	9.86
24x10	1.05	50.69	7.64	7.36	28x12	1.21	66.62	10.71	10.37
28x10	1.20	56.06	8.16	7.87	32x12	1.37	72.77	11.31	10.97
32x10	1.36	61.42	8.75	8.46	36X12	1.52	78.92	11.95	11.61
36x10	1.51	66.86	9.39	9.11	40x12	1.67	85.00	12.55	12.21

(1) NOTE: The constant quantity includes the toe wall in all instances, the auxiliary slab under end of barrel, thickened apron where applicable and center extension wall thickened apron or upstream headwall.

NOTE: The quantities shown in above table are correct and will be used on the final estimate as the basis of payment unless authorized modifications are made.

EXAMPLE: 37.8’ of 20’ X 5’ Box Culvert (St.Std. BD-5). From Field Observations the average cut to flow line is as follows:
Barrel 1.9 Ft., Upstream headwalls 2.1 Ft., Downstream Headwall 1.5 Ft.
From Table: Str. Exc. (37.8 x 0.88 x 2.73) + (21.48x2.60) + (21.48x2.00) + (0.91x2)
= 191.44 Cu. Yds.
Pay 191.4 Cu. Yds.

Table 29 - Continued



SKETCH SHOWING LIMITS FOR COMPUTING
STRUCTURE EXCAVATION

STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR IBS & IBD AND
BS & BD SERIES BOX CULVERTS - 30º SKEW (4:1 SLOPE)
FOR STANDARD ISK-30-4W FOR IBS & IBD SERIES

SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.	SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.
BS-4					BS-5				
4x4	0.26	8.79	0.47	0.47	5x5	0.30	11.73	0.56	0.56
5x4	0.30	9.51	0.51	0.51	6x5	0.34	12.56	0.59	0.59
6x4	0.34	10.22	0.54	0.54	7x5	0.38	13.38	0.62	0.62
7x4	0.37	10.93	0.57	0.57	8x5	0.41	14.22	0.66	0.66
8x4	0.41	11.65	0.60	0.60	9x5	0.45	15.04	0.69	0.69
9x4	0.45	12.36	0.63	0.63	10x5	0.49	15.86	0.72	0.72
10x4	0.48	13.07	0.67	0.67	12x5	0.56	17.52	0.78	0.78
IBS & BS-6					IBS & BS-8				
4x6	0.27	15.55	0.60	0.60	8x8	0.42	27.82	1.38	1.38
6x6	0.34	17.63	0.66	0.66	10x8	0.49	30.44	1.58	1.58
8x6	0.42	19.71	0.72	0.72	12x8	0.57	33.06	1.82	1.82
10x6	0.49	21.79	0.78	0.78	14x8	0.64	35.69	2.10	2.10
12x6	0.57	23.88	0.84	0.84	16x8	0.72	38.31	2.37	2.37
14x6	0.65	25.96	0.90	0.90	18x8	0.79	40.94	2.66	2.66
16x6	0.73	28.04	0.96	0.96	20x8	0.90	43.56	2.96	2.96
18x6	0.81	30.12	1.02	1.02					
20x6	0.90	32.20	1.08	1.08					
IBS & BS - 10					IBS & BS -12				
10x10	0.51	36.67	6.68	6.68	12x12	0.59	48.33	9.76	9.76
12x10	0.58	39.63	6.96	6.96	14x12	0.66	51.71	10.01	10.01
14x10	0.65	42.60	7.24	7.24	16x12	0.73	55.10	10.30	10.30
16x10	0.73	45.57	7.54	7.54	18x12	0.81	58.50	10.61	10.61
18x10	0.81	48.53	7.86	7.86	20x12	0.90	61.89	10.95	10.95
20x10	0.91	51.50	8.20	8.20	22x12	0.98	65.29	11.34	11.34
22x10	0.98	54.46	8.58	8.58	24x12	1.06	68.68	11.75	11.75

TABLE 30

STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR IBS & IBD AND
BS & BD SERIES BOX CULVERTS - 30º SKEW (4:1 SLOPE) CONTINUED:

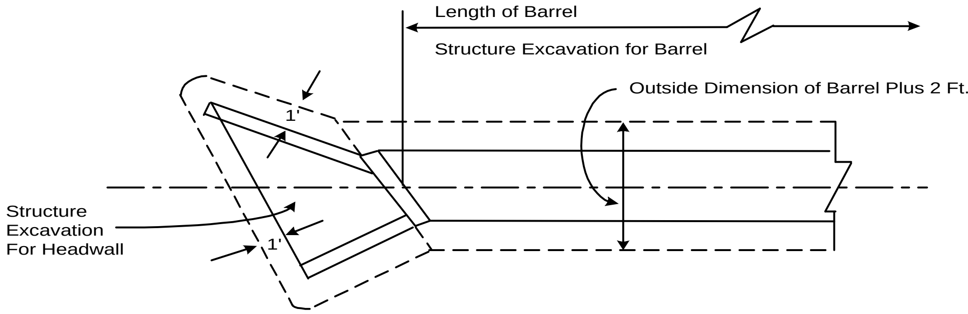
SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.	SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.
IBD & BD-4					IBD & BD-5				
8x4	0.43	12.01	0.62	0.62	10x5	0.50	16.29	0.74	0.74
10x4	0.50	13.43	0.68	0.68	12x5	0.58	17.98	0.80	0.80
12x4	0.57	14.86	0.75	0.75	16x5	0.73	21.28	0.93	0.93
16x4	0.73	17.74	0.88	0.88	20x5	0.88	24.63	1.06	1.06
20x4	0.88	20.62	1.01	1.01	24x5	1.03	27.97	1.19	1.19
24x4	1.03	23.47	1.13	1.13	28x5	1.19	31.31	1.32	1.32
IBD & BD-6					IBD & BD-8				
12x6	0.58	24.49	0.86	0.86	16x8	0.74	39.19	2.20	2.20
16x6	0.74	28.70	0.98	0.98	20x8	0.92	44.50	2.65	2.65
20x6	0.88	32.86	1.10	1.10	24x8	1.05	49.80	3.18	3.18
24x6	1.03	37.02	1.22	1.22	28x8	1.19	55.05	3.69	3.69
28x6	1.19	41.27	1.35	1.35	32x8	1.35	60.35	4.23	4.23
32x6	1.34	45.58	1.47	1.47					
IBD & BD-10					IBD & BD-12				
20x10	0.90	52.67	8.22	7.94	24x12	1.07	70.25	11.65	11.31
24x10	1.05	58.61	8.76	8.47	28x12	1.21	77.03	12.22	11.88
28x10	1.20	64.60	9.33	9.04	32x12	1.37	83.90	12.89	12.56
32x10	1.36	70.59	10.00	9.71	36X12	1.52	90.75	13.61	13.28
36x10	1.51	76.65	10.72	10.43	40x12	1.67	97.53	14.28	13.95

(1) NOTE: The constant quantity includes the toe wall in all instances, the auxiliary slab under end of barrel, thickened apron where applicable and center extension wall thickened apron on upstream headwall.

NOTE: The quantities shown in above table are correct and will be used on the final estimate as the basis of payment unless authorized modifications are made.

EXAMPLE: 42.4’ of 2’ x 6’ Box Culvert (St. Std. BS-6). From Field Observation, the average cut to flow line is as follows:
Barrel 2.4 Ft., Upstream Headwall 2.6 Ft., Downstream Headwall 1.8 Ft.
From Table: Str. Excav. (42.4 x 0.57 x 3.28)+ (23.88 x 3.18) + (23.88 x 2.38) + (0.84 x 2) = 213.72 Cu. Yds.
Pay 213.7 Cu. Yds.

Table 30 - Continued:



SKETCH SHOWING LIMITS FOR COMPUTING
STRUCTURE EXCAVATION

STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR IBS & IBD AND
BS & BD SERIES BOX CULVERTS - 45º SKEW (4:1 SLOPE)
FOR STANDARD ISK-45-4W FOR IBS & IBD SERIES

SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.	SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.
BS-4					BS-5				
4x4	0.26	10.46	0.56	0.56	5x5	0.30	13.97	0.66	0.66
5x4	0.30	11.35	0.60	0.60	6x5	0.34	14.99	0.70	0.70
6x4	0.34	12.21	0.64	0.64	7x5	0.38	16.00	0.74	0.74
7x4	0.37	13.09	0.68	0.68	8x5	0.41	17.01	0.78	0.78
8x4	0.41	13.96	0.72	0.72	9x5	0.45	18.03	0.82	0.82
9x4	0.45	14.83	0.76	0.76	10x5	0.49	19.04	0.86	0.86
10x4	0.48	15.70	0.80	0.80	12x5	0.56	21.06	0.94	0.94
IBS & BS-6					IBS & BS-8				
4x6	0.27	18.47	0.71	0.71	8x8	0.42	33.18	1.69	1.69
6x6	0.34	21.01	0.78	0.78	10x8	0.49	36.39	1.94	1.94
8x6	0.42	23.57	0.85	0.85	12x8	0.57	39.61	2.22	2.22
10x6	0.49	26.11	0.93	0.93	14x8	0.64	42.82	2.57	2.57
12x6	0.57	28.66	1.00	1.00	16x8	0.72	46.03	2.91	2.91
14x6	0.65	31.21	1.08	1.08	18x8	0.79	49.24	3.26	3.26
16x6	0.73	33.76	1.15	1.15	20x8	0.90	52.45	3.64	3.64
18x6	0.81	36.31	1.23	1.23					
20x6	0.90	38.85	1.30	1.30					
IBS & BS - 10					IBS & BS -12				
10x10	0.51	43.78	7.97	7.97	12x12	0.59	57.73	11.65	11.65
12x10	0.58	47.42	8.30	8.30	14x12	0.66	61.87	11.96	11.96
14x10	0.65	51.05	8.64	8.64	16x12	0.73	66.04	12.31	12.31
16x10	0.73	54.68	9.01	9.01	18x12	0.81	70.19	12.70	12.70
18x10	0.81	58.31	9.40	9.40	20x12	0.90	74.34	13.11	13.11
20x10	0.91	61.94	9.82	9.82	22x12	0.98	78.50	13.59	13.59
22x10	0.98	65.57	10.29	10.29	24x12	1.06	82.65	14.11	14.11

TABLE 31

STRUCTURE EXCAVATION (ONE FT. DEPTH) FOR IBS & IBD AND
BS & BD SERIES BOX CULVERTS - 45º SKEW (4:1 SLOPE) CONTINUED:

SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.	SIZE	C.Y. L.F. Bbl.	C.Y. One H.W.	(1) C.Y. Const. U.S.	(1) C.Y. Const. D.S.
IBD & BD-4					IBD & BD-5				
8x4	0.43	14.39	0.74	0.74	10x5	0.50	19.54	0.88	0.88
10x4	0.50	16.13	0.82	0.82	12x5	0.58	21.61	0.96	0.96
12x4	0.57	17.88	0.89	0.89	16x5	0.73	25.65	1.12	1.12
16x4	0.73	21.40	1.05	1.05	20x5	0.88	29.75	1.27	1.27
20x4	0.88	24.93	1.21	1.21	24x5	1.03	33.84	1.43	1.43
24x4	1.03	28.42	1.37	1.37	28x5	1.19	37.93	1.59	1.59
IBD & BD-6					IBD & BD-8				
12x6	0.58	29.40	1.02	1.02	16x8	0.74	47.09	2.69	2.69
16x6	0.74	34.55	1.17	1.17	20x8	0.92	53.58	3.25	3.25
20x6	0.88	39.65	1.32	1.32	24x8	1.05	60.07	3.90	3.90
24x6	1.03	44.75	1.47	1.47	28x8	1.19	66.50	4.52	4.52
28x6	1.19	49.95	1.62	1.62	32x8	1.35	72.99	5.19	5.19
32x6	1.34	55.10	1.77	1.77					
IBD & BD-10					IBD & BD-12				
20x10	0.90	63.37	9.79	9.50	24x12	1.07	84.55	13.89	13.56
24x10	1.05	70.63	10.44	10.16	28x12	1.21	92.86	14.59	14.26
28x10	1.20	77.67	11.15	10.86	32x12	1.37	101.26	15.42	15.09
32x10	1.36	85.31	11.97	11.68	36X12	1.52	109.65	16.30	15.97
36x10	1.51	92.72	12.85	12.56	40x12	1.67	117.96	17.13	16.79

(1) NOTE: The constant quantity includes the toe wall in all instances, the auxiliary slab under end of barrel, thickened apron where applicable and center extension wall thickened apron on upstream headwall.

NOTE: The quantities shown in above table are correct and will be used on the final estimate as the basis of payment unless authorized modifications are made.

EXAMPLE: 47.2’ of 10’ x 8’ Box Culvert (St. Std. BS-8, 45º Skew) from Field Observations the average cut to flow line is as follows:
Barrel 2.1 Ft., Upstream Headwall 2.4 Ft., Downstream Headwall 1.6 Ft.
From Table: Str. Exc. (47.2 x 0.49 x 2.89) + (36.39 x 3.11) + (36.39 x 2.31) + (1.94 x 2) = 267.95 Cu. Yds.
Pay 268.0 Cu. Yds.

Table 31 - Continued:

STANDARD SINGLE CELL 15º SKEW BOX CULVERTS - 2:1 SLOPE

CONCRETE QUANTITIES FOR 40' LENGTH IN BARREL, WINGS, PARAPETS, CUTOFF WALLS, APRONS AND FOOTINGS

SIZE S X H FEET	STD. PLAN NO.:	CU.YD. PER FT.	CONCRETE CUBIC YARD	SIZE S X H FEET	STD. PLAN NO.	CU. YD. PER FT.	CONCRETE CUBIC YARD
2x2	BS-2	0.1852	9.34	14x8	BS-8	1.6543	99.28
3x2	BS-2	0.2346	11.59	16x8	BS-8	1.9743	114.36
4x2	BS-2	0.2903	14.09	18x8	BS-8	2.2310	130.53
5x2	BS-2	0.3519	16.83	20x8	BS-8	2.6944	147.80
6x2	BS-2	0.4197	19.81	10x10	BS-10	1.3371	92.03
7x2	BS-2	0.4794	22.46	12x10	BS-10	1.5452	102.37
8x2	BS-2	0.5494	25.52	14x10	BS-10	1.7777	113.71
3x3	BS-3	0.2716	14.36	16x10	BS-10	2.1100	129.08
4x3	BS-3	0.3272	16.92	18x10	BS-10	2.4691	145.55
5x3	BS-3	0.4020	20.26	20x10	BS-10	2.8935	164.66
6x3	BS-3	0.4702	23.33	22x10	BS-10	3.3425	184.95
7x3	BS-3	0.5195	25.62	12x12	BS-12	1.7968	128.11
8x3	BS-3	0.6106	29.61	14x12	BS-12	1.9876	137.85
9x3	BS-3	0.7083	33.86	16x12	BS-12	2.2458	150.49
4x4	BS-4	0.3644	20.04	18x12	BS-12	2.6172	167.70
5x4	BS-4	0.4421	23.59	20x12	BS-12	3.0154	186.01
6x4	BS-4	0.4884	25.83	22x12	BS-12	3.5154	208.62
7x4	BS-4	0.5761	29.75	24x12	BS-12	4.0555	232.87
8x4	BS-4	0.6538	33.27				
9x4	BS-4	0.7546	37.72				
10x4	BS-4	0.8449	41.74				
5x5	BS-5	0.4825	26.94				
6x5	BS-5	0.5478	30.02				
7x5	BS-5	0.6193	33.35				
8x5	BS-5	0.6970	36.93				
9x5	BS-5	0.7809	40.75				
10x5	BS-5	0.8912	45.63				
12x5	BS-5	1.0700	53.69				
4x6	BS-6	0.4825	31.01				
6x6	BS-6	0.5910	36.59				
8x6	BS-6	0.7631	44.78				
10x6	BS-6	0.9609	53.98				
12x6	BS-6	1.1844	64.22				
14x6	BS-6	1.5062	78.44				
16x6	BS-6	1.7881	91.01				
18x6	BS-6	2.1471	106.67				
20x6	BS-6	2.5339	123.44				
8x8	BS-8	0.9136	62.99				
10x8	BS-8	1.0892	72.09				
12x8	BS-8	1.3194	83.51				

NOTE: To Convert to IBS Standards - Determine concrete required for addition 110 ft. of barrel and concrete for two (2) auxiliary slabs; add these amounts to quantities shown in this table.

NOTE: The quantities shown are correct and will be used on the final estimate as the basis of payment unless authorized modifications are made.

NOTE: For BS Culverts modified for high fills, compute concrete quantities from Standard Drawing CM-2 and the above table.

EXAMPLE: 43.6' of 4' X 4' - 15º Skew.
From Table (40' Lgt.) = 20.04 Cu. Yds.
0.3644 x (43.6 - 40.0) = 1.31 Cu. Yds.
TOTAL = 21.35 Cu. Yds.

TABLE 40

STANDARD SINGLE CELL 30º SKEW BOX CULVERTS - 2:1 SLOPE
CONCRETE QUANTITIES FOR 40' LENGTH IN BARREL,
WINGS, PARAPETS, CUTOFF WALLS, APRONS AND FOOTINGS

SIZE S X H FEET	STD. PLAN NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STD. PLAN NO.	CU. YD. PER FT.	CONC. CU. YD.
2x2	BS-2	0.1852	9.32	18x8	BS-8	2.2310	131.18
3x2	BS-2	0.2346	11.60	20x8	BS-8	2.6944	148.69
4x2	BS-2	0.2903	14.13	10x10	BS-10	1.3371	91.40
5x2	BS-2	0.3519	16.89	12x10	BS-10	1.5452	101.94
6x2	BS-2	0.4197	19.91	14x10	BS-10	1.7777	113.48
7x2	BS-2	0.4794	22.58	16x10	BS-10	2.1100	129.07
8x2	BS-2	0.5494	25.74	18x10	BS-10	2.4691	145.75
3x3	BS-3	0.2716	14.29	20x10	BS-10	2.8935	165.09
4x3	BS-3	0.3272	16.89	22x10	BS-10	3.3425	185.60
5x3	BS-3	0.4020	20.26	12x12	BS-12	1.7968	127.17
6x3	BS-3	0.4702	23.37	14x12	BS-12	1.9876	137.14
7x3	BS-3	0.5195	25.70	16x12	BS-12	2.2458	150.01
8x3	BS-3	0.6106	29.72	18x12	BS-12	2.6172	167.45
9x3	BS-3	0.7083	34.01	20x12	BS-12	3.0154	186.00
4x4	BS-4	0.3644	19.91	22x12	BS-12	3.5154	208.86
5x4	BS-4	0.4421	23.50	24x12	BS-12	4.0555	233.37
6x4	BS-4	0.4884	25.78				
7x4	BS-4	0.5761	29.77				
8x4	BS-4	0.6538	33.31				
9x4	BS-4	0.7546	37.80				
10x4	BS-4	0.8449	41.87				
5x5	BS-5	0.4825	26.75				
6x5	BS-5	0.5478	29.88				
7x5	BS-5	0.6193	33.26				
8x5	BS-5	0.6970	36.89				
9x5	BS-5	0.7809	40.76				
10x5	BS-5	0.8912	45.69				
12x5	BS-5	1.0700	53.85				
4x6	BS-6	0.4825	30.49				
6x6	BS-6	0.5910	36.21				
8x6	BS-6	0.7631	44.52				
10x6	BS-6	0.9609	53.87				
12x6	BS-6	1.1844	64.24				
14x6	BS-6	1.5062	78.58				
16x6	BS-6	1.7881	91.28				
18x6	BS-6	2.1471	107.04				
20x6	BS-6	2.5339	124.02				
8x8	BS-8	0.9136	62.44				
10x8	BS-8	1.0892	71.78				
12x8	BS-8	1.3194	83.43				
14x8	BS-8	1.6543	99.45				
16x8	BS-8	1.9743	114.77				

NOTE: To Convert to IBS Standards - Determine concrete required for addition 110 ft. of barrel and concrete for two (2) auxiliary slabs; add these amounts to quantities shown in this table.

NOTE: The quantities shown are correct and will be used on the final estimate as a basis of payment, unless authorized modifications are made.

NOTE: For BS Culverts modified for high fills, compute concrete quantities from Std. Drawing CM-2 and the above Table.

EXAMPLE - 41.6 of 3' x 3' - Skewed 30º
From Table (40' Lgt.) = 14.29 Cu. Yds.
0.2716 x (41.6-40.0) = 0.43 Cu. Yds.
TOTAL = 14.72 Cu. Yds.

TABLE 41

STANDARD SINGLE CELL 45º SKEW BOX CULVERTS - 2:1 SLOPE CONCRETE QUANTITIES FOR 40' LENGTH IN BARREL, WINGS, PARAPETS, CUTOFF WALLS, APRONS AND FOOTINGS

SIZE S X H FEET	STD. PLAN NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STD. PLAN NO.	CU. YD. PER FT.	CONC. CU. YD.
2x2	BS-2	0.1852	10.00	18x8	BS-8	2.2310	143.05
3x2	BS-2	0.2346	12.35	20x8	BS-8	2.6944	161.14
4x2	BS-2	0.2903	14.94	10x10	BS-10	1.3371	103.31
5x2	BS-2	0.3519	17.78	12x10	BS-10	1.5452	114.36
6x2	BS-2	0.4197	20.86	14x10	BS-10	1.7777	126.41
7x2	BS-2	0.4794	23.60	16x10	BS-10	2.1100	142.52
8x2	BS-2	0.5494	26.75	18x10	BS-10	2.4691	159.73
3x3	BS-3	0.2716	15.51	20x10	BS-10	2.8935	179.60
4x3	BS-3	0.3272	18.20	22x10	BS-10	3.3425	200.70
5x3	BS-3	0.4020	21.66	12x12	BS-12	1.7968	144.13
6x3	BS-3	0.4702	24.85	14x12	BS-12	1.9876	154.63
7x3	BS-3	0.5195	27.26	16x12	BS-12	2.2458	168.08
8x3	BS-3	0.6106	31.37	18x12	BS-12	2.6172	186.12
9x3	BS-3	0.7083	35.74	20x12	BS-12	3.0154	205.26
4x4	BS-4	0.3644	21.83	22x12	BS-12	3.5154	228.77
5x4	BS-4	0.4421	25.53	24x12	BS-12	4.0555	253.95
6x4	BS-4	0.4884	27.91				
7x4	BS-4	0.5761	31.97				
8x4	BS-4	0.6538	35.64				
9x4	BS-4	0.7546	40.23				
10x4	BS-4	0.8449	44.41				
5x5	BS-5	0.4825	29.39				
6x5	BS-5	0.5478	32.64				
7x5	BS-5	0.6193	36.14				
8x5	BS-5	0.6970	39.88				
9x5	BS-5	0.7809	43.87				
10x5	BS-5	0.8912	48.92				
12x5	BS-5	1.0700	57.31				
4x6	BS-6	0.4825	34.69				
6x6	BS-6	0.5910	40.73				
8x6	BS-6	0.7631	49.37				
10x6	BS-6	0.9609	59.04				
12x6	BS-6	1.1844	69.74				
14x6	BS-6	1.5062	84.43				
16x6	BS-6	1.7881	97.47				
18x6	BS-6	2.1471	113.58				
20x6	BS-6	2.5339	130.81				
8x8	BS-8	0.9136	71.49				
10x8	BS-8	1.0892	81.35				
12x8	BS-8	1.3194	93.56				
14x8	BS-8	1.6543	110.16				
16x8	BS-8	1.9743	126.05				

NOTE: To Convert to IBS Standards - Determine concrete required for addition 110 ft. of barrel and concrete for two (2) auxiliary slabs; add these amounts to quantities shown in this table.

NOTE: The quantities shown are correct and will be used on the final estimate as a basis of payment unless authorized modifications are made.

NOTE: For BS Culverts modified for high fills, compute concrete quantities from Standard Drawing CM-2 and the above Table.

EXAMPLE - 52.3' of 10' X 8' - Skewed 45º
From table (40' Lgt.) = 81.35 Cu. Yds
1.0892 x (52.3-40.0') = 13.40 Cu. Yds.
TOTAL = 94.75

TABLE 42

STANDARD DOUBLE CELL 15º SKEW CULVERTS - 2:1 SLOPE

CONCRETE QUANTITIES FOR 40' LENGTH
IN BARREL, WINGS, PARAPETS, CUTOFF WALLS, APRONS AND FOOTINGS

SIZE S X H FEET	STD. PLAN NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STD. PLAN NO.	CU. YD. PER FT.	CONC. CU. YD.
4x4	BD-4	0.6327	32.52	8x8	BD-8	1.7037	103.29
5x4	BD-4	0.7546	38.19	10x8	BD-8	2.1319	124.70
6x4	BD-4	0.8889	44.36	12x8	BD-8	2.6921	151.60
8x4	BD-4	1.2199	59.21	14x8	BD-8	3.1875	175.76
10x4	BD-4	1.6019	76.11	16x8	BD-8	3.7805	203.93
12x4	BD-4	2.0982	97.14	10x10	BD-10	2.4680	146.97
5x5	BD-5	0.8102	42.46	12x10	BD-10	2.9147	168.69
6x5	BD-5	0.9737	49.92	14x10	BD-10	3.4676	194.75
8x5	BD-5	1.2801	63.99	16x10	BD-10	4.1782	227.38
10x5	BD-5	1.6667	81.28	18x10	BD-10	5.0243	265.55
12x5	BD-5	2.1841	103.83	12x12	BD-12	3.3688	203.98
14x5	BD-5	2.7778	129.44	14x12	BD-12	3.8796	228.76
6x6	BD-6	1.1104	61.38	16x12	BD-12	4.6145	262.85
8x6	BD-6	1.4649	78.08	18x12	BD-12	5.4258	300.07
10x6	BD-6	1.7670	92.61	20x12	BD-12	6.1111	332.02
12x6	BD-6	2.2535	114.62				
14x6	BD-6	2.8897	142.65				
16x6	BD-6	3.5656	172.26				

NOTE: The quantities shown are correct and will be used on the final estimate as the basis of payment, unless authorized modifications are made.

EXAMPLE - 46.5' of 14' X 5' - 15º Skew
From Table (40' Lgt.) = 129.44 Cu.Yds.
2.7778 x (46.5-40.0) = 18.06 Cu.Yds.
TOTAL = 147.50 Cu.Yds.

TABLE 43

STANDARD DOUBLE CELL 30º SKEW CULVERTS - 2:1 SLOPE

CONCRETE QUANTITIES FOR 40' LENGTH
IN BARREL, WINGS, PARAPETS, CUTOFF WALLS, APRONS AND FOOTINGS

SIZE S X H FEET	STD. PLAN NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STD. PLAN NO.	CU. YD. PER FT.	CONC. CU. YD.
4x4	BD-4	0.6327	32.59	8x8	BD-8	1.7037	103.73
5x4	BD-4	0.7546	38.35	10x8	BD-8	2.1319	125.60
6x4	BD-4	0.8889	44.61	12x8	BD-8	2.6921	152.99
8x4	BD-4	1.2199	59.64	14x8	BD-8	3.1875	177.63
10x4	BD-4	1.6019	76.71	16x8	BD-8	3.7805	206.29
12x4	BD-4	2.0982	97.92	10x10	BD-10	2.4680	147.41
5x5	BD-5	0.8102	42.55	12x10	BD-10	2.9147	169.54
6x5	BD-5	0.9737	50.11	14x10	BD-10	3.4676	196.03
8x5	BD-5	1.2801	64.38	16x10	BD-10	4.1782	229.10
10x5	BD-5	1.6667	81.87	18x10	BD-10	5.0243	267.73
12x5	BD-5	2.1841	104.63	12x12	BD-12	3.3688	204.48
14x5	BD-5	2.7778	130.44	14x12	BD-12	3.8796	229.74
6x6	BD-6	1.1104	61.46	16x12	BD-12	4.6145	264.31
8x6	BD-6	1.4649	78.43	18x12	BD-12	5.4258	302.03
10x6	BD-6	1.7670	93.24	20x12	BD-12	6.1111	334.46
12x6	BD-6	2.2535	115.51				
14x6	BD-6	2.8897	143.83				
16x6	BD-6	3.5656	173.71				

NOTE: The quantities shown are correct and will be used on the final estimate as the basis of payment, unless authorized modifications are made.

EXAMPLE - 42.2' of 6' X 4' - 30º Skew
From Table (40' Lgt.) = 44.61 Cu.Yds.
0.8889 x (42.2-40.0) = 1.96 Cu.Yds.
TOTAL = 46.57 Cu.Yds.

TABLE 44

STANDARD DOUBLE CELL 45º SKEW CULVERTS - 2:1 SLOPE

CONCRETE QUANTITIES FOR 40' LENGTH IN
BARREL, WINGS, PARAPETS, CUTOFF WALLS, APRONS AND FOOTINGS

SIZE S X H FEET	STD. PLAN NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STD. PLAN NO.	CU. YD. PER FT.	CONC. CU. YD.
4x4	BD-4	0.6327	34.93	8x8	BD-8	1.7037	114.95
5x4	BD-4	0.7546	40.90	10x8	BD-8	2.1319	137.91
6x4	BD-4	0.8889	47.36	12x8	BD-8	2.6921	166.42
8x4	BD-4	1.2199	62.79	14x8	BD-8	3.1875	192.15
10x4	BD-4	1.6019	80.26	16x8	BD-8	3.7805	221.92
12x4	BD-4	2.0982	101.88	10x10	BD-10	2.4680	161.76
5x5	BD-5	0.8102	45.79	12x10	BD-10	2.9147	184.87
6x5	BD-5	0.9737	53.58	14x10	BD-10	3.4676	212.33
8x5	BD-5	1.2801	68.30	16x10	BD-10	4.1782	246.46
10x5	BD-5	1.6667	86.25	18x10	BD-10	5.0243	286.17
12x5	BD-5	2.1841	109.48	12x12	BD-12	3.3688	224.70
14x5	BD-5	2.7778	135.75	14x12	BD-12	3.8796	251.05
6x6	BD-6	1.1104	66.97	16x12	BD-12	4.6145	286.80
8x6	BD-6	1.4649	84.58	18x12	BD-12	5.4258	325.71
10x6	BD-6	1.7670	100.00	20x12	BD-12	6.1111	359.28
12x6	BD-6	2.2535	122.92				
14x6	BD-6	2.8897	151.88				
16x6	BD-6	3.5656	182.40				

NOTE: The quantities shown are correct and will be used on the final estimate as the basis of payment, unless authorized modifications are made.

EXAMPLE: 41.2' of 12' X 8' - 45º Skew
From Table (40' Lgt.) = 166.42 Cu.Yds.
2.6921 x (41.2-40.0) = 3.23 Cu.Yds.
TOTAL = 169.65 Cu.Yds.

TABLE 45

STANDARD SINGLE CELL 15º SKEW BOX CULVERTS - 3:1 SLOPE

CONCRETE QUANTITIES FOR 150' LENGTH IN
BARREL, WINGS, PARAPETS, CUTOFF WALLS, TWO AUXILIARY SLABS,
APRONS AND FOOTINGS

SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.
4x4	IBS-4-2W,IWS-3, IBJL-1,ISK-15-3W	0.3644	63.14	8x8	IBS-8-2W,IWS-3, IBJL-1,ISK-15-3W	0.9136	175.96
5x4	"	0.4421	75.54	10x8	"	1.0892	205.96
6x4	"	0.4884	83.12	12x8	"	1.3194	243.33
7x4	"	0.5761	96.98	14x8	"	1.6543	297.09
8x4	"	0.6538	109.33	16x8	"	1.9743	348.51
9x4	"	0.7546	125.15	18x8	"	2.3210	403.95
10x4	"	0.8449	139.40	20x8	"	2.6944	463.42
5x5	IBS-5-2W,IWS-3, IBJL-1,ISK-15-3W	0.4825	84.06	10x10	IBS-10-2W,IWS-3, IBJL-1, ISK-15-3W	1.3371	256.41
6x5	"	0.5478	94.63	12x10	"	1.5452	290.62
7x5	"	0.6193	106.14	14x10	"	1.7777	328.48
8x5	"	0.6970	118.57	16x10	"	2.1100	381.40
9x5	"	0.7809	131.92	18x10	"	2.4691	438.37
10x5	"	0.8912	149.26	20x10	"	2.8935	505.15
12x5	"	1.0700	177.58	22x10	"	3.3425	575.84
4x6	IBS-6-2W,IWS-3, IBJL-1,ISK-15-3W	0.4825	89.92	12x12	IBS-12-2W,IWS-3, IBJL-1,ISK-15-3W	1.7968	350.00
6x6	"	0.5910	108.19	14x12	"	1.9876	381.76
8x6	"	0.7631	136.13	16x12	"	2.2458	423.89
10x6	"	0.9609	167.90	18x12	"	2.6172	483.04
12x6	"	1.1844	203.52	20x12	"	3.0154	546.23
14x6	"	1.5062	253.97	22x12	"	3.5154	625.01
16x6	"	1.7881	298.36	24x12	"	4.0555	709.85
18x6	"	2.1471	354.33				
20x6	"	2.5339	414.47				

NOTE: The quantities shown are correct and will be used on the final estimate as the basis of payment, unless authorized modifications are made.

NOTE: For culverts modified for high fills, use Standard Drawing IBSM-3W and above table.

EXAMPLE -155.2' of 12' X 10' - 15º Skew

From Table (150' Lgt.)	=	290.62 Cu.Yds.
1.5452 x (155.2-150.0)	=	8.04 Cu.Yds.
TOTAL	=	298.66 Cu.Yds.

TABLE 46

STANDARD SINGLE CELL 30º SKEW BOX CULVERTS - 3:1 SLOPE

CONCRETE QUANTITIES FOR 150’ LENGTH IN
BARREL, WINGS, PARAPETS, CUTOFF WALLS, TWO AUXILIARY SLABS,
APRONS AND FOOTINGS

SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.
4x4	IBS-4-2W,IWS-3, IBJL-1,ISK-30-3W	0.3644	63.86	8x8	IBS-8-2W,IWS-3, IBJL-1,ISK-30-3W	0.9136	179.40
5x4	“	0.4421	76.32	10x8	“	1.0892	209.24
6x4	“	0.4884	83.98	12x8	“	1.3194	247.49
7x4	“	0.5761	97.90	14x8	“	1.6543	301.63
8x4	“	0.6538	110.31	16x8	“	1.9743	353.41
9x4	“	0.7546	126.19	18x8	“	2.3210	409.23
10x4	“	0.8449	140.50	20x8	“	2.6944	469.06
5x5	IBS-5-2W,IWS-3, IBJL-1,ISK-30-3W	0.4825	85.06	10x10	IBS-10-2W,IWS-3, IBJL-1,ISK-30-3W	1.3371	261.45
6x5	“	0.5478	95.69	12x10	“	1.5452	295.96
7x5	“	0.6193	107.28	14x10	“	1.7777	334.16
8x5	“	0.6970	119.79	16x10	“	2.1100	387.40
9x5	“	0.7809	133.22	18x10	“	2.4691	444.69
10x5	“	0.8912	150.64	20x10	“	2.8935	511.83
12x5	“	1.0700	179.10	22x10	“	3.3425	582.88
4x6	IBS-6-2W,IWS-3, IBJL-1,ISK-30-3W	0.4825	91.36	12x12	IBS-12-2W,IWS-3, IBJL-1,ISK-30-3W	1.7968	357.26
6x6	“	0.5910	109.85	14x12	“	1.9876	389.36
8x6	“	0.7631	137.99	16x12	“	2.2458	431.85
10x6	“	0.9609	169.98	18x12	“	2.6172	491.38
12x6	“	1.1844	205.82	20x12	“	3.0154	554.95
14x6	“	1.5062	256.49	22x12	“	3.5154	634.13
16x6	“	1.7881	301.10	24x12	“	4.0555	719.37
18x6	“	2.1471	357.27				
20x6	“	2.5339	417.63				

NOTE: The quantities shown are correct and will be used on the final estimate as the basis of payment, unless authorized modifications are made.

NOTE: For culverts modified for high fills, use Standard Drawing IBSM-3W and above table.

EXAMPLE: - 148.5’ of 10 ‘ x 6’ - 30º Skew
From Table (150’ Lgt.) = 169.98 Cu.Yds.
0.9609 x (150 - 148.5) = 1.44 Cu.Yds.
TOTAL = 168.54 Cu.Yds.

TABLE 47

STANDARD SINGLE CELL -45º SKEW BOX CULVERTS - 3:1 SLOPE

CONCRETE QUANTITIES FOR 150' LENGTH IN
BARREL, WINGS, PARAPETS, CUTOFF WALLS, TWO AUXILIARY SLABS,
APRONS AND FOOTINGS

SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.
4x4	IBS-4-2W,IWS-3, IBJL-1,ISK-45-3W	0.3644	65.96	8x8	IBS-8-2W,IWS-3, IBJL-1,ISK-45-3W	0.9136	89.44
5x4	"	0.4421	78.58	10x8	"	1.0892	220.04
6x4	"	0.4884	86.38	12x8	"	1.3194	259.05
7x4	"	0.5761	100.44	14x8	"	1.6543	314.03
8x4	"	0.6538	112.99	16x8	"	1.9743	366.61
9x4	"	0.7546	129.05	18x8	"	2.3210	423.23
10x4	"	0.8449	143.50	20x8	"	2.6944	483.88
5x5	IBS-5-2W,IWS-3, IBJL-1,ISK-45-3W	0.4825	87.98	10x10	IBS-10-2W,IWS-3, IBJL-1,ISK-45-3W	1.3371	275.37
6x5	"	0.5478	98.79	12x10	"	1.5452	310.56
7x5	"	0.6193	110.54	14x10	"	1.7777	349.46
8x5	"	0.6970	123.21	16x10	"	2.1100	403.40
9x5	"	0.7809	136.82	18x10	"	2.4691	461.43
10x5	"	0.8912	154.40	20x10	"	2.8935	529.29
12x5	"	1.0700	183.20	22x10	"	3.3425	601.12
4x6	IBS-6-2W,IWS-3, IBJL-1,ISK-45-3W	0.4825	95.88	12x12	IBS-12-2W,IWS-3, IBJL-1,ISK-45-3W	1.7968	377.22
6x6	"	0.5910	114.83	14x12	"	1.9876	410.04
8x6	"	0.7631	143.45	16x12	"	2.2458	453.31
10x6	"	0.9609	175.90	18x12	"	2.6172	513.66
12x6	"	1.1844	212.20	20x12	"	3.0154	578.03
14x6	"	1.5062	263.37	22x12	"	3.5154	658.11
16x6	"	1.7881	308.44	24x12	"	4.0555	744.25
18x6	"	2.1471	365.11				
20x6	"	2.5339	425.93				

NOTE: The quantities shown are correct and will be used on the final estimate as the basis of payment, unless authorized modifications are made.

NOTE: For culverts modified for high fills, use Standard Drawing IBSM-3W and above table.

EXAMPLE - 150.5' of 24' X 12' - 45º SKEW
From Table (150 lgt.) = 744.25 Cu.Yds.
4.0555 x (150.5 - 150.0) = 2.03 Cu.Yds.
TOTAL = 746.28 Cu.Yds.

TABLE 48

STANDARD SINGLE CELL -15º SKEW BOX CULVERTS - 4:1 SLOPE

CONCRETE QUANTITIES FOR 150' LENGTH IN
BARREL, WINGS, PARAPETS, CUTOFF WALLS, TWO AUXILIARY SLABS,
APRONS AND FOOTINGS

SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.
4x4	IBS-4-2W,IWS-4, IBJL-1,ISK-15-4W	0.3644	65.58	8x8	IBS-8-2W,IWS-34 IBJL-1,ISK-15-4W	0.9136	187.59
5x4	"	0.4421	78.16	10x8	"	1.0892	217.96
6x4	"	0.4884	85.92	12x8	"	1.3194	256.73
7x4	"	0.5761	99.94	14x8	"	1.6543	311.42
8x4	"	0.6538	112.45	16x8	"	1.9743	363.73
9x4	"	0.7546	128.45	18x8	"	2.3210	420.08
10x4	"	0.8449	142.86	20x8	"	2.6944	480.44
5x5	IBS-5-2W,IWS-4, IBJL-1,ISK-15-4W	0.4825	87.46	10x10	IBS-10-2W,IWS-10 IBJL-1,ISK-15-4W	1.3371	272.61
6x5	"	0.5478	98.22	12x10	"	1.5452	307.60
7x5	"	0.6193	109.92	14x10	"	1.7777	346.21
8x5	"	0.6970	122.55	16x10	"	2.1100	399.88
9x5	"	0.7809	136.11	18x10	"	2.4691	457.59
10x5	"	0.8912	153.65	20x10	"	2.8935	525.15
12x5	"	1.0700	182.36	22x10	"	3.3425	596.62
4x6	IBS-6-2W,IWS-4, IBJL-1,ISK-15-4W	0.4825	95.20	12x12	IBS-12-2W,IWS-4, IBJHL-1,ISK-15-4W	1.7968	373.48
6x6	"	0.5910	114.05	14x12	"	1.9876	406.05
8x6	"	0.7631	142.57	16x12	"	2.2458	449.03
10x6	"	0.9609	174.92	18x12	"	2.6172	509.07
12x6	"	1.1844	211.13	20x12	"	3.0154	573.14
14x6	"	1.5062	262.20	22x12	"	3.5154	652.84
16x6	"	1.7881	307.17	24x12	"	4.0555	738.59
18x6	"	2.1471	363.72				
20x6	"	2.5339	424.44				

NOTE: The quantities shown are correct and will be used on the final estimate as the basis of payment, unless authorized modifications are made.

NOTE: For culverts modified for high fills, use Standard Drawing IBSM-3W and above table.
NOTE: For culverts modified for high fills, use Standard Drawing IBSM-4W and above table.

EXAMPLE - 151.7' of 10' x 6' - 15º Skew

From Table (150' lgt.)	=	174.92 Cu.Yds.
0.9609 x (151.7 - 150.0)	=	1.63 Cu.Yds.
TOTAL	=	176.55 Cu.Yds.

TABLE 49

STANDARD SINGLE CELL 30º SKEW BOX CULVERTS - 4:1 SLOPE

CONCRETE QUANTITIES FOR 150’ LENGTH IN
BARREL, WINGS, PARAPETS, CUTOFF WALLS, TWO AUXILIARY SLABS,
APRONS AND FOOTINGS

SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.
4x4	IBS-4-2W,IWS-4, IBJL-1,ISK-30-4W	0.3644	67.36	8x8	IBS-8-2W,IWS-4 IBJL-1,ISK-30-4W	0.9136	196.00
5x4	“	0.4421	80.04	10x8	“	1.0892	226.82
6x4	“	0.4884	87.88	12x8	“	1.3194	266.07
7x4	“	0.5761	101.98	14x8	“	1.6543	321.25
8x4	“	0.6538	114.59	16x8	“	1.9743	374.05
9x4	“	0.7546	130.69	18x8	“	2.3210	430.89
10x4	“	0.8449	145.18	20x8	“	2.6944	491.74
5x5	IBS-5-2W,IWS-4, IBJL-1,ISK-30-4W	0.4825	89.92	10x10	IBS-10-2W,IWS-4 IBJL-1,ISK-30-4W	1.3371	283.93
6x5	“	0.5478	100.77	12x10	“	1.5452	319.32
7x5	“	0.6193	112.58	14x10	“	1.7777	358.38
8x5	“	0.6970	125.31	16x10	“	2.1100	412.46
9x5	“	0.7809	138.98	18x10	“	2.4691	470.61
10x5	“	0.8912	156.62	20x10	“	2.8935	538.59
12x5	“	1.0700	185.52	22x10	“	3.3425	610.54
4x6	IBS-6-2W,IWS-4, IBJL-1,ISK-30-4W	0.4825	99.14	12x12	IBS-12-2W,IWS-4, IBJHL-1,ISK-30-4W	1.7968	389.52
6x6	“	0.5910	118.27	14x12	“	1.9876	422.54
8x6	“	0.7631	145.09	16x12	“	2.2458	466.01
10x6	“	0.9609	179.74	18x12	“	2.6172	526.56
12x6	“	1.1844	216.22	20x12	“	3.0154	591.09
14x6	“	1.5062	267.59	22x12	“	3.5154	671.33
16x6	“	1.7881	312.86	24x12	“	4.0555	757.63
18x6	“	2.1471	369.71				
20x6	“	2.5339	430.71				

NOTE: The quantities shown are correct and will be used on the final estimate as the basis of payment, unless authorized modifications are made.

NOTE: For culverts modified for high fills, use Standard Drawing IBSM-4W and above table.

Example - 12’ x 10 x 155.2 - 30º Skew
From Table (150’ lgt.) = 319.32 Cu.Yds.
1.5452 x (155.2 -150.0) = 8.04 Cu.Yds.
TOTAL = 327.36 Cu.Yds.

TABLE 50

STANDARD SINGLE CELL -45º SKEW BOX CULVERTS - 4:1 SLOPE

CONCRETE QUANTITIES FOR 150' LENGTH IN
BARREL, WINGS, PARAPETS, CUTOFF WALLS, TWO AUXILIARY SLABS,
APRONS AND FOOTINGS

SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.
4x4	IBS-4-2W,IWS-4, IBJL-1,ISK-45-4W	0.3644	69.68	8x8	IBS-8-2W,IWS-4 IBJL-1,ISK-45-4W	0.9136	207.14
5x4	"	0.4421	82.56	10x8	"	1.0892	238.92
6x4	"	0.4884	90.58	12x8	"	1.3194	279.17
7x4	"	0.5761	104.88	14x8	"	1.6543	335.41
8x4	"	0.6538	117.67	16x8	"	1.9743	389.23
9x4	"	0.7546	133.95	18x8	"	2.3210	447.09
10x4	"	0.8449	148.64	20x8	"	2.6944	508.96
5x5	IBS-5-2W,IWS-4, IBJL-1,ISK-45-4W	0.4825	93.14	10x10	IBS-10-2W,IWS-4 IBJL-1,ISK-45-4W	1.3371	299.59
6x5	"	0.5478	104.21	12x10	"	1.5452	335.82
7x5	"	0.6193	116.24	14x10	"	1.7777	375.74
8x5	"	0.6970	129.19	16x10	"	2.1100	430.72
9x5	"	0.7809	143.06	18x10	"	2.4691	489.77
10x5	"	0.8912	160.92	20x10	"	2.8935	558.65
12x5	"	1.0700	190.24	22x10	"	3.3425	631.58
4x6	IBS-6-2W,IWS-4, IBJL-1,ISK-45-4W	0.4825	104.06	12x12	IBS-12-2W,IWS-4, IBJHL-1,ISK-45-4W	1.7968	412.08
6x6	"	0.5910	123.77	14x12	"	1.9876	446.02
8x6	"	0.7631	153.21	16x12	"	2.2458	490.49
10x6	"	0.9609	186.46	18x12	"	2.6172	552.02
12x6	"	1.1844	223.58	20x12	"	3.0154	617.59
14x6	"	1.5062	275.57	22x12	"	3.5154	698.93
16x6	"	1.7881	321.46	24x12	"	4.0555	786.35
18x6	"	2.1471	378.91				
20x6	"	2.5339	440.56				

NOTE: The quantities shown are correct and will be used on the final estimate as the basis of payment, unless authorized modifications are made.

NOTE: For culverts modified for high fills, use Standard Drawing IBSM-4W and above table.

Example - 150.5 of 24' X 12' - 45º Skew
From Table (150' lgt.) = 786.35 Cu.Yds.
4.0555 x (150.5 -150.0) = 2.03 Cu.Yds.
TOTAL = 788.38 Cu.Yds.

TABLE 51

STANDARD DOUBLE CELL -15º SKEW CULVERTS - 2:1 SLOPE

QUANTITIES FOR 150' LENGTH IN BARREL, WINGS, PARAPETS, CUTOFF WALLS, TWO AUXILIARY SLABS, APRONS AND FOOTINGS, CENTERWALL UPSTREAM HEADWALL

SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.
4x4	IBD-4-2 W	0.6409	104.29	8x8	IBD-8-2W	1.7284	296.18
5x4	IBJL-1	0.7649	123.88	10x8	IBJL-1	2.1628	366.02
6x4	ISK-15-2W	0.9012	145.32	12x8	ISK-15-2W	2.7291	455.88
8x4	"	1.2364	197.61	14x8	"	3.2307	535.85
10x4	"	1.6225	257.55	16x8	"	3.8299	630.60
12x4	"	2.1119	332.98	10x10	IBD-10-2W	2.4989	425.31
5x5	IBD-5-2W	0.8205	134.27	12x10	IBJL-1	2.9517	497.46
6x5	IBJL-1	0.9860	160.21	14x10	ISK-15-2W	3.5108	585.69
8x5	ISK-15-2W	1.2966	209.02	16x10	"	4.2276	697.81
10x5	"	1.6873	269.85	18x10	"	5.0779	830.10
12x5	"	2.2088	350.35	12x12	IBD-12-2W	3.4058	582.74
14x5	"	2.8066	442.28	14x12	IBJL-1	3.9228	665.04
6x6	IBD-6-2W	1.1227	186.73	16x12	ISK-15-2W	4.6639	781.30
8x6	IBJL-1	1.4814	243.45	18x12	"	5.4814	909.11
10x6	ISK-15-2W	1.7876	292.23	20x12	"	6.1728	1017.74
12x6	"	2.2782	368.77				
14x6	"	2.9185	467.82				
16x6	"	3.5985	572.79				

NOTE: The quantities shown are correct and will be used on the Final Estimate as the basis of payment, unless authorized modifications are made.

NOTE: For culverts modified for high fills, use Standard Drawings IBDM-2W and above table.

EXAMPLE - 142.19 of 14' X 5' - 15º Skew
From Table (150' Lgt.) = 442.28 Cu.Yds.
2.8066 x (142.19 - 150) = -21.92 Cu.Yds.
TOTAL = 420.36 Cu.Yds.

TABLE 52

STANDARD DOUBLE CELL -30º SKEW CULVERTS - 2:1 SLOPE

QUANTITIES FOR 150’ LENGTH IN BARREL, WINGS, PARAPETS, CUTOFF WALLS, TWO AUXILIARY SLABS, APRONS AND FOOTINGS, CENTERWALL UPSTREAM HEADWALL

SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.
4x4	IBD-4-2 W	0.6409	104.36	8x8	IBD-8-2W	1.7284	296.62
5x4	IBJL-1	0.7649	124.04	10x8	IBJL-1	2.1628	366.92
6x4	ISK-30-2W	0.9012	145.57	12x8	ISK-30-2W	2.7291	457.27
8x4	“	1.2364	198.04	14x8	“	3.2307	537.72
10x4	“	1.6225	258.15	16x8	“	3.8299	632.96
12x4	“	2.1119	333.76	10x10	IBD-10-2W	2.4989	425.75
5x5	IBD-5-2W	0.8205	134.36	12x10	IBJL-1	2.9517	498.31
6x5	IBJL-1	0.9860	160.40	14x10	ISK-30-2W	3.5108	586.97
8x5	ISK-30-2W	1.2966	209.41	16x10	“	4.2276	699.53
10x5	“	1.6873	270.44	18x10	“	5.0779	832.28
12x5	“	2.2088	351.15	12x12	IBD-12-2W	3.4058	583.24
14x5	“	2.8066	443.28	14x12	IBJL-1	3.9228	666.02
6x6	IBD-6-2W	1.1227	186.81	16x12	ISK-30-2W	4.6639	782.76
8x6	IBJL-1	1.4814	243.80	18x12	“	5.4814	911.07
10x6	ISK-30-2W	1.7876	292.86	20x12	“	6.1728	1020.18
12x6	“	2.2782	369.66				
14x6	“	2.9185	469.00				
16x6	“	3.5985	574.24				

NOTE: The quantities shown are correct and will be used on the final estimate as the basis of payment, unless authorized modifications are made.

NOTE: For culverts modified for high fills, use Standard Drawings IBDM-2W and above table.

EXAMPLE - 184.6’ of 6’ x 4’ - 30º Skew
From Table (150’ Lgt.) = 145.57 Cu.Yds.
0.9012 x (184.6 - 150.0) = 31.18 Cu.Yds.
TOTAL = 176.75 Cu.Yds.

TABLE 53

STANDARD DOUBLE CELL - 45º SKEW CULVERTS - 2:1 SLOPE

QUANTITIES FOR 150’ LENGTH IN BARREL, WINGS, PARAPETS, CUTOFF WALLS, TWO AUXILIARY SLABS, APRONS AND FOOTINGS, CENTERWALL UPSTREAM HEADWALL

SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.
4x4	IBD-4-2W	0.6409	106.70	8x8	IBD-8-2W	1.7284	307.84
5x4	IBJL-1	0.7649	126.59	10x8	IBJL-1	2.1628	379.23
6x4	ISK-45-2W	0.9012	148.32	12x8	ISK-45-2W	2.7291	470.70
8x4	“	1.2364	201.19	14x8	“	3.2307	552.24
10x4	“	1.6225	261.70	16x8	“	3.8299	648.59
12x4	“	2.1119	337.72	10x10	IBD-10-2W	2.4989	440.10
5x5	IBD-5-2W	0.8205	137.60	12x10	IBJL-1	2.9517	513.64
6x5	IBJL-1	0.9860	163.87	14x10	ISK-45-2W	3.5108	603.27
8x5	ISK-45-2W	1.2966	213.33	16x10	“	4.2276	716.89
10x5	“	1.6873	274.82	18x10	“	5.0779	850.72
12x5	“	2.2088	356.00	12x12	IBD-12-2W	3.4058	603.46
14x5	“	2.8066	448.59	14x12	IBJL-1	3.9228	687.33
6x6	IBD-6-2W	1.1227	192.32	16x12	ISK-45-2W	4.6639	805.25
8x6	IBJL-1	1.4814	249.95	18x12	“	5.4814	934.75
10x6	ISK-45-2W	1.7876	299.62	20x12	“	6.1728	1045.00
12x6	“	2.2782	377.07				
14x6	“	2.9185	477.05				
16x6	“	3.5985	582.93				

NOTE: The quantities shown are correct and will be used on the final estimate as the basis of payment, unless authorized modifications are made.

NOTE: For culverts modified for high fills, use Standard Drawings IBDM-2W and above table.

EXAMPLE - 151.2’ of 12’ x 8’ - 45º Skew
From Table (150’ Lgt.) = 470.70 Cu.Yds.
2.7291 x (151.2-150) = 3.27 Cu.Yds.
TOTAL = 473.97 Cu.Yds.

TABLE 54

STANDARD DOUBLE CELL -15ºSKEW BOX CULVERTS - 3:1 SLOPE

QUANTITIES FOR 150' LENGTH IN BARREL, WINGS, PARAPETS, CUTOFF WALLS, TWO AUXILIARY SLABS, APRONS & FOOTINGS, CENTERWALL UPSTREAM HEADWALL

SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.
4x4	IBD-4-2W,IWD-3, IBJL-1,ISK-15-3W "	0.6409	107.86	8x8	IBD-8-2W,IWD-3 IBJL-1,ISK-15-3W "	1.7284	312.88
5x4	"	0.7649	127.82	10x8	"	2.1628	384.55
6x4	"	0.9012	149.60	12x8	"	2.7291	476.27
8x4	"	1.2364	202.61	14x8	"	3.2307	558.01
10x4	"	1.6225	263.25	16x8	"	3.8299	654.60
12x4	"	2.1119	339.40				
5x5	IBD-5-2W,IWD-3, IBJL-1,ISK-15-3W "	0.8205	139.27	10x10	IBD-10-2W,IWD-3 IBJL-1,ISK-15-3W "	2.4989	447.91
6x5	"	0.9860	165.65	12x10	"	2.9517	521.49
8x5	"	1.2966	215.24	14x10	"	3.5108	611.24
10x5	"	1.6873	276.93	16x10	"	4.2276	724.94
12x5	"	2.2088	358.18	18x10	"	5.0779	858.93
14x5	"	2.8066	451.05	12x12	IBD-12-2W,IWD-3 IBJL-1,ISK-15-3W "	3.4058	614.80
6x6	IBD-6-2W,IWD-3, IBJL-1,ISK-15-3W "	1.1227	195.30	14x12	"	3.9228	698.75
8x6	"	1.4814	253.24	16x12	"	4.6639	816.83
10x6	"	1.7876	303.15	18x12	"	5.4814	946.48
12x6	"	2.2782	380.88	20x12	"	6.1728	1056.75
14x6	"	2.9185	481.24				
16x6	"	3.5985	587.46				

NOTE: The quantities shown are correct and will be used on the final estimate as the basis of payment unless authorized modifications are made.

NOTE: For culverts modified for high fills, use Standard Drawing IBDM-3W and above table.

EXAMPLE - 145.4' of 12' x 6' - 15º Skew
From Table (150' Lgt.) = 380.88 Cu.Yds.
2.2782 x (150.0-145.4) = 10.48 Cu.Yds.
TOTAL = 370.40 Cu.Yds.

TABLE 55

STANDARD DOUBLE CELL - 30ºSKEW BOX CULVERTS - 3:1 SLOPE

CONCRETE QUANTITIES FOR 150’ LENGTH IN BARREL, WINGS, PARAPETS, CUTOFF WALLS, TWO AUXILIARY SLABS, APRONS & FOOTINGS, CENTERWALL UPSTREAM H.W.

SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.
4x4	IBD-4-2W,IWD-3, IBJL-1,ISK-30-3W	0.6409	108.86	8x8	IBD-8-2W,IWD-3 IBJL-1,ISK-30-3W	1.7284	317.78
5x4	“	0.7649	128.94	10x8	“	2.1628	390.15
6x4	“	0.9012	150.86	12x8	“	2.7291	482.59
8x4	“	1.2364	204.15	14x8	“	3.2307	565.05
10x4	“	1.6225	265.05	16x8	“	3.8299	662.34
12x4	“	2.1119	341.46				
5x5	IBD-5-2W,IWD-3, IBJL-1,ISK-30-3W	0.8205	140.65	10x10	IBD-10-2W,IWD-3 IBJL-1,ISK-30-3W	2.4989	454.51
6x5	“	0.9860	167.19	12x10	“	2.9517	528.71
8x5	“	1.2966	217.08	14x10	“	3.5108	619.08
10x5	“	1.6873	279.07	16x10	“	4.2276	733.44
12x5	“	2.2088	360.62	18x10	“	5.0779	868.08
14x5	“	2.8066	453.81				
6x6	IBD-6-2W,IWD-3, IBJL-1,ISK-30-3W	1.1227	197.62	12x12	IBD-12-2W,IWD-3, IBJL-1,ISK-30-3W	3.4058	624.16
8x6	“	1.4814	256.00	14x12	“	3.9228	708.81
10x6	“	1.7876	306.33	16x12	“	4.6639	827.63
12x6	“	2.2782	384.48	18x12	“	5.4814	958.02
14x6	“	2.9185	485.28	20x12	“	6.1728	1069.01
16x6	“	3.5985	591.92				

NOTE: The quantities shown are correct and will be used on the Final Estimate as the basis of payment, unless authorized modifications are made.

NOTE: For culverts modified for high fills, use Standard Drawing IBDM-3W and above table.

EXAMPLE - 151.2’ of 12’ x 8 - 30º Skew
From Table (150’ Lgt.) = 482.59 Cu.Yds.
2.7291 x (151.2-150.0) = 3.27 Cu.Yds.
TOTAL = 485.86 Cu.Yds.

TABLE 56

STANDARD DOUBLE CELL - 45ºSKEW BOX CULVERTS - 3:1 SLOPE

CONCRETE QUANTITIES FOR 150’ LENGTH IN BARREL, WINGS, PARAPETS, CUTOFF WALLS, TWO AUXILIARY SLABS, APRONS & FOOTINGS, CENTERWALL UPSTREAM HEADWALLS

SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.
4x4	IBD-4-2W,IWD-3, IBJL-1,ISK-45-3W	0.6409	111.60	8x8	IBD-8-2W,IWD-3 IBJL-1,ISK-45-3W	1.7284	330.94
5x4	“	0.7649	131.96	10x8	“	2.1628	404.83
6x4	“	0.9012	154.16	12x8	“	2.7291	498.87
8x4	“	1.2364	208.03	14x8	“	3.2307	582.83
10x4	“	1.6225	269.51	16x8	“	3.8299	681.70
12x4	“	2.1119	346.50				
5x5	IBD-5-2W,IWD-3, IBJL-1,ISK-45-3W	0.8205	144.45	10x10	IBD-10-2W,IWD-3 IBJL-1,ISK-45-3W	2.4989	471.81
6x5	“	0.9860	171.31	12x10	“	2.9517	547.33
8x5	“	1.2966	221.86	14x10	“	3.5108	639.04
10x5	“	1.6873	284.49	16x10	“	4.2276	754.84
12x5	“	2.2088	366.72	18x10	“	5.0779	890.94
14x5	“	2.8066	460.59				
6x6	IBD-6-2W,IWD-3, IBJL-1,ISK-45-3W	1.1227	204.08	12x12	IBD-12-2W,IWD-3, IBJL-1,ISK-45-3W	3.4058	648.66
8x6	“	1.4814	263.38	14x12	“	3.9228	734.81
10x6	“	1.7876	314.61	16x12	“	4.6639	855.21
12x6	“	2.2782	393.68	18x12	“	5.4814	987.24
14x6	“	2.9185	495.44	20x12	“	6.1728	1099.75
16x6	“	3.5985	603.02				

NOTE: The quantities shown are correct and will be used on the final estimate as the basis of payment unless authorized modifications are made.

NOTE: For culverts modified for high fills, use Standard Drawing IBDM-3W and above table.

EXAMPLE - 154.2’ of 10’ x 10’ - 45º Skew
From Table (150’ Lgt.) = 471.81 Cu. Yds.
2.4989 x (154.2-150.0) = 10.50 Cu.Yds.
TOTAL = 482.31 CuYds.

TABLE 57

STANDARD DOUBLE CELL 15ºSKEW BOX CULVERTS - 4:1 SLOPE

CONCRETE QUANTITIES FOR 150’ LENGTH IN BARREL, WINGS, PARAPETS, CUTOFF WALLS, TWO AUXILIARY SLABS, APRONS & FOOTINGS, CENTERWALL UPSTREAM HEADWALLS

SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.
4x4	IBD-4-2W,IWD-4, IBJL-1,ISK-15-4W	0.6409	111.04	8x8	IBD-8-2W,IWD-4 IBJL-1,ISK-15-4W	1.7284	328.18
5x4	“	0.7649	131.32	10x8	“	2.1628	401.61
6x4	“	0.9012	153.42	12x8	“	2.7291	495.11
8x4	“	1.2364	207.11	14x8	“	3.2307	578.57
10x4	“	1.6225	268.43	16x8	“	3.8299	676.90
12x4	“	2.1119	345.24				
5x5	IBD-5-2W,IWD-4, IBJL-1,ISK-15-4W	0.8205	143.69	10x10	IBD-10-2W,IWD-4 IBJL-1,ISK-15-4W	2.4989	467.85
6x5	“	0.9860	170.47	12x10	“	2.9517	542.85
8x5	“	1.2966	220.82	14x10	“	3.5108	634.04
10x5	“	1.6873	283.29	16x10	“	4.2276	749.20
12x5	“	2.2088	365.32	18x10	“	5.0779	884.66
14x5	“	2.8066	459.01				
6x6	IBD-6-2W,IWD-4, IBJL-1,ISK-15-4W	1.1227	202.98	12x12	IBD-12-2W,IWD-4, IBJL-1,ISK-15-4W	3.4058	643.34
8x6	“	1.4814	262.08	14x12	“	3.9228	728.91
10x6	“	1.7876	313.11	16x12	“	4.6639	848.71
12x6	“	2.2782	391.98	18x12	“	5.4814	980.06
14x6	“	2.9185	493.52	20x12	“	6.1728	1091.95
16x6	“	3.5985	600.90				

NOTE: The quantities shown are correct and will be used on the final estimate as the basis of payment, unless authorized modifications are made.

NOTE: For culverts modified for high fills, use Standard Drawing IBDM-4W and above table.

EXAMPLE - 155.4’ of 12’ X 6’ - 15º Skew
From Table (150’ Lgt.) = 391.98 Cu.Yds.
2.2782 x (155.4-150.0) = 12.30 Cu.Yds.
TOTAL = 404.28 Cu.Yds.

TABLE 58

STANDARD DOUBLE CELL - 30ºSKEW BOX CULVERTS - 4:1 SLOPE

CONCRETE QUANTITIES FOR 150’ LENGTH IN BARREL, WINGS, PARAPETS, CUTOFF WALLS, TWO AUXILIARY SLABS, APRONS & FOOTINGS, CENTERWALL UPSTREAM H.W.

SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.
4x4	IBD-4-2W,IWD-4, IBJL-1,ISK-30-4W	0.6409	113.20	8x8	IBD-8-2W,IWD-4 IBJL-1,ISK-30-4W	1.7284	338.48
5x4	“	0.7649	133.64	10x8	“	2.1628	412.81
6x4	“	0.9012	155.94	12x8	“	2.7291	507.27
8x4	“	1.2364	209.97	14x8	“	3.2307	591.65
10x4	“	1.6225	271.63	16x8	“	3.8299	690.92
12x4	“	2.1119	348.80				
5x5	IBD-5-2W,IWD-4, IBJL-1,ISK-30-4W	0.8205	146.67	10x10	IBD-10-2W,IWD-4 IBJL-1,ISK-30-4W	2.4989	481.19
6x5	“	0.9860	173.65	12x10	“	2.9517	556.97
8x5	“	1.2966	224.40	14x10	“	3.5108	648.96
10x5	“	1.6873	287.25	16x10	“	4.2276	764.98
12x5	“	2.2088	369.70	18x10	“	5.0779	901.30
14x5	“	2.8066	463.79				
6x6	IBD-6-2W,IWD-4, IBJL-1,ISK-30-4W	1.1227	208.12	12x12	IBD-12-2W,IWD-4, IBJL-1,ISK-30-4W	3.4058	662.14
8x6	“	1.4814	267.76	14x12	“	3.9228	748.63
10x6	“	1.7876	319.33	16x12	“	4.6639	869.39
12x6	“	2.2782	398.78	18x12	“	5.4814	1001.70
14x6	“	2.9185	500.90	20x12	“	6.1728	1114.51
16x6	“	3.5985	608.86				

NOTE: The quantities shown are correct and will be used on the final estimate as the basis of payment, unless authorized modifications are made.

NOTE: For culverts modified for high fills, use Standard Drawing IBDM-4W and above table.

EXAMPLE - 149.0’ of 12’ x 8’ - 30º Skew
From Table (150’ Lgt.) = 507.27 Cu. Yds.
2.7291 x (149.0 - 150.0) = 2.73 Cu. Yds.
TOTAL = 504.54 Cu. Yds.

TABLE 59

STANDARD DOUBLE CELL 45ºSKEW BOX CULVERTS - 4:1 SLOPE

CONCRETE QUANTITIES FOR 150’ LENGTH IN BARREL, WINGS, PARAPETS CUTOFF WALLS
TWO AUXILIARY SLABS, APRONS & FOOTINGS, CENTERWALL UPSTREAM HEADWALL

SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.	SIZE S X H FEET	STANDARD PLAN SHEET NO.	CU.YD. PER FT.	CONC. CU. YD.
4x4	IBD-4-2W,IWD-4, IBJL-1,ISK-45-4W	0.6409	116.34	8x8	IBD-8-2W,IWD-4 IBJL-1,ISK-45-4W	1.7284	353.66
5x4	“	0.7649	137.14	10x8	“	2.1628	429.95
6x4	“	0.9012	159.80	12x8	“	2.7291	526.41
8x4	“	1.2364	214.57	14x8	“	3.2307	612.75
10x4	“	1.6225	276.99	16x8	“	3.8299	714.00
12x4	“	2.1119	354.90				
5x5	IBD-5-2W,IWD-4, IBJL-1,ISK-45-4W	0.8205	151.01	10x10	IBD-10-2W,IWD-4 IBJL-1,ISK-45-4W	2.4989	501.11
6x5	“	0.9860	178.43	12x10	“	2.9517	578.57
8x5	“	1.2966	230.02	14x10	“	3.5108	672.24
10x5	“	1.6873	293.73	16x10	“	4.2276	790.04
12x5	“	2.2088	377.04	18x10	“	5.0779	928.18
14x5	“	2.8066	471.99				
6x6	IBD-6-2W,IWD-4, IBJL-1,ISK-45-4W	1.1227	215.56	12x12	IBD-12-2W,IWD-4,IBJL-1, ISK-45-4W	3.4058	690.46
8x6	“	1.4814	276.40	14x12	“	3.9228	778.83
10x6	“	1.7876	329.15	16x12	“	4.6639	901.61
12x6	“	2.2782	409.80	18x12	“	5.4814	1035.94
14x6	“	2.9185	513.16	20x12	“	6.1728	1150.71
16x6	“	3.5985	622.34				

NOTE: The quantities shown are correct and will be used on the Final Estimate as the basis of payment unless authorized modifications are made.

NOTE: For Culverts modified for high fills, use Standard Drawing IBDM-4W and above table.

EXAMPLE - 145.2’ of 10’ x 10’ - 45º Skew
From Table (150’ Lgt.) = 501.11 Cu.Yds.
2.4989 x (145.2 - 150.0 -) = -11.99 Cu.Yds.
TOTAL = 489.12 Cu Yds.

TABLE 60

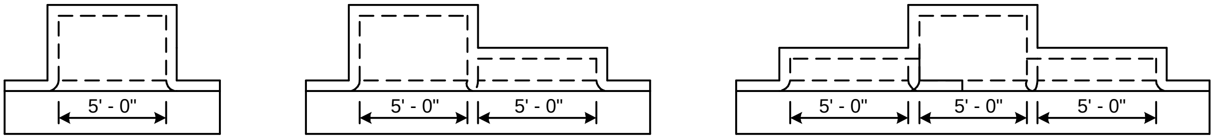
SUMMARY DATA FOR SIGNPOST FOOTINGS
Concrete (Class "B") in Cubic Yards
Steel (Structural) in Lbs.

POST SIZE - TYPE	FOOT DIA M	FOOTING DEPTH											
		ITEM	3'-0"	3'-6"	4'-0"	4'-6"	5'-0"	5'-6"	6'-0"	6'-6"	7'-0"	7'-6"	8'-0"
3 I 5.7	1'-6"	Conc.	0.20	0.23	0.26	0.29	0.33	0.36	0.39	0.43	0.46	0.49	0.52
		Steel	19	22	26	29	32	35	39	42	45	48	52
4 I 7.7	1'-6"	Conc.	0.20	0.23	0.26	0.29	0.33	0.36	0.39	0.42	0.46	0.49	0.52
		Steel	19	22	26	29	32	35	39	42	45	48	52
6 B 8.5	2'-0"	Conc.	0.35	0.41	0.46	0.52	0.58	0.64	0.70	0.76	0.81	0.87	0.93
		Steel	21	25	28	32	35	39	43	46	50	53	57
6 B 12	2'-0"	Conc.	0.35	0.41	0.46	0.52	0.58	0.64	0.70	0.76	0.81	0.87	0.93
		Steel	29	34	39	44	49	54	59	64	69	74	79
6 WF 15.5	2'-0"	Conc.	0.35	0.41	0.46	0.52	0.58	0.64	0.70	0.75	0.81	0.87	0.93
		Steel	38	45	52	59	66	72	79	86	93	100	107
8 WF 17	2'-0"	Conc.	0.35	0.41	0.46	0.52	0.58	0.64	0.70	0.75	0.81	0.87	0.93
		Steel	49	58	67	76	85	94	103	112	121	130	139
8 WF 20	2'-0"	Conc.	0.35	0.40	0.46	0.52	0.58	0.64	0.69	0.75	0.81	0.87	0.93
		Steel	61	73	84	96	108	119	131	142	154	165	177
10 WF 21	2'-0"	Conc.	0.35	0.40	0.46	0.52	0.58	0.64	0.69	0.75	0.81	0.87	0.93
		Steel	76	90	105	119	134	148	163	177	192	206	221
10 WF 25	2'-0"	Conc.	0.34	0.40	0.46	0.52	0.58	0.64	0.69	0.75	0.81	0.87	0.93
		Steel	94	112	130	148	166	184	203	221	239	257	275
12 WF 27	2'-0"	Conc.	0.34	0.40	0.46	0.52	0.58	0.64	0.69	0.75	0.81	0.87	0.93
		Steel	114	136	158	181	203	225	247	269	291	313	335

NOTE: The quantities shown in above Table are correct and will be used on the final estimate as the basis of payment, unless authorized modifications are made.

TABLE 70

CONCRETE AND REINFORCING STEEL FOR STORM SEWER STRUCTURE TYPE SS-2



QUANTITIES SHOWN IN TABLE ARE FOR ONE REGULAR INLET 5’-0”
FOR INLETS WITH ONE EXTENSION (10’-0”), ADD 0.89 C.Y. CONCRETE AND 101 LBS. REINFORCING STEEL.
FOR INLETS WITH TWO EXTENSIONS (15’-0”), ADD 1.78 C.Y. CONCRETE AND 202 LBS. STEEL.

INLET DEPTH	“W”					
“H” (Ft.)	2’ - 6”		3’ - 0”		3’ - 6”	
	CONC.	STEEL	CONC.	STEEL	CONC.	STEEL
3.0	2.00	191	2.15	195	2.31	199
3.1	2.03	193	2.18	197	2.35	201
3.2	2.06	195	2.22	199	2.38	203
3.3	2.09	198	2.25	202	2.42	206
3.4	2.13	200	2.28	204	2.45	208
3.5	2.16	202	2.32	206	2.49	210
3.6	2.19	203	2.35	207	2.53	211
3.7	2.22	204	2.39	208	2.56	212
3.8	2.25	206	2.42	210	2.60	214
3.9	2.29	207	2.45	211	2.63	215
4.0	2.32	208	2.49	212	2.66	216
4.1	2.35	210	2.52	214	2.70	218
4.2	2.38	213	2.56	217	2.73	221
4.3	2.41	215	2.59	219	2.77	223
4.4	2.44	218	2.62	222	2.80	226
4.5	2.47	220	2.65	224	2.83	228
4.6	2.50	221	2.68	225	2.87	229
4.7	2.53	222	2.72	226	2.90	230
4.8	2.56	222	2.75	226	2.94	230
4.9	2.60	223	2.78	227	2.97	231
5.0	2.63	224	2.82	228	3.01	232
5.1	2.66	227	2.85	231	3.05	235
5.2	2.69	230	2.89	234	3.08	238
5.3	2.72	232	2.92	236	3.12	240
5.4	2.76	235	2.95	239	3.15	243
5.5	2.79	238	2.99	242	3.19	246
5.6	2.82	239	3.02	243	3.22	247
5.7	2.85	240	3.06	244	3.26	248
5.8	2.88	240	3.09	244	3.29	248
5.9	2.92	241	3.12	245	3.33	249
6.0	2.95	242	3.15	246	3.36	250
6.1	2.98	244	3.18	248	3.39	252
6.2	3.01	246	3.22	250	3.44	254
6.3	3.04	249	3.25	253	3.47	257

TABLE 71

CONCRETE AND REINFORCING STEEL FOR STORM SEWER STRUCTURE TYPE SS-2

INLET DEPTH	"W"					
"H" (Ft.)	2' - 6"		3' - 0"		3' - 6"	
	CONC.	STEEL	CONC.	STEEL	CONC.	STEEL
6.4	3.08	251	3.28	255	3.51	259
6.5	3.11	253	3.31	257	3.54	261
6.6	3.14	254	3.35	258	3.58	262
6.7	3.17	255	3.38	259	3.61	263
6.8	3.21	257	3.41	261	3.65	265
6.9	3.24	258	3.45	262	3.68	266
7.0	3.27	259	3.48	263	3.72	267
7.1	3.30	261	3.51	265	3.75	269
7.2	3.33	263	3.55	267	3.79	271
7.3	3.36	266	3.58	270	3.82	274
7.4	3.40	268	3.61	272	3.86	276
7.5	3.43	270	3.65	274	3.89	278
7.6	3.46	271	3.68	275	3.93	279
7.7	3.49	272	3.71	276	3.96	280
7.8	3.52	274	3.75	278	4.00	282
7.9	3.55	275	3.78	279	4.03	283
8.0	3.58	276	3.81	280	4.07	284
8.1	3.62	278	3.85	282	4.11	286
8.2	3.65	280	3.88	284	4.14	288
8.3	3.68	283	3.91	287	4.18	291
8.4	3.71	285	3.95	289	4.21	293
8.5	3.74	287	3.98	291	4.25	295
8.6	3.77	288	4.01	292	4.28	296
8.7	3.80	289	4.05	293	4.32	297
8.8	3.84	291	4.08	295	4.35	299
8.9	3.87	292	4.11	296	4.39	300
9.0	3.90	293	4.15	297	4.42	301

TABLE 71 -CONTINUED

CONCRETE AND REINFORCING STEEL FOR STORM SEWER STRUCTURE TYPE SS-2

INLET DEPTH	"W"					
"H" (Ft.)	4' - 0"		4' - 6"		5' - 0"	
	CONC.	STEEL	CONC.	STEEL	CONC.	STEEL
3.0	2.47	203	2.63	207	2.79	211
3.1	2.50	205	2.67	209	2.83	213
3.2	2.54	207	2.71	211	2.87	215
3.3	2.58	210	2.75	214	2.91	218
3.4	2.62	212	2.79	216	2.95	220
3.5	2.66	214	2.83	218	3.00	222
3.6	2.69	215	2.87	219	3.04	223
3.7	2.73	216	2.91	220	3.07	224
3.8	2.76	218	2.95	222	3.11	226
3.9	2.80	219	2.99	223	3.14	227
4.0	2.83	220	3.01	224	3.18	228
4.1	2.87	222	3.05	226	3.22	230
4.2	2.90	225	3.08	229	3.26	233
4.3	2.94	227	3.13	231	3.30	235
4.4	2.98	230	3.18	234	3.34	238
4.5	3.02	232	3.21	236	3.40	240
4.6	3.06	233	3.25	237	3.44	241
4.7	3.09	234	3.29	238	3.48	242
4.8	3.13	234	3.33	238	3.52	242
4.9	3.17	235	3.36	239	3.56	243
5.0	3.21	236	3.40	240	3.60	244
5.1	3.25	239	3.44	243	3.64	247
5.2	3.28	242	3.48	246	3.68	250
5.3	3.32	244	3.52	248	3.72	252
5.4	3.36	247	3.56	251	3.76	255
5.5	3.40	250	3.60	254	3.81	258
5.6	3.43	251	3.64	255	3.85	259
5.7	3.47	252	3.68	256	3.89	260
5.8	3.50	252	3.72	256	3.93	260
5.9	3.54	253	3.75	257	3.97	261
6.0	3.57	254	3.78	258	4.00	262
6.1	3.60	256	3.81	260	4.04	264
6.2	3.64	258	3.86	262	4.08	266
6.3	3.67	261	3.90	265	4.12	269
6.4	3.71	263	3.94	267	4.16	271
6.5	3.75	265	3.98	269	4.20	273
6.6	3.78	266	4.02	270	4.24	274
6.7	3.82	267	4.06	271	4.28	275
6.8	3.86	269	4.10	273	4.32	277
6.9	3.90	270	4.13	274	4.36	278
7.0	3.93	271	4.17	275	4.40	279

TABLE 71 -CONTINUED

CONCRETE AND REINFORCING STEEL FOR STORM SEWER STRUCTURE TYPE SS-2

INLET DEPTH	"W"					
"H" (Ft.)	4' - 0"		4' - 6"		5' - 0"	
	CONC.	STEEL	CONC.	STEEL	CONC.	STEEL
7.1	3.97	273	4.21	277	4.44	281
7.2	4.01	275	4.25	279	4.49	283
7.3	4.04	278	4.29	282	4.53	286
7.4	4.08	280	4.33	284	4.57	288
7.5	4.11	282	4.37	286	4.61	290
7.6	4.15	283	4.41	287	4.65	291
7.7	4.19	284	4.45	288	4.69	292
7.8	4.23	286	4.48	290	4.73	294
7.9	4.27	287	4.52	291	4.77	295
8.0	4.30	288	4.56	292	4.81	296
8.1	4.34	290	4.60	294	4.85	298
8.2	4.38	292	4.64	296	4.89	300
8.3	4.41	295	4.68	299	4.93	303
8.4	4.45	297	4.72	301	4.97	305
8.5	4.49	299	4.76	303	5.01	307
8.6	4.52	300	4.80	304	5.06	308
8.7	4.56	301	4.83	305	5.10	309
8.8	4.60	303	4.87	307	5.14	311
8.9	4.64	304	4.91	308	5.18	312
9.0	4.67	305	4.95	309	5.22	313

NOTE: The quantities shown, minus volumetric displacement of concrete by pipe culverts through inlet walls, will be used as the basis of final payment unless this plan is modified.

EXAMPLE: Determine concrete & reinforcing steel for SS-2 inlet with one extension, used with concrete pavement. Inlet height ("H") 7.2 Ft., width ("W") 3' - 6"; one 24" pipe, one 30" pipe.

	Conc. C.Y.	Steel Lbs.
From Table 5' - 0" inlet	3.79	271
Add for one extension	.89	101
Add for M bars, 5' - 0" inlet *		73
Add for M bars one extension *		27
	4.68	472
Deduction for one 24" pipe	.09	
Deduction for one 30" pipe	.14	
Pay Quantity	4.45	472

* NOTE: This step is not necessary unless constructed in conjunction with concrete pavement.

See SS-2 Standard Drawing for these additional (Bars M) steel quantities.

TABLE 71 -CONTINUED

Form TMD-125

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

DAILY REPORT OF LIME STABILIZATION
REPORT NO.___1___

Lime:Brand___Airco Alloy & Carbide___
Wgt.(lbs/cu.ft.)___
Water: Source __City of Forest___
Raw Soil: Clay; Silt; Silty Clay (Circle One)
Std.Dens. (lbs/cu.ft.)___86.4___
Class of Treatment: (A;)B;C;D;(Circle One)
Depth of Treatment: Specified___6”___
Range permitted___4½“ - 7”___
Method of Mixing___Rotary___
Type of Rollers ___Pneumatic & Sheepfoot___

Project No._STP-0023-02(016)/103123___
County___Scott___
Contractor __Delta Construction Company___
Length of Project (Mi.)___.5 Miles___
Progress to Date: (include. this report)___
Processed: Lin Ft.___132___
Sq. Yds.___616.0___
Lime Allowed: Lbs.___58,510___
Percent Complete ___12.8___

SECTIONS PROCESSED

First application: (A,B,C,D)						
Date	7-9-99					
Lane	Right					
Station to	518+00					
Station	523+87					
Net Length: Ft.	587					
Ave. Width: Ft.	40 & Var.					
Square Yards	2730.2					
Lime: % Specified	*					
Ordered: Lbs	54,222					
Plus 5%:Lbs	56,933					
Spread: Lbs	52,050					
Allowed: Lbs.	52,050					
Time: Spread Begun:	4:00					
Incorp. Complete:	6:30					
Temperature: Low (ºF)	78					
High (ºF)	96					
Second Application (Class A); or Compaction after Mellowing Period Class B)						
Date (A,B)*	7-19-99					
Lane (A,B)	Right					
Station to (A,B)	518+00					
Station (A,B)	519+32					
Net Length: Ft. (A)	132					
Ave. Width: Ft. (A)	42					
Square Yards (A)	616.0					
Lime: %Specified: (A)						
Ordered: Lbs. (A)	6800					
Plus 5% Lbs. (A)	7140					
Spread: Lbs. (A)	6460					
Allowed: Lbs. (A)	6460					
Time: Spread Begun: (A)	9:05					
Incorp. Complete(A)	1:45					
Temperature: Low (ºF)	74					
High(ºF)	96					
Pulverization Percent (A,B,C)	67.5					
Depth: Actual (A,B,C)						

*Information to be shown for class(es) of treatment shown in ( ). *3.31 lbs. per sq. yd. per 1” depth - Initial; 1.84 lbs. per sq. yd. per 1” depth - Final
Reports for Classes A and B to be submitted after sections are completed.
Distribution:
Original: Testing Engineer
cc: Contract Administration Engineer (To be submitted with final estimate)
District Testing Engineer
Project Engineer

____
Inspector

____
Project Engineer

Use back of form for remarks and additional information.

Form TMD-128

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

DAILY REPORT OF LIME STABILIZATION

Date: 11-17-99
Report No. 1 (7")
Cement: Brand Dundee and Marquette
Specified % by Vol. 5.25
Water: Source City of Vicksburg
Type Cure: MC-1
Method of Mixing Rex Mixer
Type Rollers Sheepfoot and rubber tire
Type Soil being Stabilized Gran. Material
Std. Density of Raw Soil (Lbs/Cu.Ft.)
Lbs. Cement req'd. per sq. yd. 25,907

Project No. STP-0020-01(037)/123456
County: Warren
Inspector Simpson
Contractor J.H. Moon & Sons
Length Proj.(mi) 1.307
Part of Roadway Structure* shoulder
Temp.: Low ºF High ºF
Weather: A.M. P.M.
Totals to date (including this report)
Processed: Lin Ft. 4302.05
Processed: Sq. Yd. 5258.06
Pounds Cement Allowed 2,576,633
% Complete 13.8

* If multiple layer show to which layer this report applies 7" Soil Cement

SECTIONS PROCESSED

Lane Rt. Lane	I-20 "C"	"C"	"C" & "D"			
Station to	*	12 + 95	**			
Station		26 + 72				
Net Length	1,395.0	1,377.0	1530.05			
Ave. Width	11	11	11			
Sq. Yds.	1,705.0	1,683.0	1,870.06			
Depth: Specified	7	7	7			
Range Permitted	6½ - 7½	6½ - 7½	6½ - 7½			
Actual Measurements	7¼	7	6 ¾			
Cement (Lbs) Each Section						
Ordered	44,171	43,601	48,448			
Plus 5%	46,380	45,781	50,870			
Spread	45,900	45,430	48,180			
Excess Spread	-	-	-			
Net Allowed	45,900	45,430	48,180			
Passing No. 4 Sieve (%)						
Time: Spreading Begun	9:25	12:15	2:45			
1st Appl. water	11:00	2:00	3:30			
Compaction Completed	1:30	3:30	4:30			
Finishing Completed	3:30	4:30	6:00			

REMARKS: * I-20 Rt., Lane 39 + 00 - 44 + 64.25; Ln. "C" 4 + 64.24 = 12 + 95
** Ln "C" 26 + 72 - 32 + 01.49 Ln. "D" 875 + 00 - 35 + 52.00 (Eq 883+07.36 Bk= 33+58.80 Ah

DISTRIBUTION:

Copy to State Materials Engineer
Copy to Contract Administration Engineer (To be submitted with final estimate)
Copy to District Materials Engineer
Copy to Project Engineer

Inspector

Project Engineer

(Use back of form if needed)

TMD-203

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

Jackson, Mississippi

Project No. IM-0055-02(026)/100118

County Madison

FINAL PILE RECORD

SUMMARY OF 10 BP 42 Steel PILING

Fill in Type (Use One Type Only)

NOTE: List pile length and cut-off to nearest tenth foot.

(1) Bridge	(2) Station	(3) Recommended Length	(4) Gross Length	(5) Cut-off	(6) Length in Place	(7) Col. (3)-Col. (6) (Plus or Minus)	(8) No. Test Piles	(9) No. Load Tests
"A"	866 + 34	418	418	23.7	394.3	23.7	1	0
TOTALS		418	418	23.7	394.3	23.7	1	0

NOTE: If column 7 is a Plus Quantity, pay for as "pile cut-offs" at one-half contract price.
Do not fill in Columns 3 and 7 for untreated timber piles.

REMARKS: ______

Certified Correct:

ATTACH ORIGINALS OF FORMS PR-3 AND SUBMIT WITH FINAL ESTIMATE

______
Project Engineer

TMD-440 **MISSISSIPPI DEPARTMENT OF TRANSPORTATION** **Sheet 1 of 2**
Rev. 8-80 **JACKSON, MISSISSIPPI**

PILE LOAD TEST REPORT

Load Test No. 1 **Project** STP-0006-03(018)/100000 **County** Itawamba Date April 17, 1999

Bridge No. D **Br. Sta. No.** 837+04.11 Type of Loading Hydraulic Design Load 36 Tons

Location of Load Test: Sta 837+72.13 **at** 20.23 **Feet Right, ~~Left~~ of Center Line**

Test Pile No. ____ **Permanent Pile No.** 21 **Bent No.** 2R **Date Driven** April 4, 1999

Length of Pile 50 **Ft.** **Maximum Allowable Settlement** 1½ **In.** **Type of Pile:** HP 10x42

Elevation Tip of Pile 347.0 **Elevation Ground at Pile** 396.0 Prebore Depth 0 Ft.

Elevation of Butt Before Loading 397.0 **After Removing Load** 397.0

LOAD ON PILE TONS, LBS.	TIME	Movement GAGE1	Movement GAGE2	Average Movement Inches	REMARKS
0	6:30	0	0	0	
17,970	6:31	.028	.021	.0245	Began Loading
	6:36	.028	.021	.0245	
	6:41	.031	.021	.0260	
	6:46	.031	.021	.0260	
35,939	6:46	.053	.045	.0490	
	6:51	.054	.045	.0490	
	6:56	.054	.045	.0490	
	7:01	.054	.046	.0495	
54,125	7:01	.081	.071	.0760	
	7:06	.082	.071	.0765	
	7:11	.082	.071	.0765	
	7:16	.082	.071	.0765	
72,095	7:16	.107	.095	.1010	
	7:21	.109	.095	.1020	
	7:26	.109	.096	.1025	
	7:31	.109	.096	.1025	
90,064	7:31	.132	.116	.1240	
	7:36	.134	.118	.1260	
	7:41	.134	.118	.1260	
	7:46	.134	.118	.1260	
108,034	7:46	.158	.139	.1485	
	7:51	.160	.141	.1505	
	7:56	.160	.141	.1505	
	8:01	.160	.142	.1510	
126,003	8:01	.185	.162	.1735	
	8:06	.185	.164	.1745	
	8:11	.187	.164	.1755	
	8:16	.187	.164	.1755	
143,973	8:16	.208	.184	.1960	
	9:21	.212	.187	.1995	
	8:26	.213	.188	.2005	
	8:31	.213	.189	.2010	

Distribution
Bridge Engineer — Original
State Construction Engineer — Copy
State Materials Engineer — Copy
District Engineer — Copy
Project Files — Copy

____
Project Engineer

TMD-440 **MISSISSIPPI DEPARTMENT OF TRANSPORTATION** **Sheet 2 of 2**
Rev. 8-80 **JACKSON, MISSISSIPPI**

PILE LOAD TEST REPORT

Load Test No. 1 **Project** STP-0006-03(018)/100000 **County** Itawamba Date April 17, 1999

Bridge No. D **Br. Sta. No.** 837+04.11 Type of Loading Hydraulic Design Load 36 Tons

Location of Load Test: Sta 837+72.13 **at** 20.23 **Feet Right, ~~Left~~ of Center Line**

Test Pile No. ____ **Permanent Pile No.** 21 **Bent No.** 2R **Date Driven** April 4, 1999

Length of Pile 50 **Ft.** **Maximum Allowable Settlement** 1½ **In.** **Type of Pile:** HP 10x42

Elevation Tip of Pile 347.0 **Elevation Ground at Pile** 396.0 Prebore Depth 0 Ft.

Elevation of Butt Before Loading 397.0 **After Removing Load** 397.0

LOAD ON PILE TONS, LBS.	TIME	Movement GAGE1	Movement GAGE2	Average Movement Inches	REMARKS
161,942	8:31	.238	.210	.244	
	8:36	.243	.215	.229	
	8:41	.245	.217	.231	
	8:46	.245	.217	.231	
180,128	8:46	.277	.247	.262	
	8:51	.283	.253	.268	
	8:56	.285	.255	.270	
	9:01	.286	.255	.2705	Loading Complete
180,128	11:01	.289	.262	.2755	Began Unloading
143,973	11:04	.265	.238	.2515	
	11:09	.262	.238	.2500	
	11:14	.262	.238	.2500	
	11:19	.262	.238	.2500	
108,034	11:19	.230	.207	.2185	
	11:24	.230	.207	.2185	
	11:29	.230	.208	.2190	
	11:34	.230	.208	.2190	
72,528	11:34	.196	.177	.1865	
	11:39	.197	.177	.1870	
	11:44	.197	.178	.1875	
	11:49	.197	.178	.1875	
54,125	11:49	.176	.158	.1670	
	11:54	.176	.158	.1670	
	11:59	.176	.158	.1670	
	12:04	.176	.158	.1670	
17,970	12:04	.118	.101	.1095	
	12:09	.111	.102	.1065	
	12:14	.111	.102	.1065	
	12:19	.111	.101	.1060	
0	12:19	.057	.060	.0585	
	2:19	.054	.061	.0575	Completed Loading Test

Distribution		
	Bridge Engineer	Original
	State Construction Engineer	Copy
	State Materials Engineer	Copy
	District Engineer	Copy
	Project Files	Copy

____
Project Engineer

TMD-600

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
Jackson, Mississippi
PILE REPORT
DROP HAMMER

Bridge No. “A” Rt. Lane
Station 866 + 34
Hammer Wt. “W” 3000 Lbs.

Project No. IM-0055-02(026)/100118
County Madison
Sheet 1 of 6

RECORD OF 10 BP 42 Steel PILING

Fill in Type Used

NUMBERED
DIAGRAM OF
FOOTING
OR BENT

Note: List Pile Length And Cut-Off to Nearest Tenth Foot. Show Penetration for Last 10 Blows in Decimals of Inch.

Bent No.	Pile No.	Recomm’d Length	Gross Length	Cut off	Length in Place	Penet. in Ground	Last 10 Blows Hammer Drop “H” Feet	Penet. in Inches	Av. Penet. Per Blow “S” In.	Bearing in Tons	Butt Size Inches	Tip Size Inches	Date Driven
5	1	38	38	3.8	34.2	33.2	10	0.50	0.05	85.7	10	10	1-20-99
5	2	38	38	0.2	37.8	36.8	10	1.75	0.175	63.2			1-20-99
5	3	38	38	1.2	36.8	35.8	10	2.25	0.225	57.1			1-20-99
5	4	38	38	2.0	36.0	35.0	10	1.25	0.125	70.6			1-20-99
5	5	38	38	1.4	36.6	35.6	10	1.75	0.175	63.2			1-20-99
5	6	38	38	3.7	34.3	33.3	10	1.00	0.100	75.0	10	10	1-18-99
5	7	TEST PILE		----	----	----	----	----	----	----	----	----	----
5	8	38	38	4.9	33.1	32.1	10	0	0	100.0	10	10	1-18-99
5	9	38	38	2.1	35.9	34.9	10	0.75	0.075	80.0			1-18-99
5	10	38	38	0.6	37.4	36.4	10	2.00	0.200	60.0			1-17-99
5	11	38	38	0.8	37.2	36.2	10	2.25	0.225	57.1			1-17-99
5	12	38	38	3.0	35.0	34.0	10	1.00	0.100	75.0	10	10	1-17-99
SHEET TOTALS		418	418	23.7	394.3								

REMARKS __________

Copies To:
BRIDGE ENGINEER
DISTRICT ENGINEER
ATTACH ORIGINALS TO FINAL PILE RECORD

Inspector __________

TMD-601 **MISSISSIPPI DEPARTMENT OF TRANSPORTATION**

PILE REPORT
STEAM HAMMER

Bridge No. "C" Lt. Lane Project No. IM-0055-02(026)/100118

Station 997 + 00 County Madison

Make & Size of Hammer Fairchild No.20 Sheet 1 of 4

RECORD OF 14" x 14" Prestressed Concrete PILING
Fill in Type Used

NUMBERED DIAGRAM OF FOOTING OR BENT — Bent - 2 - 3 - 4

Note: List Pile Length And Cut-Off to Nearest Tenth Foot. Show Penetration for Last 10 Blows in Decimals of Inch.

Bent No.	Pile No.	Recomm'd Length	Gross Length	Cut Off	Length in Place	Penet. in Ground	Final Set Of Pile: Strokes Per Minute	Final Set Of Pile: Energy Per Blow	Final Set Of Pile: Av.Penet. Per Blow "S" In.	Bearing in Tons	Butt Size Inches	Tip Size Inches	Date Driven
2	1	35	35	0	35	28.3	60	20,000	0.176	53.2	14	14	8-12-99
2	Test Pile		--	--	--	--	--	--					
2	3	35	35	0	35	28.4	60	20,000	0.200	50.0			8-12-99
2	4	35	35	0	35	28.5	60	20,000	0.261	43.4			8-12-99
2	5	35	35	0.70	34.3	27.7	60	20,000	0.293	40.6	14	14	8-12-99
3	1	40	40	0	40	26	60	20,000	0.231	46.4	14	14	8-7-99
3	2	40	40	0	40	26	60	20,000	0.184	41.3			8-7-99
3	3	40	40	0	40	26	60	20,000	0.273	42.3			8-7-99
3	4	40	40	0	40	26	60	20,000	0.273	42.3			8-7-99
3	5	40	40	0	40	26	60	20,000	0.286	41.2	14	14	8-7-99
4	1	40	40	0	40	26	60	20,000	0.273	42.3	14	14	8-6-99
4	2	40	40	0	40	26	60	20,000	0.255	44.0			8-6-99
4	3	40	40	0	40	26	60	20,000	0.267	42.8			8-6-99
4	4	40	40	0	40	26	60	20,000	0.267	42.8			8-6-99
4	5	40	40	0	40	26	60	20,000	0.255	44.0	14	14	8-6-99
SHEET TOTALS		540	540	0.70	539.3								

REMARKS

Copies To:
BRIDGE ENGINEER
DISTRICT ENGINEER
ATTACH ORIGINALS TO FINAL PILE RECORD FORM **Inspector**

CHECK OFF SHEET FOR SUBMISSION OF FINAL DATA

☐ The Project Engineer has signed all pages of the as-built plans in the upper right- hand corner in black ink. This should be his/her original signature. Facsimile stamps should not be used for any official purpose.

☐ All changes in the plans have been made on the as-built plans in red ink that will not bleed, run or fade.

☐ Final quantity changes have been entered on the summary sheet of the as- built plans and are the same as the quantities listed on the CSD-200.

☐ Three notarized P.E. Affidavits have been signed and attached to the inside cover of the first diary binder.

☐ A diary has been prepared for each calendar day, from the first day time was charged or the day the Contractor started work, whichever occurred first, until released from maintenance by the Executive Director. If final data is submitted before the final maintenance release letter has been received, the remaining diaries can be submitted when this letter is received.

☐ All diaries have been signed by the Project Engineer designated by the Chief Engineer. If the Project Engineer changes during the duration of the project, submit a letter from the Chief Engineer authorizing this change. If anyone but the Project Engineer signs the diaries, he/she should be authorized by the Chief Engineer to sign these diaries.

☐ The first page in the diary is the General Data sheet.

☐ The second page in the diary is the pre-construction minutes.

☐ The day all pay items were complete has been noted in the diary.

☐ Supporting data for all quantities recorded in the CSD-200 is included.

☐ All pay item summary sheets (Quantity Sheets) have been signed by the Project Engineer.

☐ All computations are signed and dated by the person doing the original computations and also signed and dated by the person doing the checking.

☐ Any change in prices, pay items, or time extensions is supported by a supplemental agreement. All supplemental agreements have been signed by the proper persons and placed in the appropriate three-ring binder. If all supplemental agreements have not been signed, this should be so noted by the covering letter.

☐ All quantity adjustments have been recorded on the CSD-200.

☐ All tickets have been signed at the point of delivery and are in sequence.

☐ The percent of moisture has been recorded on each ticket when moisture has been used to compute quantities.

CHECK OFF SHEET FOR SUBMISSION OF FINAL DATA Page 2

- ☐ All tickets have been initialed and an explanation of why the changes have been made is written on the ticket.

- ☐ Every ticket has been accounted for.

- ☐ Tickets have been separated by date. The printout of the day's run is wrapped around the ticket of the day's run. The date, pay item number, and total for the day's run is written on the back of the printout so it will be visible to Final Plans. If the day's total as shown on the Contractor ticket is not the same as the total shown on the computer printout, an adding machine tape or Excel Spreadsheet recap on disk with label of the ticket that verifies the computer printout total is attached. The computer diskette with the ticket program file has been submitted.

- ☐ Computations for truck measurements have been signed. One copy of the truck measurement form is filed in the appropriate binder corresponding to the appropriate pay item.

- ☐ All final data material is neatly and clearly identified by project number, county, and urban or rural where appropriate.

- ☐ Form CAD-97 has been completed, signed and placed in the appropriate binder.

- ☐ Diaries have been placed in Diary Binders, approximately 1½" thick.

- ☐ Are there plans for this project? Yes_____, No______.

- ☐ Final Plans has been notified by e-mail of all information sent by the network.

- ☐ Form CAD-12 has been completed, signed and placed in the appropriate binder. Supporting data is included for deductions and incentives listed on the CAD-12. Include proper documentation such as Form CAD-280 with supporting asphalt reports; the Profile Index Price Adjustment sheet (Form CAD-410); and testing invoices from the District Lab.

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

CAD-724A (REV 8-01)
COMPUTER VERSION

PROJECT NUMBER: ______________
FMS: ______________
COUNTY: ______________

STATEMENT OF DAILY CHARGES
FOR LIQUIDATED DAMAGES
FOR EACH CALENDAR DAY OF DELAY
FOR PROJECTS USING TIME UNITS

ORIGINAL COMPLETION DATE ______________
REVISED COMPLETION DATE BY S/A ______________
(IF NOT REVISED BY S/A THIS SHOULD WILL THE SAME AS ORIGINAL COMPLETION DATE)

CONTRACTOR: ______________
ADDRESS: ______________

(A) COMPUTATION OF TOTAL TIME UNITS ALLOWED BASED ON THE ORIGINAL TIME UNITS.

(1) ORIGINAL TIME UNITS:	0.00
(2) TIME UNITS BY SUPPLEMENTAL AGREEMENTS:	0.00
(3) TIME UNITS DUE TO INCREASE IN QUANTITIES:	0.00
TOTAL TIME UNITS FOR **(A)**:	0.00

(B) COMPUTATION OF TOTAL TIME UNITS ALLOWED BASED ON ORIGINAL COMPLETION DATE OR S/A COMPLETION DATE.

(1) TIME UNITS USED AT THE END OF THE ORIGINAL COMPLETION DATE ON PROPOSAL OR THAT REVISED BY SUPPLEMENTAL AGREEMENT:	______________	0.00
(2) TIME UNITS DUE TO INCREASE IN QUANTITIES:		0.00
(3) TIME UNITS ON SUPPLEMENTAL AGREEMENTS FOR SUPPLEMENT AGREEMENTS THAT DO NOT INCLUDE AN EXTENSION OF CONTRACT TIME:		0.00
TOTAL TIME UNITS FOR **(B)**:		0.00

TOTAL TIME UNITS ALLOWED. USE **(A)** OR **(B)** WHICHEVER IS THE LARGEST: 0.00

(1) DATE ON DIARY USING 0.00 TIME UNITS, ______________
(IF TIME UNITS ARE GREATER THAN THOSE ON THE DATE WORK COMPLETE, USE THE DATE WORK COMPLETE)
(2) ORIGINAL COMPLETION DATE ______________
(3) LATEST COMPLETION DATE ESTABLISHED BY SA ______________

LATEST OF THE ABOVE THREE DATES ______________

DAYS DELAY FOR PLACING PAVEMENT MARKINGS: ______________

(C) REVISED COMPLETION DATE (TIME EXPIRED): ______________

(D) DATE WORK COMPLETE: ______________

DAYS BETWEEN **(C)** & **(D)** ______________

TOTAL LIQUIDATED DAMAGE DAYS ______________

ORIGINAL COST OF CONTRACT: ______________

LIQUIDATED DAMAGES PER DAY: ______________

TOTAL LIQUIDATED DAMAGES: ______________ X ______________

= ______________

TO BE SUBMITTED WITH THE CAD-001 EACH MONTH AND WITH FINAL ESTIMATE.

SIGNED: ______________
PROJECT ENGINEER

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

CAD-724A (REV 8-01)
NON COMPUTER VERSION

PROJECT NUMBER: ____________
FMS: ____________
COUNTY: ____________

STATEMENT OF DAILY CHARGES
FOR LIQUIDATED DAMAGES
FOR EACH CALENDAR DAY OF DELAY
FOR PROJECTS USING TIME UNITS

ORIGINAL COMPLETION DATE ____________
REVISED COMPLETION DATE BY S/A ____________
(IF NOT REVISED BY S/A THIS SHOULD WILL THE SAME AS ORIGINAL COMPLETION DATE)

CONTRACTOR: ____________
ADDRESS: ____________

(A) COMPUTATION OF TOTAL TIME UNITS ALLOWED BASED ON THE ORIGINAL TIME UNITS.

(1) ORIGINAL TIME UNITS: ____________
(2) TIME UNITS BY SUPPLEMENTAL AGREEMENTS: ____________
(3) TIME UNITS DUE TO INCREASE IN QUANTITIES: ____________
TOTAL TIME UNITS FOR **(A)**: **(A)** ____________

(B) COMPUTATION OF TOTAL TIME UNITS ALLOWED BASED ON ORIGINAL COMPLETION DATE OR S/A COMPLETION DATE.

(1) TIME UNITS USED AT THE END OF THE ORIGINAL COMPLETION DATE ON PROPOSAL OR THAT REVISED BY SUPPLEMENTAL AGREEMENT (LATEST DATE) ____________
(2) TIME UNITS DUE TO INCREASE IN QUANTITIES: ____________
(3) TIME UNITS ON SUPPLEMENTAL AGREEMENTS FOR SUPPLEMENT AGREEMENTS THAT DO NOT INCLUDE AN EXTENSION OF CONTRACT TIME: ____________

TOTAL TIME UNITS FOR **(B)**: **(B)** ____________

TOTAL TIME UNITS ALLOWED. USE **(A)** OR **(B)** WHICHEVER IS THE LARGEST: **(C)** ____________

(1) DATE ON DIARY USING TIME UNITS TIME UNITS AS INDICATED BY (C) ____________
(IF TIME UNITS ARE GREATER THAN THOSE ON THE DATE WORK COMPLETE, USE THE DATE WORK COMPLETE)
(2) ORIGINAL COMPLETION DATE ____________
(3) LATEST COMPLETION DATE ESTABLISHED BY SA ____________

LATEST OF THE ABOVE THREE DATES **(D)** ____________

DAYS DELAY FOR PLACING PAVEMENT MARKINGS: **(E)** ____________

REVISED COMPLETION DATE (TIME EXPIRED): **(F) =(D) + (E)** ____________

DATE WORK COMPLETE: **(G)** ____________

DAYS BETWEEN **(F)** & **(G) =** TOTAL LIQUIDATED DAMAGE DAYS **(H)** ____________

ORIGINAL COST OF CONTRACT: **(I)** ____________

LIQUIDATED DAMAGES PER DAY: **(J)** ____________

TOTAL LIQUIDATED DAMAGES: ____________ **(H)** **X** ____________ **(J)**

= ____________ **(H) X (J)**

TO BE SUBMITTED WITH THE CAD-001 EACH MONTH AND WITH FINAL ESTIMATE.

SIGNED: ____________
PROJECT ENGINEER

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

CAD-724B (REV 1-00)

PROJECT NUMBER: ______________________

FMS: ______________________

COUNTY: ______________________

STATEMENT OF DAILY CHARGES FOR LIQUIDATED DAMAGES FOR EACH CALENDAR DAY OF DELAY

FOR PROJECTS WITHOUT TIME UNITS

BEGINNING OF CONTRACT TIME ____________

ORIGINAL COMPLETION DATE ____________

REVISED COMPLETION DATE BY S/A ____________

CONTRACTOR: ______________________________

ADDRESS: ______________________________

(A) COMPLETION DATE ESTABLISHED BY SUPPLEMENT AGREEMENT OR ORIGINAL COMP DATE IF NONE BY SUPPLEMENTAL AGREEMENT: --------------- ____________

(B) ADDITIONAL DAYS DUE TO INCREASE IN QUANTITIES: ------------------------------------- + ____________

(C) CONTRACT TIME ENDS: (DATE)-- = ____________

(D) CONTRACTOR COMPLETED WORK: (DATE)-- ____________

(E) TOTAL LIQUIDATED DAMAGE DAYS: ____________ (D + C)

ORIGINAL COST OF CONTRACT: ____________

(F) LIQUIDATED DAMAGES PER DAY: ____________

(G) TOTAL LIQUIDATED DAMAGES: ____________ (F) X ____________ (E)

= ____________ (F X E)

TO BE SUBMITTED WITH THE CAD-001 EACH MONTH AND WITH FINAL ESTIMATE.

SIGNED: ______________________________ PROJECT ENGINEER

CAD-12
(REV 10-01)

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
CONTRACT ADMINISTRATION DIVISION

REPORT OF DEDUCTIONS AND INCENTIVE PAYMENTS FOR FINAL ESTIMATES

PROJECT NO: ______________________

COUNTY: ______________________

NOTE: CHARGES OR INCENTIVE PAYMENTS TO BEMADE ON FINAL ESTIMATE (STATE NONE IF THERE ARE NO CHARGES OR INCENTIVE PAYMENTS)

IDENTIFY ITEM OR ITEMS AND ATTACH SUPPORTING DATA.

ITEMS	REMARKS
SIGN REPLACEMENT:	
TESTING CHARGES:	
LANE CLOSURE CHARGES:	
DEDUCT FOR ASPHALT DEFICIENCIES:	
SMOOTHNESS INCENTIVE:	

____
DATE

____
PROJECT ENGINEER

CAD-97 REV: 04/05/2002

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

CONTRACT ADMINISTRATION DIVISION
FINAL PLANS SECTION
JACKSON, MISSISSIPPI

APPROVED BITUMINOUS HOT MIX DESIGN TO BE USED WHEN DETERMINING PERCENT OF ASPHALT FOR FUEL ADJUSTMENTS.

Project No. : ________________/_______________ **County :** ______________________

PAY ITEM	DESCRIPTION	MIX DESIGN	*PERCENT ASPHALT	FROM DATE	TO DATE
A CAD-97A (SUPPLEMENTAL FORM) MUST BE SUBMITTED FOR EACH PAY ITEM THAT USES MORE THAN ONE MIX DESIGN ON ANY GIVEN DATE OR ESTIMATE PERIOD.					
A CAD-97 (SUPPLEMENTAL FORM) MUST BE SUBMITTED FOR EACH PAY ITEM THAT USES MORE THAN ONE MIX DESIGN ON ANY GIVEN DATE OR ESTIMATE PERIOD.					

I CERTIFY THAT THE MIX DESIGN LISTED ABOVE WERE THE DESIGN MIXES APPROVED FOR THE DATES INDICATED.

*** DO NOT USE TOTAL AMOUNT OF ASPHALT IN MIX. USE PERCENT OF ASPHALT ADDED TO MIX.**

DISTRIBUTION:
CONTRACT ADMIN . DIVISION
DISTRICT TEST ENGINEER
FILES

____
PROJECT ENGINEER

____
DATE

CAD-97A 04/05/2002

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

CONTRACT ADMINISTRATION DIVISION

FINAL PLANS SECTION

SUPPLEMENT REPORT FOR APPROVED BITUMINOUS HOT MIX DESIGN TO BE USED WHEN DETERMINING PERCENT OF ASPHALT FOR FUEL ADJUSTMENTS

(ONE FORM FOR EACH PAY ITEM)

QUANTITIES OF HOT MIX IN TONS FOR EACH ESTIMATE IN WHICH A PAY ITEM USED MORE THAN ONE MIX DESIGN ON A GIVEN DATE.

(Required only for the estimates in which when the dates of the CAD-97 overlap for a given pay item or when more than one mix designed is used per estimate period.)

PROJ NO.: ________________ / ________________________ **PAY ITEM:** ____________

COUNTY: ________________ / ________________________

EST NO.	QUANTITY USED		EST NO.	QUANTITY USED		EST NO.	QUANTITY USED
1			18			35	
2			19			36	
3			20			37	
4			21			38	
5			22			39	
6			23			40	
7			24			41	
8			25			42	
9			26			43	
10			27			44	
11			28			45	
12			29			46	
13			30			47	
14			31			48	
15			32			49	
16			33			50	
17			34			51	

DISTRIBUTION:
CONTRACT ADMIN . DIVISION
DISTRICT TEST ENGINEER
FILES

____
PROJECT ENGINEER

____
DATE

CHAPTER 10
SURVEYING

10.1 Construction Surveying - General. Surveying for most projects let to contract by the Department is now performed by Contractor forces in accordance with Section 699 of the Standard Specifications. When the contract provides a pay item for construction stakes, the Department is responsible for establishing basic horizontal and vertical alignment. The surveying work and information provided for the Contractor should be performed with the same accuracy and diligence as work done by the Department when no pay item for construction stakes is provided. Even though the Contractor is responsible for the majority of the surveying when a pay item is provided, the inspector should be familiar with contents of this chapter and the Surveying Manual in order to properly monitor the Contractor's surveying work.

It should be understood that this section of the manual does not set the policies or procedures for surveying. The MDOT Surveying Manual establishes uniform policies and procedures for surveys within the Mississippi Department of Transportation. Surveying personnel should familiarize themselves with the content of the Surveying Manual.

A. <u>General.</u> This section of the construction manual is not a substitute for a textbook or handbook on surveying. It is assumed that party chiefs, instrument men and other affected project personnel have the necessary tables, handbooks, and other data. This section of the manual will in general provide the standard methods of staking to be used on Mississippi Department of Transportation construction projects. The instruction and methods contained herein generally should provide sufficient latitude to cover all but the most unusual of circumstances.

Construction surveying represents a large portion of the construction engineering cost and therefore, requires study to eliminate needless refinements. Surveying techniques that will provide clear guidance, a maximum of economy, and proper auditable documentation to substantiate quantities should be utilized.

Centerlines, right-of-way monuments, and bench marks should be established to required limits of accuracy. Other stakes should only be established to standards commensurate with their use. Construction survey parties are under the direction of the Project Engineer. Therefore, the Project Engineer must be assured that construction survey personnel assigned to the Project Engineer are familiar with proper methods of staking and that training has been or will be provided as necessary.

When there is no payment for construction staking in the contract, the Standard Specifications provide that the Engineer will set construction stakes establishing lines, slopes, and profile-grade in road work and centerline and bench marks for bridge work, culvert work, protective and accessory structures and appurtenances deemed necessary. The Engineer will furnish the Contractor all necessary information relating to lines, slopes and grades. These stakes and marks shall constitute the field control by with which the Contractor shall establish other necessary controls and perform the work. It is expected that the Contractor will provide grade foremen, carpenter foremen, etc., capable of setting intermediate grade stakes, forms and the like from the Engineer's field layout staking.

The specifications further provide that the Contractor be held responsible for the preservation of all stakes and marks, and if any of the construction stakes or marks have been carelessly, negligently, or willfully destroyed or disturbed by the Contractor, the cost of replacing them will be charged against the Contractor and will be deducted from the payment for the work. It also provides that the Department will be responsible for the accuracy of lines, slopes, grades, and other engineering work which is set forth under this section.

On projects where considerable staking is required, the Project Engineer should begin staking as far in advance of the beginning of construction operations as conditions will permit. This lead time should assure that staking will be maintained well in advance of the Contractor's operations and requirements. In the event that stakes stand over the winter, their message and possible displacement should be checked prior to use. Bench marks, temporary bench marks, and other primary controls should be rechecked prior to use after a winter layover. When staking is delegated to an assistant, the Project Engineer will ascertain that the assistant is acquainted with the procedures to be followed. The Project Engineer will direct the work so that lost or destroyed points may be reproduced with a minimum of expense. The Contractor and Project Engineer share the responsibility to keep each other informed as to work schedules to properly plan the staking work. No delays in staking should be permitted that will hinder the construction operations. However, Contractors will be expected to finish as they go, within the stakes that are set.

Work procedures in staking a project must be conducted in a manner to avoid errors, which may lead to additional expense for the project. In staking structures or other work requiring exactness, the work must be carefully done and rechecked before being released as final. The Party Chief must be familiar with the methods and procedures in staking. Concurrence as to the method and procedure to be used must be obtained from the Project Engineer before the start of staking operations. Each member of the survey party, especially new members, should be properly instructed in the proper method of taking measurements and setting stakes. Periodic observations and checks on the work are essential in assuring that the survey work proceeds properly and conforms to the accuracy required.

The Project Engineer and members of the Project Engineer's staff responsible for staking should confer with the Contractor's foremen concerning the method of staking to be used, how stakes are to be marked and guarded, offsets to be used, spacing, etc. Information to be placed on stakes, abbreviations to be used, location of message on stakes, etc., should be carefully explained to avoid misunderstanding or misinterpretation.

B. <u>Accuracy.</u> The degree of accuracy used in the various operations of construction surveying and staking is to be consistent with the use. Basic horizontal and vertical controls are to conform to recognized accuracies. Other construction stakes should be set to accuracies commensurate with their use. The accuracies and tolerances required for the various construction stakes as set out elsewhere in this chapter. Accurate and complete survey notes taken for future reference must be entered in the field notebook at the time the survey work is performed.

C. <u>Relations with the Public.</u> Survey and staking personnel are to conduct themselves in the same manner as any other construction employee. Frequently, survey parties are more conspicuous to the passing public than other State employees on the project. To this extent, the public relations on the project may hinge on the appearance and conduct of the survey and staking personnel.

Even though the staking being done is for a construction project, it does not necessarily mean that final acquisition of all parcels of right-of-way has been accomplished. Many of the abutting property owners have had their property and improvements altered or partially eliminated by our work. The manner in which we treat their remaining property may determine their permanent feelings toward the Department. For example, staking a driveway approach may be an extremely minor detail in the overall job activity, but to the individual property owner involved it may be the most vital aspect of the whole job.

D. Safety. Particular attention must be made to the safety of the survey crew in performing survey work, especially where the work is subject to traffic. The Party Chief is responsible for safe procedures on survey work and the party chief must insure proper use of safety measures, such as colored warning vests, warning devices, red flags, etc. See Chapter 6 of the MUTCDs for more information regarding traffic and safety.

10.2 Care of Surveying Equipment.

A. General. The surveying instruments used by the survey party are precise and expensive. The retention of their value and the results of the work depend to a large degree upon the proper care and functioning of this equipment.

The care of equipment applies just as much to a hand level or a measuring tape as it does to surveying equipment. The net output of a party can be held up by a dull bush blade or a poor quality stake as much as an instrument that is difficult to set up. The degree of care that is required for precision instruments is obvious.

Field employees are not expected to take any instrument apart and clean and oil it except in cases which demand immediate attention. Field employees will be expected to keep clean the external parts of the instruments, such as leveling, clamp, and tangent screws. It may be necessary to make the simpler adjustments of the instruments from time to time to obtain proper results in their field work.

The Resident Engineer or party chief is to personally supervise any cleaning or adjustments of surveying equipment.

Surveying instruments, when not in use, are to be kept in their respective boxes to exclude dust and to preserve the condition of the instruments.

Instruments must not be exposed to rain, snow, or rapid changes in temperature. They should not be unnecessarily exposed to intense sunlight. A hood or other cover should be used in emergencies to protect the instruments from the weather until they can be put in their cases. In the winter, care must be exercised to see that instruments are kept at as nearly a uniform temperature as possible. An instrument should not be taken suddenly from outside cold weather into a heated room, or vice versa, without wrapping it for protection so that the temperature of the instrument changes gradually.

B. Handling Equipment

1. All tripods used for any type of control work must be checked frequently to ensure that no loose connections exist at the head, shoe, or extension joint.
2. Check each leg one at a time by raising it slightly and applying a twisting action. Tighten any connection where movement is observed or felt.
3. Always place the tripod legs on solid ground even if it means spading away the grass and top layer of soil under each shoe. Covers should be kept on the head of all tripods to prevent scarring which will cause problems with centering and leveling.
4. Any tripod with a warped head should be replaced.
5. Instruments must be attached to the tripod to avoid damage. The attachment must be snug enough to hold without movement but not so tight as to stress the tripod head or tribrach.
6. Spread the legs of tripods far enough apart so that wind will not affect the instrument.
7. The tension on the legs at the tripod head should be adjusted to allow the legs to extend slowly.
8. All equipment including tripods should be free of mud before putting away for the day.
9. The optical plummet and circular level of tribrachs must be checked frequently and kept in good adjustment. Tribrachs must be carried in cushioned containers to maintain their adjustment.
10. Even though the tribrachs' circular bubble is kept in good adjustment, the more sensitive tubular bubble should be used for the final leveling for targets.
11. Tribrachs should be centered and leveled accurately enough to produce a maximum of one (1) mm eccentricity.
12. Targets should be selected that will not introduce phase error into the angle observations.
13. All prisms should be numbered and the prism constant determined for each.
14. The prism type and number should be recorded for each EDM distance observed.
15. Prisms should be kept clean to increase their effectiveness and in protective cases when not in use to prevent damage to the glass.
16. No lens or glass of any kind should ever be touched with the fingers. The moisture will damage the protective coating and reduce the effectiveness of the equipment.
17. All equipment should be kept as free of dust and moisture as possible. Remove dust with a soft camel hair brush. Allow wet instruments to air dry in the office. The moisture will migrate to the insides of the instrument and cause damage if left wet in the case.
18. Instruments should be carried in their carrying case. On very short moves, they may be allowed to remain on the tripod if carried in the vertical position.
19. Instruments transported in vehicles should be confined inside padded compartments.
20. Clamps should never be viced down but brought only to a snug pressure to prevent movement.
21. Never allow total stations to be pointed to the sun unless an objective filter is attached and a solar observation is in progress.
22. Never lean any piece of equipment against trees, vehicles or buildings where it can fall. Fingers should be kept from the face of level rods to preserve the graduations. Rotating the rod 90 degrees will place them on the side and avoid damage to the graduated strip.

C. <u>Transporting Equipment.</u> Equipment loaded into vehicles for transportation should be carefully handled and placed to avoid damage. It is suggested that each piece of surveying equipment be inserted in cases, hanger or holder, installed in or on the transportation vehicle for that purpose, to avoid rubbing against other objects. Special boxes should be installed in the vehicles to hold the instrument cases. If the instrument is to be transported only a short distance, it may be carried on the lap without putting it in its case. When transporting an instrument in this manner without casing it, care must be exercised to avoid any damage to the instrument. If it is not enough people in the party for a driver and a person to hold each instrument, the instruments are to be transported in their cases.

D. Accidental Damage to Surveying Equipment. Resident Engineers are charged with the responsibility and care of all equipment used by persons under their supervision. Repair costs in cases of inexcusable or avoidable accidents will be charged to the person(s) directly responsible. All accidents of any consequence involving damage to equipment must be fully and promptly reported to the Assistant District Engineer - Construction, who is to review the facts in each case and determine the responsibility and disposition of the repair or replacement charged.

10.3 Construction Centerline. The first survey work on a project will be to establish or re-establish the construction centerline or control line. This line will conform to the construction centerline or other stationed control line shown on the plans, either of which may or may not be coincidental with the existing survey line. When errors are found in alignment data, they are to be corrected and shown on the project and final plans with reference to the plan line.

In order to permit the field party to proceed, the alignment book should be prepared by the Project Engineer or the Project Engineer's designated representative subsequent to a thorough field review and prior to actual staking.

The construction centerline will be marked by stakes driven on line behind the point, with the station and plus station facing the zero station of the survey. If the line traverses a traveled way, centerline points will be referenced at right angles with the station and plus station numbers and the distance right or left marked on the side of the stake facing centerline. At the time the centerline is reproduced, or immediately thereafter, control points will be referenced so that the centerline can be readily re-established when required. In general, referencing is recommended for the beginning and ending of curves, points of intersection, points on tangents at approximately 1,000-foot intervals, and points on long curves where visibility is restricted. It is good practice to reference often enough so that each point will "see" at least one other point.

There are various methods of referencing control points, the selection of which must be left to the judgment of the Project Engineer. The choice of method may be based on the terrain of the area, the area of the right-of-way to be disturbed by construction operations, or the use to which the land adjacent to the right-of-way is put. Reference points will be placed at locations with the least possibility of being disturbed during the construction period and from which it is possible to "reset" the centerline with a minimum of delay. The utility of the reference points after cutting or filling to final grades must be considered. Records and sketches of the reference points will be kept in the alignment notebooks.

Swing or chain ties will be avoided, if possible, at least at major control points (PCs, PTs & PIs). Three point right angles ties should be used where possible, preferably two points to the right and one to the left, or vice versa.

The permissible error of closure for horizontal and angular measurements shall be in accordance with the MDOT Survey Manual. It is essential that the transit be "double centered" at the beginning of use, adjusted if required, and checked often enough to insure proper adjustment.

Errors of closure, either in angle or distance, which would change design quantities should be promptly reported to the Project Engineer for proper disposition.

Parallel Offset Lines. It is often advantageous to run a line which is parallel to the survey centerline. This line may be used as an aid for the original staking of the project or as an aid in determining right angles for the taking of cross-sections.

1. Determine Offset Distance

    a. Study the plan and cross-sections to determine the distance to offset the parallel line. The line should fall outside the limits of construction, but be close enough to the top of cut or toe of fill to be useful.

    b. The offset distance will vary for different sections of the project, depending on the depth of the cut or fill.

2. Set Out Control Points

    a. Using an instrument at the control points on the centerline (PCs, PTs, POCs, POTs), set out points at right angles to the centerline, at a distance equal to the offset of the proposed offset line.

    b. If a hub with a tack in the top is used for this point, it may also serve as a control point tie for the centerline.

10.4 Bench Marks. A complete, tight and dependable set of bench marks is one of the most important items of a construction survey. A large portion of the pay quantities rely on elevations as the basis of measurement. A loose line of bench marks can be the basis of disagreement and claims.

The equipment used for this work shall be in good repair and adjustment. Bench marks should be checked by the two-peg method and adjusted if necessary. Each rod used should be checked for extended length and condition.

Before any staking involving elevations is done on the project, the bench marks shown on the plans will be checked for location and elevation. At this time, any bench mark that may be disturbed by construction will be re-established and any needed temporary bench marks will be set.

Bench marks will not be set on utility poles, which may become unstable. A spike or bolt driven into a pole can cause a serious safety hazard to individuals using the bench mark and to those charged with maintenance of the service.

The following procedure applies in checking and establishing bench marks:

1. During the reading process, the rod will be plumbed and readings will be recorded to the nearest 0.01 foot.

2. Backsight and foresight distances and elevations will be substantially balanced within any level loop.

3. Side shots on bench marks will not be permitted. The turn through method will be employed.

4. Bench marks will be established at intervals and locations consistent with good engineering practice and generally not in excess of 1,000 feet.

5. Allowable vertical error in feet will be 0.05 x ÖM, where M is equal to the length of the level circuit in miles.

Errors in bench mark elevations will be corrected so that the elevations of succeeding bench marks will not be affected. When an error that may affect the elevation of succeeding bench marks is found, the matter will be referred immediately to the Project Engineer, who will make the correction.

		C & GS Datum				
B.M.	6.10				20.21	Q-111 at L & N RR Sta.
	6.12		7.41			in Waveland
	6.31		6.13			
	4.76		4.23			
	6.43		5.55			
	5.32		5.46			This Circuit 1.5 mi.
	5.72		6.14			
	5.01		5.18			
	5.74		5.98			
	6.01		4.79			
	6.98		7.12			
B.M.#1			5.23		21.51	R.R. SPIKE IN BASE 10” PINE
	64.50	use	63.22			100’ RT. STA. 13 + 50
Diff	1.28	1.30				
B.M.#1	5.92					
	5.87		6.85			

B.M.#2			*7.11*			*R.R. Spike in Base 10" Bay 95'*
	11.79		*13.96*			*Lt. Sta. 23 + 40*
Diff			*-2.17*		*19.34*	
BM#2	*4.98*					
	5.85		*6.12*			
	5.98		*7.31*			
	4.47		*6.83*			
BM#3	______		*6.01*			*R.R. Spike in Base 10" Post*
	21.28		*26.27*	*use*		*Oak 150' Rt. Sta. 36 + 25*
Diff			*4.99*	*4.98*		
					14.36	
BM#3	*6.21*					
	6.35		*7.91*			
	6.71		*6.02*			
	______		*7.15*			*R.R. Spike in Base 24" Water*
	19.27		*21.08*	*use*		*Oak 125' Rt. Sta. 50 + 40*
			-1.81	*1.80*		
BM#3	*5.57*				*12.56*	
	6.01		*6.12*			
	6.31		*5.98*			
	5.35		*5.10*			
	______		*5.62*			
BM#4	*23.24*		*22.82*		*12.98*	*U.S. C&G.S. BM Q-98*
Diff	*0.42*					*100' Rt. Sta. 65 + 60*
Total						
Diff			*-7.27*			
Datum						
Diff			*-7.23*			
To be distributed			*-0.04*			*Allowable error - Ö1.5x0.05=0.06*

BM#4	*5.23*					
	5.98		*6.13*			
	5.25		*5.43*			
	6.43		*6.37*			
BM#5	______		<u>*5.36*</u>			*R.R. Spike in Base 12" Red*
	22.89		*23.32*			*Oak 125' Lt. Sta. 80 + 20*
			0.43		*12.55*	

10.5 Setting Right-Of-Way Stakes. The right-of-way is to be staked on both sides of the centerline in accordance with the Right-of-Way plans prepared by the Roadway Design Division. At points where right-of-way markers are to be located, sufficient hub stakes with tacks or iron rods (1/2" or larger in diameter, 18" long) are to be set for placing markers at the points indicated on the plans. These stakes or iron rods are to be set and guarded to provide the correct information for positioning the marker and its orientation in accordance with the applicable plan standard.

Right and left of every station, and closer when deemed necessary, the right-of-way is to be marked with a standard flat stake showing the station number on the face side with the notation "R-W" and the distance from centerline on the reverse side.

10.6 Staking Limits of Clearing and Grubbing. This portion of the construction staking will generally be among the earliest operations undertaken by the Contractor.

The specifications will provide that the work will be measured by one of the following methods:

1. <u>Area Basis.</u> The work to be paid for will be the number of acres and fractions thereof acceptably cleared and grubbed within the limits staked for clearing and grubbing by the Engineer. Areas not shown on the plans or not staked for clearing and grubbing will not be measured for payment. The limits of the areas to be cleared and grubbed are to be staked to exclude those areas not requiring clearing and grubbing. Areas not included for measurement of clearing and grubbing will be areas covered by existing roadway, cultivated fields, lakes, ponds, existing stream beds, and other areas on which there are only scattered small bushes.

The clearing limits will be staked as determined by the inspection of the design cross-sections allowing an extra width of at least five (5) feet between the slope stake and the clearing line. Sharp breaks in the width of the clearing line should be avoided and stakes should be adjusted accordingly. Clearing lines on the inside of curves and at intersections likewise should be given special attention to provide adequate sight distance when contract quantities and right-of-way limits permit. Culvert locations should be considered when staking clearing limits.

Distances will be measured to the nearest foot and stakes will be placed to clearly designate the intended limits. Intervals for placing stakes will be dependent on terrain and denseness of the foliage. Generally, spacings of 100 feet will be adequate. In areas of heavy timber, clearing stakes should be set to avoid leaving trees on the clearing line. Revisions of originally-staked distances which are required as the work progresses will be duly-recorded in the field notes.

2. Lump Sum Basis. In the event that measurements and payment for the work is by the lump sum basis, the limits of the work may be staked and notes kept the same as for the area basis set forth above. No calculation of areas is required unless changes were made in the right-of-way, in which case measurement is to be made as provided in Subsection 201.04. (Refer to Section 200 of Section 1.4 of this manual).

	C_L		C&G Limits				Date: Aug 6, 1992
Sta.	*Lt.*	*Rt.*	*Width*	*Avg.Width*	*Dist.*	*Sq. Ft.*	*Party Notes - Jones*
115	*26-0*	*16-30*	*40*				*Tape - Smith*
				41	*100*	*4100*	*Tape - Brown*
114	*27-3*	*13-31*	*42*				
				45	*100*	*4500*	
113	*32-8*	*8-32*	*48*				
				50	*50*	*2500*	
+50	*33-11*	*5-35*	*52*				*Computation: BCG 8-8-92*
				51	*50*	*2550*	
112	*33-13*	*3-33*	*50*				
				46.5	*100*	*4650*	*Comp: BCJ 8-9-92*
111	*32-19*	*0-30*	*43*				*CK: ABC 8-10-92*
				40.5	*50*	*2025*	
+50	*31-21*	*0-28*	*38*				
				38	*50*	*1900*	
110	*36-20*	*5-27*	*38*				
						22,225	

Note: 1. Total each page.

2. Full page headings need to be made only at the beginning of each day's work.

3. Succeeding pages for that day need only be numbered and initialed by the party

10.7 Field Data Collection and Processing of Cross-Sections. Collection of cross-sections and final earthwork quantities will be performed at the project office using Department approved software and the methods & procedures established in the latest version of the "MDOT Survey Manual" under the section titled "Quantity Measurements & Calculations, Construction Surveys". This manual is available in the Department's Roadway Design Division.

10.8 Setting Slope Stakes.

Office Preparation of Notes. Prior to cross-sectioning and slope staking, the Resident Engineer should prepare slope stake books. The slope stake book will show the subgrade elevations of the centerline and each shoulder, considering the crown slope and super elevation, and the “constant” distance(s) to the subgrade shoulder line for fill sections and the “constant” distance(s) to a point on the back slope at the same elevation as the subgrade shoulder for cut sections. When books are prepared and grade computations performed properly, time may be saved during slope staking.

If the plans are provided with plotted cross-sections, the tentative location of the slope stake may be determined. The cross-sections will show the approximate cut or fill and the distance from centerline to the slope stake. It is helpful to make an entry in the slope stake book of the cut or fill and distance from centerline as shown on the section. These figures will only provide a fast reference for the first trial shot, and often the identical values are determined to fit the field conditions. These trial values provide a check of field work, since a wide variation in the trial shot and actual shot may be due to an error in computations or reading the rod.

Slope Staking for Embankments. Slope stakes for embankment sections are to be set at the toe of the slope and marked to show the vertical distance from the ground at the point where the stake is driven to the subgrade elevation for the shoulder line of the embankment. In setting slope stakes for embankment sections, the following method shall be used:

The slope stake shall be set by taking trial readings at right angles to the centerline until a point is found. The distance from the centerline is equal to the slope ratio times the fill from the ground at the point to the subgrade elevation of the shoulder, plus the distance from the centerline to the subgrade shoulder line.

The fill which is marked on the slope stake is to be the fill from the elevation of the ground at the point where the stake is set to the subgrade shoulder elevation.

Slope Stakes for Cuts. Slope stakes for cuts are the stakes set at the point of intersection of the back slope with the natural ground. They are to be marked to show the vertical distance or cut from the elevation of the ground at the point where the stake is driven to the elevation for the point on the back slope opposite the subgrade shoulder.

In determining the point at which to set the slope stake, it will first be necessary to determine the point at which the horizontal distance from the centerline to the point on the back slope opposite the subgrade shoulder, plus the quantity obtained by multiplying the cut by the backslope ratio, is equal to the measured distance from that point to the centerline. The slope stake is to be set at this point, and the cut from the elevation at this point to the elevation of the point on the backslope opposite the subgrade shoulder elevation is to be marked on the stake.

Marking and Driving Slope Stakes. The cut or fill should be marked on the front side (side facing the centerline) and near the top of the slope stake. The distance from the centerline to slope stake should be marked on the back of the stake. The backslope ratio should be marked on the edge of the stake.

Both vertical (cuts and fills) and horizontal distances should be shown to the nearest 0.1 foot.

Tangent Constants:			Fill	22^2			Date:				
			Cut	32^7			Party:				
Sta	Lt.Sh.		CL		Rt.Sh.						
B.M.	7.08	322.50			315.42		N.I.S.20" Red Oak 100' LT. 10+00				
10			320.17 (PlanGr)				GR 4^5				4^5
	318.00		318.67 (SubGr)		318.00		RR 6^8				0^2
							F 2^3 4:1				C 4^3 4:1
							31^4				49^9
11			319.17				GR 5^5				5^5
	317.00		317.67		317.00		RR 8^2				5^5
							F 2^7 4:1				C 0^0 4:1
							33^0				32^7
12			318.17				GR 6^5				6^5
	316.00		316.67		316.00		RR 10^0				8^8
							F 3^5 4:1				F 2^3 4:1
T.P.	2.81	316.09	9.22	313.28			36^2				32^4
13			317.17				GR 1^1				1^1
	315.00		315.67		315.00		RR 5^1				3^6
							F 4^0 4:1				F 2^5 4:1
							38^2				32^2

10.9 Staking Side Roads and Private Entrances. Centerline and radius points should be established, cross-sections taken, and slope stakes set before grading operations are begun on county road turnouts. The centerline of the county road turnout should be intersected with the centerline of the project and the stations of each centerline and angle of intersection recorded so that the centerline of the turnout may be re-established for subsequent work, such as blue tops, final cross-sections, etc.

Ramps or private entrances should be constructed at the locations shown on the plans. Ramps or entrances shall not be changed from the-location on the plans unless a formal agreement is obtained from the property owner, for which procedures should be initiated through the Assistant District Engineer - Construction.

Radius points for ramps should be set so that the proper turning radii and correct width may be constructed for the ramps.

10.10 Staking Box Bridges, Box Culverts and Pipe Culverts.

General - Culverts and box bridges should be staked as soon as possible and the box culvert, box bridge, and pipe culvert list prepared. The revised structure lists should be forwarded to the Contractor as soon as possible to facilitate ordering construction materials. Delay in staking of pipes or boxes can cause a delay in the Contractor's operation, which may lead to a claim against the Department.

All staking information should be recorded in a bound field book and forwarded to the Final Plans Section with other final data at the completion of the project.

Box Culverts and Box Bridges - Before staking box culverts or box bridges, it is helpful to profile the stream or ditch in which the structure is to be built and then plot this profile on cross-section paper. For a stream or ditch which meanders appreciably within the probable limits of the structure, the profile should not be taken by measuring along the meander but should be taken along the proposed centerline of the structure with "side" shots in the ditch opposite measured points on the proposed centerline of the structure. A proper flow line for the structure can then be determined from this profile. A cross-section of the roadway should then be plotted over the flow line and the required length of the structure determined. In plotting the cross-section of the roadway, be sure to determine differences in shoulder elevations that may be caused by superelevation or skew angles. Box culverts or box bridges are normally to be constructed perpendicular to the centerline of the roadway or on skew angles of 15°, 30°, or 45°. If different skew angles are absolutely necessary, a special design box will be required. In staking box culverts and box bridges, hub stakes with tacks should be set on the parapet lines on each side of the centerline of the structures at a sufficient distance to prevent disturbance. Elevations should be taken on each hub and the cut to flow line computed. Each hub should be guarded with a flat stake bearing the notation "PARP LN" and offset from the centerline of the structure on the face side and the cut to flow line on the other.

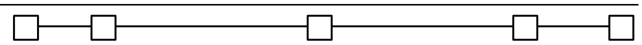
See example notes for staking computation and sketches.

Pipe Culverts - Pipe culverts are to be located at the most practical, best-fit, field conditions. Where straightening of the channel is not provided for, the culvert should be located with respect to the existing channel so as to provide the most direct and unimpeded flow. Pipe culverts will often be shifted from the plan location to better fit flow conditions.

When staking pipe culverts, the plan lengths and flow line elevations of the pipe should first be checked in the field and, if necessary, adjusted to fit field conditions. Flow line elevations of a pipe culvert will be based on the elevations of the natural flow line of the channel taken outside the limits of the proposed fill slopes so that a desirable uniform pipe gradient may be obtained through the embankment area.

After the length of the pipe has been determined as shown in the example notes, the gradient of the pipe should be computed and the grades of inlet and outlet offset stakes computed using this gradient.

Pipe culverts are staked by setting a hub and tack on the centerline of the culvert at an offset distance from each end of the pipe, sufficiently far from the construction operations to be safe from being disturbed. Elevations are taken on the top of the hub stakes. The guard stake will be marked with the length and size of pipe, cut or fill from hub to flow line at the hub and the distance to end of pipe.

136' - 24" pipe Station 318+66			*Staked 9-13-02*	*ABC - PC*
				BCD - Instrument
	Lt.	*Rt.*		*CDE - Rod*
Shldr. Grade	*341.3*	*341.3*		*DEF - Rod*
F.L.	*319.6*	*325.1*		*EFG - Notes*
D + T	*+2.2*	*+2.2*		
	321.8	*327.3*		
Fill	*19.5*	*14.0*	*GR 8.69*	*GR 1.59*
3:1	*58.5*	*42.0*	*RR <u>8.75</u>*	*RR <u>1.37</u>*
1/2 Rdwy	*20.0*	*20.0*	*F 0.06*	*C 0.22*
	78.5	*62.0*		
less "C" (FES)	*-2.5*	*-2.5*		
	76.0	*59.5*	*20' 76.3'*	*59.7' 20'*
Use	*76.3*	*59.7*		
Slope = 5.5 / 136 = 0.0404				
20' Offset	*-0.8*	*+0.8*		
O.S. F.L.	*318.8*	*325.9*		
B.M. 2.28	*327.49*	*2.28 325.21*	*NIR 24" Red Oak 75' Lt. 318+00*	
O.S. Gr. Rod 8.69		*1.59*		
Laid 136' and 2 FES 9-15-02 JKL				

8 x 6 Box Culvert 30° skew Lt. Fwd.

Station 318+66

	Lt.	Rt.	
Shldr. Grade	*320.61*	*322.42*	
F.L.	*310.40*	*31.10*	
	317.53	*317.23*	
Fill	*3.08*	*5.19*	
3:1	*9.24*	*15.57*	
+ Parapet	*0.83*	*0.83*	
1/2 Rdwy	*20.00*	*20.00*	
	30.07	*36.40*	
/ Cos 30°	*34.72*	*42.03*	<u>*76.75*</u>

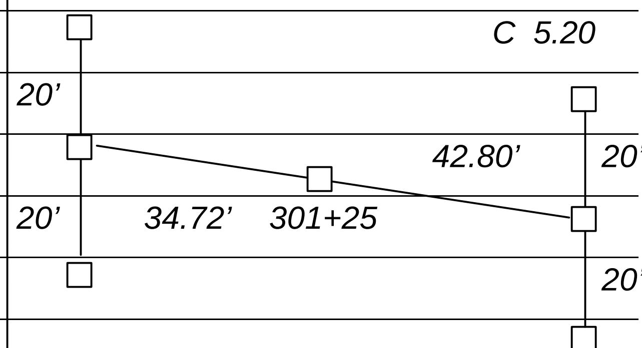
B.M.	*4.34*	*319.50*	*4.34*	*315.16*
F.L. Gr. Rod	*9.10*			*9.40*

Staked 9-13-02

ABC - PC
BCD - Instrument
CDE - Rod
DEF - Rod
EFG - Notes

GR 9.10
RR <u>*3.81*</u>
C 5.29

GR 9.40
RR <u>*4.20*</u>
C 5.20



NIR 30" Hickory 100' Lt. 300+00

10.11 Layout of Bridges. It has been a statewide trend to provide in all construction contracts a pay item for bridge construction staking. Whether performed by the Contractor or by MDOT forces, the following shall be performed:

A. <u>General.</u> The Standard Specifications require only that the Engineer furnish the Contractor with centerline controls and bench marks for bridges. The specifications make the Department responsible for the accuracy of the stakes and bench marks at the time they are set by the Engineer, or the Engineer's representatives, and therefore extreme accuracy is essential. Except for centerline stakes and bench marks, the specifications required that the Contractor shall establish and maintain all other necessary controls. Contractor is responsible for the accuracy of the horizontal and vertical controls established by the Contractor, and the work performed from these controls.

It is the responsibility of Department personnel, to inspect all work performed by the Contractor, including any horizontal or vertical controls established by the Contractor.

In order to preserve the centerline points and bench marks established by the Engineer, and in order to properly inspect other controls established by the Contractor and the work performed from such controls, it is necessary that the Engineer establish sufficient reference points from which basis control points may be re-established and the Contractor's work adequately inspected and verified. All control points and reference points established by the Engineer should be checked by a closed traverse.

B. <u>Bench Marks.</u> A good bench mark that is not likely to be disturbed should be established at each bridge site. It is desirable that this bench mark be referenced by at least one other bench mark in the same vicinity, such that both may be seen from the same setup so that one will verify the accuracy of the other. These bench marks should be thoroughly checked by tying into other bench marks used in the work and should be used to set all subsequent control elevations of the bridge work.

C. <u>Checking.</u> A thorough check of all measurements, angles and elevations should be made to insure that no error exists. The checking should, if possible, be done by persons other than those who did the original staking. If feasible, the checking should be done by different procedures. Reference points for centerline points should, if possible, be set at the same angles from centerline and at the same offset distance. This will provide a convenient method for checking skew angles and offset distances by measuring parallel to centerline through the offset stakes. There are many other ways within good engineering knowledge to verify the accuracy of layout work.

Never assume anything when staking a bridge and make certain the staking is correct. Insist that the Contractor provide and accurately maintain all working control points, such as for individual pile locations, cutoff elevations, form lines and grades, header grades, etc.

If ever in doubt, consult the plans, check dimensions on the plans for errors, and check your own controls and those provided by the Contractor.

10.12 Setting Grading Stakes, Finishing Stakes and Paving Stakes.

A. Grade Stakes. In some instances, such as in an interchange area where site grading is indicated beyond the normal typical section, it may be necessary to provide the Contractor with basic grade stakes indicating the cut or fill and offset from the shoulder line and additional rough grading stakes in the area of the side grading.

These stakes will generally consist of standard flat stakes and will be set to rough line and grade only to the accuracy commensurate with the intended use.

Cut or fill from the ground at the stake and offset, if any, to the point of grade should be marked on the stake.

B. Finishing Stakes or Blue Tops. When the rough grading of the roadbed has been substantially completed, the Project Engineer should set finishing stakes (blue tops) at centerline and shoulders of the roadway at intervals of not more than 100 feet. On minimum width roadway sections, the stake at centerline may be eliminated. Closer intervals may be needed because of sharp changes in grade or alignment, widening or superelevation. Finishing stakes are generally to be placed at the required locations and driven so that the top of the stake is at the elevation of the finished grade of the pertinent earthwork. The grade foreman and motor patrol operator should finish the grade to very nearly that required before calling for blue tops. If blue tops are called for and the grade is found to consistently vary more than ±0.3 of a foot, the Contractor should be called back to provide closer grading prior to setting blue tops.

Finishing stakes are also normally to be placed at the top of subgrade and base courses. In areas of critical drainage, staking must be provided to assure adequate slope. Ponding of water along embankments, in the roadway, or in the ditches must not be permitted.

Finishing stakes are to be set accurately to line, solidly driven, and guarded by the Contractor. Heights of Instrument (H.I.s) and grade rods are to be recorded to the nearest 0.01 foot and the top of the stake driven to the elevations of the grade at that point.

C. Paving Stakes. Stakes for paving should be set with extreme care. The centerline control points must be reproduced to provide alignment for the pavement. Before establishing horizontal and vertical controls, consult with the Contractor, in order that the controls may be set at offset distances convenient to the Contractor's proposed operations. Usually these controls are set two (2) or more feet from the edge of the pavement.

There are several suitable methods of setting paving grade stakes. One of the most accurate methods is to drive a 2 x 2 hub flush with the surface of the ground and provide the cut or fill (usually fill) to the elevation of the normal pavement edge. To do this, centerline control points are to be offset at right angles to the centerline and to the offset distance agreed on with the Contractor and driving a hub flush with the ground and marking the line with a tack. The offset tack line is then established at the required intervals for line and grade by actually running the line using the same deflections on curves as for centerline and using adjusted cord lengths as set out in Section 10.3. The line should be established with 2 x 2 hubs driven flush with the ground and using a tack in each hub.

This offset tack line is to be used for control of pavement alignment and for grade references on that side of the pavement.

After the offset tack line is established, a very convenient method of setting the offset grade line on the opposite side of the pavement is by use of two tapes simultaneously, one measuring normal to the roadway from the tack point and the other measuring the computed diagonal distance from the tack point behind to the appropriate offset distance on the other tape. The 2 x 2 hub should be driven flush with the ground at the point thus established. It is to be noted that on tangents, the diagonal distance measured should be a constant distance. For circular curves, the diagonal distance must be computed for each degree of curvature. For spiral curves, it may be more convenient to establish the offset grade point opposite the tack line points using a surveying instrument.

A desirable and accurate method for providing the Contractor with precise grade information is to turn through the project, recording accurate level shots on all bench marks and all grade hubs at the same time and being sure that the respective shots right and left on the grade hubs are recorded to the hundredth right and left in the field notebook. These notes can then be taken to the office to serve as a final line for check levels. If found to be accurate, the cut or fill from the hub to the pavement edge elevation can be computed by calculator and recorded in the field notebook adjacent to the rod reading.

Then one person may go to the field and mark on the face side of the guard stake the cut or fill to grade and on the back side of the guard stake, mark the station number. If it is practicable to reproduce the notes establishing these grades, a copy should be furnished to the Contractor in case a guard stake is destroyed or a question arises as to the proper reference marks on the stake.

As stated above, there are other accurate methods of providing line and grade. However, driving stakes such that the top of the stake is at the elevation of the paving grade is not desirable because of the susceptibility of such stakes being struck by equipment or posing a hazard to personnel. For widening and overlays where traffic is required to be maintained, such method may pose a hazard to traffic.

Unless planned equipment and proposed Contractor’s operations would justify otherwise, all paving stakes should be set at 25-foot intervals. All grades for pavements are to be provided to the nearest 0.01 foot.

10.13 Staking Manholes, Catch Basins and Inlets. Manholes, catch basins, and inlets are usually constructed before any curb or curb and gutter operations start on a project. For this reason, extreme care should be exercised in staking so that they will fit properly into the design of the road. The castings are usually adjusted to the required elevation after the curb and gutter forms are set.

Position of manholes, catch basins, and inlets is usually fixed by the straddle hub method with a grade hub offset such distance as to protect it from disturbance. Guard stakes at the straddle hubs should indicate clearly the portion of the structure staked and the distance thereto. The guard stake at the grade hub should give the cut or fill to the top of the structure, the cut or fill to the flow line, and the distance to the point on the structure to which these grades refer.

On projects where there is a considerable number of manholes, catch basins, and inlets to be constructed, separate field books may be necessary for each type of the work. Separate pages, as needed, are to be used for each structure. For each structure, the field book should show the location, type, and size, with a staking diagram showing all distances and pertinent elevations, date staked, and the staking party.

10.14 Staking Underdrains and Sewers. For relatively short and straight lines of underdrains and sewers, a procedure similar to that used in providing controls for culverts may be used in establishing the alignment and flow line.

The flow line elevation of sewers and underdrains must conform to those of any existing drains to which they must be connected and should provide for adequate outlet.

Underdrains should be staked at elevations established by and conforming to the grades and typical sections indicated on the plans and structures to which they must be connected.

Lines of underdrains and sewers having considerable length or changes in alignment may be made by an offset control line run parallel to the centerline of the structure and at a convenient offset distance which will insure permanency of the control stakes during construction operations.

Unless the equipment and operations proposed to be used by the Contractor justify otherwise, control grades should be set at intervals of not greater than 25 feet. All grade stakes are to be set reflecting a grade to the nearest 0.01 foot.

10.15 Staking Channel Changes and Ditches. This work is generally indicated as Unclassified Excavation. In some cases, the item of Channel Excavation may be indicated in the contract, with the material to be disposed of outside of the highway right-of-way. In certain cases, Channel Excavation may be reclassified as Unclassified Excavation as provided in Subsection 203.04.1.

In either case, the site from which the excavation is to be made will require slope staking and cross-sectioning, if measurement for payment is to be made by the F.M. method.

Normally, the plans will show the typical section to be used for the construction of channels and special ditches. If a typical section is not indicated on the plans, the channel or ditch should be of sufficient dimensions to accommodate existing field conditions and requirements.

10.16 Staking Curb, Curb and Gutter, Sidewalks, Guard Posts and Guard Rail. Stakes for curb, curb and gutter and/or sidewalk forms are to be set with an instrument to the alignment and grade shown on the plans or established. Stakes should be set at full and half stations on tangents, 25 to 50-foot intervals on horizontal curves and not greater than twenty-five (25)-foot intervals on vertical curves. Usually, curb returns and sidewalk radii can be staked using a tape or ruler.

Except for instances where controls are established by existing construction, accurate alignment and grade, correct to the nearest 0.01 foot, is to be established using an offset line of tacked hubs generally behind the form line. Final position of the forms should be checked visually by sighting along the form in both directions. In the event pouring is delayed appreciably, the forms should be thoroughly checked for line and grade prior to use.

A field book is to be maintained indicating a staking diagram for detached structures, with respect to centerline, and is to be used during placement, showing dates and locations of pours, staking party members and initials of party member(s) making measurements for payment.

Guard rail and guard post locations will be indicated on the plans with special installation features indicated on standard sheets or other drawings.

Sufficient line stakes with tacks are to be set at intervals sufficient to properly establish the guard rail alignment. The point of beginning and ending of guard rail should be shown on the plans. For specific criteria, see the standard sheets. Stakes may be graded for the top of rail or the bolt hole, whichever is desired. Location of guard rail for signs, pier protection, etc. is generally specified on the plans or standard sheets. Check with the Contractor to determine the Contractor's method of operation so that the stake location will not conflict with the necessary positioning of the Contractor's equipment and to determine that the Contractor and the Inspector both thoroughly understand the information contained on the stakes.

10.17 Notes, Records and Party Chief's Report. All field notes recording the layout and measurement of construction are to be made in standard bound field notebooks or cross-section books, as applicable. These books are permanent source documents and may be referred to by others.

Notes must be neat, legible, precise, and sufficiently detailed to convey their intent to anyone not familiar with the project.

Erasures of errors in field notes are unacceptable. A line must be drawn through those portions of notes in error (leaving the original note legible) with corrections noted directly above and initialed where quantity measurements are involved.

All field notebooks are to be identified on the outside of the front cover indicating project number, book number, and content. Each page of the book should be numbered in the upper outside corner of the page. Each book should be indexed and its content referred to by page numbers. One or more sheets should be reserved at the front of each book for indexing.

The date, weather conditions, and party personnel are to be shown at the beginning of each day's notes. As a general rule, field notes for each phase of the work should be placed in a separate series of field books. Under certain conditions, it may be feasible to combine minor items into one or more "Miscellaneous" books, with adequate index coverage.

10.18 Party Chief's Daily Report - Form CSD-603. It is essential that the daily activities of Project Office personnel working on construction projects be adequately documented. The subject form is to be used to record the activities of those personnel engaged in the construction surveying phases of the work.

Each Party Chief is to keep a factual daily account of all work performed by the construction survey party. The back of each sheet may be used for additional names and information or additional sheets may be used, if necessary. If the back of the sheet or additional sheets are used, make an appropriate note at the bottom of each sheet referring to such additional information on the back or additional sheet(s) for that daily report.

The form is also to be used to record preliminary engineering activities.

ABBREVIATIONS & SYMBOLS

A

Absorbed Haul	A.H.
Abutment	Abut.
Acre and Acres	Ac.
Ahead	Ah.
Alternate spaces	Alt. Spa
Aluminum	Alum.
And	&
Approximately	Approx.
Asphalt	Asph.
At	@
Auxiliary	Aux
Average daily traffic	A.D.T.

B

Back	Bk.
Back-to-back	B.-B.
Base line	BL
Batter	Batt.
Beam	Bm.
Bearing	Brg.
Begin	Beg.
Beginning of project	B.O.P.
Beginning of survey	B.O.S.
Benchmark	B.M.
Bituminous	Bit.
Bituminous coated corrugated metal pipe	B.C.C.M.P.
Bottom	Bot.
Bridge	Br.
Building	Bldg.

C

California bearing ratio	C.B.R.
Centerline	C_L
Center of mass	C.M.
Center-to-center	c.c.
Cement	Cem.
Cement composition	Cem.Comp.
Channel Change	Ch.Ch.
Class	Cls.
Concrete	Conc
Connection	Conn.
Construction	Const.
Continued	Cont’d.
Continuous	Cont.

Continuous reinforced cement concrete	C.R.C.C.
Contractor	Contr.
Corner	Cor.
Corporate	Corp.
Correction	Corr.
Corrugated	Corru.
Corrugated metal pipe	C.M.P.
County	Co.
Course	Cse.
Creosote	Creo.
Cross-over	x-over
Crown (normal crown slope x lane width)	C.R.
Cubic feet (quantities)	C.F.
Cubic feet (fluids, etc.)	$Ft.^3$
Cubic feet per second	C.F.S.
Cubic yard (quantities)	C.Y.
Cubic yard (fluids, etc.)	$Yd.^3$
Culvert	Culv.
Curve to spiral	C.S.

D

Degree of curve (circular)	D
Degree of curve (spiral)	Dc
Delta	△
Delta of curved (spiral)	△c
Delta of spiral (spiral)	△s
Design hour volume	D.H.V.
Design speed	V
Detail	Det.
Diameter	Dia.
Diameter (in bar schedule)	
Diameter of bend	D
Diameter of bar	d
Diaphragm	Diaph.
Dimensions	Dim.
Directional distribution (% of traffic)	D
Ditch	Dt.
Double	Dbl.
Double bituminous surface treatment	D.B.S.T.
Down stream	D.S.
Drainage Area	D.A.
Drawing	Dwg.
Drive	Dr.

E

Each	Ea.
Easement	Ease.
Electrical	Elec.

Elevation	Elev.
Embankment	Emb.
Encasement	Enc.
End of project	E.O.P.
End of survey	E.O.S.
Equal	Eq.
Equation	Equa.
Estimated	Est.
Excavation	Exc.
Expansion	Exp.
Expansion material	Exp. Mat'l.
Extension	Exten.
External	Ext.

F

Face-to-face	F.-F.
Final measurement	F.M.
Finish	Fin.
Finished grade	Fin.Gr.
Fire hydrant	F.H
Fixed	Fix.
Flared end section	F.E.S.
Flow line	FL
Feet and foot	Ft.
Forward	Fwd.
Frontage	Fr.
Furnish	Furn.

G

Gage	Ga.
Gallon	Gal.
Galvanized	Galv.
Grade	Gr.
Ground	Grnd.
Group	Gp.

H

Headwall	Hdwl.
Height	Ht.
Hexagonal head	Hex. Hd.
High strength	H.S.
High Water	H.W.
Highway	Hwy.
Hook	Hk.
Horizontal	Hor.
Hot Mix Asphalt	HMA

I

Including	Incl.
Inside diameter	I.D.
Interchange	Intch.
Intermediate	Int.
Intersection	Intrs.
Interstate	I.
Invert	Inv.

J

Joint	Jt.
Junction	Jct.

K

Kips per square foot	K.S.F.

L

Lane	Ln.
Left	Lt.
Left forward	Lt. Fwd.
Length	Lgth.
Length of curve (circular)	L
Length of curve (spiral)	L c
Length of skewed culvert	L S K
Length of spiral	L s
Linear	Lin.
Linear foot	L.F.
Longitudinal	Long.
Long tangent	L.T.
Loose vehicle measure	L.V.M.
Lump sum	L.S.

M

Manhole	M.H.
Material	Mat'l
Maximum	Max.
Medium line	ML
Medium	Med.
Miles	Mi.
Miles per hour	M.P.H.
Minimum	Min.
Modified	Mod.
Municipal	Mun.

N

Nail-in-root	N.I.R.
Nail-in-side	N.I.S.
Normal crown	N.C.

Number	No.
O	
Opposite	Opp.
Ordinate	Ord.
Original	Orig.
Ounce	Oz.
Outside diameter	O.D.
Out-to-out	O-O
P	
Pavement	Pave.
Pavement width	P.W.
Perforated	Perf.
Permissible	Permis.
Place	Pl.
Plate	PL
Point of curve	P.C.
Point of intersection	P.I.
Point of vertical tangent	P.V.T.
Point of vertical curve	P.V.C.
Point of vertical intersection	P.V.I.
Point on curve	P.O.C.
Point on subtangent	P.O.S.T.
Point on tangent	P.O.T.
Population	Pop.
Pounds	Lb.
Pounds per cubic foot (quantities)	Lb./C.F.
Pounds per cubic foot (fluids, etc.)	Lb./Ft.^{3}
Pounds per square foot (quantities)	Lb./S.F.
Pounds per square foot (fluids, etc.)	Lb./Ft.^{2}
Pounds per square inch (quantities)	Lb./S.I.
Pounds per square inch (fluids, etc.)	Lb./In.^{2}
Pounds per square inch (stress)	p.s.i.
Precast	Prec.
Present	Pres.
Prestressed	Prest.
Project	Proj.
Projection	Proj'n
Property line	PL
Q	
Quantity	Quan.
R	
Radius	R
Railroad	R.R.
Reinforced	Reinf.

Reinforcement	Reinf.
Reinforcing	Reinf.
Remove	Rem.
Required	Req'd
Reverse crown	R.C.
Revised	Rev.
Right	Rt.
Right forward	Rt. Fwd.
Right-of-way	ROW
Road	Rd.
Roadway	Rdwy.
Round	Ø
Route	Rt.

S

Sanitary	San.
Section (typical or cross-section)	Sect.
Section (land)	Sec
Section line	SL
Selected	Sel.
Sheet	Sh.
Shoulder	Shldr.
Skew	Sk.
Slope	Sl.
Soil cement water mix	S.C.W.M.
Space	Spa.
Special design	Spec. Des.
Special provision	Spec. Prov.
Specifications	Specs
Spiral to curve	S.C.
Spiral to tangent	S.T.
Square	Sq.
Square inch	S.I. or In.^{2}
Square foot	S.F. or Ft.^{2}
Square yard	S.Y. or Yd.^{2}
Standard	Std.
Station	Sta.
Station yard	Sta. Yd.
Straight	Str.
Street	St.
Stress relieved	S.R.
Structure	Struct.
Structural excavation	Struct. Exc.
Superelevation	Super
Supplements	Supp.
Surface, surfaced and surfacing	Surf.
Survey	Surv.

Symbol	Sym.
Symmetrical	Symm.

T

Tangent	Tan.
Tangent to spiral	T.S.
Telephone	Tel.
Temporary	Temp.
Thickness	Th.
Timber	Tim.
Transverse	Trans.
Truck	Trk.
Trucks (% of traffic)	T
Typical	Typ.

U

Underdrain	Undrn.
Unstable material	U.M.
Untreated	Untr.
Upstream	U.S.
Unit	U.

V

Variable and varies	Var.
Vertical	Vert.
Vertical curve	V.C.
Volume	Vol.

W

Water	W.
Water meter	W.M.
Water valve	W.V.
Wearing	Wear.
Weight	Wt.
With	w/
Working point	W.P.
Working number	W. No.

FORMS

FORM CSD-001

CSD-001
Rev. 10/2006

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
AGREEMENT FOR PROPOSED FORCE ACCOUNT EXTRA WORK

Submit 2 Copies

Project No. ______________________ County__________________________ Date: ______________________________

TO THE EXECUTIVE DIRECTOR OF THE MISSISSIPPI DEPARTMENT OF TRANSPORTATION:

Pursuant to your request for a proposal covering proposed “Extra Work” herein stipulated for which unforeseen work there are no quantities or unit prices included in our contract for the construction of the above mentioned project: (1) (We) hereby agree to perform the necessary work and furnish the necessary labor, materials, and equipment that may be required of me (us) at not to exceed the unit prices quoted below. The work to be performed and materials furnished in accordance with the standard specifications of the Mississippi Department of Transportation and the special provisions applicable to the above project. Description of Extra Work and Reasons therefore: (List Stations Involved)

____
____
____

LABOR, TEAMS AND FOREMAN

Classification	Estimated Hours	Hourly Rate	Estimated Amount

Sub-Total plus of Labor, Teams and Foreman Estimated Total Labor

MATERIALS

Material	Estimated Quantity	Unit Price	Estimated Cost or Amt.
Freight			

Sub-Total plus Estimated Total Material

RENTAL ON EQUIPMENT

Kind and Number	Estimated Hours	Unit Price	Estimated Amount

Estimated Total Rental

_____ Liab./Prop. Insur., Soc. Security, Work. Comp., Unemp. Tax ________ @ _________ of net labor cost _______________

Sub Total _______________

Plus ______ of Sub Total (Bond Premium and Sales Tax) _______________

Estimated Total Cost _______________

Respectfully Submitted,

Approval Recommended:

____
Contractor Date

____
District Engineer Date

____
Surety Date

____
State Construction Engineer Date

The above proposal is hereby accepted and construction may begin.

Executive Director

Federal Highway Administration(Non-Exempt Projects)

By: ______________________________
Chief Engineer Date

____
Division Administrator Date

FORM CSD-081

CSD-081 Page 1 of ___

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

QUANTITY ADJUSTMENT

1. QUANTITY ADJUSTMENT NO.__________ 2. PROJECT NO.____________________________

3. DATE________________________________ 4. COUNTY ________________________________

5. The following adjustments on the above project, with stations, quantities and items involved, are recommended for the reasons stated in detail. (Attach additional pages if necessary)

6. Total Estimated Cost Per Estimate Dated _________ $___________

7. Changes by Previous Quantity Adjustment ____________________

8. This Quantity Adjustment ____________________

9. *Adjustment of Construction Engineering and Contingencies ________

10. Revised Total Estimated Cost of Project $____________________

C.E. will be adjusted in direct proportion to changes in construction items.

Approval Requested ___________________

____
Resident / Project Engineer

APPROVED __________________________ APPROVED ____________________________

____________________________________ ____________________________________
District Engineer Federal Highway Administration

MISSISSIPPI DEPARTMENT OF TRANSPORATION

CSD-081 Page __ of __

QUANTITY ADJUSTMENT ATTACHMENT

QUANTITY ADJUSTMENT NO. ___________ PROJECT NO. ________________________

DATE ________________________________ COUNTY _____________________________

The following adjustments on the above project, with stations, quantities and items involved, are recommended for the reasons stated in detail.

FORM CSD-094

CSD-094

MISSISSIPPI DEPARTMENT OF TRANSPORATION
CONSTRUCTION DIVISION

Construction Progress Report ________________

Project No.______________________________ County ______________________________

Contractor ______________________________ Contract Grouping ______________________

Inspection Made By ________________________ Project Location ________________________

Date Inspection Made ______________________ Type of Construction ____________________

1. Status of Project

   (a) Time Units Table ___________ (c) Percent Time Elapsed ________________
   Based on the smaller of (a) or (b)

   (b) Time Units Assessed ________ (d) Percent Complete on Date of Inspection ________________

2. Work in Progress

3. Work Done to Date

4. Comments and Recommendations

Copies to:

District Engineer (Original)
Project Engineer
Construction Engineer

Signed: ______________________________

Title: ______________ Engineer

Office Address: ______________________

FORM CSD-121

(Front)

CSD-121

INSPECTORS DAILY REPORTS

PROJECT NO. ______________________________

Date _________________ Day ________________

Soil Condition _______________________________

Hours Worked by Contractor ___________________

Weather Condition ____________________ A. M.

____________________ P. M.

RE: CONTRACTOR'S OPERATIONS: __________

EQUIPMENT AND PERSONNEL

____

____

____

____

____

____

____

____

____

____

____

____

____

____

____

____

____

(over)

(Back)

RE: ENGR.ACTIVITIES ____________________

____

____

____

____

____

____

____

Personnel __________________________________

____

____

____

Other Information ____________________________

____

____

____

Car Used ___________________________________

S.R. Beg. Day _______________________________

S. R. End Day _______________________________

Total State Mileage ___________________________

Charge ________ Miles to Proj. ______________

Charge ________ Miles to Proj. ______________

Charge ________ Miles to Proj. ______________

Charge ________ Miles to Proj. ______________

Signed: ____________________________________

Inspector

FORM CSD-155

CSD-155
07/14/2004

MDOT NOTICE OF CLAIM FORM

THIS FORM IS REQUIRED TO BE SUBMITTED AS PER SUBSECTION 105.17 - CLAIMS FOR ADJUSTMENTS AND DISPUTES TO FILE A NOTICE OF CLAIM FOR ADDITIONAL COMPENSATION AND/OR TIME.

Project Number: ____________________
County: ____________________
Route & Termini: ____________________
Date Claim was Submitted: ____________________

Claim Number: ____________________
Type of Claim: ____________________
Date and Time (AM, PM) of Event: ____________________
Location of Event: ____________________
Specific Subsection(s) of Contract Addressing Event: ____________________

Description of Event: ____________________

Describe How the Event Impacted the Project (current & future): ____________________

Describe Requested Compensation: ____________________

Attach any additional sheets as necessary to complete the form and attach auditable documentation for additional compensation requests.

I certify that the foregoing statements made by me are true. I am aware that if any statement made herein is willfully false or fraudulent, that I am subject to punishment by law. I further certify that I have made a good faith effort to disclose the full nature and extent of this claim.

____
COMPANY

____
NAME

____
POSITION

____
SIGNATURE OF CLAIMANT'S AUTHORIZED REPRESENTATIVE

Instructions: Each claim submitted on a project should be sequentially numbered.

FORM CSD-165

CSD-165

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
EQUIPMENT RENTAL REQUEST

____
Date

____
Project No.

____
County

This is our formal request that you approve our rental of equipment {*Describe the equipment being rented here*} for use on the above project. We advise and affirm that there is not a side agreement or mutual understanding between {*Prime Contractor's name here*}, Prime Contractor and {Name of Lessor here}, lessor, whereby we are required to pay any bonus, premium, stipend, stipulation, gratuity, or extra compensation of any nature whatsoever, in addition to the agreed rental prices for equipment being rented and used on construction of the above mentioned project. In addition, there does not exist a bond between {*Prime Contractor's name here*}, Prime Contractor, and {*Name of Lessor here*}, lessor. A schedule of the equipment, rental rates, indicating with or without, as applicable, labor used in the operation of the eqipment, and the anticipated duration of use expressed in units of time (hours, days, weeks or months) are as follows:

*SCHEDULE

{*List equipment, rates, labor, etc. here*}

We further certify that the rental prices shown with or without operators are reasonable for the units of equipment being rented, and that any rental prices shown with operators are reasonable and include an amount for payment of labor used in the operation of such equipment by {*Name of Lessor here*}, lessor, at the effective rates shown in the contract.

Approved
Mississippi Department of Transportation
By:

____
Signature

____
Title

____
Prime Contractor

By: ______________________________
Signature

____
Title

____
NOTARY PUBLIC

(Seal)

*Attach additional sheet(s) if necessary.

Original: Project File
Contractor
pc: District Engineer
Construction Division
Contract Administration Division

FORM CSD-200

CSD-200 Sheet 1

Project No.____County

Mississippi Department of Transportation

____

FINAL REPORT

OF

PROJECT ENGINEER

FROM ________________________ TO ____________________________

ACCOMPANYING ESTIMATE NO. & FINAL

____

SHEETS INCLUDED

1 _______________
2 _______________
3 _______________
4 _______________
5 _______________
6 _______________
7 _______________

TYPE ________________

____________________________CONTRACTOR

_______________________PROJECT ENGINEER

CSD-200 Sheet No. 2 of 3

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

CONTRACTOR'S ESTIMATE

Project No.: 12-3456-78-910-10 County: Hinds

In Account With ABC Construction Co., Inc. P.O. Box 123, Jackson, MS 39215

Item Number		Item	TOTAL QUANTITY ORIGINAL	FINAL	Unit	Unit Price	Amount	
202-B		Removal of Paved Ditch Original quantity was underestimated. Quantity paid was by field measure.	50.000	414.560	SY	20.0000	7291.20	**
203-G	E	Excess Excavation FM Instead of moving excess material, material was left in place.	100.000	0.000	CY	15.0000	-1500.00	**
304-A	GY	Granular Material (LVM) (Cl.6 Gp. D)	1794.000	1805.000	CY	7.8500	86.35	
907-625-B		Traffic Stripe (Skip Yellow)	6.000	5.918	M	126.8700	-10.40	
907-625-F		Legend	924.000	1858.000	LF	0.3700	345.58	
907-626-H		Thermoplastic Legend (White) 120 mil	288.000	410.000	LF	0.6900	-102.12	

{ All item listed on the estimate will be listed on report CSD-200 }

CONTRACT TIME DATA

1. Date Work Started________________________
2. Date Work Completed________________________
3. Contract Time Expired________________________
4. Date Contract Time Began____________________
5. Date Released from Maintenance_______________
6. Date Accepted by State______________________
7. Calendar Days Between #2 & #14 (   )
8. Delay for Placing Pav't. Markings (Cal Days) (   )

9. Original Contract Completion Date ____________________
10. Time Ext. approved by Suppl. Agreem't. ________________
11. Automatic Time Ext. Due to Incr. Qtys. ________________
12. Original Time Units ____________________
13. Total Time Units ______________________
14. Final Completion Date __________________

15. COMPUTATION OF LIQUIDATED DAMAGES

Sundays between #2 & #14 ____________ Holidays not worked between #2 & #14 _________ Saturdays not worked between #2 & #14 _________

16. Total of #15 ________________ 17. Total Liquidated Damages #7 Minus #8 Minus #16 __________ Days @ ____________

PROJECT LENGTH DATA

Project Begins Sta End Sta

Non-Part Section Sta To Sta

Equation: Station +Feet -Feet Station = Station +Feet -Feet

	URBAN		RURAL		NON-PART.		TOTALS	
Length Roadway	________ Ft	________ Mi	________ Ft	________ Mi	________ Ft	________Mi	________ Ft	________ Mi
Length Bridges	________ Ft	________ Mi	________ Ft	________ Mi	________ Ft	________Mi	________ Ft	________ Mi
Length Except	________ Ft	________ Mi	________ Ft	________ Mi	________ Ft	________Mi	________ Ft	________ Mi
Length Project	________ Ft	________ Mi	________ Ft	________ Mi	________ Ft	________Mi	________ Ft	________ Mi
						Net Total	________ Ft	________ Mi

Project Engineer Signature ______________________________

FORM CSD-201

CSD-201

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

FIRST CONSTRUCTION REPORT

Memorandum To
State Construction Engineer

Project No. ______________________
County ______________________

Place ______________________
Date ______________________

Project/Detail,
Property ID or ______________________
Maintenance Section ______________________

______________________ Highway No. and Location

______________________ Type of Construction

Contractor and Address ______________________
____

Contract Time Began ______________________ Work Began ______________________
Date Specified for Contract Time to Begin ______________________
Date Notice to Proceed issued ______________________
Nature of Work ______________________
Contractor's Superintendent, Address and Phone No. ______________________
____
P.E.'s Address ______________________
Phone Nos. ______________________ Office ______________________ Residence
Location of Office ______________________
Date First Construction Engineering Expense Incurred ______________________

Yours truly,

PROJECT ENGINEER

cc: Federal Highway Administration (If Federal-Aid Project)
Contract Administration Engineer
District Engineer
State Materials Engineer
Financial Management Division
Files

NOTE: Report above as soon as contractor arrives on project.

FORM CSD-202

CSD-202
Rev. 10/2006

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
FORCE ACCOUNT STATEMENT EXTRA WORK PERFORMED

Submit 2 Copies

Project No. ______________ County______________ Date: ______________

Below is a statement of force worked (and material used) as per agreement previously entered into in writing in performing work on the above project, under directions from the Engineer. The work is described in detail as follows:

____
____
____
____
____

Dates work done

LABOR, TEAMS AND FOREMAN

Classification	Hours Worked	Hourly Rate	Amount

Sub-Total plus of Labor, Teams and Foreman Total Labor

MATERIALS

Material	Quantity	Unit Price	Amount
Freight			

Sub-Total plus on Materials & Freight Total Material ______________
Plus Sales Tax if Paid

RENTAL ON EQUIPMENT

Kind and Number	Hours	Unit Price	Amount

Total Rental

________ Liab./Prop. Insur., Soc. Security, Work. Comp., Unemp. Tax _____ @ ______ of net labor cost ______________

Sub Total ______________

Plus __________ of Sub Total (Bond Premium and Sales Tax) ______________

Total Cost ______________

I do hereby certify, that the foregoing account is full, true, and correct, is due and remains unpaid.

______________________________ By: ______________________________
Contractor Date Surety Date

Certified Correct::

____
Project Engineer

Approval Recommended:

______________________________ ______________________________
District Engineer Date State Construction Engineer Date

____
FHWA (Non-Exempt Federal Aid Projects) Date

Remarks: ____

____

FORM CSD-203

Forms CSD-203, CSD-481 & CSD-720 are in a bound book

FERTILIZERS REQUIRED

TYPES	RATES
1. AGRICULTURAL LIMESTONE	_______TONS./ACRE
2. COMBINATION FERTILIZER ( )	_______LBS./ACRE
3. AMMONIUM NITRATE	_______LBS./ACRE
4. SUPERPHOSPHATE	(BID)

TYPES AND RATES ORDERED AND USED AS FOLLOWS:

(A) TYPE____________ RATE_______LBS./ACRE

(B) TYPE____________ RATE_______LBS/ACRE

LOCATION STA. TO STA.		ACRE(S)	DATE SPREAD	LIME STONE	COMBINATION FERT. ( )	AMMONIUM NITRATE	DATE SPREAD	SUPERPHOSPATE 4(A)	SUPERPHOSPATE 4(B)	R E M A R K S
TOTALS										

CSD-203

____

INSPECTOR

FORM CSD-325

CSD-325

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
Inspection of Hot Mix Asphalt
Laydown Equipment

Project ______________________________ County ______________________________
Route ________________ Termini ____
Contractor ____
Project Engineer ____
Inspected By ______________________________ Date ________________________
Reviewed By __________________________, P.E. Date ________________________

1. HAULING UNITS - General
   a. Are the truck beds clean, tight and in good condition? Yes____ No____
   b. Are trucks equipped with properly attached tarpaulins? Yes____ No____
   c. Are holes provided in the bed for inserting thermometers? Yes____ No____
   d. Does the truck drip oil (engine, fuel, hydraulic), grease or fuel on the pavement? Yes____ No____

2. ASPHALT PAVERS
   MAKE ____
   MODEL ____
   a. Is the paver self-contained and a power-propelled unit capable of spreading the widths and thicknesses shown on the plans? Yes____ No____ Yes____ No____
   b. Does the paver drip oil (engine, fuel, hydraulic), grease of fuel on the pavement? Yes____ No____
   c. Is the paver equipped with quick and efficient steering devices and capable of reverse and forward travelling speeds? Yes____ No____
   d. Is the paver equipped with adequate variable forward speed controls? Yes____ No____
   e. Are the sides of the hopper sloped so that material will fall onto the slot feeders? Yes____ No____
   f. Is the screed or strike-off assembly adjusted to the required typical section? Yes____ No____
   g. Are the surfaces of the screed plates true and in good condition? Yes____ No____
   h. Are mat thickness and crown controls in good condition and adjustment? Yes____ No____
   i. Is the screed heater working properly? Yes____ No____
   j. Are screed vibrators in good condition and adjustment? Yes____ No____
   k. Is the screed extended the full width of the pavement placed? Yes____ No____
   l. Is the auger within approximately 12 inches of the end of the screed? Yes____ No____

m. Is the screed heated and vibrated for the full width of the screed unit? Yes____ No____

n. Is a ten foot straight edge or other approved device at the work site? Yes____ No____

o. Is the automatic screed control in adjustment and is the correct sensor attached when applicable? Yes____ No____

p. Is the correct ski attached, when applicable? Yes____ No____

3. ROLLERS

a. Are the rollers in good mechanical condition without obvious defects? Yes____ No____

b. Can each roller start, stop and reverse smoothly? Yes____ No____

c. Are scrapers and wetting pads and/or sprinkler systems on each roller in good operating condition? Yes____ No____

d. Are all steel tires straight across and free from grooves or pits? Yes____ No____

e. For pneumatic tired rollers, are the tires in good condition and free of tears, pits or holes and are they at uniform pressure? Yes____ No____

f. For vibratory rollers, is the vibrating mechanism in good condition and proper adjustment? Yes____ No____

g. Does the roller drip oil (engine, fuel, hydraulic), grease or fuel on the pavement? Yes____ No____

h. List the make and model of each roller below. Yes____ No____

Copies: State Construction Engineer
State Materials Engineer
District Engineer

FORM CSD-481

Forms CSD-203, CSD-481 & CSD-720 are in a bound book
This form is shown on two pages.

REPORT OF BITUMINOUS AND VEGETATIVE MATERIALS APPLIED

*BITUMINOUS MATERIAL							VEGETATIVE MATERIAL		
MAKE OF DISTRIBUTOR & SERIAL NO.	CAPACITY PER CALIBRATION TABLE	CALIBRATION CERTIFIED BY & DATE	GRADE OF MAT'L.	MATERIAL MOVED BY TANK CAR # OR TANK TRUCK #	SATISFACTORY CARD NUMBERS OR CAR SEAL NUMBERS		TOTAL QUANTITY TONS	DEDUCTION TONS	NET TONNAGE ALLOWED CONTRACTOR

DATE APPLIED	APPLIED MATERIAL STA.	APPLIED MATERIAL STA.	ACRES	TEMP. MAT'L.	STICK MEASURE BEFORE IN GALS	STICK MEASURE AFTER IN GALS	NET GALLONS AS MEASURED	NET GALS. AT 60 F	SPREAD GALLONS PER ACRE	GALLONS PER ARCE ORDERED (- 10%)	ASPHALT UNDER SHOT	NO. OF BALES MULCH TYPE __	AVG. WT. PER BALE	NO. TONS PLACED	TONS PER ACRE	TONS PER ACRE ORDERED (+ 15%)	MULCH OVER SHOT	REMARKS (ON BACK LINE(S))
TOTALS																		

CSD 481

SHOW REMARKS ON FOLLOWING SHEETS.

*BITUMINOUS MATERIAL QUANTITIES RECORDED FOR APPLICATION PURPOSES ONLY - NOT A PAY ITEM.

INSPECTOR

REMARKS	REMARKS
1. ______________________	12. ______________________
2. ______________________	13. ______________________
3. ______________________	14. ______________________
4. ______________________	15. ______________________
5. ______________________	16. ______________________
6. ______________________	17. ______________________
7. ______________________	18. ______________________
8. ______________________	19. ______________________
9. ______________________	20. ______________________
10. ______________________	21. ______________________
11. ______________________	22. ______________________

INSTRUCTIONS **INSTRUCTIONS**

MATERIAL TRANSFERRED FROM OTHER PROJECTS SHOULD BE EXPLAINED IN THE ABOVE REMARKS.

THE CONTRACTOR SHALL HAVE THE DISTRIBUTOR CALIBRATED BY AN AGENCY AND IN A MANNER APPROVED BY THE ENGINEER PRIOR TO BEING USED ON PROJECTS. ARRANGEMENTS MAY BE MADE FOR THE DEPARTMENT TO CALIBRATE DISTRIBUTORS AT BATESVILLE, NEWTON AND HATTIESBURG. COPIES OF ALL CALIBRATION CERTIFICATIONS SHALL BE FILED WITH THE CONTRACT ADMINISTRATION ENGINEER, STATE MATERIALS ENGINEER AND THE DISTRICT ENGINEER. SHOW NAME OF CALIBRATING AGENCY OR MDOT, AND DATE OF CALIBRATION CERTIFICATION.

LIST SATISFACTORY CARD OR CAR SEAL NUMBERS FOR CURRENT DELIVERIES; SUBMIT A SEPARATE LIST OF ALL DELIVERIES OF MATERIALS WITH INVOICES WITH FINAL PLANS. ALL ORIGINAL COPIES OF THIS REPORT ARE TO BE SUBMITTED WITH FINAL PLANS AND COMPUTATIONS. SUBMIT ONE COPY TO THE STATE MATERIALS ENGINEER.

FORM CSD-601

CSD-601

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

Project Engineer's Affidavit Accompanying Final Estimate

STATE OF MISSISSIPPI
COUNTY OF ______________________

PROJECT NO. ______________________
COUNTY OF ______________________
CONTRACTOR ______________________

This is to certify that to the best of my knowledge and belief:

(a) The above project has been constructed in accordance with the "Final Plans" (reduced blueline prints), sketches, prints and cross-sections which bear my signature in the upper right hand corner of each sheet thereof, and same have been filed with the Mississippi Department of Transportation, Jackson, Mississippi.

(b) The work meets the requirements of the specifications therefore.

(c) All materials used requiring laboratory test have been tested and are covered by "Accepted" Laboratory reports.

(d) Sufficient data has been submitted to permit the Mississippi Department of Transportation to make an accurate check of quantities.

(e) The quantities shown on the final estimate are correct.

(f) The Contractor has removed all equipment from sight of the highway or has stored same in such manner off the right-of-way that same does not appear to have been abandoned or "junked". This likewise applies to all materials except those stored in a manner satisfactory to the District Engineer for the use of the Department at some later date.

Signature ______________________________
Project Engineer

Sworn to and subscribed before me this the ________ day of ____________________, _______

____
Notary Public

____
My Commission expires

Note: Submit in TRIPLICATE for each project.

FORM CSD-603

CSD-603

Project No.____________________

PARTY CHIEF'S DAILY REPORT

Date ____________________ Weather ____________________

Day____________________ Worked____________________

Station to Station

C/L Stakes____________________

R.O.W.____________________

Original X Sec.____________________

Final X Sec.____________________

Slope Stakes____________________

Bridges____________________

Ref. Points____________________

Property Lines____________________

Topography____________________

Other____________________

Box Culv.	Pipe Culv.	Pipe S.D.	Inlets
Sta.	Sta.	Sta.	Sta.

Vehicle No. ____________________

Speedometer In____________________
Speedometer Out ____________________
Miles Traveled____________________

PERSONNEL

Party Chief	Instrumentation	Rodmen

Signed:____________________
Party Chief

FORM CSD-611

CSD-611

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

PROGRESS PERCENTAGES

Project Office ______________________ Date ______________________

Function Code ______________________

PROJECT NUMBER												
1	2	3	4	5	6	7	8	9	10	11	12	13

CONTRACT AMOUNT										
15	16	17	18	19	20	21	22	23	24	25

CONTRACT TIME UNITS			BEGINNING % TIME		BEGINNING % EARNED		PROGRESS SCHEDULE #	
27	28	29	31	32	34	35	37	38

PHASE NUMBER		A V T U								BEGINNING TIME UNIT				ENDING TIME UNIT			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

____
Project Engineer

FORM CSD-720

CSD-720 Sheet 1 of __

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
CLASS I SUPPLEMENTAL AGREEMENT

WHEREAS, WE, ______________________________, Contractor entered into a contract with the Mississippi Transportation Commission on the _______ day of __________ _____, for the construction of ____ Project No.________________________, _______________________, Count__; and

REQUEST:

REASON:

OTHER:

COST:

This agreement in no way modifies or changes the original contract of which it becomes a part, except as specifically stated herein.

NOW, THEREFORE, WE, ____, Contractor, hereby agree to said Supplemental Agreement consisting of the above mentioned items and prices and agree that this Supplemental Agreement is hereby made a part of the original contract to be performed under the specifications thereof, and that the original contract is in full force and effect, except insofar as it might be modified by this Supplemental Agreement.

Approved, this _______ day of ________________, ____

______________________________	______________________________
RESIDENT/PROJECT ENGINEER	CONTRACTOR
______________________________	______________________________
DISTRICT ENGINEER (If Applicable)	FHWA (If Applicable)

This has been discussed with the District (*name of District contract person goes here*), FHWA (*name of FHWA contract person goes here, if applicable)* and the Construction Division (*name of Construction Division contact person goes here*).

CSD-720 Sheet 1 of __

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
CLASS II SUPPLEMENTAL AGREEMENT

WHEREAS, WE, ___________________________, Contractor, and _____________________, Surety, entered into a contract with the Mississippi Transportation Commission on the _______day of _____________, for the construction of ____ Project No.__________________________________, Count __; and

WHEREAS:

This agreement in no way modifies or changes the original contract of which it becomes a part, except as specifically stated herein.

NOW, THEREFORE, WE, ____, Contractor, and _____________________________________, Surety, hereby agree to said Supplemental Agreement consisting of the above mentioned items and prices and agree that this Supplemental Agreement is hereby made a part of the original contract to be performed under the specifications thereof, and that the original contract is in full force and effect, except insofar as it might be modified by this Supplemental Agreement.

Dated, this _______ day of ________________, ____

____________________ SURETY	____________________ CONTRACTOR
By: ____________________	____________________

RECOMMENDATION FOR APPROVAL:

____________________ RESIDENT/PROJECT ENGINEER	____________________ FHWA (If Applicable)

APPROVED: ________, _____

____
DISTRICT ENGINEER

This has been discussed with the FHWA (*name of FHWA contract person goes here, if applicable)* and the Construction Division (*name of Construction Division contact person goes here*).

CSD-720 Sheet 1 of __

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
CLASS III SUPPLEMENTAL AGREEMENT

WHEREAS, WE, ______________________________, Contractor, and __________________, Surety, entered into a contract with the Mississippi Transportation Commission on the _______day of _______, ____, for the construction of ____ Project No.____, Count __; and

WHEREAS:

This agreement in no way modifies or changes the original contract of which it becomes a part, except as specifically stated herein.

NOW, THEREFORE, WE, ____, Contractor, and ____, Surety, hereby agrees to said Supplemental Agreement consisting of the above mentioned items and prices and agree that this Supplemental Agreement is hereby made a part of the original contract to be performed under the specifications thereof, and that the original contract is in full force and effect, except insofar as it might be modified by this Supplemental Agreement.

Dated, this _______ day of ________________, ______

____________________ SURETY	____________________ CONTRACTOR
By: ____________________	By: ____________________

RECOMMENDATION FOR APPROVAL:

____________________ DISTRICT ENGINEER	____________________ FHWA (If Applicable)
____________________ STATE CONSTRUCTION ENGINEER	____________________ CHIEF ENGINEER

APPROVED: ____________________________, _____

MISSISSIPPI TRANSPORTATION COMMISSSION

By: ____________________
EXECUTIVE DIRECTOR

CSD-720 Sheet 1 of __

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
CLASS IV SUPPLEMENTAL AGREEMENT

WHEREAS: We, ____.____,

Contractor, and ____,

Surety, entered into a contract with the Mississippi Transportation Commission on the ______ day of _______________, 20____, for the construction of _________________________________; and,

WHEREAS:

WHEREAS:

NOW THEREFORE, We, ____,

Contractors, and ____,

Surety, hereby agree to said Supplemental Agreement consisting of the above mentioned items and prices and agree that this supplemental agreement is hereby made a part of the original contract to be performed under the specification thereof, and that the original contract is in full force and effect, except insofar as it might be modified by this Supplemental Agreement.

Dated, this______ day of __________________, 20___

________________________________	________________________________
Surety	Contractor
By: ____________________________	By: ____________________________

APPROVED: _________________________, 20___

________________________________	________________________________
State Construction Engineer	FHWA (If Applicable)

CSD-720
Sheet 2

Sheet ___ of ___

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

SUPPLEMENTAL SHEET

Project No. ____

County ____

DETAIL EXPLANATION OF NECESSITY OF WORK INVOLVED:

JUSTIFICATION OF UNIT PRICES SUBMITTED:

____
DISTRICT ENGINEER

CSD-720
Sheet 3

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

SUPPLEMENTAL SHEET

Project No. ____

County ____

DETAIL ANALYSIS OF UNIT PRICES

BY: ____________________________________
CONTRACTOR

If additional space is needed, use extra sheets.

FORM CSD-723

Forms CSD-203, CSD-481 & CSD-720 are in a bound book

This form is shown on two pages.

SEEDS

TYPES

1. ______________________
2. ______________________
3. ______________________
4. ______________________

SEEDS TRANSFERRED FROM OTHER
IN THE REMARKS.

LOCATION STA. TO STA.		ACRE(S)	DATE SOWN	______ SEED			______ SEED		
				ORDER	PAY	LOT NO.	ORDER	PAY	LOT NO.
TOTALS									

CSD 723

REQUIRED

RATES

______________________________ LBS. / ACRE
______________________________ LBS. / ACRE
______________________________ LBS. / ACRE
______________________________ LBS. / ACRE

PROJECTS SHOULD BE EXPLAINED

______ SEED			______ SEED			REMARKS
ORDER	PAY	LOT NO.	ORDER	PAY	LOT NO.	

____
INSPECTOR

FORM CSD-724

This form is shown on two pages.

CSD-724

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
SURFACE TREATMENT
REPORT OF MATERIALS APPLIED

Report No. ____________________

BITUMINOUS MATERIAL					
Make of Distributor & Serial No.	Capacity Per Calibration Chart No.	CALIBRATION Certification by	Grade of Material	MATERIAL Moved By Tank Truck No.	SATISFACTORY Card Numbers

Date Applied	Applied Material		Width	Square Yards	Temperature of Material	Stick Measure				Net Gals. As Measured	Net Gals At 60ºF
						Before		After			
	STA.	STA.				In.	Gals.	In.	Gals.		

REMARKS: (1) ____________________
(2) ____________________
____
____

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
SURFACE TREATMENT
REPORT OF MATERIALS APPLIED

Project No. ____________________
County ____________________
Inspector ____________________

				AGGREGATE			
Total Quantity Gals.	Deduct Gals.	Net Gallons Allowed Contractor		Total Cubic Yards Placed		Deductions Cubic Yards	Net Cubic Yards Allowed Contractor
Spread Gals. Per Square Yard	Gals. Per Square Yard Order +5 - 15%	Asphalt Overshot	Cubic Yards Placed	Spread Cubic Feet / Square Yard	Cubic Feet/ Square Yard Ordered +(5)(15)%	Aggregate Overshot	Remark Key (1)(2)(etc.)

Prepared by: ____________________

Project Engineer: ____________________

FORM CSD-760

CSD-760

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
TIME UNIT ASSESSMENT REPORT

Date: ____________________

Project No: ____________________

County: ____________________

PERIOD____________________TO ____________________

TOTAL TIME UNITS PREVIOUSLY ASSESSED ____________

_______ (Month)	26________	10_______
	27________	11_______
	28________	12_______
	29________	13_______
	30________	14_______
	31________	15_______
_______ (Month)	1________	16_______
	2________	17_______
	3________	18_______
	4_______	19_______
	5_______	20_______
	6_______	21_______
	7_______	22_______
	8_______	23_______
	9_______	24_______
		25_______

TOTAL TIME UNITS ASSESSED DURING PERIOD ____________

TOTAL TIME UNITS ASSESSED TO DATE ____________

CERTIFIED CORRECT: ________________________
PROJECT ENGINEER

Original: Contractor
Copies: Project File
District Engineer
Central File

FORM CSD-761

CSD-761

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
TRAFFIC CONTROL PLAN REPORT

DATE ______________ PROJECT ______________ INSPECTOR ______________

TIME ______________ COUNTY ______________

(✓) CHECK BLOCK IF APPLICABLE

	ADVANCED WARNING ZONE	APPROACH ZONE	WORK ZONE	DETOUR
SIGNS	☐☐☐☐☐☐☐	☐☐☐☐☐☐☐	☐☐☐☐☐☐☐	☐☐☐☐☐☐☐
BARRICADES	☐☐☐☐☐☐☐	☐☐☐☐☐☐☐	☐☐☐☐☐☐☐	☐☐☐☐☐☐☐
PAVEMENT MARKINGS	☐☐☐☐☐☐☐	☐☐☐☐☐☐☐	☐☐☐☐☐☐☐	☐☐☐☐☐☐☐
OTHER DEVICES	☐☐☐☐☐☐☐	☐☐☐☐☐☐☐	☐☐☐☐☐☐☐	☐☐☐☐☐☐☐
FLAGMEN				

OPERATING CHARACTERISTICS

		Location			Location
1.	Queues	______	6.	Jay Walking	______
2.	Speed	______	7.	Erratic Maneuvers	______
3.	Gawking	______	8.	Brake lighting	______
4.	Accidents	______	9.	Skid marks	______
5.	Congestion	______	10.	Other	______

COMMENTS/ACTION RECOMMENDED

____

____

____

____

(ADDITIONAL COMMENTS ON BACK)

DATE

Contractor Notified ______________

Action Taken ______________

Action Deferred ______________ Signed: ______________

FORM CSD-880

CSD-880

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
WORKSHEET FOR FUEL PRICE ADJUSTMENT

PROJECT NO.

COUNTY DIESEL GASOLINE

CONTRACT BASE PRICE PER GALLON ________________ ______________

ESTIMATE PERIOD_______________________________ TO ________________________________

ITEM	UNIT	QUANTITY	FUEL PER UNIT		TOTAL FUEL PER ITEM	
			DIESEL	GASOLINE	DIESEL	GASOLINE
		TOTALS FOR PERIOD				

DIESEL GASOLINE

BASE PRICES FOR CURRENT PERIOD ______________ __________________

PRICE DIFFERENTIALS ______________ __________________

ADJUSTMENT=TOTAL FUEL X PRICE DIFFERENTIAL = ______________ __________________

TOTAL FUEL ADJUSTMENT FOR PERIOD (DIESEL+GASOLINE)= ______________________________________

FORM CSD-881

CSD-881 Sheet_____of______

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
WORK SHEET FOR MATERIAL PRICE ADJUSTMENT

PROJECT NO.

COUNTY

MATERIAL

CONTRACT BASE PRICE

ESTIMATE PERIOD TO

ITEM NO.	ITEM	QUANTITY	UNIT	MATERIAL PER UNIT	TOTAL MATERIAL PER ITEM
				TOTAL MATERIAL	

REFERENCE BASE PRICE FOR CURRENT PERIOD ___________________

PRICE DIFFERENTIAL ___________________

ADJUSTMENT=TOTAL MATERIAL X PRICE DIFFERENTIAL= ___________________

ADJUSTMENT FOR FUEL AND OTHER MATERIALS ___________________

TOTAL ADJUSTMENT FOR ESTIMATE PERIOD ___________________

FORM CSD-882

CSD-882

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
WORK SHEET FOR FINAL MATERIAL PRICE ADJUSTMENT

PROJECT NO. COUNTY

(1)	(2)	(3)	(4) PET. PRODUCTS PER UNIT			(5)	TOTAL MATERIAL REQUIREMENT FOR:	
						TOTAL	(6)	(7)
ITEM	FCQ	PRQ	Dsl	Gas	Asp	PER UNIT	FCQ	PRQ

NOTE: In columns (2) (3) (6) & (7) do not enter fractions of a unit, round quantities to nearest whole number.

						TOTALS	(8)	(9)

(1) Coded items or group of coded items (structures) which are subject to compensation adjustments.
(2) Final checked quantities of the items or final dollar value of structures to closest dollar.
(3) Quantities or dollar value shown on last estimate in which the Contractor worked.
(4) Petroleum products per pay unit or per $1,000 for structures.
(5) Total petroleum products required per pay unit or per $1,000 for structures.
(6) Total petroleum products for final checked quantity of each item, i.e. (2) x(5) to closest gallon.
(7) Total petroleum products for quantity of each item shown on last estimate in which the Contractor worked, i.e. (3) x (5) to closest gallon.
(8) Total petroleum products requirement based on final checked quantities.
(9) Total petroleum products requirement based on quantities shown on last estimate in which the Contractor worked.

$$FA = \frac{PPR\ (FCQ)}{PPR\ (PRQ)} \times EA$$

Where
FA = Final adjustment for changes in costs of petroleum products
PPR(FCQ) = (8) above
PPR(PRQ) = (9) above
EA = Adjustment shown on CSD-001 of last estimate in which the Contractor worked

ADVANCED AUTHORITY - METHOD 1

CSD-720 Sheet 1 of __

ADVANCED AUTHORITY
MISSISSIPPI DEPARTMENT OF TRANSPORTATION
CLASS II SUPPLEMENTAL AGREEMENT

WHEREAS, WE, ABC Construction Co., Inc., Contractor, and DEF Bonding, Inc., Surety, entered into a contract with the Mississippi Transportation Commission on the 16th day of August, 2006 for the construction of U.S. Highway 61 in Vicksburg, Project No. NH-0009-00(123)/123456301 - Warren, County; and

WHEREAS: In the course of construction of this project, some hidden drainage pipe was discover which is essential for proper drainage of adjacent property;

WHEREAS: It has become necessary to immediately connect this line of pipe to the project drainage system;

WHEREAS: The Contractor has agreed to install approximately 40 linear feet of 30" pipe at $80.00 per linear foot;

WHEREAS: This work will be added to the contract without adding any additional contract time; and this agreement in no way modifies or changes the original contract of which it becomes a part, except as specifically stated herein; and

NOW, THEREFORE, WE, __________________, Contractor, and ________________, Surety, hereby agree to said Supplemental Agreement consisting of the above mentioned items and prices and agree that this Supplemental Agreement is hereby made a part of the original contract to be performed under the specifications thereof, and that the original contract is in full force and effect, except insofar as it might be modified by this Supplemental Agreement.

Dated, this _______ day of ________________, ____

N/A	N/A
Surety	Contractor
By: N/A	N/A

RECOMMENDATION FOR APPROVAL:

John Smith	
Resident / Project Engineer	FHWA (If Applicable)

APPROVED: 09/06/2006

James Smith
District Engineer

This has been discussed with Construction Division (Jones) and FHWA.

ADVANCED AUTHORITY - METHOD 2

ADVANCED AUTHORITY TO PROCEED BY CONTRACT MODIFICATIONS
CLASS II SUPPLEMENTAL AGREEMENT

Date:09/06/2006

Project No: NH-0009-00(123)/123456301-- Warren County
Contractor: ABC Construction Co., Inc.

pc:
Contract Administration Engineer
State Construction Engineer
District Engineer
Project Engineer
Central File

In the course of construction of this project, some hidden drainage pipe was discover which is essential for proper drainage of adjacent property. It has become necessary to immediately connect this line of pipe to the project drainage system. The Contractor has agreed to install approximately 40 linear feet of 30" pipe at $80.00 per linear foot. This work will be added to the contract without adding any additional contract time. This agreement will in no way modify or change the original contract, except as stated herein.

Approval Recommended: Approved By:

N/A
Project Engineer

James Smith
District Engineer

This has been discussed with Construction Division (Jones) and FHWA (Jackson).

EDGE DRAIN INSPECTION FORM

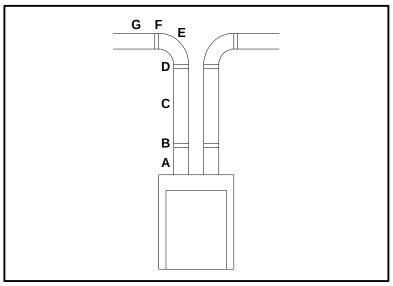
This form is shown on two pages.

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

EDGE DRAIN AND EDGE DRAIN OUTLET/VENT INSPECTION FORM

Project No. ____________________

Location: ____________________



					Distress Observation						
					Pipe Section						
Date	Route	Station	Direction of Travel	Distance Inspected	A	B	C	D	E	F	G

EDGE DRAIN INSPECTION FORM

This form is shown on two pages.

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

Page ____

EDGE DRAIN AND EDGE DRAIN OUTLET/VENT INSPECTION FORM

County: ______________________________

Contractor: ______________________________

Distress Observation:

1. Sag
2. Sag w/Standing Water
3. Sag w/Siltation
4. Compressed Coupling
5. Compressed Pipe
6. Backfill in Pipe
7. Separation at Coupling
8. Tear in Pipe
9. Obstructions

% Compressed	Video Tape Counter Number	Comments

ROAD OPENING AND TRAFFIC CHANGE FORM

Road Opening and Traffic Change
Notification Sheet

Today's Date: ______________________________

Date of Opening or Traffic Change: ______________________________

Approximate Time of Switch: ______________________________

Is Media Contract Necessary? _______ Yes _______ No

Description of Project:

Project Number: ______________________________ County: ____________________

Route: ______________________________

Termini: ______________________________ Length: ____________________

(Check all that apply)

_____	Construct four lanes on new location	_______	Overlay project
_____	Add two lanes parallel to existing lanes	_______	Bridge repair / construction
_____	Part of the 1987 Four-Lane Highway Program	_______	Paving only
_____	A Gaming Project accelerated	_______	Grading only
_____	Detours necessary / already in place	_______	Traffic control change (specify below)
_____	Road Closure for bridge replacement		

Contractor: (complete this section only if applicable)

Name: ______________________________

Address: ______________________________

Phone (s): ______________________________

Contract Cost: ______________________________

Date Let to Contract: ______________________________

MDOT Contact Person:______________________________ Phone: ____________________

Fax: ____________________

Comments concerning traffic changes:

____

____

____

Distribution: Outreach Division 67-01
Traffic Engineering Division 76-01
Maintenance Division 75-01
Construction Division 73-01
Transportation Commissioner
District Engineer

SILTATION INSPECTION FORM

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
Monthly Siltation Inspection Worksheet

MSR No.	
Report No.	

Date	Project No.	County

Contractor	Contractor Inspector
Total Rainfall for Period	MDOT Inspector

Silt Fence

Location	New	Maint.	Location	New	Maint.

Hay Bales

Location	New	Maint.	Location	New	Maint.

Slope Drains

Location	New	Maint.	Location	New	Maint.

Silt Basins

Location	New	Maint.	Location	New	Maint.

Rip Rap Berms

Location	New	Maint.	Location	New	Maint.

Brush Dikes

Location	New	Maint.	Location	New	Maint.

Monthly Inspection Worksheet required; P.E. may request additional inspection as needed.

FORM TMD-125

TMD-125
REV. 1-96

MISSISSIPPPI DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
JACKSON, MS
DAILY REPORT OF LIME STABILIZATION
REPORT NO. ____________________

Lime: Brand ______________________________
Unit Weight (lbs./cu.ft.) ________________
Water: Source ______________________________
Raw Soil: Clay, Silts: Silty Clay (Circle One)
Std. Dens. (lbs./cu.ft.) ________________
Class of Treatment: A; B; C; D; (Circle One)
Depth of Treatment: Specified ________________
Range Permitted ________________
Method of Mixing ______________________________
Type of Rollers ______________________________

Project No. ______________________________
County ______________________________
Contractor ______________________________
Length of Project (Mi.) ________________
Progress to Date: (incl. this report) ________________
Processed: Lin.Ft. ________________
Sq. Yds. ________________
Lime Allowed: Lbs. ________________
Percent Complete ________________

SECTIONS PROCESSED

First Application: (A, B, C, D)						
Date						
Lane						
Station to						
Station						
Net Length: Ft.						
Ave. Width: Ft.						
Square Yards						
Lime: % Specified						
Ordered: Lbs.						
Plus 5%: Lbs.						
Spread: Lbs.						
Allowed: Lbs.						
Time:						
Spread Begun:						
Incorp. Complete:						
Temperature: Low (°F)						
High (°F)						
Second Application (Class A): or Compaction after Mellowing Period (Class B)						
Date (A, B) *						
Lane (A, B)						
Station to (A, B)						
Station (A, B)						
Net Length: Ft. (A)						
Ave. Width: Ft. (A)						
Square Yards (A)						
Lime: % Specified (A)						
Ordered: Lbs. (A)						
Plus 5%: Lbs. (A)						
Spread: Lbs. (A)						
Allowed: Lbs. (A)						
Time:						
Spread Begun: (A)						
Incorp. Complete: (A)						
Temperature: Low (°F) (A)						
High (°F) (A)						
Pulverization: Percent (A, B, C)						
Depth: Actual (A, B, C)						

* Information to be shown for class(es) of treatment shown in ( ).
Reports for Classes A and B to be submitted after sections are completed.
Distribution:
Original: State Materials Engineer
cc: Contract Adm. Engineer (To be submitted with final estimate with tickets (pink copies) attached.)
District Materials Engineer
Project Engineer

____
Inspector

____
Project Engineer

FORM TMD-725

TMD-725
Rev. 1-96

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
Materials Division
Jackson, Mississippi

Project No. ______________________________

______________________________ County

____
Date of Final Inspection

STATEMENT OF ESTIMATED FINAL QUANTITIES AND CERTIFIED TESTS OF MATERIALS

This is to certify that all materials used in the construction of captioned project have been tested and meet the requirements of the specifications and further to certify that the quantities have been checked against and agree with the most recent Contractor's Monthly Estimate.

Listed below are approximate final quantities of construction materials requiring tests:

ITEM NO.	ITEM	FINAL QUANTITY ESTIMATE	UNIT	QUANTITY COVERED BY TEST REPORTS

____
Project Engineer

Original: State Materials Engineer
PC: State Construction Engineer
Contract Adm. Engineer
District Engineer
District Materials Engineer
Contractor
Project File

GLOSSARY

Absorption	The process of a solid taking up liquid into its interior by capillarity.
Abrasion	The process of wearing away by rubbing.
Aggregate, coarse	Aggregates predominantly retained on the No. 4 Sieve.
Aggregate, fine	Those aggregates which entirely pass the 3/8" Sieve, almost entirely pass the No. 4 Sieve, and are predominantly retained on the No. 200 Sieve.
Aggregate, dense graded	A well-graded aggregate so proportioned as to contain a relatively small percentage of voids.
Aggregate, open graded	A well-graded aggregate containing little or no fines, with a relatively large percentage of voids.
Aggregate, well-graded	An aggregate possessing proportionate distribution of successive particle sizes.
Air-entraining agent	A substance used in concrete to increase the amount of entrained air in the mixture. Entrained air is present in the form of minute bubbles.
Air-entraining cement	Cements into which air-entraining agents have been interground at the mill.
Arterial highway	A general term denoting a highway primarily for through traffic, usually on a continuous route.
Asphalt	A black thermoplastic cementitious material, consisting predominantly of bitumens, and occurring in nature or obtained in the refining of petroleum. It may be of semi-solid or liquid consistency.
Asphalt liquid	An asphalt material having a soft or fluid consistency that is beyond the range of measurement by the standard penetration test. Liquid asphalts include the following normally designed types:
Rapid curing asphalt (RC)	Liquid asphalt produced by cutting back an asphalt cement with a naptha or gasoline-type diluent of high volatility.
Medium-curing asphalt (MC)	Liquid asphalt produced by cutting back an asphalt cement with kerosene-type diluent of medium volatility.

Slow-curing asphalt (SC)	Liquid asphalt produced by cutting back an asphalt cement with relatively low-volatile, or heavy petroleum oil. Also called “road oil.”
Emulsified asphalt	An emulsion of asphalt cement and water which contains a small amount of an emulsifying agent; heterogeneous system containing two normally immiscible phased (asphalt and water) in which the water forms the continuous phase of the emulsion and minute globules of asphalt form the discontinuous phase. Emulsified asphalts may be of either the anionic or cationic type, depending upon the emulsifying agent.
At-grade intersection	An intersection where all roadways join or cross at the same level.
Auxiliary lane	The portion of the roadway adjoining the traveled way for parking, change of speed or for other purposes supplementary to through traffic movement.
Backfill	Material used to replace or the act of replacing material removed during construction; also may denote material placed or the act of placing material adjacent to structures.
Back sight	A sight taken on a known point, or a reading on a known elevation.
Back slope	A surface that slopes downward toward the traveled way.
Base lift	The layer or layers of specified or selected material of designed thickness placed on a subgrade to support subsequent lifts.
Batch	The combined ingredients which will produce a volume of mix.
Batch plant	A location where aggregates are proportioned by weight with either cement or bituminous components prior to mixing.
Batter pile	A pile that is purposely driven at an angle with the vertical.
Bench mark	A relatively permanent point of known or assumed elevation along the course of a survey line. (Abbreviate B.M.)
Berm	A shelf or ledge, usually narrow.

Binder	The material used to bind the aggregate particles together in a mixture.
Bitumen	The term bitumen covers a group of hydrocarbons including asphalt, tar, and coal tar pitch, soluble in carbon disulphide.
Bituminous concrete	A designed combination of dense graded mineral aggregate filler and bituminous cement mixed in a central plant, laid and compacted while hot.
Bituminous material	A substance which is characterized by the presence of bitumen, or one from which bitumen can be derived.
Bleeding (bituminous)	The presence of an excessive amount of asphalt cement on the surface of a bituminous pavement.
Bleeding (concrete)	The movement of mixing water to the surface of freshly placed concrete.
Blue tops	Hubs driven into the subgrade to indicate the finished subgrade elevation.
Camber	A slight upward curvature built into a structure or a structural member, to allow for the deflection of the structure under load.
Cap	A heavy horizontal member placed on top of the piles or posts of a trestle bent.
Catch basin	Collector box with settling chamber to catch debris and heavy soils carried by storm water.
Cement	The substance used for binding particles of aggregate together to form a pavement or structure. Examples include portland cement (PC) and asphalt cement (AC).
Cement paste	A mixture of portland cement and water.
Channelized intersection	An at-grade intersection in which traffic is directed into definite paths by islands.
Cloverleaf	A 4-leg interchange with loops for left turns and outer connections for right turns or two-way ramps for these turns. A full cloverleaf has ramps for two turning movements in each quadrant.

Completion date	The calendar date shown in the proposal on or before which the work contemplated under the contract shall be completed.
Concrete	The product resulting from mixing aggregates, such as sand, crushed stone, and gravel, with any cementing material.
Concrete, portland cement	The product resulting from the mixing of portland cement, aggregate and water.
Crack	A fissure or open seam not necessarily extending through the body of a material.
Crown	The highest point on the curved surface of a road; and a measure of the vertical distance between the highest point and the edge or lowest point of the surface.
Darby	A long handle wood float used in concrete finishing.
Daylighting	As applied to column forms. The providing of openings in the forms for the purpose of inspecting and working the concrete. As applied to highways in cuts. Cutting back the slope on the inside of a curve or at an intersection for the purpose of increasing sight distance.
Detour	A road designated as a temporary route to carry vehicular traffic around a section of a highway which is closed to through traffic.
Density	The weight per unit volume of a material, usually expressed in pounds per cubic foot.
Diamond interchange	A 4-leg interchange with a single one-way ramp in each quadrant. All left turns are made directly on the minor highway.
Divided highway	A highway with separate roadways for traffic in opposite directions.
Dowel	A load transfer element usually consisting of a plain round steel bar.
Drift pin	A metal pin, tapered at one or both ends, used to draw members of a steel structure into position by being driven through the corresponding rivet holes, or used to hold other members in position.

Embankment	A structure of soil, soil-aggregate or broken rock between the embankment foundation and the subgrade.
Embankment foundation	The material below the original ground surface which has physical characteristics that affect the support of the embankment.
Expressway	A divided arterial highway for through traffic with full or partial control of access and generally with grade separations at intersections.
Faulting	Differential vertical displacement of rigid slabs at a joint or crack.
Flexible pavement	A pavement structure which maintains intimate contact with and distributes loads to the subgrade and depends upon aggregate interlock, particle friction, and cohesion for stability.
Floor beam	A bridge member that extends from truss to truss or from girder to girder across the bridge and carries the stringers.
Fog seal	A thin application of bituminous material without cover aggregate.
Follower	A short piece of a pile that rests on the pile being driven and transmits the blow of the hammer to it. It is used when the top of the pile is below the leads of the pile driver.
Foresight	Sight taken to a point the location of which is to be determined.
Freeway	An expressway with full control of access.
Frontage road or street	A local road or street auxiliary to and located along the side of an arterial highway for service to abutting property and adjoining areas and for control of access.
Gradation	A general term used to describe the composition by size of the aggregate particles in a mixture. It is usually expressed as the proportion (percent) of the aggregate that will pass each of several sieves of different sizes.
Grade separation	A crossing of two highways, or a highway and a railroad, at different levels.

Grading limits	The lines beyond which no material is excavated in cuts and no material is deposited in fills.
Grout	A sand-cement mortar of liquid consistency, used to consolidate a mass of loose material or to fill seams, cracks, and joints.
Gusset plate	A plate of metal used at some joints of a framed structure.
Gutter flag	Area from the face of the curb and the edge of the pavement lane.
High-early strength cement	A type of portland cement which differs from regular cement in chemical composition and particle size (finer). Concrete made with high-early strength cement gains strength faster than that made with regular cement.
Highway separation	Any structure carrying highway traffic over or under another highway or street.
Inlets	A connection between the surface of the ground and a sewer for the admission of surface water which is thence conducted to a sewer.
Island	A defined area between traffic lanes for control of vehicle movements or for pedestrian refuge. Within an intersection, a median or an outer separation is considered an island.
Interchange	A highway separation with access connections between the highways.
Interchange ramp	A turning roadway at an interchange for travel between intersection legs.
Intermediate lift mixture	A graded bituminous mixture normally having less bituminous material than a surface lift mixture and used for construction of the course upon which the surface lift is placed.
Intersection	The general area where two or more highways join or cross, within which are included the roadway and roadside facilities for traffic movement in that area.
Intersection entrance	That part of the intersection leg for traffic entering the intersection.
Intersection exit	That part of an intersection leg for traffic leaving the intersection.

Intersection leg	Any one of the highways radiating from and forming part of an intersection. The common intersection of two highways crossing each other has four legs.
Joint	A designed vertical plane of separation or weakness. (Reference to concrete pavement)
Construction joint	A joint made necessary by a prolonged interruption in the placing of concrete.
Contraction joint	A joint within a rigid slab to control the location of transverse cracks.
Expansion joint	A joint located to provide for expansion of a rigid slab, without damage to itself, adjacent slabs, or structures.
Longitudinal joint	A joint normally placed between traffic lanes to control longitudinal cracking.
Laitance	A weak mortar that collects at the surface of freshly placed concrete; usually caused by an excess of mixing water or by over finishing.
Leads	The two vertical members of a pile driver that steady the hammer and the pile during the driving.
Leveling course	The layer of material placed on an existing surface to eliminate irregularities prior to placing an overlaying course.
Local road or street	A street or road primarily for access to residence, business or other abutting property.
Loop	A one-way turning roadway that curves about 270 degrees to the right to accommodate a left-turning movement. It may include provision for a left turn at a terminal to accommodate another turning movement.
Lute	A tool that resembles a rake in general form but has a smooth, straight bottom edge in place of teeth. It is used to smooth and shape bituminous surfaces.
Median	The portion of a divided highway separating the traveled ways for traffic in opposite directions.
Median lane	A speed change lane within the median to accommodate left turning vehicles.
Mesh	The square openings of a sieve.

Mineral filler	Limestone dust, portland cement or other similar material.
Moisture content	The proportion of moisture present in a material, expressed as a percentage of the oven dry weight.
Moisture density relationship	The effect of moisture content on the density of a soil compacted according to certain specified conditions.
Mud sill	A timber platform laid on earth as a bed for the sill of a framed trestle bent or one of the timbers in such a platform.
Plant mixed surfacing	A designed combination of mineral aggregate and bituminous material mixed in a central plant.
Plasticity	The property of a soil which allows it to be deformed beyond the point of recovery without cracking or appreciable volume change.
Plastic limit	The moisture content which is the boundary between the plastic and semi-solid states of consistency of a soil. It is defined as the moisture content at which a soil will just begin to crumble when rolled into a thread approximately 1/8 inch in diameter.
Portland cement	The product obtained by pulverizing clinker consisting essentially of hydraulic calcium silicates, to which no additions have been made subsequent to calcination other than water and/or untreated calcium sulfate, except that additions not to exceed 1.0 percent of other materials may be interground with the clinker at the option of the manufacturer, provided such materials in the amounts indicated have been shown to be not harmful.
Prime coat	An application of a low viscosity liquid bituminous material to coat and bind mineral particles preparatory to placing a base or surface course.
Profilograph	A wheeled instrument used for testing riding qualities of road & bridge surfaces.
Pugmill	a type of mixer used for mixing bituminous paving materials. Mixing is accomplished by means of paddles on a rotating shaft.
Pumping	The injection of foundation material, either wet or dry, through joints or cracks or along edges of rigid slabs, due to vertical movements of the slab under traffic.

Quarry	A deposit of ledge rock from which the rock is excavated by cutting or blasting.
Quartering	A method of reducing the size of a sample without altering the particle size relationship.
Ramp	A connection roadway between two intersecting highways at a highway separation; also may include other access connections.
Reflection crack	A crack appearing in a resurface or overlay caused by movement at joints or cracks in underlying base or surface.
Refinery	A plant for producing petroleum products from crude petroleum oil.
Resurfacing	The placing of one or more new courses on an existing surface.
Right of access	The right of ingress to a highway from abutting land and egress from a highway to abutting land.
Rigid pavement	A pavement structure which distributes loads to the subgrade having as one course a portland cement concrete slab of relatively high bending resistance.
Roadbed material	The material below the subgrade in cuts and embankments and in embankment foundations extending to such depth as affects the support of the pavement structure.
Road mixed surfacing	A designed combination of material components of a flexible pavement mixed on the roadbed or in a traveling plant.
Sample splitting	See quartering.
Screens	In aggregate processing, sections of heavy wire mesh used to separate the aggregate into various size fractions.
Seal coat	A thin treatment consisting of bituminous material, usually with cover aggregate, applied to a surface course. The term includes, but is not limited to, sand seal, chip seal, slurry seal, contract seal, and fog seal.
Slurry seal	A seal coat consisting of a semi-fluid mixture of asphaltic emulsion and fine aggregate.
Segregation	The lack of homogeneity of an aggregate.

Specific gravity surface dry basis (solids)	the ratio of the weight in air of a given volume saturated of material at a stated temperature with its permeable voids filled with water to the weight of a volume of distilled water equal to the total volume of the material at a stated temperature. The total volume includes the combine value of solid matter, permeable voids and impermeable voids.
Standard drawings	Reproduction of approved drawings of standard details for specific items of work.
Standardized plant names	Official Code of Standardized Plant Names of the American joint committee on horticultural Nomenclature.
Stabilization	Modification of soils or aggregates by incorporating materials that will increase load bearing capacity, firmness, and resistance to weathering or displacement.
Soundness	The resistance of an aggregate to break down by expansion forces of freezing water or a crystallizing chemical.
Surface lift	The top layer of a pavement structure designed to accommodate the traffic load, which resists skidding, traffic abrasion, and the disintegration effects of climate.
Surface moisture	That part of the moisture content of aggregate which has not been absorbed into the particles.
Surface treatment	One or more applications of bituminous material and cover aggregate or thin plant mix, on an old pavement or any element of a new pavement structure.
Tack coat	An application of bituminous material to an existing surface to provide bond with a superimposed course.
Tie bar	A deformed steel bar or connector imbedded in the concrete across a joint to prevent separation of abutting slabs.
Traffic lane	The portion of a traveled way for the movement of a single line of vehicles.
Tremie	An arrangement of a hopper and a spout used for placing concrete.
Trestle bent	The term is used in connection with trestle type structures. A framed bent is a structural unit, consisting of posts that rest upon a sill and support a cap. A pile bent consists of piles that support a cap. The bent supports the stringers and deck.

Voids, permeable	Those voids in the individual particles of a dry material which become filled with water when the PERMEABLE material is soaked or otherwise processed in accordance with the procedure specified.
Voids, impermeable	Those voids in the individual particles of a dry material which do not become filled with water when the material is soaked or otherwise processed in accordance with the procedure specified.
Wale (or waler)	A (usually) heavy timber or beam used as a guard or additional support. (In cofferdams, wales support the sheeting).
Water gain	Excess water forced to the surface of concrete by the shaking down of the material during its transportation or during compaction.
Wear	The abrasion of aggregates. The wear test measures the resistance of an aggregate to abrasion.

USEFUL TABLES AND CHARTS

CONVERSION OF MINUTES AND SECONDS TO DECIMAL PARTS OF A DEGREE

Minutes		Seconds		Minutes		Seconds	
0’	0.000000	0”	0.000000	30’	0.500000	30”	0.008333
1	.016667	1	.000278	31	.516667	31	.008611
2	.033333	2	.000556	32	.533333	32	.008889
3	.050000	3	.000833	33	.550000	33	.009167
4	.066667	4	.001111	34	.566667	34	.009444
5	.083333	5	.001389	35	.583333	35	.009722
6	.100000	6	.001667	36	.600000	36	.010000
7	.116667	7	.001944	37	.616667	37	.010278
8	.133333	8	.002222	38	.633333	38	.010556
9	.150000	9	.002500	39	.650000	39	.010833
10	.166667	10	.002778	40	.666667	40	.011111
11	.183333	11	.003056	41	.683333	41	.011389
12	.200000	12	.003333	42	.700000	42	.011667
13	.216667	13	.003611	43	.716667	43	.011944
14	.233333	14	.003889	44	.733333	44	.012222
15	.250000	15	.004167	45	.750000	45	.012500
16	.266667	16	.004444	46	.766667	46	.012778
17	.283333	17	.004722	47	.783333	47	.013056
18	.300000	18	.005000	48	.800000	48	.013333
19	.316667	19	.005278	49	.816667	49	.013611
20	.333333	20	.005556	50	.833333	50	.013889
21	.350000	21	.005833	51	.850000	51	.014167
22	.366667	22	.006111	52	.866667	52	.014444
23	.383333	23	.006389	53	.883333	53	.014722
24	.400000	24	.006667	54	.900000	54	.015000
25	.416667	25	.006944	55	.916667	55	.015278
26	.433333	26	.007222	56	.933333	56	.015556
27	.450000	27	.007500	57	.950000	57	.015833
28	.466667	28	.007778	58	.966667	58	.016111
29	.483333	29	.008056	59	.983333	59	.016389

EXAMPLE: 0° 21’ 09” = 0.350000 + 0.002500 = 0.352500°

DECIMAL PARTS OF A FOOT AND INCH

	DECIMAL PARTS OF A FOOT												
Inches	0”	1”	2”	3”	4”	5”	6”	7”	8”	9”	10”	11”	Ins.
	.0000	.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167	
1/32	.0026	.0859	.1693	.2526	.3359	.4193	.5026	.5859	.6693	.7526	.8359	.9193	1/32
1/16	.0052	.0885	.1719	.2552	.3385	.4219	.5052	.5885	.6719	.7552	.8385	.9219	1/16
3/32	.0078	.0911	.1745	.2578	.3411	.4245	.5078	.5911	.6745	.7578	.8411	.9245	3/32
1/8	.0104	.0938	.1771	.2604	.3438	.4271	.5104	.5938	.6771	.7604	.8423	.9271	1/8
5/32	.0103	.0964	.1797	.2630	.3464	.4297	.5130	.5964	.6797	.7630	.8464	.9297	5/32
3/16	.0156	.0990	.1823	.2656	.3490	.4323	.5156	.5990	.6823	.7656	.8490	.9323	3/16
7/32	.0182	.1016	.1849	.2682	.3516	.4349	.5182	.6016	.6849	.7682	.8516	.9349	7/32
1/4	.0208	.1042	.1875	.2708	.3542	.4375	.5208	.6042	.6875	.7708	.8542	.9375	1/4
9/32	.0234	.1068	.1901	.2734	.3568	.4401	.5234	.6068	.6901	.7734	.8568	.9401	9/32
5/16	.0260	.1094	.1927	.2760	.3594	.4427	.5260	.6094	.6927	.7760	.8594	.9427	5/16
11/32	.0286	.1120	.1953	.2786	.3620	.4453	.5286	.6120	.6953	.7786	.8620	.9453	
3/8	.0313	.1146	.1979	.2813	.3646	.4479	.5313	.6146	.6979	.7813	.8646	.9479	3/8
13/32	.0339	.1172	.2005	.2839	.3672	.4505	.5339	.6172	.7005	.7839	.8672	.9505	13/32
7/16	.0365	.1198	.2031	.2865	.3698	.4531	.5365	.6198	.7031	.7865	.8698	.9531	7/16
15/32	.0391	.1224	.2057	.2891	.3724	.4557	.5391	.6224	.7057	.7891	.8724	.9557	15/32
1/2	.0417	.1250	.2083	.2917	.3750	.4583	.5417	.6250	.7083	.7917	.8750	.9583	1/2
17/32	.0443	.1276	.2109	.2943	.3776	.4609	.5443	.6276	.7109	.7943	.8776	.9609	17/32
9/16	.0469	.1302	.2135	.2969	.3802	.4635	.5469	.6302	.7135	.7969	.8802	.9635	9/16
19/32	.0495	.1328	.2161	.2995	.3828	.4661	.5495	.6328	.7161	.7995	.8828	.9661	19/32
5/8	.0521	.1354	.2188	.3021	.3854	.4688	.5521	.6354	.7188	.8021	.8854	.9688	5/8
21/32	.0547	.1380	.2214	.3047	.3880	.4714	.5547	.6380	.7214	.8047	.8880	.9714	21/32
11/16	.0573	.1406	.2240	.3073	.3906	.4740	.5573	.6406	.7240	.8073	.8906	.9740	11/16
13/32	.0599	.1432	.2266	.3099	.3932	.4766	.5599	.6432	.7266	.8099	.8932	.9766	13/32
3/4	.0625	.1458	.2292	.3125	.3958	.4792	.5625	.6458	.7292	.8125	.8958	.9792	3/4
25/32	.0651	.1484	.2318	.3151	.3984	.4818	.5651	.6484	.7318	.8151	.8984	.9818	25/32
13/16	.0677	.1510	.2344	.3177	.4010	.4844	.5677	.6510	.7344	.8177	.9010	.9844	13/16
27/32	.0703	.1536	.2370	.3203	.4036	.4870	.5703	.6536	.7370	.8203	.9036	.9870	27/32
7/8	.0729	.1563	.2396	.3229	.4063	.4896	.5729	.6563	.7396	.8229	.9063	.9896	7/8
29/32	.0755	.1589	.2422	.3255	.4089	.4922	.5755	.6589	.7422	.8255	.9089	.9922	29/32
15/16	.0781	.1615	.2448	.3281	.4115	.4948	.5781	.6615	.7448	.8281	.9115	.9948	15/16
31/32	.0807	.1641	.2474	.3307	.4141	.4974	.5807	.6641	.7474	.8307	.9141	.9974	31/32

WEIGHTS AND MEASURES

Volume Equivalents

Cubic Inches	Cubic Feet	Cubic Yards	Liters	U.S. Gallons	British Imperial Gallons
1	0.0005787	0.00002143	0.01639	0.004329	0.003605
1,728.0	1	0.03704	28.32	7.481	6.229
46,656.0	27.0	1	764.6	202.0	168.2
61.02	0.03531	0.001308	1	0.2642	0.220
231.0	0.1337	0.004951	3.785	1	0.8327
277.4	0.1605	0.005946	4.546	1.201	1

Weight Equivalent

Ounces (Avoirdupois)	Pounds (Avoirdupois)	Short Tons	Long Tons	Metric Tons	Kilograms
1	0.0625	0.00003125	0.00002790	0.00002835	0.02835
16.0	1	0.0005000	0.0004464	0.0004536	0.4536
32,000.0	2,000.0	1	0.8929	0.9072	907.2
35,840.0	2,240.0	1.12	1	1.016	1.016
35,274.	2,204.6	1.102	0.9842	1	1,000.0
35.27	2.205	0.001102	0.0009842	0.001	1

Linear Measure Equivalents

Inches	Feet	Yards	Meters	Rods	Kilometers	Miles
1	0.08333	0.02778	0.02540	0.005051	0.00002540	0.00001578
12.0	1	0.3333	0.3048	0.06061	0.0003048	0.0001894
36.0	3.0	1	0.9144	0.1818	0.0009144	0.0005682
39.37	3.281	1.094	1	0.1988	0.001000	0.0006214
198.0	16.5	5.5	5.029	1	0.005029	0.003125
39,370.0	3,280.8	1,093.6	1,000.0	1,98.8	1	0.6214
63,360.0	5,280.0	1,760.0	1,609.3	320.0	1.609	1

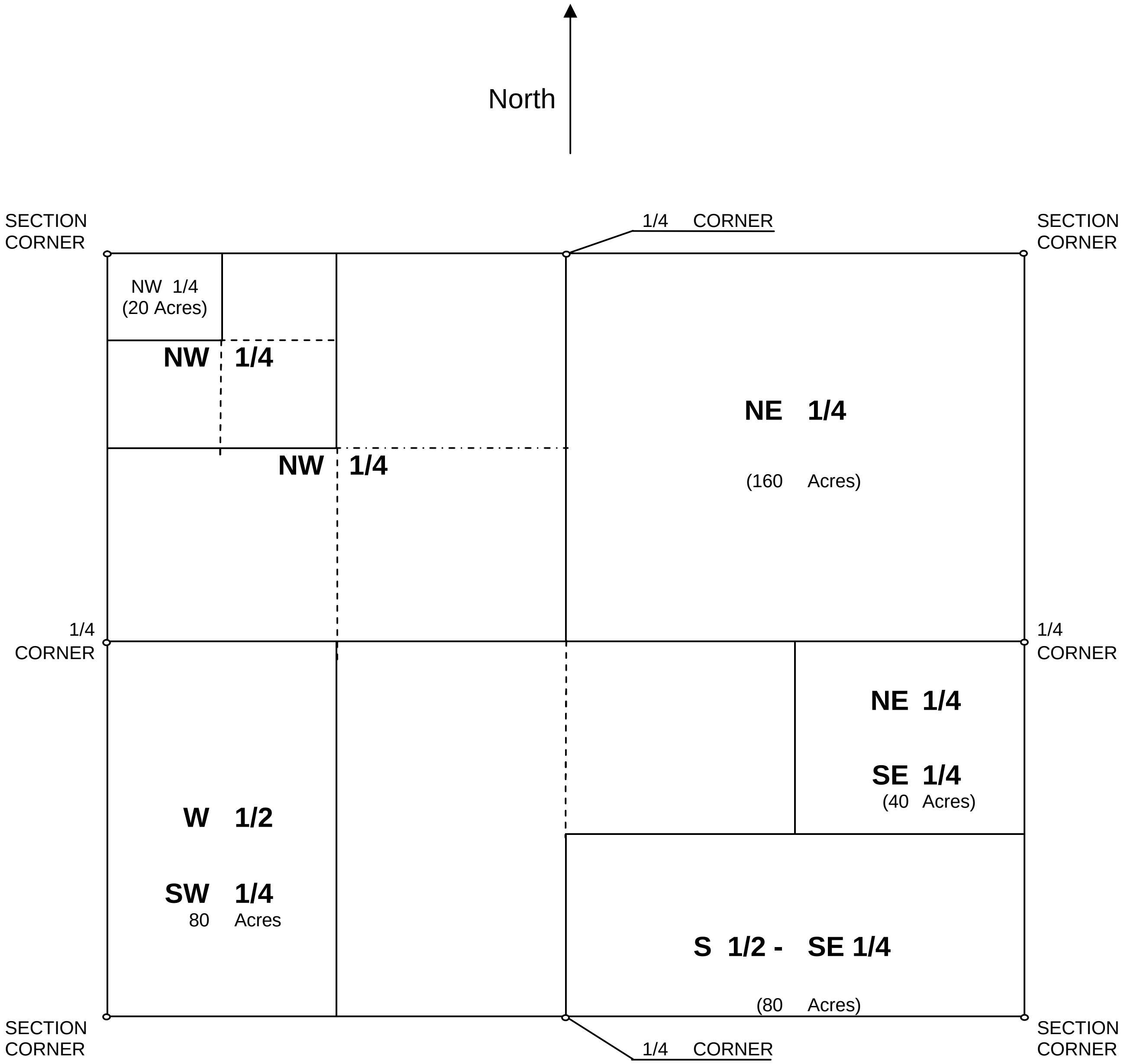
Square Measure Equivalents

Square Inches	Square Feet	Square Yards	Square Meters	Square Rods	Acres	Square Miles
1	0.006944	0.0007716	0.0006452	0.000025511	----------	----------
144.0	1	0.1111	0.09290	0.003673	0.00002296	----------
1,296.0	9.0	1	0.8361	0.03306	0.0002066	----------
1,550.	10.76	1.196	1	0.03954	0.0002471	----------
39,204	272.25	30.25	25.29	1	0.006250	----------
6,272,640	43,560	4,840.	4,047	160	1	0.001562
-----	-----	3,097,600	2,589,998	102,400.0	640.0	1

North

	R12W	RANGE LINE R11W					R11W	RANGE LINE R10W
T 10 N	36	31	32	33	34	35	36	31 TOWNSHIP LINE
T 9 N	1	6	5	4	3	2	1	6
	12	7	8	9	10	11	12	7
	13	18	17	16	15	14	13	18
	24	19	20	21	22	23	24	19
	25	30	29	28	27	26	25	30
T 9 N	36	31	32	33	34	35	36	31 TOWNSHIP LINE
T 8 N	1	6	5	4	3	2	1	6

Typical Township Subdivision



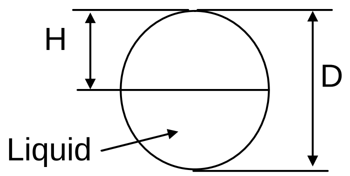
- Not to Scale -

Typical Subdivisions of a Section

TABLE FOR DETERMINING VOLUME OF LIQUID IN A PARTIALLY FILLED CYLINDRICAL TANK

The below listed values may be used for any cylindrical tank under the following conditions:

1. The capacity and diameter are known.
2. The tank is in a level position.
3. The ends of the tank are planes normal to the longitudinal axis



RATION H/D	PERCENT CAPACITY	RATIO H/D	PERCENT CAPACITY	RATIO H/D	PERCENT CAPACITY
0.0	100.00	0.34	70.02	0.67	28.78
0.01	99.83	0.35	68.81	0.68	27.59
0.02	99.52	0.36	67.59	0.69	26.40
0.03	99.13	0.37	66.36	0.70	25.23
0.04	98.66	0.38	65.13	0.71	24.07
0.05	98.13	0.39	63.89	0.72	22.92
0.06	97.55	0.40	62.65	0.73	21.78
0.07	96.92	0.41	61.40	0.74	20.66
0.08	96.25	0.42	60.14	0.75	19.55
0.09	95.54	0.43	58.88	0.76	18.46
0.10	94.80	0.44	57.62	0.77	17.38
0.11	94.02	0.45	56.36	0.78	16.31
0.12	93.20	0.46	55.09	0.79	15.27
0.13	92.36	0.47	53.82	0.80	14.24
0.14	91.49	0.48	52.55	0.81	13.23
0.15	90.59	0.49	51.27	0.82	12.24
0.16	89.67	0.50	50.00	0.83	11.27
0.17	88.73	0.51	48.73	0.84	10.33
0.18	87.76	0.52	47.45	0.85	9.41
0.19	86.77	0.53	46.18	0.86	8.51
0.20	85.76	0.54	44.91	0.87	7.64
0.21	84.73	0.55	43.64	0.88	6.80
0.22	83.69	0.56	42.38	0.89	5.99
0.23	82.62	0.57	41.12	0.90	5.20
0.24	81.55	0.58	39.86	0.91	4.46
0.25	80.45	0.59	38.60	0.92	3.75
0.26	79.34	0.60	37.35	0.93	3.08
0.27	78.22	0.61	36.11	0.94	2.45
0.28	77.08	0.62	34.87	0.95	1.87
0.29	75.93	0.63	33.64	0.96	1.34
0.30	74.77	0.64	32.41	0.97	0.87
0.31	73.60	0.65	31.19	0.98	0.48
0.32	72.41	0.66	29.98	0.99	0.17
0.33	71.22			1.00	0.00

EXAMPLE: 1200 gallon tank, 60 inches in diameter, distance (h) from top of tank to liquid is 15 inches. h/d ratio = 15/60 = 0.25. From Table: Opposite h/d ratio of 0.25, percent capacity = 80.45. Volume of liquid = 0.8045 x 1200 = 965.4 gallons.

(Not to be used in lieu of Required Calibration).

WIND-CHILL CHART

EQUIVALENT TEMPERATURE °F

Estimated Wind Speed MPH	ACTUAL THERMOMETER READING °F											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	5	-9	-21	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-36	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-124
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-49	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
Wind Speeds greater than 40 MPH have little additional effect	Little Danger For Properly Clothed Person				Increasing Danger			Great Danger				
					DANGER FROM FREEZING OF EXPOSED FLESH							

To use the chart, find the estimated or actual wind speed in the left-hand column and the actual temperature in degrees F in the top row. The equivalent temperature is found where these two intersect. For example, with a wind speed of 20 mph and a temperature of 40°F, the equivalent temperature is 18°F and persons working outside should be clothed accordingly.

TABLE FOR ESTIMATING QUANTITES OF BITUMINOUS MIXTURES

Tons/Mile @ 110 lbs. per S.Y. per in.												
Tons to Sq. Yd.		.027	.030	.032	.037	.041	.055	.079	.082	.096	.110	.137
Width	Sy/Mi	1/2”	9/16”	5/8”	11/16”	3/4”	1”	1 1/4”	1 1/2”	1 3/4”	2”	2 1/2”
18	1056	291	327	363	399	436	580	727	872	1017	1161	1452
20	1173	322	363	404	443	484	645	807	967	1129	1291	1631
21	1232	339	381	423	466	508	678	847	1017	1185	1355	1694
22	1290	355	399	444	488	532	710	888	1065	1242	1420	1774
23	1349	371	417	464	511	557	742	927	1114	1299	1485	1856
24	1408	387	436	484	532	580	774	968	1163	1354	1548	1935
25	1466	405	454	504	555	605	806	1008	1210	1411	1613	2016
26	1525	419	471	524	577	630	839	1049	1258	1468	1677	2097
27	1584	436	490	544	599	653	871	1088	1307	1524	1742	2178
28	1642	452	508	565	621	678	904	1129	1355	1581	1807	2259
29	1701	467	526	584	643	701	936	1169	1403	1637	1872	2339
30	1760	484	544	605	666	726	968	1210	1453	1694	1937	2421
31	1818	500	563	626	687	750	1000	1249	1500	1750	2000	2500
32	1877	517	580	645	710	774	1032	1291	1549	1806	2064	2581
33	1936	532	599	666	732	798	1065	1332	1597	1863	2129	2662
34	1994	548	617	686	754	823	1097	1371	1645	1920	2194	2742
36	2112	580	653	726	798	871	1162	1452	1742	2033	2324	2904
38	2229	623	689	766	843	919	1227	1532	1840	2146	2453	3066

NOTE: The above values are based on 110 lbs. per sq. yd. per inch thickness, which value is usually used in estimating the tonnage on the plans. The actual compacted-in-place values range from approximately 105 lbs. to 110 lbs. for the neat dimension of the theoretical section. 110 lbs. is used in estimating in order to allow for a reasonable angle of repose at the edges.

RANDOM SAMPLING TABLE

	Random Numbers													
	1		2		3		4		5		6		7	
	815	722	048	964	248	826	665	147	767	147	133	870	796	957
	296	205	680	264	469	208	897	815	866	126	922	571	804	252
1	007	573	390	664	846	400	328	613	989	960	647	645	960	982
	053	042	256	264	444	440	379	639	457	661	754	665	346	904
	919	264	641	943	267	259	399	222	715	645	914	424	078	696
	005	047	879	773	422	351	740	995	818	426	438	766	620	766
	007	698	627	561	863	880	762	360	846	931	760	658	779	880
2	690	657	958	552	189	273	265	086	408	599	298	801	127	485
	259	579	298	886	679	487	189	822	654	697	336	542	859	035
	097	834	735	129	308	183	282	357	059	416	349	378	389	880
	915	425	279	301	040	863	298	997	555	848	290	092	796	732
	179	563	909	491	200	599	061	205	180	020	737	835	361	427
3	465	185	188	496	023	510	206	587	281	154	569	533	205	873
	921	896	948	781	846	828	099	254	441	484	255	212	355	204
	145	627	356	812	396	473	568	563	616	495	896	201	774	180
	984	075	333	642	016	924	669	984	048	455	465	041	468	457
	349	639	887	827	344	170	875	408	324	700	706	888	777	693
4	700	282	394	464	232	534	949	258	699	948	196	728	001	667
	539	549	069	672	683	829	113	428	802	882	473	466	065	978
	760	295	409	073	587	257	229	800	399	961	411	142	606	595
	907	522	839	299	658	388	504	837	556	143	317	573	562	415
	643	674	333	319	148	244	597	923	974	892	359	041	237	519
5	089	003	316	253	616	340	812	356	568	693	483	455	785	817
	950	683	935	707	105	045	764	543	023	172	288	147	627	922
	156	104	204	383	911	219	595	816	271	482	467	229	322	856
	164	818	041	533	794	214	830	923	366	312	596	917	727	023
	186	819	055	919	047	130	976	248	947	064	350	048	867	982
6	731	351	474	876	990	710	888	710	187	202	231	729	351	430
	574	167	231	493	450	331	125	410	807	453	448	125	989	912
	304	839	237	144	150	457	227	197	099	743	686	304	707	254
	166	350	859	982	323	523	168	692	827	384	738	325	419	444
	967	202	425	789	053	221	243	542	350	196	110	914	603	197
7	389	642	143	826	665	441	006	355	359	191	633	296	033	598
	316	763	174	533	441	644	647	753	765	316	126	330	603	923
	789	194	236	278	479	025	376	208	721	393	348	089	850	878
	039	333	570	742	634	173	628	399	056	912	688	255	388	469
	744	332	439	101	899	156	528	738	731	886	889	744	518	993
8	090	009	207	954	926	454	095	888	165	511	793	975	162	660
	422	124	870	142	209	045	645	313	860	294	476	059	524	168
	161	080	265	417	819	656	742	563	000	671	775	706	287	341