CITY OF EAGLE PASS
PUBLIC WORKS DEPARTMENT

CONSTRUCTION SPECIFICATIONS

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A-1.01 AUTHORITY OF PUBLIC WORKS DIRECTOR AND/OR CITY ENGINEER: The work will be observed, tested, and inspected by the Public Works Director and/or City Engineer, and performed to his/her specifications. The Public Works Director and/or City Engineer will decide all questions which may arise as to the quality and acceptability of materials furnished and work performed, as to the manner of performance and rate of progress of said work, as to interpretation of the plans and specifications relating to the work, as to the fulfillment of the contract on the part of the Contractor, and to the rights of different contractors on the project.

The decision of the Public Works Director and/or City Engineer will be final.

A-1.02 ADEQUACY OF DESIGN: It is understood that the Owner selected the Project Engineer named herein to prepare the plans and specifications, and all supplements thereto, and it is agreed that the Owner will be responsible for the adequacy of the design, sufficiency of the plans and specifications, and safety of structures, provided the Contractor has complied with said plans and specifications, all modifications thereof, and additions and alterations thereto approved by the Project Engineer. The burden of proof shall be upon the Contractor to show that he has fully complied with the plans and specifications, all modifications thereof, and all additions and alterations thereto.

A-1.03 PLANS: Plans will show the lines, grades, cross-sections, details, and general features of the work. Where shop drawings or working drawings are required, they shall be furnished by the Contractor and approved by the Public Works Director and/or City Engineer. Authorized alterations to the plans will be endorsed on approved copies of the plans or shown on supplementary sheets.

The approval by the Public Works Director and/or City Engineer of the Contractor’s shop drawings or working drawings will not relieve the Contractor of any responsibility under the contract.

The Contractor shall furnish the Public Works Director and/or City Engineer with such blue print copies of shop drawings or working drawings as may be required for approval and for the purposes of supervision.
A-1.04 CONFORMITY WITH PLANS: The finished work shall conform with the lines, grades, cross-sections, details, and dimensions shown on the plans. Such deviations from the plans as may be required will, in all cases, be determined by the Public Works Director and/or City Engineer and authorized in writing.

A-1.05 COORDINATION OF PLANS AND SPECIFICATIONS AND SUPPLEMENTAL AGREEMENTS: The plans, specifications and supplemental agreements are essential parts of the contract, and a requirement occurring in one is as binding as though occurring in all. In case of disagreement, the plans shall govern over “Technical Provisions” and “Special Provisions” shall govern over “Technical Provisions”. The Contractor shall not take advantage of any apparent error or omission on the plans or specifications. In the event the Contractor discovers an apparent error or discrepancy, he/she shall immediately call upon the Public Works Director and/or City Engineer for his/her interpretation and decision, and such decision shall be final.

A-1.06 COOPERATION OF CONTRACTOR: The Contractor shall give the work the constant attention necessary to facilitate the progress thereof and shall cooperate with the Public Works Director and/or City Engineer and with other contractors in every way possible.

The Contractor shall have on the work at all times, a satisfactory and competent English-speaking superintendent, authorized to receive orders, and act for him/her as his/her agent. The Contractor shall designate to the Public Works Director and/or City Engineer in writing the name of such superintendent, and the designated superintendent may not be removed from the work without written permission from the Public Works Director and/or City Engineer.

A-1.07 CONSTRUCTION STAKES: The Project Engineer will set stakes determining the location and line of the work and will set such elevation stakes and benchmarks, as may, in his/her opinion, be necessary for the satisfactory prosecution of the work. The Contractor shall be responsible for the preservation of such stakes and benchmarks, and, in the opinion of the Project Engineer, any of the stakes or benchmarks have been carelessly or willfully destroyed or disturbed by the Contractor, the cost of replacing them will be charged against the Contractor and may be deducted from subsequent estimates paid him/her.

The Contractor shall furnish and set, at his/her own expense, such additional construction stakes and blue tops as seems necessary for the satisfactory prosecution of the work.

Any missing construction stakes which have been destroyed by the different utility companies, vandals and/or the contractor at the time of construction will be replaced by the Contractor at his own expense.

The Public Works Director and/or City Engineer may, at his option, do spot or complete checks on all construction alignment and grades to determine the accuracy of the Contractor’s survey work. These checks, however, will not relieve the Contractor of his responsibility of constructing the work to the lines and grades as shown on the plans or approved change orders. Computa-
tions, sketches, and other drawings used in the design and layout of this project will be made available to the Contractor, however, these items will not relieve the Contractor of his responsibility.

**A-1.08 APPROVAL OF MATERIALS:** The sources of supply materials shall be subject to the approval of the Public Works Director and/or City Engineer. Representative samples of materials proposed for use shall be submitted, if required, for examination and testing by an independent testing laboratory selected by the City.

Results obtained from testing such samples may be used for preliminary approval, but will not be used as final acceptance of materials. All materials proposed for use may be inspected or tested at any time during their preparation or use.

If, at any time, it is found that sources of supplies which have been approved do not furnish a product of uniform quality, or if the product becomes unacceptable at any time, the Contractor shall furnish approved material from another source.

Any material which, after approval, has for any reason become unfit for use shall not be incorporated into the work.

**A-1.09 SAMPLES AND TESTS:** Samples and testing procedures shall conform to the requirements of appropriate designations of the American Association of State Highway Officials (AASHO) or the American Society of Testing Materials (ASTM).

Tests for determining the fitness of materials; tests for the purpose of obtaining preliminary approval of materials; tests for determining concrete mixes will be at the expense of the Contractor. Tests for the actual control of the work, such as soil compaction tests and concrete compressive strength tests shall be done at the expense of the Owner. Any and all retesting because of failure in soil compaction or concrete compressive strength test shall be done at the expense of the Contractor. Tested and accepted subgrade shall be covered and protected with a flexible base within a maximum of (7) seven days. Tested and accepted flexible base shall be primed and cured a minimum of 72 hours and shall be cured with asphalt within (7) seven days. Failure to comply with the seven days limitation may result in the need for retesting at the Contractor's expense, depending on weather conditions and at the discretion of the Public Works Director and/or City Engineer.

The Contractor shall provide such facilities as the Public Works Director and/or City Engineer may require for conducting field tests and collecting and forwarding samples. All sampling and testing shall be under the control of the Public Works Director and/or City Engineer and shall be done in laboratories approved by him/her.
A-1.10 STORAGE: Materials shall be stored as to insure the preservation of their quality and fitness for the work. Material which is not, in the opinion of the Public Works Director and/or City Engineer, properly stored and protected will not be included as material on hand in the estimates.

A-1.11 AUTHORITY AND DUTIES OF INSPECTORS: Inspector employed by the City of Eagle Pass shall be authorized to inspect all work done and any part of the work as to the preparation, fabrication, or manufacture of materials to be used.

The Inspector shall be authorized to call to the attention of the Contractor any failure of the work and materials to conform to the specifications or the plans. He/She will in no case act as foreman or perform other duties for the Contractor, nor shall he/she interfere with the management of the work. In the event the Contractor does not comply with the requirements of the City of Eagle Pass and the Project Engineer, the Inspector may stop all work until the non-compliance is corrected.

Inspection as provided herein shall not relieve the Contractor from any obligation to perform the work in conformity with the requirements of the plans and specifications. No inspector shall be authorized to revoke, alter, enlarge, or release any requirements of the plans and specifications, or to issue instructions contrary the plans and specifications, or to approve or accept any portion of the work.

The Contractor shall furnish every reasonable facility for ascertaining whether or not the work is performed in accordance with the plans and specifications.

No backfill shall be made unless inspected by the Public Works Director and/or City Engineer or the County’s Representative designated in writing and verbal approval of field Engineer is given to such work; if the Contractor should backfill any work without such inspection and approval, the Contractor shall remove or uncover such portion or the finished work as may be directed. After examination, the Contractor shall restore said portion of the work to the standard required by the plans and specifications. Should the work thus exposed and examined prove acceptable or unacceptable, the uncovering or removing and replacing of the covering or making good of the parts removed shall be done at the Contractor’s expense.

A-1.12 SUSPENSION OF WORK: In case of any dispute arising between the Contractor and the Inspector as to materials furnished or the manner of performing the work, the Inspector shall have authority to reject materials or suspend work until the question at issue can be referred to and decided by the Public Works Director and/or City Engineer.

If the Contractor refuses to suspend work on verbal order, the Inspector shall issue a written order to suspend work giving the reason for such suspension. After placing the order in the hands of the Contractor’s man in charge, the Inspector shall immediately leave the job. Work done during the absence of the Inspector shall not be accepted.
A-1.13 REMOVAL OF DEFECTIVE AND UNAUTHORIZED WORK: All work which has been rejected or condemned shall be repaired or removed and replaced as the Public Works Director and/or City Engineer may direct, at the expense of the Contractor. Materials not conforming to the requirements of the plans and specifications shall be removed immediately from the site of the work and replaced with satisfactory material at the expense of the Contractor.

Work done without lines and grades, work done beyond the lines and grades shown on the plans, work done without inspection, or any extra or unclassified work done without written authority will be done at the Contractor’s risk and will be considered unauthorized. At the option of the Public Works Director and/or City Engineer, may be ordered removed and replaced at the expense of the Contractor.

Upon the failure of the Contractor to repair satisfactorily or to remove and replace rejected, unauthorized, or condemned work or materials immediately after receiving formal notice from the Public Works Director and/or City Engineer, the City of Eagle Pass may, at its own option:

(a.) Recover for such defective work or materials on the Owner’s Performance Bond;

(b.) Recover for such defective work or materials by action in a court having proper jurisdiction in such matters, or;

(c.) Employ labor and equipment and satisfactorily repair, or remove and replace, such defective work or materials and charge the cost of same to the Owner.

A-1.14 FINAL INSPECTION: Whenever the work provided for under the contract has been satisfactorily completed and the final clean-up performed, the Contractor shall notify the Public Works Director and/or City Engineer in writing to make the “Final Inspection”. Inspection will be made within (10) ten days. After such final inspection, if the work is found to be satisfactory, the Contractor will be notified in writing of the acceptance of same.
DIVISION B
TECHNICAL PROVISIONS
SECTION I
GENERAL CONSTRUCTION AND PREPARATION
OF SITE SPECIFICATIONS

B-1.01 DESCRIPTION OF SITE: This item shall consist of the preparation of site for
collection operations by the removal and disposal of all obstructions which are not oth-
wise provided for in the plans and specifications.

Such obstructions shall be considered to include removal of sections of existing utility lines
(water, sewer, & force main), existing fences/gates, and other such materials as shown on the
plans including concrete slabs.

This item shall include the removal of obstructions in accordance with the item “Clearing and
Grubbing” of the Texas Department of Transportation Standard Specifications. It is the intent
of this item to provide for the disposal of all objectional materials not specifically provided for
elsewhere in the plans/specifications. All materials to be salvaged by the City shall be properly
disposed of by the Contractor as directed.

B-1.02 FINAL CLEAN-UP: Upon the completion of the work and before acceptance
and final payment will be made, the Contractor shall clean and remove from the site of the work,
surplus and discarded materials, temporary structures, and debris of every kind. He/She shall
leave the site of the work in a neat and orderly condition equal to that which originally existed.
Surplus and waste materials removed from the site of the work shall be disposed of at loca-
tions satisfactory to the Public Works Director and/or City Engineer. Ground around any
structures shall be dressed to final grade as shown on plans.

B-1.03 MATERIALS-GENERAL: The materials shall be the best procurable, as required
by the plans, specifications, and special provisions. The Contractor shall not start delivery of
materials until the Public Works Director and/or City Engineer has approved the source of
supply. Only materials conforming to these specifications shall be used in the work and such
materials shall be used only after approval has been given by the Public Works Director and/or
City Engineer and only so long as the quality of said materials remains equal to the requirements
of the specifications. The Contractor shall furnish approved materials from other sources, if for
any reason the product from any source at any time before commencement or during the pro-
secution of the work proves unacceptable. After approval, any material which has become mix-
ed with or coated with dirt or any other foreign substances during the delivery and handling will not be permitted to be used in the work.

**B-1.04 MATERIALS-STORAGE:** Any and all materials, such as cement, lime, mill work, or other materials or equipment subject to deterioration by exposure to weather or other factors, shall be stored in such a manner to protect them from deterioration or damage preceding the time they become a permanent part of final structure.
DIVISION C  
TECHNICAL PROVISIONS  
SECTION I  
EXCAVATION AND EMBANKMENT OF STREETS  

C-1.01 DESCRIPTION: This item shall consist of doing all required excavation within the limits of the roadway (except for excavation otherwise classified such as excavation for drainage structures, etc.): the removal and proper utilization or disposal of all excavated materials; the erection of all embankments; and the constructing, shaping, compacting, and finishing of all earthwork on the entire roadway and approaches thereto in conformity with the lines, grades, and typical sections as shown on the plans and established by the Project Engineer.

C-1.02 GENERAL: All material encountered of whatever nature within the limits indicated shall be removed and disposed of as directed. The Contractor shall inform and satisfy himself as to the character, quantity, and distribution of all material to be excavated.

The rough excavation shall be carried to such depth that sufficient material will be left above the designated grade to allow for compaction. Likewise on embankments, sufficient material shall be placed above the designated grade to allow for compaction and settlement. Should the Contractor excavate below the designated lines, he/she shall replace such material excavated with approved material in an approved manner and condition at his/her own expense.

The Public Works Director and/or City Engineer shall have complete control over the excavation, moving, placing, and disposition of all material, and he shall determine the suitability of material to be placed in embankments.

EQUIPMENT  

C-1.03 GRADING EQUIPMENT: The Contractor may use any type of earth-moving equipment he/she wishes or has at his/her disposal, provided such equipment is in satisfactory condition and of such capacity that the grading schedule as planned by the Contract and approved by the Public Works Director and/or City Engineer can be maintained.

C-1.04 COMPACTING EQUIPMENT:
(a.) Tamping rollers shall consist of two metal rollers, drums, or shells or 40 inches minimum diameter, each not less than 42 inches in length and unit-mounted in a rigid frame in such manner that each roller may oscillate independently of the other; and each roller, drum, or shell shall be surmounted by metal studs with tamping feet projecting not less than seven (7) inches from the surface of the drum and spaced not less than six (6) inches nor more
than ten (10) inches measured diagonally from center to center. The area of each tampering foot shall be not less than five (5) square inches nor more than eight (8) square inches. Each unit shall be provided with a suitable tamper foot cleaning device. Where more than one rolling unit is used, the rolling units shall be pivoted on the main frame in a manner which will permit the rolling units to adapt themselves to uneven ground and to rotate individually. When empty, the weight of the roller shall be such that the unit pressure applied by the tamping foot in contact with the ground is not less than 120 pounds per square inch.

(b.) Pneumatic rollers shall consist of not less than nine (9) pneumatic tired wheels running on two axles in such manner that the rear group of tires will not follow in the tracks of the forward group and shall be mounted on a rigid frame provided with platform or body suitable for ballast loading. The front axle shall rotate around the kingpin so located that the roller may be turned within a minimum circle. The pneumatic tire roller under working conditions shall have an effective rolling width of approximately sixty (60) inches and shall give a minimum compression of three hundred and twenty-five (325) pounds per inch of width of tire trend. The roller shall be drawn by either a suitable tractor or a truck of adequate tractive effort.

(c.) Smooth self-propelled rollers shall weigh at least ten tons and may be tandem or three-wheel type. The wheels of the roller shall be equipped with adjustable scrapers.

CONSTRUCTION METHODS

C-1.05 EXCAVATION: The excavation material shall be handled in such a manner as to allow the selected material to be properly placed in embankment and in the capping of the pavement subgrades as determined by the Public Works Director and/or City Engineer. Any suitable surplus material shall be stock-piled in approved areas for later use as directed by the Public Works Director and/or City Engineer.

The Contractor shall make the distribution as indicated on the plans, and the widening or narrowing of the section or raising or lowering of the grade to avoid haul will not be permitted. During the process of excavation, the grade shall be maintained in such condition that it will be well drained at all times. When directed, temporary drains and drainage ditches shall be installed to intercept and divert surface water.

In cut areas, the top of the subgrade shall be scarified and compacted to a minimum depth of six (6) inches to not less than the comparable density of the adjoining material. When the required density cannot be obtained, the material shall be undercut and replaced with suitable material as directed. The material placed to refill and undercut portion shall be handled and compacted as specified for embankments.
During compacting operations, water shall be added to the subgrade material. Such watering shall be done by approved methods and using approved equipment. This moisture shall not be more than 2% above or below the optimum.

**C-1.06 BORROW:** Borrow excavation shall consist of excavation made outside the normal grading limits to obtain material for the completion of embankments and for other purposes. It shall be the Contractor's responsibility to locate and obtain the supply, and the Contractor shall notify the Public Works Director and/or City Engineer sufficiently in advance to permit tests to be made.

All borrow pits shall be opened up immediately to expose the vertical face of various strata of acceptable material to obtain a uniform product. Borrow pits shall be drained and left in a neat and presentable condition with all slopes dressed uniformly.

**C-1.07 PREPARATION OF EMBANKMENT AREA:** Immediately prior to the placing of material, the entire area upon which the embankment is to be placed shall be stripped of all grass, weeds, brush and other organic materials, and shall be scarified and broken to a depth of six (6) inches. All roots, debris, large stones or objectional material that would interfere with the compaction of fill will be moved and disposed of as directed. A thin layer (approximately three (3) inches) of fill material shall be spread over the scarified foundation, and the whole area compacted as required herein. When embankments are to be placed on natural slopes steeper than 3 to 1, horizontal benches shall be constructed as directed by the Public Works Director and/or City Engineer.

**C-1.08 CONSTRUCTION OF EMBANKMENTS:** Embankments shall be formed of satisfactory materials placed in successive horizontal layers of not more than six (6) inches in loose depth for the full width of the cross section. The material in the layers shall have the proper moisture content before rolling to obtain the required compaction. Wetting or drying of the material and manipulation to secure a uniform moisture throughout the layer shall be required. Should material be too wet to permit proper compaction, corrective work on all portions of the embankment thus affected shall be done with the proper equipment and methods approved by the Public Works Director and/or City Engineer.

Each layer placed as specified above shall be compacted to not less than the comparable density of the adjoining material. Compaction shall extend through the entire depth of each layer and the embankment, when complete, shall be homogeneous and uniformly compacted mass. The moisture shall not be more than 2% above or below the optimum.

Under the paved areas and for a depth of six (6) inches below the surface of the subgrade, the embankment shall be compacted to not less than ninety-eight percent of the maximum density.
as determined by procedures set out under TEX-113E. Backfill behind back of curb shall be properly compacted to a depth of four (4) inches, however, any areas inaccessible to a roller shall be consolidated and compacted with approved mechanical tampers. Stones or rock fragments larger than four (4) inches in their greatest dimension will not be permitted in the top six (6) inches of the embankment.

The Contractor shall be responsible for the stability of all embankments and shall replace any portion which is the opinion of the Public Works Director and/or City Engineer has become displaced due to negligence on the part of the Contractor.

C-1.09 TRUENESS TESTS: In those areas upon which a sub-base or base course is to be placed, the surface of the subgrade shall be of such smoothness that when tested with a sixteen (16) foot straightedge, it shall show no deviation in excess of five-hundredths (0.05) of a foot from true grade as established by grade pins or hubs. In areas not under sub-base or base course, the surface shall not deviate more than one tenth (0.10) of a foot from true grade as established by grade pins or hubs.
DIVISION D
TECHNICAL PROVISIONS
SECTION I
FLEXIBLE BASE COURSE

The surface of the subgrade shall be finished to line and grade as established and in conformity with the plans. Any deviation in excess of (1/4") quarter inch in cross section and in a length of 16 feet measured longitudinally shall be corrected by loosening, adding, or removing material, reshaping and recompacting by sprinkling and rolling. The Public Works Director and/or City Engineer must be notified of the completion of the subgrade, and must approve the subgrade for line, grade and compaction.

D-1.01 GENERAL: Flexible base shall consist of a foundation course for surface course or for other base courses, shall be composed of either caliche (argillaceous limestone, calcareous or calcareous clay particles, with or without stone, conglomerate, gravel, sand or other granular materials) crushed stone, gravel, iron ore topsoil, shell, etc.; and shall be constructed as herein specified in one or more courses in conformity with the plans and to the lines and grades shown on the plans or established by the Public Works Director and/or City Engineer.

D-1.02 MATERIAL: The material shall be crushed or uncrushed as necessary to meet the requirements hereinafter specified, and shall consist of durable coarse aggregate particles mixed with approved binding materials.

A. Types: Type A material shall consist of crushed or broken aggregate (excluding gravel aggregate). Type B material shall consist of gravel aggregate. Type C material shall consist of iron ore topsoil. Type D material shall consist of shell aggregate with sand admixture. Type E material shall consist of shell aggregate with sand and caliche admixture. Type F material shall consist of caliche. Unless the type of material to be used is specified on the plans, the Contractor may use any one of these types, provided the material proposed for use by the Contractor meets the requirements set forth in the specification test limits tabulation.

B. Grades: It is the intent of this specification that unless otherwise indicated on the plans, the final course of the base material shall consist of Grades 1 or 2 and other base courses or subbase materials may consist of Grades 1, 2, 3 or 4. All grades shall, when tested by Texas Highway Department Standard laboratory test procedures, meet the physical requirements as set forth in the specification test limits tabulation.
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<tr>
<td></td>
<td>Max LL....................35</td>
</tr>
<tr>
<td></td>
<td>Max PI....................12</td>
</tr>
<tr>
<td>TYPE C</td>
<td>Retained on %</td>
</tr>
<tr>
<td>Iron Ore Topsoil</td>
<td>Sq. Sieve</td>
</tr>
<tr>
<td></td>
<td>2-1/2&quot;....................0</td>
</tr>
<tr>
<td></td>
<td>No. 40..................50-85</td>
</tr>
<tr>
<td></td>
<td>Max LL....................35</td>
</tr>
<tr>
<td></td>
<td>Max PI....................12</td>
</tr>
<tr>
<td>TYPE D</td>
<td>Retained on %</td>
</tr>
<tr>
<td>Sand-Shell</td>
<td>Sq. Sieve</td>
</tr>
<tr>
<td></td>
<td>1-3/4&quot;...................0-10</td>
</tr>
<tr>
<td></td>
<td>No. 4....................45-65</td>
</tr>
<tr>
<td></td>
<td>No. 40..................50-70</td>
</tr>
<tr>
<td></td>
<td>Max LL....................35</td>
</tr>
<tr>
<td></td>
<td>Max PI....................12</td>
</tr>
</tbody>
</table>
CONSTRUCTION METHODS

D-1.03 FIRST COURSE, TYPE A, TYPE B, TYPE C AND TYPE F MATERIAL:
Immediately before placing the base material, the subgrade shall be checked as to conformity with grade and section. The flexible base materials shall be placed on the approved subgrade in courses not to exceed (8") eight inches compacted depth. The material shall be delivered in approved vehicles of a uniform capacity, and it shall be the responsibility of the Contractor that the required amount of specified material shall be delivered in each 100-foot station. Material deposited upon the subgrade shall be spread and shaped the same day unless otherwise directed by the Public Works Director and/or City Engineer in writing. In the event inclement weather or other unforeseen circumstances render impractical the spreading of the material during the first 24-hour period, the material shall be scarified and spread as directed by the Public Works Director and/or City Engineer. The material shall be sprinkled, if directed, and shall then be bladed, dragged and shaped to conform to typical sections as shown on plans. All areas and “nests” of segregated coarse or fine material shall be corrected or removed and replaced with well graded material, as directed by the Public Works Director and/or City Engineer. If additional binder is considered desirable or necessary after the material is spread and shaped, it shall be furnished and applied in the amount directed by the Public Works Director and/or City Engineer. Such binder material shall be carefully and evenly incorporated with the material in place by scarifying, harrowing, brooming or by other approved methods.

The course shall be compacted by the method of compaction hereinafter specified as the “Ordinary Compaction” method or the “Density Control” method of compaction.

When “Ordinary Compaction” method is to be used, the following provisions shall apply:

The course shall be sprinkled as required and rolled as directed until a uniform compaction is secured. Throughout this entire operation, the shape of the course shall be maintained by blading and the surface upon completion shall be smooth and in conformity with the typical
sections shown on plans and to the established lines and grades. In that area on which pavement is to be placed, any deviation in excess of 1/4 inch in cross section and in a length of 16 feet measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding suitable material as required, reshaping and recompacting by sprinkling and rolling.

When the “Density Control” method of compaction is to be used, the following provisions shall apply:

The course shall be sprinkled as required and compacted to the extent necessary to provide not less than the percent density as hereinafter specified under “Density”. In addition to the requirements specified for density, the full depth of flexible base shown on the plans shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section of flexible base is completed, tests as necessary will be made by the Project Engineer. If the material fails to meet the density requirements, it shall be reworked as necessary to meet these requirements. Throughout this entire operation the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and in conformity with the typical sections shown on the plans and to the established lines and grades. In that area on which pavement is to be placed, any deviation in excess of 1/4 inch in cross section and in length of 16 feet measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding suitable material as required, reshaping and recompacting by sprinkling and rolling. Should the base course, due to any reason or cause, lose the required stability, density or finish before the surfacing is complete, it shall be recompacted and refinished at the sole expense of the Contractor.

Where Type C material is used, the material shall be scarified, thoroughly wetted, mixed, manipulated, and bladed so as to secure a uniformly wetted material, and pulled in over the subgrade in courses and set under the action of blading and rolling. The work of mixing, blading, rolling, shaping and subsequent maintenance shall be performed by the continuous use of a sufficient number of satisfactory rollers and power maintainers with adequate scarifier attachments.

**FIRST COURSE, TYPE D MATERIAL:** Immediately before placing the base material, the subgrades shall be checked as to conformity with grade and section, and corrections made if necessary. All materials shall be delivered in approved vehicles of a uniform capacity. The required amount of shell shall be uniformly spread across the section and allowed to dry sufficiently to insure proper slaking and mixing of the binder material. Immediately upon completion of the drying period, as determined by the Public Works Director and/or City Engineer, the specified amount of sand admixture as required to produce a combined material meeting
the requirements herein before specified, shall be spread uniformly across the shell. The material shall then be sprinkled as required and thoroughly mixed by blading and harrowing, or other approved methods.

Failure to proceed with the placing of sand admixture or mixing and placing operations will be grounds for the suspension of placing of shell. Under no conditions will the Contractor be allowed to place an excessive amount of shell without proceeding with the mixing and placing operations.

The course shall be compacted by the method of compaction hereinafter specified as the "Ordinary Compaction" method or the "Density Control" method of compaction as indicated on the plans.

When the "Ordinary Compaction" method is to be used, the following provisions shall apply:

After mixing, all material shall be windrowed, and then spread over the section in layers not to exceed (2") two inches in loose depth. If necessary to prevent segregation, the material shall be wetted in the windrow prior to spreading. After each lift is spread, it shall be sprinkled and rolled to secure maximum compaction as directed by the Public Works Director. Succeeding layers shall then be placed similarly until the course is completed. All areas and "nests" of segregated coarse or fine material shall be corrected or removed and replaced with well graded material, as directed by Public Works Director and/or City Engineer. The course shall then be sprinkled as required and rolled as directed until a uniform compaction is secured. Throughout this entire operation, the shape of the course shall be maintained by blading; and the surface, upon completion, shall be smooth and in conformity with the typical sections shown on plans, and to the established lines and grades. In that area on which pavement is to be placed, any deviation in excess of 1/4 inch in cross section and in a length of 16 feet measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding suitable material as required, reshaping and recompacting by sprinkling and rolling.

When the plans indicate that the "Density Control" method of compaction is to be used, the compaction method shall be the same as prescribed for Types A, B, C, and Type F material.

When permitted by the Public Works Director and/or City Engineer, Type D material may be mixed in a central mixing plant and delivered to the road as a combined mixture. When this method is used the combined mixture shall meet the requirements for Type D material as herein before specified and the placing and compacting requirements shall be the same as prescribed for Type A, B, C and Type F material.
**FIRST COURSE, TYPE E MATERIAL:** The construction methods for placing the first course of Type E material shall be the same as prescribed for Type D material except that after the shell and sand have been placed, the prescribed amount of caliche shall then be spread across the sand and shell. The composite mixture shall then be sprinkled as required and thoroughly mixed by blading and harrowing or other approved methods. Compaction of the first course of Type E material shall be the same as prescribed above for Type D material.

Failure to proceed with placing the sand and caliche admixture or mixing and placing operations will be grounds for the suspension of placing of shell. Under no conditions will the Contractor be allowed to place an excessive amount of shell without proceeding with the mixing and placing operations.

**D-1.04 SUCCEEDING COURSES:** Construction methods shall be the same as prescribed for the first course. Prior to placing the surfacing on the completed base, the base shall be “dry cured” to the extent directed by the Public Works Director and/or City Engineer.

**D-1.05 DENSITY:** When the “Density Control” method of compaction is indicated on the plans each course of flexible base shall be compacted to the percent density shown on the plans. The testing will be as outlined in Test Method Tex-114-E. It is the intent of this specification to provide in that part of the base included in the top (8") eight inches immediately below the finished surface of the roadway, not less that 100 percent of the density as determined by the compaction ratio method. Field density determination shall be made in accordance with Test Method TEX-115-E.

**D-1.06 Tolerances:** When tolerances are permitted by the plans, the limits establishing reasonably close conformity with the percent density specified are defined by the following: The Public Works Director and/or City Engineer may accept the work, providing not more than 25% of the density tests performed each day are outside the specified density by no more that three (3) pounds per cubic foot and where no two consecutive tests on continuous work are outside the specified limits.

After the Public Works Director and/or City Engineer has accepted the base, all manhole ring and covers, clean-outs, water valves or other appurtenances in the paved area, will be encased in concrete and set to the proper street grade. Any adjustments necessary to bring the appurtenances to grade will be done by the Contractor.
DIVISION D
TECHNICAL PROVISION
SECTION 2
CONCRETE

D-2.01 DESCRIPTION: These specifications shall govern for the materials used, the storing measuring, and handling of materials, and for the proportioning and mixing of Portland Cement Concrete.

MATERIALS

D-2.02 CEMENT: Portland Cement shall conform to the requirements of the latest revision of ASTM Designation C150, Type I, or Type II. Only one brand or kind of cement shall be used in any one structure except as permitted in writing by the Public Works Director and/or City Engineer. All cement shall be delivered in bags plainly marked with the brand and name of the manufacturer.

D-2.03 COARSE AGGREGATE: The coarse aggregate shall conform to the requirements of the latest revision of ASTM Designation C-33 and ASTM Designation D-448. Coarse aggregate for the various classes of concrete shall conform to the requirements of the following table:

Table 1 COARSE AGGREGATE GRADATION CHART
Percent Retained on each sieve

<table>
<thead>
<tr>
<th>Aggregate Grade No.</th>
<th>Nominal Size</th>
<th>2-1/2 In.</th>
<th>2 In.</th>
<th>1-1/2 In.</th>
<th>1 In.</th>
<th>3/4 In.</th>
<th>½ In.</th>
<th>3/8 In.</th>
<th>No. 4</th>
<th>No. 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 1/4</td>
<td>0</td>
<td>0-20</td>
<td>15-50</td>
<td>-</td>
<td>60-80</td>
<td>-</td>
<td>-</td>
<td>95-100</td>
<td>-</td>
</tr>
<tr>
<td>2 (467)*</td>
<td>1 1/2</td>
<td>0</td>
<td>0-5</td>
<td>-</td>
<td>30-65</td>
<td>-</td>
<td>70-90</td>
<td>95-100</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0-5</td>
<td>-</td>
<td>10-40</td>
<td>40-75</td>
<td>-</td>
<td>95-100</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4 (57) *</td>
<td>1</td>
<td>0</td>
<td>0-5</td>
<td>-</td>
<td>40-75</td>
<td>-</td>
<td>90-100</td>
<td>95-100</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>5 (67) *</td>
<td>3/4</td>
<td>0</td>
<td>0-10</td>
<td>-</td>
<td>45-80</td>
<td>-</td>
<td>90-100</td>
<td>95-100</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>6 (7) *</td>
<td>½</td>
<td>0</td>
<td>0-10</td>
<td>30-60</td>
<td>85-100</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>3/8</td>
<td>0</td>
<td>5-30</td>
<td>75-100</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>No. 4</td>
<td>0</td>
<td>0-5</td>
<td>35-60</td>
<td>90-100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
* Numbers in parenthesis indicate that these gradations conforms to corresponding ASTM gradation form ASTM C-33.

The amount of deleterious substances in coarse aggregate shall not exceed the following percentage by weight:

<table>
<thead>
<tr>
<th>Material removed by decantation</th>
<th>1.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shale, slate and similar materials</td>
<td>1.0%</td>
</tr>
<tr>
<td>Clay lumps</td>
<td>0.25%</td>
</tr>
<tr>
<td>Soft fragments</td>
<td>3.0%</td>
</tr>
<tr>
<td>Other deleterious substances (Including friable, thin, elongated or laminated pieces)</td>
<td>5.0%</td>
</tr>
</tbody>
</table>

The sum of all deleterious materials exclusive of materials removed by decantation shall not exceed 5% by weight.

**D-2.04 FINE AGGREGATE:** The fine aggregate shall conform to the requirements of the latest revision of ASTM Designation C-33.

<table>
<thead>
<tr>
<th>AGGREGATE GRADE #1</th>
<th>3\8 In.</th>
<th>No. 4</th>
<th>No. 8</th>
<th>No. 16</th>
<th>No. 30</th>
<th>No. 50</th>
<th>No. 100</th>
<th>No. 200</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>0-5</td>
<td>0-20</td>
<td>15-50</td>
<td>35-75</td>
<td>65-90</td>
<td>90-100</td>
<td>97-100</td>
</tr>
</tbody>
</table>

The amount of deleterious substances in fine aggregate shall not exceed the following percentage by weight:

<table>
<thead>
<tr>
<th>Materials removed by decantation</th>
<th>3.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay Lumps</td>
<td>0.5%</td>
</tr>
<tr>
<td>Other deleterious substances (Such as coal, shale, coated or soft flaky particles) Material finer than No. 200 sieve (a) In concrete subject to surface abrasion (b) All other concrete</td>
<td>2.5%</td>
</tr>
</tbody>
</table>

**D-2.05 WATER:** Water shall be clean and free from deleterious amounts of acids, alkalies, and organic materials.
EQUIPMENT

D-2.06 GENERAL: All equipment will be inspected by the Public Works Director and/or City Engineer and only equipment approved by him may be used. Any equipment disapproved shall be removed from the jobsite within 24 hours after it has been inspected.

D-2.07 CEMENT STORAGE FACILITIES: All cement shall be stored in well ventilated, weatherproof buildings which will protect the cement from dampness. The floor supporting the cement shall clear the ground a sufficient distance to prevent the absorption of moisture by the cement. Provision for storage shall be ample, and the shipment of cement shall be segregated in such manner as to provide easy access for identification of each shipment.

The Public Works Director and/or City Engineer may permit small quantities of cement to be stored in the open for periods not exceeding 48 hours, if a raised platform and adequate waterproof coverings are provided.

D-2.08 AGGREGATE STORAGE FACILITIES: If the aggregates are stored on the ground, the sites for the stockpiles shall be grubbed clear of all weeds and grass, and leveled off. The bottom layer of aggregate shall not be disturbed nor used without cleaning.

When the contract requires the used of two or more sizes of aggregate, the different sizes shall be stored in a manner as to prevent intermixing.

Materials in all stockpiles shall be handled and placed in such manner that segregation of materials within the stockpile will be avoided.

D-2.09 MEASURING EQUIPMENT: Equipment for measuring concrete materials shall be such that the proportions can be accurately controlled and easily checked at any time during the work, preferably measurement by weight rather than by volume.

D-2.10 MIXING EQUIPMENT: The mixing shall be done in a batch mixer of approved type and size which will insure the uniform distribution of the material throughout the mass so that the mixture will be uniform in color and smooth in appearance. Whenever a concrete mixer is not suitable or adequate for the work, it shall be removed from the site upon written order from the Public Work Director and/or City Engineer. Pick-up and throw-over blades in the mixer drum which are worn down more than ten percent (10%) in depth shall be repaired or replaced.

D-2.11 CLASSIFICATION AND MIX DESIGN: It shall be the responsibility of the Contractor to furnish the mix design, using a Coarse Aggregate Factor acceptable to the Public Works Director and/or City Engineer, for the class(es) of concrete specified to conform with the requirements contained herein and in accordance with SDHPT Bulletin C-11 and Supplement thereto. The Contractor shall perform, at his own expense, the work required to sub-
stantiate the design, except the testing of strength specimens, which will be done by the Testing Laboratory. Complete concrete design data shall be submitted to the Public Works Director and/or City Engineer for approval and shall be less than 1 year old.

It shall also be the responsibility of the Contractor to determine and measure the batch quantity of each ingredient including all water, not only for batch designs, but for all concrete produced for the project, so that the mix conforms to these specifications and other requirements shown on the plans.

Trial batches will be made and tested using all the proposed ingredients prior to placing of concrete, and when the aggregate, and/or type, brand or source of cement, or admixture is changed. When the brand and/or source of cement only is changed, the Public Works Director and/or City Engineer may waive trial batches only if a prior record of satisfactory performance of the cement has been established.

Trial batches shall be made in the mixer to be used on the job. When Transit Mix concrete is to be used, the trial designs will be made in a transit mixer representative of the mixers to be used. Batch size shall not be less than fifty percent (50%) of its rated mixing capacity.

Mix designs from previous or concurrent jobs may be used without trial batches if it is shown that no substantial change in any of the proposed ingredients has been made. Mix design shall be current or less than one (1) year old.

The coarse aggregate factor shall not be more than 0.82, but when the voids in the coarse aggregate exceed 48 percent (48%) of the total dry loose volume, the coarse aggregate factor shall not exceed 0.85. The coarse aggregate factor shall not be less than 0.68 unless authorized by the Public Works Director and/or City Engineer in writing.

Water reducing or retarding agents may be used with all classes of concrete at the option of the Contractor, and will be required for hot weather concreting for cased drilled shafts and for continuous slab placement.

When entrained air is required, the concrete shall be designed to entrain five (5) percent air when Grade 1 or 2 coarse aggregate is used, six (6) percent when Grade 3 or 4 coarse aggregate is used, and seven (7) percent for Grade 5, 6 or 7 unless otherwise specified by the Public Works Director and/or City Engineer. Concrete as placed shall contain the proper amount of entrained air as required herein with a tolerance of plus or minus 1-1/2 percentage points. Acceptance of concrete with occasional variation between 1-1/2 and three (3) percentage points over the specified amount will be based on strength tests as required by the Public Works Director and/or City Engineer. Such concrete which fails to meet strength requirements may be accepted on the basis of structural reviews subject to the provisions of Article 420.25. When the quantity of entrained air is found to be more than three (3) percentage points over or two (2) percentage points under those values given herein, the concrete will be rejected.
DIVISION D
TECHNICAL PROVISIONS
SECTION 11
CONCRETE ENCASEMENT, CRADLES, SADDLES, AND COLLARS

D-11.01 DESCRIPTION: This Item shall govern for placing concrete encasement, cradles saddles, and collars, when called for the Project plans or as directed by the Public Works Director and/or City Engineer.

D-11.02 MATERIALS: Concrete: All concrete shall conform to the provisions of SDHPT Specifications, Item 421, 1995, “Concrete” (Class B) or shall be of the class noted on the plans.

D-11.03 CONSTRUCTION METHODS:

1. Concrete Encasement: When concrete encasement is shown on the plans or when directed by the Public Works Director and/or City Engineer, the trench shall be excavated and fine graded to a depth conforming with details and sections shown on the plans. The pipe shall be supported by precast concrete blocks of the same strength as the concrete for encasement and securely tied down to prevent floatation. Encasement shall then be placed to a depth and width conforming with details and sections shown on the plans.

2. Concrete Cradles: When concrete cradles are shown on the plans or when called for by the Public Works Director or City Engineer, the trench shall be prepared and the pipe supported in the same manner as described in this specification and shall be constructed in accordance with details and sections shown on the plans.

3. Concrete Saddles: When shown on the plans or when directed by the Public Works Director and/or City Engineer, pipe to receive concrete saddle shall be backfilled in accordance with SDHPT Item No. 401., “Excavation, Trenching, and Backfill” to the spring line and concrete placed for a depth and width conforming with details and sections shown on the plans.

4. Concrete Collars: When shown on the plans or when directed by the Public Works Director and/or City Engineer, concrete collars shall be constructed in accordance with details and sections shown on the plans.
DIVISION D
TECHNICAL PROVISIONS
SECTION 12
BITUMINOUS PRIME COAT

GENERAL

D-12.01 DESCRIPTION: This item shall consist of an application of asphaltic material on the completed base course in accordance with these specifications and as directed by the Public Works Director and/or City Engineer.

MATERIAL

D-12.02 CUT-BACK ASPHALT: The bituminous material shall conform to the following:

GRADE MC-30

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinematic Vis. at 140 F, CST</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>Flash Point T.O.C. F</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

When distilled ASTM Method D-402, the distillate-off volume shall be as follows:

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off at 437 F%</td>
<td>----</td>
<td>25</td>
</tr>
<tr>
<td>Off at 500 F%</td>
<td>40</td>
<td>70</td>
</tr>
<tr>
<td>Off at 600 F%</td>
<td>75</td>
<td>93</td>
</tr>
<tr>
<td>Residue from 680 F Distillation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume %</td>
<td>50</td>
<td>----</td>
</tr>
</tbody>
</table>

The residue when poured from the flash without cooling immediately upon reaching the maximum temperature specified, shall have the following characteristics:

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration at 77 F, 100 gms., 5 sec</td>
<td>120</td>
<td>250</td>
</tr>
<tr>
<td>Ductility at 77F, 5 cm/min., cms.</td>
<td>100</td>
<td>----</td>
</tr>
<tr>
<td>Solubility in CCI 4%</td>
<td>99.5</td>
<td>----</td>
</tr>
</tbody>
</table>

The material shall be free from water.
MC-30 shall be applied uniformly at the rate of 0.15 gallons per square yard. At Contractor's option, appropriate emulsified asphalt, water mixture may be used in lieu of MC-30. Number of applications, mixture rate, and depth of penetration shall be approved by Public Works Director and/or City Engineer prior to use of emulsified asphalt.

CONSTRUCTION METHODS

D-12.03 APPLICATION OF ASPHALT: Asphalt shall not be applied when the air temperature is below 50°F and is falling, and it may be applied when the air temperature is 40°F and rising; the air temperature to be taken in the shade and away from artificial heat. No asphalt shall be placed when general weather conditions in the opinion of the Public Works Director and/or City Engineer are not suitable.

All storage tanks, piping, retorts, booster tanks, and distributors used in storing or handling asphalt shall be kept clean and in good operating condition at all times, and they shall be operated in such a manner that there will be no contamination of the asphalt with foreign material. Asphalt shall not be heated above 400°F at any time, and when applied, shall be at a temperature of not less than 70°F, and not more than 150°F. The Public Works Director and/or City Engineer will select the temperature of application, and the Contractor shall apply the asphalt at a temperature within 15°F of the temperature selected. All asphalt heated above 400°F will be rejected.

Before the application of asphalt, the surface of the base shall be cleaned of dirt, dust, or other deleterious matter by sweeping or other approved methods and, if required by the Public Works Director and/or City Engineer lightly sprinkled with water.

Asphalt shall be applied on the clean surface by an approved type of self-propelled pressure distributor so operated as to distribute the asphalt in the quantity specified evenly and smoothly under a pressure necessary for proper distribution. The Contractor shall provide all necessary facilities for determining the temperature of the asphalt in all the heating equipment and in the distribution for determining the rate at which it is applied and for insuring uniformity at the junction of two distributor loads. Asphalt shall be applied for the full width of the surface treatment in one application unless the width exceeds twenty-two (22) feet. No traffic or hauling will be permitted over the freshly applied asphalt.
Entrained air will be required for bridge slabs, top slabs of direct traffic culverts, concrete pavement, dense and regular concrete overlays piers, bents, precast piling (non prestressed), drilled shafts placed in water, bridge railings, concrete traffic barrier and for other items of work as may be specified, on the plans or in other specifications. Unless otherwise specified, entrained air will not be required when Class "H" concrete is used for precast traffic barrier or precast bridge repair.

D-2.12 QUALITY OF CONCRETE: The concrete shall be uniform, workable, and of a consistency acceptable to the Public Works Director and/or City Engineer. The cement content, maximum allowable water/cement ratio, the desired and maximum slump, the proper amount of entrained air and the strength requirements for all classes of concrete shall conform to the requirements of these specifications. It shall be the responsibility of the Contractor to provide concrete meeting these specifications.

During the progress of the work, the Project Engineer will cast test cylinders or beams, perform slump and entrained air tests, and will make temperature checks, as required, to insure compliance with the specifications.

A strength test shall be defined as the average of the breaking strength of two cylinders or two beams as the case may be. Specimens will be tested in accordance with Test Methods TEX-418-A or TEX-420-A.

If the required strength of consistency of the class of concrete being produced cannot be secured with the minimum cement specified or without exceeding the maximum water/cement ratio, the Contractor will be required to furnish different aggregates, use of water-reducing agent, an air-entraining agent, or increase the cement content in order to provide concrete meeting these specifications.

All test specimens, beams or cylinders, representing tests for removal of forms and/or false work shall be cured using the same methods, and under the same conditions as concrete represented.

"Design Strength" beams and cylinders shall be cured in accordance with SDHPT Bulletin C-11 and Supplement thereto.

The Contractor shall provide and maintain curing facilities as described in SDHPT Bulletin C-11 and Supplement thereto, for the purpose of curing test specimens. Provision shall be made to maintain the water in the curing tank at temperature between 70 F and 90 F.

When control of concrete quality is by twenty-eight day compressive tests, job control will be by seven day compressive tests which are shown to provide the required twenty-eight day strength based on results from trial batches. Thereafter, if the required seven day strength is not secured with the quantity of cement specified in Table 4 or 5, changes in the batch design will be made as specified in this article.
<table>
<thead>
<tr>
<th>Class of Conc.</th>
<th>Sx. Cem. per CY Min.</th>
<th>Min. Comp. Strgth (fc) 28 day psi</th>
<th>Min. Bm. Strgth 7 day psi</th>
<th>Max Water Cement Ratio</th>
<th>Coarse Aggr. No.</th>
<th>General Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5.0</td>
<td>3000</td>
<td>500</td>
<td>6.5</td>
<td>1-2 3-4</td>
<td>Drilled Shafts, Bridge Substructure, Culverts, (not direct traffic) Inlets, Manholes, Headwalls, Concrete Approach Slab, Curb &amp; Gutter, Concrete Barrier Railing, Concrete Retards, Sidewalk, Driveways</td>
</tr>
<tr>
<td>B</td>
<td>4.0</td>
<td>2000</td>
<td>330</td>
<td>8.0</td>
<td>2-3-4-5-6-7</td>
<td>Rip-rap, Long Span Structures, Thrust Beams</td>
</tr>
<tr>
<td>C</td>
<td>6.0</td>
<td>3600</td>
<td>600</td>
<td>6.0</td>
<td>1-2-3-4-5-8</td>
<td>Drilled Shafts Bridge Railing &amp; Substructure Culverts, Wing Walls Concrete Approach Slab, Concrete Barrier Railing, Machine Laid Curb</td>
</tr>
<tr>
<td>S</td>
<td>6.0</td>
<td>3600</td>
<td>600</td>
<td>5.0</td>
<td>2-3-4-5</td>
<td>Bridge Slab, Top Slab of Direct Traffic Culverts</td>
</tr>
<tr>
<td>D</td>
<td>3.0</td>
<td>1500</td>
<td>250</td>
<td>11.0</td>
<td>2-3-4-5-6-7</td>
<td>Rip-Rap</td>
</tr>
<tr>
<td>H</td>
<td>6.0</td>
<td>As specified in plans</td>
<td>N/A</td>
<td>5.5</td>
<td>3-4-</td>
<td>Pre-stressed Concrete Beams Boxes &amp; Piling Concrete Barrier Railing</td>
</tr>
</tbody>
</table>

* Grade 8 aggregate for use in machine laid curb.
Entrained air will be required for bridge slabs, top slabs of direct traffic culverts, piers, bents, precast piling (non-prestressed), drilled shafts placed in water, bridge railing, and concrete barrier railing. When Class “H” concrete is used in barrier railing entrained air will not be required.

Grade 1 coarse aggregate will not be permitted in cased drilled shafts.

When Type II cement is used with Classes “C” or “S” concrete, the 7 day beam break requirement will be 550 psi minimum, and with Class “A”, 460 psi minimum.

The use of Grade 7 aggregate must have prior approval of the Public Works Director and/or City Engineer.

*Grade 8 aggregate for the use in machine laid curb.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C-C</td>
<td>7.0</td>
<td>5500 (7-day-4500)</td>
<td>900</td>
<td>4.2</td>
<td>2-3-4-5-</td>
<td>Bridge Slab, Special High Strength Concrete, when a high-range water reducing agent is used</td>
</tr>
<tr>
<td>E</td>
<td>6.0</td>
<td>3000</td>
<td>500</td>
<td>6.0</td>
<td>2-3-4-5-</td>
<td>Seal Concrete</td>
</tr>
<tr>
<td>F</td>
<td>6.0 to 8.0</td>
<td>Specified in Plans</td>
<td>f’c 6</td>
<td>5.5</td>
<td>2-3-4-5-</td>
<td>Railroad Structures, occasionally for Bridge Pier Columns or Bents</td>
</tr>
<tr>
<td>H-H</td>
<td>6.0 to 8.0</td>
<td>Specified in Plans</td>
<td>N/A</td>
<td>4.5</td>
<td>3-4-5-6</td>
<td>Prestressed Concrete</td>
</tr>
</tbody>
</table>

Class C-C concrete may be used only when included in the contract, or permitted by Field Change. A high-range water reducing admixture will be required. Class H-H concrete may be used only when properly certified by the Materials and Tests Engineer.

When Class “H-H” concrete is used, entrained air will not be required.

**D-2.13 CONSISTENCY:** The consistency of the concrete as placed should allow the completion of the finishing operation without the addition of water to the surface. When
field conditions are such that additional moisture is needed for the final concrete surface finishing operation, the required water shall be applied to the surface by fog spray only and shall be held to minimum. The concrete shall be workable, cohesive, possessing satisfactory finishing qualities, and of the stiffest consistency that can be placed and vibrated into a homogeneous mass. Excessive bleeding shall be avoided. Slump requirements will be as specified in Table 3, which follows:

**TABLE 3**

<table>
<thead>
<tr>
<th>CONCRETE DESIGNATION</th>
<th>DESIRED SLUMP</th>
<th>MAXIMUM SLUMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Concrete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Case Drilled Shafts</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>(2) Slurry Placed Shafts</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>(3) Uncased Drilled Shafts Thin-Walled Sections (9&quot; or less)</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(4) Slabs, Caps, Columns, Piers, Wall Sections over 9&quot;, etc.</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(5) Prestressed Concrete Members Class H, Class H-H</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>(6) Concrete Traffic Barrier (Cast-in place or Precast) (Slip-form)</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>1 ½</td>
<td>As designated by the Public Works Director and/or City Engineer</td>
</tr>
<tr>
<td>Concrete Placed Under Water</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Riprap, Curb, Gutter, and other Miscellaneous Concrete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>As specified by the Public Works Director and/or City Engineer</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** No concrete will be permitted with slump in excess of the maximums shown.

(a) The mortar will cling to the coarse aggregate
(b) The concrete is not sufficiently fluid to segregate when transported to the place of deposit
(c) The concrete, when dropped directly from the discharge chute, will flatten out at the center of the pile but the edges of the pile will stand up and not flow.
(d) The mortar will show no free water when removed from the mixer.
(e) The concrete will settle into place when deposited in the forms, and when transported in metal chutes at an angle of 30 degrees horizontal, it will slide and not flow into place.
(f) The surface of the finished concrete will be free from "laitance", or a surface film of free water.

Any concrete failing to meet the requirements although meeting the slump requirements will be considered unsatisfactory; and the mix shall be changed to correct such unsatisfactory conditions.

**D-2.14 MIXING:** The first batch of materials placed in the mixer for each placement shall contain an extra quantity of sand, cement, and water sufficient to coat the inside surface of the drum without diminishing the mortar content or the mix. Upon cessation of mixing for any considerable period of time, the mixer shall be thoroughly cleaned.

The entire contents of the drum shall be discharged before any materials are placed therein for the succeeding batch. The concrete shall be mixed in quantities required for immediate use, and any concrete which is not in place within one (1) hour after water is added to the batch will not be used. Retempering of concrete will not be permitted.

After all the ingredients are assembled in the drum the mixing shall continue for a minimum time of one and one-half minute for 14 cubic foot mixers and smaller, and for a minimum time of one minute for 21 cubic foot mixers and larger. During the mixing time the drum shall revolve at a speed of 14 to 20 revolutions per minute. The mixer shall be equipped with a speed regulator to hold the mixer to the required speed of revolution. The absolute volume of the concrete batch shall not exceed 120 percent of the NRMCA-rated capacity of the mixer.

**D-2.15 READY MIX CONCRETE:** Concrete forms from a central plant of mixed-in-transit mixer trucks may be used if it complies with these specifications. The Public Works Director and/or City Engineer shall have free access at all times to the batching and mixing plant for sampling of all materials and inspection of work performed at this project. Concrete shall be delivered in water-tight containers which will not permit segregation of the materials. When delivered, the concrete shall be uniform throughout the mass.

The delivery ticket shall include the date, time, strength, slump, and amount of batch delivered.

If an extra charge of water is required at the jobsite because of too low a slump, the drum shall be turned a minimum of 30 revolutions after addition of such water. Mixer shall be completely emptied before recharging. Trucks shall not be loaded greater than NRMCA-rated capacity. The maximum time interval between the addition of the cement to the
batch and the placing of the concrete in the forms shall conform to the requirements set up under THD specifications, Item 420. Overwet mixers shall be rejected and shall not be corrected by the addition of either aggregate or cement to the particular batch in question.

D-2.16 ADVERSE WEATHER: In threatening weather which, in the opinion of the Public Works Director and/or City Engineer, may result in conditions which will adversely affect the quality of the concrete to be placed, the Public Works Director and/or City Engineer may order postponement of the work. Where work has been started and changes in weather conditions require protective measures to be used, the Contractor shall furnish adequate shelter to protect the concrete against damage from rainfall, wind, or damage due to freezing temperature. In case it is necessary to continue mixing operation during rainfall, the Contractor shall provide protective coverings for the material stockpiles as well as the concrete being placed. The covering for aggregate stockpiles will be required only to the extent as may be necessary to control the moisture conditions in the aggregate so that adequate control of the consistency of the concrete mix may be maintained.

No concrete shall be mixed without the approval of the Public Works Director and/or City Engineer when the air temperature is at or below 40 degrees Fahrenheit taken in the shade away from artificial heat and falling. If authorized by the Public Works Director and/or City Engineer, concrete may be mixed when the air temperature is 35 degrees Fahrenheit and rising. When permission is given for mixing when the temperature is below 40 degrees Fahrenheit, the Public Works Director and/or City Engineer will specify the precautions which shall be taken.

In case the air temperature is at or above 85 degrees Fahrenheit, concrete may be mixed in accordance with the requirements set up in SDHPT Specifications, Item 437.

Hand mixing of concrete will be permitted only for small placements or in the case of an emergency and then only when authorized by the Public Works Director and/or City Engineer. The Public Works Director and/or City Engineer will also specify the proportioning and methods of mixing to be used.

TESTING AND INSPECTION

D-2.17 TESTING AND INSPECTION OF MATERIALS:

(a) Concrete testing of mix designs shall be made by a commercial testing laboratory approved by the Public Works Director and/or City Engineer. One copy of the test reports shall go to the Public Works Director and/or City Engineer and one copy of same shall go to the Contractor.

(b) Selection of the testing laboratory by the Public Works Director and/or City Engineer shall be understood as in no way relieving the Contractor’s responsibility
for the satisfactory performance of the work in full conformance with the requirements of the contract. Excluding written protest by the Contractor, in advance of processing or use of materials, services of the testing laboratory shall be understood as constituting full acceptance by an approval of the Contractor.

(c) Tests of concrete and materials shall be made under the direction of the Public Works Director and/or City Engineer who shall have access to all places where materials are stored, proportioned, or mixed.

(d) The Contractor shall submit to the Public Works Director and/or City Engineer the mixes he/she intends to use which have been proven by preliminary compression test prior to commencement of work. Proving tests shall consist of at least six 6" x 12" cylinders for each mix specified. Three cylinders shall be tested at 7 days and three at 28 days.

(e) During the progress of the work one set of 3 each 6" x 12" cylinders for compression test shall be cast for each 50 c yd. or day’s pour. Cylinders shall be tested for compression at seven (7) days and at 28 days, and one cylinder will be reserved as “stand by”.

Sample used for testing must be representative of the batch tested and should be taken from the middle third portion of the batch. Samples shall be mixed with a shovel to insure uniformity throughout the sample and immediately molded into test specimens.

If test cylinders fail to meet specified strength at 28 days by more than 5%, core tests of the structure may be ordered by the Public Works Director and/or City Engineer at the Contractor’s expense. These tests shall be made by an approved laboratory.

(f) Slump tests: Slump tests shall be made on each sample taken for compression tests. Additional slump tests shall be as required by the Public Works Director and/or City Engineer.

D-2.18 TEST METHODS:

(a) ASTM Designation C-172 “Standard Method of Sampling Fresh Concrete”.

(b) ASTM Designation C-143 “Standard Method of Slump Test for Consistency of Portland Cement Concrete”.

(c) ASTM Designation C-31 “Standard Method of Making and Curing Compression and Flexure Test Specimens in the Field”.

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(d) ASTM Designation C-39 "Standard Method of Test of Compressive Strength of Molded Concrete Cylinders".

(e) ASTM Designation C-42 "Standard Methods of Securing, Preparing, and Testing Specimens from Hardened Concrete for Compressive and Flexural Strengths".

All test shall conform to the requirements of the latest revisions of the applicable ASTM Designations.

**D-2.19 PLACING, CURING, AND FINISHING:** The placing of concrete including construction of forms and falsework, curing and finishing, shall be in accordance with Division D, Section 5, CONCRETE STRUCTURES.
DIVISION D
TECHNICAL PROVISIONS
SECTION 3
CONCRETE CURB AND GUTTER

D-3.01 DESCRIPTION: This item shall consist of curb and gutter composed of Portland Cement concrete, constructed as herein specified on an approved subgrade or base course, in conformity with the lines and grades established by the Project Engineer and the details and sections shown on the plans.

MATERIALS

D-3.02 CONCRETE: Concrete shall be Class “A” and shall conform to the requirements of Division D, Section 14, titled “CONCRETE” in the specifications.

D-3.03 EXPANSION JOINT MATERIAL: Filler for expansion joints shall be preformed bituminous fiber type and shall conform to the requirements of Division D, Section 21, titled “EXPANSION JOINT”.

D-3.04 FORMS: Forms shall be metal and of a section satisfactory to the Public Works Director and/or City Engineer, straight, free from warp and of a depth equal to the depth of the finished work. Forms shall be securely staked to line and grade and maintained in true position during the placing of concrete.

D-3.05 REINFORCING STEEL: Reinforcing steel shall conform to the requirements of Division D, Section 19, titled “REINFORCING STEEL”.

CONSTRUCTION METHODS

D-3.06 SUBGRADE OR BASE COURSE: The subgrade or base course shall be excavated and shaped to line, grade and cross-section, tampered and sprinkled. The subgrade or base course shall be moist at the time concrete is placed. (Refer to Division C, Section 1, EXCAVATIONS AND EMBANKMENTS OF STREETS).

D-3.07 PLACING CONCRETE: Where reinforcing is required, it shall be placed and supported upon suitable chairs or concrete spacer blocks before concrete is poured.

D-3.08 FINISHING AND JOINTING: The surface of the concrete shall be struck off to the required line and grade with an appropriately shaped screed and shall be floated smooth while the concrete is still soft. The surface shall be floated with a wood float until a slight excess of sand appears. The outer edges and joints shall be rounded with approved tools to
the radii shown on the plans. When the concrete has taken sufficient set, the inside form shall be carefully removed, and the surface thus exposed shall be pointed up where necessary, then wetted and rubbed with a wooden block to remove all forms marks and other irregularities, producing a finish similar in appearance to the finished upper surfaces. Mortar finishing will not be permitted. Where the location of expansion joints is not indicated, joints shall be placed at spacing of not more than forty (40) feet. Expansion joint material shall be of the thickness shown on the plans and shall conform to the required section of the curb. Expansion joint material shall be placed between the curb and any abutting structures, and around all obstructions protruding through the curb and gutter as shown on the plans.

Dummy groove contraction joints shall be placed at intervals of approximately ten (10) feet. Joints shall be made so that the joint is perpendicular to the line of the curb.

**D-3.09 CURING:** When completed, the curb shall be covered with cotton mats of two thickness of ten (10) to twelve (12) ounce burlap and kept thoroughly wet for a period of four (4) days at which time the covering may be removed. Other methods of curing if approved by the Public Works Director and/or City Engineer may be used at the Contractor’s option.

**D-3.10 BACKFILLING:** The curb shall be backfilled to the full heights of the concrete, tamped, and sloped as directed.
DIVISION D
TECHNICAL PROVISIONS
SECTION 4
MACHINE LAID CONCRETE CURB AND GUTTER

D-4.01 DESCRIPTION: This item shall consist of curb and gutter composed of Portland Cement concrete, constructed as herein specified on prepared subgrade, compacted as specified or shown, with reinforcing steel and in conformity with the lines and grades established by the Public Works Director and/or City Engineer and the details and sections shown on the plans.

MATERIALS


CONSTRUCTION METHODS

D-4.03 CONSTRUCTION METHODS: Shall conform to S.D.H.P.T. Specifications 1995, Item 529, as stated for extruding curb.
DIVISION D
TECHNICAL PROVISIONS
SECTION 5
CONCRETE STRUCTURES

D-5.01 GENERAL: This item shall consist of reinforced concrete structures built in accordance with the design requirements and details shown on the plans and in conformity with the requirements herein.

MATERIALS

D-5.02 CONCRETE: Concrete shall conform to the requirements of specifications titled "Concrete". Unless otherwise specified on the plans or in the proposal, all concrete shall be Class "A".

D-5.03 REINFORCING STEEL: Reinforcing steel shall conform to the requirements of ASTM Designation A615, new deformed billet steel having minimum yield strength of 60,000 psi. Wire mesh reinforcement shall conform to the requirements of ASTM Designation A185.

D-5.04 STRUCTURAL STEEL: Structural steel shall conform to the requirements of ASTM Designation A-36.

D-5.05 EXPANSION JOINT MATERIAL:
(a) Premolded expansion joint material shall conform to the requirements of Division D, Section 7, titled, "EXPANSION JOINT MATERIALS".

(b) Poured joint material shall conform to requirements of Federal Specifications SS-S-156, SS-S-159, or SS-S-164.

D-5.06 FORM MATERIAL:
(a) Form lumber for all exposed concrete surfaces shall be CM concrete form lumber, Southern Yellow Pine or approved equal, S45 grademarked in accordance with the latest grading rules of the Souther Pine Association. Form lumber not otherwise specified shall be No. 2 Common Southern Yellow Pine, S45.

(b) Plywood form shall be of Douglas Fir Plywood, 5 ply, and at least 3/4" thick, conforming to the grading rules as required under State Department of Highways and Public Transportation Specifications.
CONSTRUCTION METHODS

D-5.07 REINFORCEMENT:
(a) Reinforcing shall be detailed, fabricated, and erected in accordance with Manual of Standard Practice for Detailed Reinforced Concrete Structure (ACT 315-57). Shop drawings shall be submitted in triplicate for approval prior to fabrication. All reinforcement shall be entirely free from rust, scale, grease, or other coating which might destroy or reduce its bond with concrete.

(b) Spacing: Unless otherwise indicated, the clear distance between parallel bars shall be not less than one and one-half times the diameter of round bars. In no case shall the distance between bars be smaller than the maximum size of the aggregates.

(c) Protective Covering: Reinforcement shall be protected by the thickness of concrete indicated on the plans. Unless otherwise specified, the protective coverings over reinforcement shall not be less than the maximum size of aggregates.

(d) Splicing and Lapping: Unless otherwise indicated, all bars shall be staggered. Adjacent sheets of mesh reinforcement shall be spliced by lapping not less than 6 inches, the lapped ends being securely wired together.

(e) Supports: All reinforcement shall be secured in place true to the lines and grades, indicated by the use of metal supports, spacers, or ties approved by the Project Engineer. Such supports shall be of sufficient number and strength to maintain the reinforcement in place throughout the concreting operations.

D-5.08 FORMS:
(a) General: Forms shall conform to the shape, lines, and dimensions of the members of structures, as called for on the plans shall be substantial and sufficiently tight to prevent leakage of mortar. All details of form construction shall be subject to the approval of the Public Works Director and/or City Engineer and permission to place concrete will not be given until all such work is complete to his satisfaction.

(b) Braces and Ties: Forms shall be properly braced and tied together so as to maintain position and shape. Metal form of an approved type shall be used to hold forms in place. Such ties shall be of a type especially designed for use in connection with concrete work and shall have provision to permit easy removal of the metal to a depth of a least one-half inch from the surface of the concrete. The use of wire from ties will not be permitted except for minor or special form areas where the use of rigid type metal ties would be impracticable. Where wire ties are used, all wires upon removal of the forms shall be cut back at least one-half inch from the face of the concrete.
(c) Curved Surface: In the case of exterior exposed curved surfaces, the Contractor shall use such forming as may be necessary to provide smooth forms of uniform curvature.

(d) Coating: Plywood forms and plywood form lining shall be mill-oiled according to standard practice recommended by the Douglas Fir Plywood Association. Form lumber for all other exposed surfaces shall be coated with approved non-staining mineral oil which shall be applied shortly before the concrete is deposited. In general, all forms shall be thoroughly wetted before the concrete is placed.

(e) Cleanouts: At the time of placing concrete, the forms shall be clean and entirely free from all chips, dirt, sawdust, and other extraneous matter. For narrow walls and other locations where access to the bottom of the forms is not readily obtainable otherwise, adequate cleanout openings shall be provided.

D-5.09 PLACING CONCRETE-GENERAL:
(a) Supervision: The Contractor shall give the Public Works Director and/or City Engineer sufficient notice before starting to place concrete in any unit of the structure to permit the inspection of forms, reinforcing steel, and preparation for placing. Concrete shall not be placed in footings until the character of the foundation has been approved by the Public Works Director and/or City Engineer and permission has been given to proceed. When footings can be placed in dry foundation pits, forms may be omitted, if desired by the Contractor and approved by the Public Works Director and/or City Engineer, and the entire excavation filled with concrete to the top of the footing.

(b) Placing: All concrete shall be placed before its initial set has occurred. The operation of depositing and compacting the concrete shall be conducted so as to form a compact, dense, impervious mass of uniform texture which shall show smooth faces on all surfaces. Each part of the forms shall be filled by depositing the concrete directly as near its final position as possible. The coarse aggregate shall be worked back from the face and the concrete forced under and around the reinforcement bars without displacing them. Depositing large quantities at one point in the forms and running or working it along the forms will not be permitted. Concrete in columns shall be placed monolithically unless otherwise provided. An interval of not less than 4 hours shall elapse between the placing of concrete above the tops of the columns or walls to allow shrinkage. Concrete in walls, columns, and deep foundations shall be placed in a manner that will avoid separation of the aggregates or displacement of the reinforcement. Suitable chutes or vertical pipes shall be provided.

(c) Vibrating: All concrete shall be placed with the aid of mechanical vibrating equipment unless otherwise directed. Vibration shall be transmitted directly to the concrete, and in no case shall it be transmitted through the forms of reinforcing steel. The duration of vibration shall at any location be held to the minimum necessary to produce thorough compaction.
Vibration shall be supplemented by hand spading to insure the flushing of mortar to the surface of all forms.

(d) **Construction Joints:** Construction joints shall be formed as shown on the plans. In all cases where they are not shown on the plans, they shall be formed as directed by the Public Works Director and/or City Engineer. Where indicated or required dowel rods shall be used. Before placing is resumed, all water and laitance shall be removed and the concrete shall be cut away, if necessary, to insure a strong dense concrete at the joint. In order to secure adequate bond, the surface of all concrete already in place shall be cleaned and roughened and shall then be spread with a ½ inch layer of mortar of the same sand-cement ratio as is used in the concrete immediately before the new concrete is deposited.

**D-5.10 FINISHING EXPOSED SURFACES:** An ordinary surface finish shall be applied to all concrete surfaces either as a final finish or preparatory to a higher grade or class of finish. Higher grades and classes of finish shall be in accordance with the Special THD Specifications, "Surface Finishes for Concrete". Where neither a grade or class of finish is specified, an ordinary surface finish shall be provided as follows:

After form removal, all porous or honeycombed areas and spalled areas shall be corrected by chipping away all loose or broken material to sound concrete. Holes and spalls caused by removal of metal ties, etc., as required by SDHPT Specifications, Item 420, shall be cleaned and filled with adhesive grout or epoxy grout. Exposed parts of metal chairs on surfaces to be finished by rubbing shall be chipped out to depth of one-half inch and the surface repaired.

All fins, runs, drips, or mortar shall be removed from surfaces which remain exposed. Form marks and chamfer edges shall be smoothed by grinding and/or rubbing.

Grease, oil, curing compound, etc., shall be removed from surfaces requiring a higher grade of finish. Discolorations resulting from spillage or splashing of asphalt, paint, or other similar material shall be removed. Repairs shall be dense, well bonded, and properly cured, and when made on surfaces which remain exposed and do not require a higher finish, shall be finished to blend with the surrounding concrete. Unless otherwise specified on the plans, ordinary surface finish shall be the final finish for the following exposed surfaces: Inlets, manholes, and sewer appurtenances.

**D-5.11 FINISHING VERTICAL SURFACES (General):** After tie rods and bolts are removed, the holes shall be filled solid with cement mortar. Honeycomb and minor defects shall not be patched until approval has been given by the Public Works Director and/or City Engineer.
D-5.12 REMOVAL OF FORMS:
(a) Finished Concrete: Forms for surfaces required to be finished shall be removed when the concrete has aged not less than ½ nor more than 2 curing days after the concrete has been placed.

(b) Unfinished Concrete: Forms and falsework may be removed when the concrete has attained a compressive strength of not less than 65 percent of the design strength except that forms for walls, columns, and sides of beams may be removed after 48 hours.

(c) Curing Day: The term “curing day” will be interpreted as any calendar day on which the temperature is above 50 F for at least 19 hours. In continued cold weather, Public Works Director and/or City Engineer will determine when sufficient time has elapsed to permit the removal of forms and falsework.

D-5.13 DEFECTIVE WORK: Any defective work discovered after the forms have been removed shall be repaired immediately. If the surface of the concrete is bulging, uneven, or shows excess honeycombing or form marks, which, in the opinion of the Public Works Director and/or City Engineer, cannot be repaired satisfactorily, the entire section shall be removed before the repair work is started. No extra compensation will be allowed for extra work or materials involved in repairing or replacing defective concrete.

D-5.14 CURING: Concrete shall be maintained in a moist condition for at least five (5) days after placement. Curing shall be commenced as soon as possible after the concrete has been finished. This shall be either by means of approved curing compound, sprinkling, or by damp curing by means of wet mats, sand, etc. Adequate protection shall be provided to prevent damage from extreme weather conditions shall they be either hot or cold temperatures, wind, or other conditions which would cause evaporation of moisture from the fresh concrete. The ACI recommendations for hot or cold weather shall be followed.

D-5.15 ADDITIONAL CONCRETE FINISH FOR EXPOSED SURFACES: Concrete shall be finished pursuant to Specification Item #427, State Department of Highways and Public Transportation, utilizing Class A grout with Type II white pigment.
D-6.01 GENERAL: This item shall govern the furnishing and placing of concrete riprap.

MATERIALS

D-6.02 MATERIALS: Concrete shall be Class “B”. The riprap will consist of a 4 inch slab with a 6 by 6 inch No.6 wire mesh reinforcements or its equal, and per requirements of specifications entitled “CONCRETE”, Division D, Section 2.

CONSTRUCTION METHODS

D-6.03 GENERAL: If the slopes and bottom of the trench for toe walls are dry and not consolidated properly, the Public Works Director and/or City Engineer may require the entire area to be sprinkled, or sprinkled and consolidated before the concrete is placed. All surfaces shall be moist when concrete is placed.

The concrete riprap shall have a toe ditch as specified on plans.

The concrete slab shall be placed, finished, and cured in accordance with the item, “CONCRETE STRUCTURES”, Division D, Section 5 of these specifications.
DIVISION D
TECHNICAL PROVISIONS
SECTION 7
REINFORCING STEEL

D-7.01 DESCRIPTION: This item shall provide for the furnishing and placing of bar reinforcing steel of the size and quantity designated for use in structures and other concrete items that require reinforcing steel as shown on the plans and in accordance with these specifications as per Division D, Section 17, Paragraphs D-17.03-D-17.04.

D-7.02 MATERIALS: Reinforcing steel shall conform to the requirement of Item 440, "Reinforcing Steel" of the State Department of Highways and Public Transportation Specifications, 1995. Reinforcing steel bars produced outside of the United States are acceptable if such bar reinforcement conforms to the requirements of the ASTM Designations.

D-7.03 PLACING REINFORCEMENT: All steel reinforcing shall be accurately placed in the position shown on the plans and firmly held during the placing and setting of concrete. All reinforcement shall be free from dust, rust, mill scale, paint, oil, or foreign material. Bars shall be tied at all intersections. Distances from forms shall be maintained by means of stays, precast blocks, ties, hangers, metal chairs, or other approved supports. Blocks for holding reinforcement from contact with the form shall be precast concrete blocks of approved shape dimensions or other equally suitable devices. The use of pebbles, pieces of broken stones or brick, metal pipe and wooden blocks shall not be permitted. Reinforcement in any sections shall be placed and then inspected and approved by the Public Works Director and/or City Engineer before the placing of concrete begins.
DIVISION D
TECHNICAL PROVISIONS
SECTION 8
WELDED WIRE FABRIC

D-8.01 DESCRIPTION: This item shall govern the furnishing and placing of the various sizes of welded wire fabric as indicated on the plans or as directed by the Public Works Director and/or City Engineer.

D-8.02 MATERIAL: All welded wire fabric used in construction shall conform to the requirements of ASTM Designation A-185. It shall be 6 by 6 inch No. 6 or 6 by 6 inch No. 10, plain electric welded reinforcing fabric as indicated on the plans.

D-8.03 CONSTRUCTION METHODS: All splices in the wire fabric shall overlap sufficiently to allow two (2) pairs or transverse wires to be tied together and no splices of less than six (6) inches will be permitted.

At the edge of the construction, the wire fabric shall not be less than one (1) inch nor more than three (3) inches from the edge of the concrete and shall have no wires projecting beyond the last member parallel to the edge of the concrete. The wire fabric shall be straightened to lie flat in place without bulges or excessive vertical displacement and shall be supported properly throughout to insure its proper position in the finished construction.
DIVISION D
TECHNICAL PROVISIONS
SECTION 9
EXPANSION JOINT MATERIALS

D-9.01 DESCRIPTION: This item shall govern for furnishing and placing of all expansion joint material as herein specified in the various items of these specifications or as shown on the plans or as directed by the Public Works Director and/or City Engineer.

D-9.02 MATERIAL: The material used for expansion joints shall conform to either of the following:

(1) Preformed Bituminous Fiber Material shall be formed from cane or other suitable fibers of a cellular nature securely bound together and uniformly impregnated with a suitable asphaltic binder and shall meet the requirements of the Standard Specifications for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction, ASTM Designation D-1751.

(2) Boards for expansion joints shall be obtained from Redwood or Cypress timber and shall be sound heartwood, free from sapwood, knots, clustered birdeye, checks, and splits. Occasional sound or hollow birdeye, when not in clusters, will be permitted provided the board is free from any other defects that will impair its usefulness as a joint filler.

D-9.03 CONSTRUCTION METHODS: All materials used shall extend the full depth of the concrete and shall be perpendicular to the exposed face. All joints shall be shaped to conform to the contour of the finished section in which they are installed. All material shall be minimum of one-half (½") inch thick.
DIVISION D
TECHNICAL PROVISIONS
SECTION 10
MEMBRANE CURING

D-10.01 DESCRIPTION: This item shall consist of curing by the impervious membrane method of all curbs, sidewalks, drive approaches, concrete riprap, concrete structures, and other concrete as specified in the various items of these specifications or as indicated on the plans.

D-10.02 MATERIALS: The membrane curing compound shall comply with the requirements as set forth under Item 526, “Membrane Curing, Type 2, White Pigmented” of the Texas Highway Department Standard Specifications, 1995.

D-10.03 CONSTRUCTION METHODS: The membrane curing compound shall be applied after the surface finishing has been completed, and immediately after the free surface moisture has disappeared. The surface shall be completely sealed with a uniform coating of the curing compound applied at the rate of coverage recommended by the manufacturer or as directed by the Public Works Director and/or City Engineer.
DIVISION D
TECHNICAL PROVISIONS
SECTION 13
BITUMINOUS TACK COAT

D-13.01 DESCRIPTION: This item shall consist of an application of asphalt material on
the completed and prime base course or existing pavement in accordance with these specifica-
tions and as directed by the Public Works Director and/or City Engineer.

MATERIAL

D-13.02 CUT-BACK ASPHALT: The bituminous material shall conform to the following:

GRADE RC-2

<table>
<thead>
<tr>
<th>Property</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity (Furol) at 122 F, Sec</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>Flash Point T.O.C. F</td>
<td>80</td>
<td>----</td>
</tr>
</tbody>
</table>

The distillate, expressed as percent by volume of total distillate to 600 F, shall be as follows:

<table>
<thead>
<tr>
<th>Property</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off at 500 F, %</td>
<td>50</td>
<td>75</td>
</tr>
<tr>
<td>Off at 600 F, %</td>
<td>70</td>
<td>90</td>
</tr>
<tr>
<td>Residue from 680 F, Distillation,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume %</td>
<td>70</td>
<td>----</td>
</tr>
</tbody>
</table>

The residue, when poured from the flash without cooling, immediately upon reaching the
maximum temperature specified, shall have the following characteristics:

<table>
<thead>
<tr>
<th>Property</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration at 77 F, 100 g., 5 sec.</td>
<td>110</td>
<td>150</td>
</tr>
<tr>
<td>Ductility at 77 F, 5 cm/min., cms.</td>
<td>100</td>
<td>----</td>
</tr>
<tr>
<td>Solubility in CCI 4%</td>
<td>99.0</td>
<td>----</td>
</tr>
<tr>
<td>Spot Test</td>
<td>Neg.</td>
<td></td>
</tr>
</tbody>
</table>

The material shall be free from water.

RC-2 cut-back asphalt used for tack coat may, upon written instruction from the Public Works
Director and/or City Engineer, be further cut-back by the addition of an approved grade of gaso-
line not to exceed fifteen (15%) percent by volume.
CONSTRUCTION METHODS

D-13.03 APPLICATION OF ASPHALT: Asphalt shall not be applied when the air temperature is below 50 F and falling, and may be applied when the air temperature is 40 F and rising; the air temperature to be taken in the shade and away from artificial heat. No asphalt shall be placed when general weather conditions in the opinion of the Public Works Director and/or City Engineer are not suitable.

All storage tanks, piping, retorts, booster tanks, and distributors used in handling asphalt shall be kept clean and in good operating conditions at all times, and they shall be operated in such a manner that there will be no contamination of the asphalt with foreign material. Asphalt shall not be heated above 400 F and at the time of application, it shall be at a temperature not less than 100 F, and not more than 175 F. The Public Works Director and/or City Engineer will select the temperature of application and the Contractor shall apply the asphalt at a temperature within 15 degrees of the temperature selected. All asphalt heated above 400 F will be rejected.

Before application of asphalt, the surface to receive the coat shall be cleaned of dirt, or other deleterious matter by sweeping or other approved methods.

Asphalt shall be applied on the clean surface by an approved type of self-propelled pressure distributor so operated as to distribute the asphalt in the quantity specified evenly and smoothly under the pressure necessary for proper distribution. The Contractor shall provide all necessary facilities for determining the temperature of the asphalt in all the heating equipment and in the distributor for determining the rate at which it is applied, and for insuring uniformity at the junction of two distributor loads. Asphalt shall be applied for the full width of the surface treatment in one application unless the width exceeds twenty-two (22) feet. No traffic or hauling will be permitted on the freshly applied asphalt.
DIVISION D
TECHNICAL PROVISION
SECTION 14
HOT MIX ASPHALTIC CONCRETE PAVEMENT-TYPE D

D-14.01 DESCRIPTION: This item shall consist of a base course, a leveling up course, a surface course, or any combination of these courses as shown on the plans, each to be composed of a compacted mixture of mineral aggregate and asphaltic material. The mixture, when designed and tested in accordance with these specifications and methods outlined in THD Bulletin C-14, shall have the following:

<table>
<thead>
<tr>
<th>DENSITY, PERCENT</th>
<th>STABILITY, PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIN 95</td>
<td>Not less than 35 nor more than 60 unless otherwise shown on plans.</td>
</tr>
<tr>
<td>MAX 99</td>
<td>97</td>
</tr>
<tr>
<td>OPTIMUM 97</td>
<td></td>
</tr>
</tbody>
</table>

The pavement shall be constructed on the previously completed and approved subgrade, base, existing pavement, bituminous surface, or, in the case of a bridge, on the prepared floor slab, as herein specified and in accordance with the details shown on the plans.

D-14.02 MATERIALS: Material used in Hot-Mix Asphaltic Concrete Pavement shall meet the requirements as set forth in Item 340 “Hot Mix Asphaltic Concrete Pavement” of the State Department of Highways and Public Transportation Specifications, 1995.

Prior to laying any asphalt, Contractor shall submit a Hot-Mix Asphaltic Concrete mix design (less than one year old) for approval. He shall also submit written assurance that material stockpiles are sufficient to produce a mix consistent with the design for the duration of the project. If material source change occurs prior to completion, Contractor shall provide a revised mix design at no additional expense to Owner.

The Contractor shall provide for quality control at the plant to ensure that paving material delivered to the site conforms to requirements of these specifications and the mix design unless otherwise specified by Public Works Director and/or City Engineer.

D-14.03 CONSTRUCTION METHODS: Construction methods used in Hot-Mix Asphaltic Concrete Pavement shall meet the requirements as set forth in Item 340 “Hot Mix Asphaltic Concrete Pavement” of the State Department of Highways and Public Transportation Specifications, 1995.

D-14.04 EQUIPMENT: Mixing plants that will not continuously produce a mixture meeting all of requirements of Item 340.4 in the State Department of Highways and Public Transportation Specifications, 1995, shall not be allowed.
DIVISION D
TECHNICAL PROVISIONS
SECTION 15
ASPHALT STABILIZED BASE

D-15.01 DESCRIPTION: This item shall consist of base courses to be composed of a compacted mixture of mineral aggregates and asphalitic materials mixed hot in a mixing plant.

D-15.02 MATERIALS:

1. Asphalitic Materials

   a. Mixture. Asphalt for the mixture shall meet the requirements for AC-10 or AC-20 asphalt. The grade of asphalt to be used will be approved by the Public Works Director and/or City Engineer after design tests have been made using the mineral aggregate approved for use in the construction of this item.

   b. Tack Coat. The asphalitic material for the tack coat shall meet the requirements for emulsified asphalt MS-1 or cut back asphalt RC-2.


   a. Description. The material shall be crushed or uncrushed and screened as necessary to meet the requirements specified and shall consist of durable coarse aggregate particles mixed with approved binding materials.

   b. Grades. Unless otherwise specified, the grading of the aggregate shall conform to the limitations as shown below:

<table>
<thead>
<tr>
<th>SIEVE SIZE</th>
<th>PERCENT RETAINED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ½&quot;</td>
<td>0</td>
</tr>
<tr>
<td>1&quot;</td>
<td>0 - 10</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>30 - 55</td>
</tr>
<tr>
<td>No. 4</td>
<td>45 - 70</td>
</tr>
<tr>
<td>No. 40</td>
<td>67 - 85</td>
</tr>
</tbody>
</table>

   Unless otherwise specified, the mineral aggregate shall meet the following physical requirements:

   Los Angeles Abrasion 50 Max.
   Liquid Limit 30 Max.
   Plasticity Index 10 Max.
D-15.03 ASPHALT STABILIZED MIXTURE:

1. **Paving Mixture.** The mixture shall consist of a uniform mixture of mineral aggregate and asphalt material. The mineral aggregate will conform to the gradation limits shown above. The asphaltic material shall form from 3.0 to 7.0 percent of the mixture by weight unless otherwise shown on the plans. The exact percentage of asphaltic material shall be based on a mix design approved by the Public Works Director and/or City Engineer.

D-15.04 EQUIPMENT:

1. **Mixing Plants.** All equipment for the handling of materials and the placement of the mixture shall be maintained in good repair and operating condition. Any equipment found to be defective and affecting the quality of the mixture will be replaced.

Mixing plants may be either the weight batching type, the continuous mixing type, or the drum type. All type of plants shall be equipped with satisfactory conveyors, power units, aggregate handling equipment, bins, and dust collectors.

2. **Truck Scales.** A set of standard platform truck scales, if needed for measurement, shall be placed at a location approved by the Public Works Director and/or City Engineer.

3. **Asphaltic Material Heating Equipment.** Asphaltic material heating equipment shall be adequate to heat the asphaltic material to the required temperature in the quantities needed.

4. **Surge Storage System.** A surge storage system may be used providing the mixture from the surge storage unit is of equal quality to that coming from the mixer.

5. **Spreading and Finishing Machine.** The spreading and finishing machine shall be of a type approved by the Public Works Director and/or City Engineer, shall be capable of producing a surface that will meet the requirements of the typical cross-section, and shall have adequate power to propel the delivery vehicles in a satisfactory manner.

6. **Motor Grader.** The motor grader, if used, shall be a self-propelled motor grader and shall be in a good operating condition.

7. **Rollers.** Roller shall be power driven and of any type capable of obtaining the required compaction.
D-15.05 STORAGE, PROPORTIONING, AND MIXING:

1. Storage and Heating of Asphaltic Materials. The asphaltic material shall be ample to meet the requirements of the plant. Asphalt shall not be heated to a temperature in excess of that recommended by the producer. All equipment used in the handling and storage asphaltic material shall be kept in a clean condition and be operated in such a manner that there will be no contamination with foreign matter.

2. Feeding and Drying of Aggregate. The feeding of various sizes of aggregate to the dryer shall be done in such a manner that a uniform and constant flow of materials in the required proportions will be maintained. In no case shall the aggregate be introduced into the mixing unit at a temperature of more than 400°F.

3. Proportioning. The proportioning of the various materials entering the asphaltic mixer shall be in accordance with these specifications.

4. Mixing.

   a. Batch Type Mixer. In the charging of the weigh box and in the charging of the mixer from the weigh box, such methods or devices shall be used as are necessary to assure a uniform asphaltic mixture.

      In introducing the batch to the mixer, all mineral aggregate shall be introduced first, the asphaltic material added, and the materials thoroughly mixed for at least 30 seconds. The mixing time may be increased, if, in the opinion of the Engineer, the mixture is not uniform.

   b. Continuous Type Mixer. The amount of aggregate and asphaltic material entering the mixer and the rate of travel through the mixer shall be coordinated so that a uniform mixture of the specified grading and asphaltic content will be produced.

   c. Dryer-Drum Mixer. The amount of aggregate and asphaltic material entering the mixer and the rate of travel through the mixer shall be coordinated so that a uniform mixture of the specified grading and asphaltic content will be produced.

   d. Tolerances. The Public Works Director and/or City Engineer will designate the asphalt content to be used in the mixture after design test have been made with the aggregate to be used in the project. When tested as determined by the Public Works Director and/or City Engineer, samples of the mixture shall not vary from the asphalt content designated by the Public Works Director and/or City Engineer by more than 0.5 percent dry weight (based on total mixture).
D-15.06 CONSTRUCTION METHODS:

1. **Prime Coat.** Before the asphalt stabilized base material is laid, the surface upon which the material will be placed shall be thoroughly cleaned and given a uniform prime coat using MC-30 cutback asphalt. The prime coat should be just sufficient to lightly coat the soil and should not exceed 0.1 gallons per square yard.

2. **Transporting Asphalt Stabilized Base.** The asphaltic mixture shall be hauled to the project site in vehicles which have been cleaned of all foreign material.

3. **Placing.** The asphalt stabilized base material shall be dumped and spread on the prepared surface with the specified spreading and finishing machine in such a manner that when properly compacted, the finished surface will be smooth, of uniform density, and will meet the requirements of the typical cross-sections.

4. **Compacting.** The base shall be compressed thoroughly and uniformly to the densities equivalent to at least 95 percent of the laboratory maximum density.

5. **Surface Tests.** The surface of the pavement, after compaction, shall be smooth and true to the established line, grade, and cross-section. Density testing of the compacted base and mix extraction and gradation tests may be required by the Public Works Director and/or City Engineer.

It is the intent of these specifications to require in-place density and that the materials be placed and compacted from 94 to 98 percent with 96% being the optimum as determined by Test Method Tex-126-E and according to Item 292 of the State Department of Highway & Public Transportation.

BLACK BASE NOTES:

1. Contractor is responsible to control the yield of black base material at 460#/S.Y. (approximately 4" thickness compacted in place) within an acceptable tolerance of 5 % more or less. Any black base in place used over the 5% tolerance will be paid by the Contractor. Any black base in-placed less than 5% tolerance may not be acceptable.

2. The City Engineering Office will be notified at least 48 hours before black base is required at the job site. Minimum order shall not be less than 75 tons per order unless agreed by plant and the Contractor.
DIVISION D
TECHNICAL PROVISIONS
SECTION 16
ONE COURSE SURFACE TREATMENT

D-16.01 DESCRIPTION:

ONE COURSE SURFACE TREATMENT (WEARING & WATERPROOFING):
This item consist of a wearing and waterproofing surface composed of a single application
of CRS-2 Emulsion or equivalent, covered with a pre-coated Type B, Grade 4 aggregate.
One course surface treatment shall not be applied when the air temperature is below 60 F
and is falling, but it may be applied when the air temperature is above 50 F and is rising,
the air temperature being taken in the shade and away from artificial heat.

D-16.02 CONSTRUCTION METHODS: The base to be treated shall be free of dirt,
dust, or other deleterious matter by sweeping or other approved methods. The base will be
primed with MC-30 at a rate of 0.15 gal./per square yards.

Emulsion material shall be applied on the clean surface by an approved type of self-propelled
pressure distributor at a rate of 0.36 to 0.40 per square yard, and operated as to distribute
the emulsion in the quantity specified, evenly and smoothly, under a pressure necessary for
proper distribution.

The Contractor shall be responsible for determining the temperature of the emulsion and for
securing uniformity at the junction of two loads.

Before the beginning of work, the distributor shall be calibrated.

Emulsion may be applied for the full width of the surface treatment in one application, unless
the width exceeds 26 feet. No traffic or hauling will be permitted over the freshly applied
emulsion. Aggregate shall be immediately and uniformly applied and spread by a self-propelled
continuous feed aggregate spreador which is approved by the Public Works Director. The pre-
coated, Type B, Grade 4 aggregate will be applied at a rate of 26 lbs. to 28 lbs. per square yard.
DIVISION D
TECHNICAL PROVISIONS
SECTION 17
COLD MIX LIMESTONE ROCK ASPHALT

D-17.01 DESCRIPTION:

COLD MIX LIMESTONE ROCK ASPHALT (CLASS A): This item shall consist of a surface course composed of a compacted layer of natural limestone rock asphalt cold mixed with a prescribed flux and shall be constructed on a completed and approved base course, existing pavement or slab and in conformity with the lines, grades and quantities shown on the construction plans. Typically the City utilizes 150 pounds per square yard of Type CC paving mixture. The Public Works Director will consider the use of any other paving mixture that meets the specifications set forth in the State Department of Highway and Public Transportation 1995 Standard Specifications.

D-17.02 EQUIPMENT: All equipment for the handling of all materials and placing of the mixture shall be maintained in good repair and operating condition and subject to approval by the Public Works Director. Any equipment found to be defective and potentially affecting the quantity of the paving mixture shall be replaced.

A. Asphalt Paver: The Spreading/Finishing Machine (Asphalt Paver/Spreader Box) shall be a type approved by the Public Works Director and shall be capable of producing a surface that will meet the requirements of the construction plans and the surface test. Where more than one course of pavement is to be placed, no succeeding course shall be placed until the preceding course has cured to the satisfaction of the Public Works Director.

B. Motor Grader: The motor grader shall be a self-propelled power grader equipped with smooth tread pneumatic tired wheels, shall have a blade length of not less than 12 feet and a wheel base of not less than 16 feet. Grader shall be in good operating condition, without any type of leak and must be approved by the Public Works Director.

C. Pneumatic Tire Rollers: The Pneumatic Tire Roller shall be an acceptable medium Pneumatic Tire Rollers (Type B) equipped with tires that will afford ground contact pressures to 90 pounds per square inch or more. The roller shall be equipped with smooth tread tires and shall be capable of being operated in both forward and reverse direction. The roller will be equipped with sprinklers for moistening the surface of the tires while operating. Where turning is impractical or detrimental to the work, the roller shall be the self-propelled type.
D. **TWO-AXLE TANDEM ROLLER/VIBRATION ROLLER:** This roller shall be an acceptable power driven tandem roller weighing not less than 8 tons.

E. **THREE WHEEL ROLLER/VIBRATORY ROLLER:** This roller shall be an acceptable power driven three wheel roller, weighing not less than 10 tons.

F. **THREE AXLE TANDEM ROLLER:** This roller shall be an acceptable power driven three axle tandem roller, weighing not less than 10 tons.

G. **STRAIGHT EDGES:** The Contractor shall provide a 16 foot straight edge for surface testing.

H. **ALTERNATE EQUIPMENT:** When permitted by the Public Works Director in writing, equipment other than that specified which will consistently produce satisfactory results may be used.

**D-17.03 CONSTRUCTION METHODS:**

1. **GENERAL:** The limestone rock asphalt mixture, tack coat or prime coat shall not be placed when the air temperature is below 60F and is falling, but it may be placed when the air temperature is above 50F and is rising. The air temperature shall be taken in the shade away from artificial heat. It is further provided that the prime coat or asphaltic mixture shall be placed only when the humidity, general weather conditions, and temperature and moisture conditions of the base or existing pavement, in the opinion of the Engineer, are suitable.

2. **PRIME COAT:** The surface upon which the prime coat is to be placed shall be cleaned thoroughly to the satisfaction of the Public Works Director. The surface shall be given a uniform application of prime coat using medium curing Type Cutback Asphalt (MC-30). The prime coat shall be applied, as directed by the Public Works Director, with an approved sprayer at a rate not to exceed 0.20 gallon residual asphalt per square yard of surface. All contract surface of curbs and structures and all joints shall be painted with a thin uniform coat of the asphaltic material meeting the requirements for prime coat. During the application of asphaltic material, care shall be taken to prevent splattering of adjacent pavement, curb and gutter and structures.

3. **TRANSPORTING ASPHALTIC MIXTURE:** The asphaltic mixture shall be hauled to the work site in tight vehicles previously cleaned of all foreign material. The dispatching of the vehicles shall be arranged so that all material delivered is placed and all rolling completed during daylight hours unless otherwise shown on the plans. In cool weather or for long hauls, covering and insulating of the truck...
bodies may be required. If necessary, to prevent the mixture from adhering to the body, the inside of the truck may be given a light coating of release agent satisfactory to the Engineer.

4. **PLACING:**

   A. The asphaltic mixture shall be dumped and spread on the approved prepared surface with the spreading and finishing machine. When properly compacted, the finished pavement shall be smooth, of uniform texture and density and shall meet the requirements of the typical cross sections and the surface tests. In addition, the placing of the asphaltic mixture shall be done without tearing, shoving, gouging or segregating the mixture and without producing streaks in the mat.

   Unloading into the finishing machine shall be controlled so that bouncing or jarring the spreading and finishing machine shall not occur and the required lines and grades shall be obtained without resorting to hand finishing.

5. **COMPACTING:**

   A. The pavement shall be compacted thoroughly and uniformly with the necessary rollers to obtain the compaction and cross section of the finished paving mixture meeting the requirements of the plans and specifications.

   B. When rolling with the three-wheel, tandem or vibratory rollers, rolling shall start by first rolling the joint with the adjacent pavement and then continue by rolling longitudinally at the sides and proceed toward the center of the pavement, overlapping on successive trips by at least one-half of the width of the roller. Alternative trips of the roller shall be slightly different in length. On super-elevated curves, rolling shall begin at the low side and progress toward the high side.

   When rolling with vibratory steel-wheel rollers, equipment operation shall be in accordance with the manufactures' recommendations. Vibratory roller shall not be left vibrating while not rolling or when changing directions. Unless otherwise shown on the plans or approved by the Public Works Director, vibratory roller shall be allowed in the vibratory mode on mats with a plan depth of less than 1-1/2 inches.

   The motion of the rollers shall be slow enough to avoid other than usual initial displacement of the mixture. If any displacement occurs, it shall be corrected to the satisfaction of the Public Works Director. The roller shall not be allowed to stand on pavement which has not been fully compacted. To prevent adhesion
of the surface mixture to the steel-wheel roller, the wheels shall be kept thoroughly moistened with water, but an excess of water will not be permitted. Necessary precautions shall be taken to prevent the dropping of diesel, gasoline, oil grease or other foreign matter on the pavement, either when the rollers are in operation or when standing.

C. The edge of the pavement along curbs, headers and similar structures, and all places not accessible to the roller, or in such position as will not allow thorough compaction with the rollers, shall be thoroughly compacted with lightly oiled tamps.

D. Rolling with a trench roller will be required on widened areas, in trenching and other limited areas where satisfactory compaction cannot be obtained with the approved rollers.

6. **IN-PLACE COMPACTION CONTROL:** In-place compaction control is required for all mixtures.

7. **ROLLING WITH A PNEUMATIC-TIRE ROLLER:** Unless otherwise shown on the plans, rolling with a pneumatic-tire roller to seal the surface shall be provided. Rolling with a tandem or other steel-wheel roller shall be provided if required to iron out any roller marks.
DIVISION D
TECHNICAL PROVISIONS
SECTION 18
CUTTING AND REPLACING PAVEMENT

D-18.01 DESCRIPTION: This item shall govern for the cutting of pavements, the removal of bases and the replacement of bases and pavements, as herein specified and in conformity with the typical sections shown on the plans and to the lines established by the Project Engineer.

D-18.02 MATERIALS:

1. Prime Coat: All prime coat shall conform to the provisions of Division D, Section 12, “Bituminous Prime Coat”.

2. Tack Coat: All tack coat shall conform to the provisions of Division D, Section 13, “Bituminous Tack Coat”.

3. Asphalt Stabilized Base: All asphalt stabilized base shall conform to the provision of Division D, Section 15, “Asphalt Stabilized Base”.

4. Hot-Mix Asphaltic Concrete Pavement: All hot-mix asphaltic concrete pavement shall conform to the provision of Division D, Section 19.06, “Hot Mix Asphaltic Concrete Pavement - Type D”.

5. Excavation and Backfilling: All excavation and backfilling shall conform to the provision of Division D, Section 19, Excavation and Backfill for Utilities”. Backfill under existing pavement.

D-18.03 CONSTRUCTION METHODS:

1. Cutting of Pavements:

   a. Concrete and asphaltic concrete pavements: All concrete and asphaltic concrete pavements shall be cut with a concrete saw. The depth of the cut shall be such that upon removal of concrete and/or asphaltic concrete the sides of the cut shall be straight and square. Care shall be taken when cutting concrete pavement, not to cut transverse reinforcing steel.

   b. Base Material: Base material shall be removed by normal trenching operations.
2. Replacement of Bases:
   
a. Base Material: Base replacement shall be of the type shown on the plans and in the bid proposals.

3. Replacement of Pavements: Pavements shall be replaced with hot-mix asphaltic concrete pavement. Replacement will be of the type shown on the plans and in the bid proposals.

When hot-mix asphalt concrete is shown on the plans as replacement of pavement it shall be furnished and placed in accordance with Division D, Section 14, “Hot-Mix Asphaltic Concrete Pavement - Type D. Flexible base shall be in accordance with the primed provisions of Division D, Section 12, “Bituminous Prime Coat”, prior to the placement of hot-mix asphaltic concrete. All concrete bases shall be tack coated with RC-2 in accordance with the provisions of Division D, Section 13, “Bituminous Tack Coat”, prior to the placement of hot-mix asphaltic concrete. Cold Mix Limestone Rock Asphalt as per Division D, Section 17, may be used in lieu of hot mix asphalt.
DIVISION D
TECHNICAL PROVISIONS
SECTION 19
REINFORCED CONCRETE STORM DRAIN PIPE

D-19.01 DESCRIPTION: This item shall consist of reinforced concrete storm drain pipe of types, sizes, and classes shown on the plans furnished and installed in accordance with the locations, elevations, and conditions set forth in the specifications or as designated by the Public Works Director and/or City Engineer.

MATERIALS

D-19.02 REINFORCED CONCRETE STORM DRAIN PIPE: Reinforced concrete storm drain pipe shall be tongue and groove pipe and shall meet the requirements of ASTM Designation C76-59T, Class 3, with either Type A or Type B Wall. Extra strength pipe shall meet the requirements of ASTM Designation C76-59T, Class 4, with either Type A or Type B Wall. Where pipe is installed under highways, it shall be Class 4 with Type "A" Wall.

D-19.03 JOINTS MATERIALS: Reinforced concrete drain pipe joints shall be constructed to Ram-Nek, rubber O-rings, or approved equal.

D-19.04 CONCRETE: Concrete used for pipe cradles shall meet the requirements of Class "C" concrete, as set out in the section titled “CONCRETE” of these specifications. This concrete shall be furnished by an approved transit mix concrete company and/or mixed on jobsite to specifications herein established.

CONSTRUCTION METHODS

D-19.05 EQUIPMENT: All equipment necessary and required for the proper construction of storm sewer and appurtenances shall be on project site in first class working condition and shall be approved by the Public Works Director and/or City Engineer before construction is permitted to start.

The Contractor shall provide such hand tamping devices and pneumatic tampers as may be necessary to obtain the proper compaction for the pipe and backfill as specified.

D-19.06 EXCAVATION:

(A) Common: Common excavation shall consist of all excavation not classified as rock excavation and shall be carried out to net lines as specified and shown on the plans. If the excavation is carried out to a point below the required depth, this portion of the trench shall
be filled at the Contractor's expense with selected material approved by the Public Works Director and/or City Engineer and thoroughly compacted to the specified elevation of the pipe bed.

(B) **Rock**: Rock excavation shall consist of the removal of boulders and detached rock ½ cubic yards in volume or greater, and all rock in ledges or masses which can be removed only by the use of bars, sledges, mechanical hammers, or by blasting.

The sides of the trenches shall be excavated to neat lines of the required width and no rock masses shall be allowed to extend into these lines. The bottom of the trench shall be excavated horizontally to a depth of a least one-half the diameter of the pipe, or a minimum of 4 (four) inches greater than the finished grade of the pipe bed. After removal of all broken material from the trench, this portion of the trench shall be filled with clean, dry sand, or an equivalent granular material to the elevation of the pipe bed.

When the use of explosives is necessary for the prosecution of the work, the Contractor shall use the utmost care not to endanger life or property. All explosives shall be stored in a secure manner and all storage places shall be clearly marked "DANGEROUS EXPLOSIVES". The method of storing and handling explosives and highly flammable materials shall conform to Federal, State, and local laws and regulations. The Contractor shall not store or use explosives until he has taken the necessary legal precautions to save the Owner against any claims arising from such possession or use of explosives, with permission secured from the Public Works Director and/or City Engineer.

(C ) **General**: Excavated material not required or acceptable for backfill shall be disposed of by the Contractor as directed by the Public Works Director and/or City Engineer, or as specified herein. If, in the opinion of the Public Works Director and/or City Engineer, the bottom of the ditch consists of unstable soil, this soil shall be removed from the full width of the trench and replaced with a pit run gravel or pipe cradles. Pit run gravel shall vary in size from 3/4" to 3-1/2". The Public Works Director and/or City Engineer shall determine the depth of removal of unstable soil and the amount of backfill necessary.

The sides of the trench shall be vertical unless otherwise approved by the Public Works Director and/or City Engineer. Spaces for the construction of pipe joints shall be excavated accurately to size so that the barrel supports the entire weight of the pipe and so that no less than 3/4 of the length of the barrel is in continuous contact with the bed. Joint holes shall be large enough to permit easy working under the bottom of the pipe. The bottom of the ditch shall be shaped as shown on the plans.

The Contractor shall install such trench bracing and sheeting as is necessary to protect the excavation, and as required for safety and to conform with governing laws. Such installations shall be governed by the requirements set forth under OSHA's Revised Standards for Excavations.
Unless otherwise provided, the bracing and sheeting shall be removed by the Contractor after
the backfilling has been replaced to a point at least 12 (twelve) inches above the top of the pipe.
In no case shall any sheeting or bracing be removed until the backfilling conditions have been
met.

The Contractor shall take adequate precautions to prevent damage to all existing utilities. **Any
utility lines cut or damaged shall be repaired and restored to their former conditions as
specified on the plans.**

**D-19.07 TUNNELING:** Pipe shall not be laid in tunnel excavation except as shown on
plans or with written permission from the Public Works Director and/or City Engineer.

**D-19.08 EXCAVATION IN STREETS:** Excavation in streets, together with the main-
tenance of traffic where specified and the restoration of the pavement riding surface shall be
in accordance with the plan details or as required by other specifications included in the con-
tract.

Refer to plans (General Notes) for special instructions.

**D-19.09 REMOVING OLD STRUCTURES:** When old inlets or manholes are encountered
and no plan provisions is made for adjustments or connection to the new sewers, such manholes
and inlets shall be removed completely to a depth one (1) foot below the bottom of the trench.
In each instance, the bottom of the trench shall be restored to grade by backfilling and compacting
by the methods provided hereinafter for backfill. Where the trench cuts through storm or sanitary
sewers which are known to be abandoned, these sewers shall be cut flush with the side of the
trench and blocked with a concrete plug in a manner satisfactory to the Public Work Director
and/or City Engineer.

**D-19.10 DEWATERING TRENCH:** Storm sewers shall not be constructed or laid in a
trench in the presence of water. All water shall be removed from the trench sufficiently prior to
the storm sewer placing operation to insure a dry, firm bed on which to place the storm sewer,
and the trench shall be maintained in such unwatered condition until all concrete and mortar is
set. Removal of water may be accomplished by bailing, pumping, or by a well-point installation
as conditions warrant.

In the event that a trench cannot be dewatered to the point where the pipe subgrade is free from
mud, or it is difficult to keep the reinforcing steel clean in cast-in-place monolithic storm sewers,
a seal shall be used in the bottom of the trench. Such seal shall consist of a lean concrete mixture
(not less than three (3) sacks of cement per cubic yard), with a minimum depth of three (3) inches.


**D-19.11 CRADLES:** When, in the opinion of the Public Works Director and/or City Engineer, the natural fill material forming the bottom of the trench does not offer a suitable foundation for the pipe, he shall determine the location and dimensions of the necessary supporting cradles which must be added.

**D-19.12 CLASS B BEDDING:** The pipe shall be bedded on fine granular materials over an earth foundation, accurately shaped by means of a template to fit the lower part of the pipe exterior for at least 15 percent of its overall height. Selected materials from excavation or borrow shall then be placed along both sides of the pipe equally in layers not more than six (6) inches thick and compacted by mechanical tampers or rammers for the remainder of the lower 30 percent of the overall height of the pipe. Material for backfill or bedding shall be select material possessing a maximum PI of 18 and a maximum liquid limit of 35 for primary backfill, and 40 for secondary backfill, unless otherwise specified in plans.

**D-19.13 LAYING AND INSTALLING PIPE:** The Contractor shall provide and install necessary batter boards, wires, or mason's lines to insure installation of the pipe to the lines and grades set by the Project Engineer. The Contractor's facilities for lowering the pipe into the trench shall be such that neither the pipe nor the trench shall be damaged, nor the pipe disturbed that is already laid. The Public Works Director and/or City Engineer will inspect all pipe before it is placed in the trench and reject any sections that are damaged by handling or bound to be defective to a degree that would affect the functioning of the pipe. Such pipe so rejected shall be immediately removed from the site of the work. Pipe having breaks or defects not sufficient to cause rejection shall be laid in such a way that the break or defect is at the top.

The laying of the pipe in the finishing trench shall be started at the lowest point and laid upgrade. The bells on bell and spigot pipe shall be laid upgrade. The pipe shall be firmly and accurately set to line and grade so that the invert will be smooth and uniform.

No pipe shall be laid within ten (10) feet of any point where excavation work is in progress or in trenches containing a perceptible amount of water or on ground that is frozen unless special permission has been furnished by the Public Works Director and/or City Engineer.

Before leaving the work at night or any other time, the upper ends of all storm sewer lines shall be securely closed with a tight fitting plug and provisions shall be made to keep the line from floating out of place should the trench fill with water. Any damage to the storm sewer lines from failure to follow these provisions shall be repaired at Contractor's expense.

Provisions must be made at all times to keep the interior of the pipe that has been laid free from dirt, silt, gravel, and any other foreign matter and any such material that is deposited within the pipe from any cause whatsoever must be removed as the work progresses.
D-19.14 PIPE JOINTS: Contractor will use Ram-Nek flexible gasket joints that meet the Federal Specification SS-S-00210 (GSA-FSS) Type I, or any material (such as Mastik) which meets the approval of the Public Works Director and/or City Engineer.

If state highway crossings are included in the project, pipe joints shall be constructed in accordance with the Texas Department of Transportation specifications and shall be subject to their inspection and approval. The Texas Department of Transportation officials shall be notified in writing 48 hours before the work is planned, and, if they so desire, their representative may be on hand to supervise the work.

D-19.15 BACKFILLING: The following notes pertain to backfilling of trenches where utility and storm sewer pipe is placed, including all structures related to this type of construction.

(1) **Timing of backfill:** All trenches and excavation shall be backfilled within twenty-four (24) hours after pipes are installed, unless other means of protecting pipe is directed by the Public Works Director and/or City Engineer. At no time, however, shall any backfilling be done until the Public Works Director and/or City Engineer has inspected the pipe to be covered.

(2) **Backfill placement:** After the bedding has been prepared and the pipes installed as required by the pertinent specifications, selected materials from excavation or borrow shall be placed along both sides of the pipe equally in uniform layer not exceeding six (6) inches in depth (loose measurement) in the primary backfill zone and ten (10) inches in depth (loose measurement) in the secondary backfill zone, wetted if required, and thoroughly compacted so that on each side of the pipe there shall be a berm of thoroughly compacted material at least as wide as the external diameter of the pipe, except insofar as undisturbed material obstructs into this area.

(3) **Addition to backfill:** Whenever excavation is made for installation pipe culverts or storm sewers across private property or beyond the limits of the embankment, the top soil removed in excavating the trench shall be kept separate and replaced, as nearly as feasible, in its original position, and the entire area involved in the construction operations shall be restored to a presentable condition.

(4) **Earth Trench:** In earth trench, the pipe shall be placed on the natural, undisturbed earth foundation with the trench bottom flat or nearly so. Where rock, shale, or boulders are encountered in the trench, the same shall be removed to a depth of six (6) inches below the grade line and the trench shall be refilled with good, sound earth, gravel, or granular material up to original grade and tamped into place.

(5) **Cleaning and restoration of the site:** After the backfill is completed and the Contractor has disposed of all surplus material, dirt, and rubbish from the site, the Contractor shall then restore all disturbed areas to their original condition. No work shall be considered complete until the surface conditions at/or adjacent to the work site are in as good or better condition.
as existed prior to the start of the job. Omissions of any of the construction features called for in the plans or in the specifications or ordered by the Public Works Director and/or City Engineer shall be corrected by the Contractor at his/her expense.

(6) **Inspection:** Prior to the final approval of the utility lines, the Public Works Director and/or City Engineer, accompanied by the Contractor’s representative, shall make a thorough inspection by appropriate methods of the entire installation. Any indication of defects in material or workmanship or obstruction in the pipe due to the Contractor’s negligence shall be corrected by the Contractor.

**D-19.16 BACKFILL-STORM SEWER:**

1. **Conditions:** There are three (3) different conditions for backfill of proposed pipe. The plans indicated which condition shall prevail in each section of block of the pipe route. If the plans do not indicate a backfill condition, Condition “A” shall prevail.

**CONDITION “A”:** If pipe is laid under an existing paved street which will be paved as part of the ongoing project, then the backfill shall consist of uniform six inch (6") layers mechanically or hand compacted to not less than 95% of the maximum density at optimum moisture content (as per TEX-113-E) in the primary backfill zone (from bedding to 12" above top of pipe) and uniform ten inch (10") layer compacted to not less than 90% of the maximum density pursuant to TEX-113-E in the secondary backfill zone up to 12" from the bottom of the subgrade elevation. The final 12" shall be layered in 2-6" lifts compacted to not less than 95% of the maximum density at optimum moisture content and the moisture shall not be more than 2% above or below the optimum.

**CONDITION “B”:** If pipe is laid along unpaved street, outside of paved street areas, and within street right-of-way but outside of the back of curb/gutter lines, then the backfill required shall consist of uniform six inch (6") layers mechanically or hand-tamped and compacted to not less than 95% of the maximum density at optimum moisture content in the primary backfill zone (from bedding to 12" above top of pipe), and the secondary backfill zone may be waterjetted or machine tamped in 10" layer, provided that said compaction technique may be tested to reach a maximum density of not less than 90%. The backfilling shall be continued in this matter to the top of the trench, with an additional 6" crown provided above the surface of the finished grade until final grading is completed. Density tests require the moisture to be not more than 2% above or below the optimum moisture.

**CONDITION “C”:** If pipe is laid outside of street right-of-way, then the backfill required shall consist of uniform six inch (6") layers mechanically of hand-tamped and compacted to not less than 95% of the maximum density at optimum moisture content as per TEX-113-E in the primary backfill zone (from bedding to 12" above top of pipe), the secondary backfill zone shall be compacted by whatever means the Contractor chooses to a density comparable with the adjacent undisturbed material and the entire area involved in the construction operation.
shall be restored to a presentable condition. Primary backfill zone requires density tests and moisture shall not be more than 2% above or below the optimum.

2. **Water Jetting:** In certain sections of the trench, excluding street intersections and underpaved areas, and only when authority is obtained in writing from the Public Works Director and/or City Engineer, backfill may be compacted by use of the jetting method. When using the jetting method, backfill above the pipe zone shall be placed in lifts not to exceed (5) five feet. Water jetting shall be delivered under sufficient volume and pressure through an approved jetting hose and pipe nozzle. The jetting hose shall have a minimum inside dimension of 2 inches (2"). The jetting hose shall be connected to an approved minimum 2 inches (2") water pump capable of delivering water at the volume and pressure as required. The pipe nozzle shall be of sufficient length to introduce the water at a depth of not less than one foot (1') above the preceding lift. Points of trench jetting shall be staggered along the length of the trench and spaced at not more than 3 feet (3') on centers. Each 5 foot (5') lift shall be jetted initially at a depth of not more than one foot (1') above the preceding lift. Sufficient water shall be introduced into the secondary backfill to cause complete subsidence of the backfill and develop free standing water at the surface of each lift.

After the final lift has been jetted as approved, twelve (12) hours shall be allowed for the reduction of the material's moisture content. When the backfill moisture content is acceptable for mechanical or pneumatic compaction, the surface shall be compacted to the satisfaction of the Public Works Director and/or City Engineer. The surface of the final lift of trenches subject to traffic shall be compacted by ditch tamping equipment.

3. **Material for backfill:** Material for backfill shall be select fill possessing a maximum plasticity index of 8 and maximum liquid limit of 35 for primary backfill and 18 for secondary backfill, unless otherwise specified in plans. The embedment and material in the pipe zone (primary backfill zone) shall be granular siliceous material free of rock over ½ inch in any dimension, which shall contain no more than twenty-five percent (25%) of weight of clay, silt, or organics such as pit-run-washed sand. Select excavation material may be acceptable; however, the Contractor may be required to submit sample sieve analysis results from a reputable independent testing laboratory in order to use such materials for embedment. In the event that the Contractor elects to test select excavated material to determine its worthiness and compliance, the testing shall be accompanied as a composite of three (3) or more locations at the direction of the Public Works Director and/or City Engineer. All material shall be free of trash, debris, or other contamination. The Contractor may elect to use sand or gravel (one or the other) in the primary backfill zone, or may elect to use gravel throughout the entire trench, this with the approval of the Public Works Director and/or City Engineer.

4. **Pipe joint backfill:** Joint holes shall be filled and tamped ahead of the rest of the backfilling operation. Tamping of these holes shall be sufficient to insure that no air pockets remain under the pipe, but it shall not be carried out to the degree that might disturb the pipe joint.
D-19.17 BACKFILL UTILITIES: Backfill for utilities shall be in accordance with backfill requirements for storm sewer and in addition thereto, the following specifications shall apply:

1. **Density requirements:** All utility pipe backfill shall be compacted to not less than 95% of the maximum density at optimum moisture content as determined by procedures set out under TEX-113-E. This compaction shall extend to the entire depth of each layer and the backfill, when completed, shall be a homogenous and uniformly compacted mass. Water jetting in this backfill operation will not be permitted.

2. **Backfill water operation:** Where trenching is done in paved areas or other areas to be paved in the future, the backfilling for utility pipe shall be in accordance with either Condition "A" or Condition "B" requirements (excluding water jetting). Contractor shall furnish water as needed.

3. **Intersection crossing:** Whenever excavation is made for installing utility pipe across a street, the Contractor has the option to fill the trench with gravel or caliche, provided material satisfies the conditions in Division D, Section 19, D-19.16 (3. Material for backfill), and meets the density requirements as set forth in Paragraph 1 above. This procedure will ensure smooth traffic flow and alleviate any possibility of bottlenecking.

4. **Railroad crossing:** Where pipe line crosses underneath railroad track, final backfilling shall be done by hand and thoroughly mechanically tamped in 6 inch (6") layers to top elevation of excavation.

5. **Requirements for controlling agencies:** Contractor shall determine all requirements of various controlling agencies in connection with backfilling, pavement replacement, and general construction before starting construction and should confirm the suitability of the backfill material.
DIVISION D
TECHNICAL PROVISIONS
SECTION 20
LAYING PROCEDURES - STORM SEWER

D-20.01 LAYING PROCEDURES:

1. **Existing Utilities:** Before commencing excavation, the Contractor shall notify all utility companies with sufficient lead time and confirm the location of existing underground lines and conduits in the work area.

2. **Dewatering:** The Contractor shall provide and maintain adequate equipment to remove and dispose of all surface and ground-watering entering excavation, trenches, or other parts of the work.

3. **Water-jetting:** In certain sections of the trench (only under Conditions B or C, Division D, Section 19, D-19.16 **BACKFILL - STORM SEWER**) and only when authority is obtained in writing from the Engineer, backfill may be compacted with water by use of the jetting method. When using the jetting method, backfill above the pipe zone shall be placed in lifts not to exceed three (3) feet.

Water jetting shall be delivered under sufficient volume and pressure through an approved jetting hose and pipe nozzle. The jetting shall have a minimum inside dimension of two inches (2""). The jetting hose shall be connected to an approved minimum two inch (2"") water pump capable of delivering water at the volume and pressure as required by Public Works Director and/or City Engineer. The pipe nozzle shall be of sufficient length to introduce the water at a depth of not less than one foot (1') above the preceding lift. Points of trench jetting shall be staggered along the length of the trench and spaced at not more than three feet (3') on centers. Each three foot (3') lift shall be jetted initially at a depth of not more than one foot (1') above the preceding lift. Sufficient water shall be introduced into the secondary backfill to cause complete subsidence of the backfill and develop free standing water at the surface of each lift.

After the final lift has been jetted as approved, twelve (12) hours shall be allowed for the reduction of the material’s moisture content. When the backfill moisture content is acceptable for mechanical or pneumatic compaction, the surface shall be compacted by ditch tamping equipment.

D-20.02 PREPARATION OF TRENCH: Except in water-bearing earth, mechanical excavation of trenches shall be limited to an elevation four inches (4"") above the elevation of the invert of the pipe after placement in its final position. All additional excavation
necessary for preparation of the trench bottom shall be made manually. Excess excavation below required level shall be backfilled with gravel which shall be thoroughly tamped. Public Works Director and/or City Engineer will determine the depth of removal, and replacement of unstable soil shall be at Contractor's expense. Contractor shall furnish pumps to keep excavation free of water.

Whenever the presence of incipient slides are noted during excavation, the trench walls shall be restrained with adequate sheeting and shoring.

When excavation are made adjacent to existing building or other structure, existing utility lines, or in paved streets, particular care shall be taken to adequately sheet, shore, and brace the sides of the excavation to prevent undermining of or settlement beneath the structures, utility lines, or pavement. Underpinning of adjacent structures or pavement shall be done by the Contractor at his/her own cost and expense, and in a manner satisfactory to the Public Works Director and/or City Engineer. When required by the Public Works Director and/or City Engineer, the pavement shall be removed, the void satisfactorily refilled, and the pavement replaced by the Contractor. The entire expense of such removal and subsequent replacement thereof shall be borne by the Contractor.

Should trenches be dry when the trench bottom is prepared, a continuous trough shall be prepared or excavated to receive the bottom quadrant of the pipe barrel. In addition, bell holes shall be excavated so that after placement, only the barrel of the pipe receives bearing pressure from the trench bottom.

Preparation of the trench bottom and placement of the pipe shall be carefully made so that, when in final position, the pipe is true to line and grade.

When sand, broken stone, or gravel is used to support the pipe, such material shall be placed, in the trench bottom in sufficient quantity so that a trough shall be formed to support the bottom quadrant of the pipe barrel.

Trenches in which concrete cradles, cushions, or encasements for pipe are to be placed, may be excavated completely with mechanical equipment. Concrete cradles, cushions, and encasements, where required, shall be constructed as shown on the plans, or, where not shown on the plans, as directed by the Public Works Director and/or City Engineer. Where concrete cradles or cushions are constructed beneath the pipe, the subgrade shall be prepared to dimensions and form as shown on the plans. Concrete cushions, cradles, or encasements shall be placed in a dry trench unless, in the opinion of the Public Works Director and/or City Engineer, such a method is not practical. Where concrete is placed in wet trench, the work shall be done strictly as directed or approved by Public Works Director and/or City Engineer. The pipe shall be firmly bedded in concrete to the proper grade. Concrete encasements placed over or on the pipe shall be so placed as not to damage or injure joints or displace the pipe. For pipe encasements, sufficient concrete shall be used that the encasement is at least four inches (4")
thick at all points. The concrete shall be wet enough during placement to permit its flow, without excessive prodding, to all required points around the pipe surface. The width of cradle shall be such as to completely fill the trench width. In the case of extremely wide trenches, the concrete cradle may be confined to a narrower width, but in no case shall it be less than twelve inches (12") greater than the diameter of the pipe at the outside of the socket.

**D-20.03 PIPE LAYING:** Pipe shall be protected during handling against impact shocks and free fall. Pipe shall be kept clean at all times, and no pipe shall be used in the work which does not conform to the appropriate ASTM Standard.

The laying of pipe in finished trenches shall be commenced at the lowest point, with the spigot ends pointing in the direction of the flow.

All pipe shall be laid with ends abutting and true to line and grade. They shall be careful centered so that they will form a sewer with a uniform invert.

Pipe shall be set firmly according to line and grade, preparatory to making pipe joints, all surfaces of the portion of the pipe to be joined shall be cleaned.
DIVISION D
TECHNICAL PROVISIONS
SECTION 21
STRUCTURAL EXCAVATION AND BACKFILL

D-21.01 DESCRIPTION: This item shall consist of doing the excavation for the placing of structures; for the disposal of all material obtained from such excavation; for the backfilling around completed structures to the finished grades as called for on the plans. Work to be done shall include all the necessary pumping or bailing, sheeting, drainage, and the construction and removal of any required cofferdams. Unless otherwise provided, the work included herein shall provide for the removal of old structures or portions thereof, trees, and other obstructions necessary to the proposed construction.

D-21.02 DEFINITIONS: “Common Structural Excavation” shall include the removal of all materials regardless of its nature.

D-21.03 USE OF EXPLOSIVES: When the use of explosives is necessary for the prosecution of the work, the Contractor shall use the utmost care not to endanger life or property. All explosives shall be stored in a secure manner, and all storage places shall be marked clearly “DANGEROUS EXPLOSIVES”. The method of storing and handling explosives and highly flammable materials shall conform with Federal and State laws and regulations. The Contractor shall not use explosives until he has taken the necessary legal precautions to save the Owner against any claims arising from such use of explosives.

CONSTRUCTION METHODS

D-21.04 EQUIPMENT: All equipment necessary and required for the proper construction of structures and appurtenances shall be on project site in first class working condition and shall be approved by Public Works Director and/or City Engineer before construction in permitted to start.

The Contractor shall provide hand tamping devices and pneumatic tampers as may be necessary to obtain the proper compaction for the bed and backfill as specified.

D-21.05 COMMON EXCAVATION: Common excavation shall be done in accordance with the lines and depths indicated on the plans or as established by Project Engineer, no excavation shall be made outside a vertical plan three feet from the footing lines and parallel thereto.

In order that the Public Works Director and/or City Engineer may judge the adequacy of a proposed foundation, the Contractor, if requested, shall make soundings to determine the character
of the subgrade materials. The maximum depth of such soundings will not be required to exceed five (5) feet below the proposed footing grade; it is the intent of this provision that soundings shall be made at the time the excavation in each foundation is approximately complete.

The final elevation to which a foundation is to be constructed shall be as shown on the plans or as raised or lowered by written order of the Public Works Director and/or City Engineer when such alterations are judged proper to satisfactorily comply with the design requirements for the structure.

When a structure is to rest on an excavated surface other than rock, special care shall be taken not to disturb the bottom of the excavation and the final removal of the foundation material to grade shall not be performed until just before the footing is placed.

**D-21.06 ROCK EXCAVATION:** All material encountered, regardless of its nature, shall be included as common structural excavation.

Unless written permission to the contrary is given by the Public Works Director and/or City Engineer, no excavation shall be made outside a vertical plane 3 (three) feet from the footing lines and parallel thereto.

Rock foundation material shall be freed from all loose material, cleaned and cut to a firm surface either level, stepped, or serrated as directed by the Public Works Director and/or City Engineer. All seams shall be cleaned out and filled out with concrete at the time the footing is placed.

**D-21.07 EXCAVATED MATERIAL:** Excavated material required to be used for backfill may be deposited by the Contractor in storage piles at points convenient for rehandling. The location of storage piles shall be subjected to the approval of the Public Works Director and/or City Engineer who may require that survey points or lines be kept free from any obstruction.

Excavated material not required for backfill shall be disposed of by the Contractor as directed by the Public Works Director and/or City Engineer or as specified herein. If, in the opinion of the Public Works Director and/or City Engineer, the bottom of the ditch consists of unstable soil, this soil shall be removed from the full width of the trench and replaced with a pit-run gravel. Pit-run gravel shall vary in size from 3/4" to 3 1/2 ". The material shall be free from large amounts of organic material such as grass, roots, etc. The Public Works Director and/or City Engineer shall determine the depth of removal or unstable soil and the amount of backfill necessary. The sides of the trench shall be vertical unless otherwise approved by the Public Works Director and/or City Engineer. The Contractor shall install such trench bracing and sheeting as is necessary to protect the excavation also as required for the safety and to conform with governing laws.
Unless otherwise provided, the bracing and sheeting shall be removed by the Contractor after the backfilling has been replaced to a point at least 12 (twelve) inches above the top of the structure. In no case shall any sheeting or bracing be removed until the backfilling conditions have been met. The cost of bracing and sheeting shall be included in the unit price per linear foot for the structures.

The Contractor shall take adequate precautions to prevent damage to all existing utilities. Any utility lines cut or damaged shall be repaired or restored to their former condition.

**D-21.08 DEWATERING TRENCH:** Removal of water may be accomplished by bailing, pumping, or by a well-point installation as conditions warrant. Pumping or bailing from any excavation shall be done through or alongside any concrete being placed. No pumping or bailing will be permitted during the placing of concrete or for a period of at least 24 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a watertight wall.

**D-21.09 BEDDING:** The structure shall be bedded as shown on plans on fine granular materials over an earth foundation accurately shaped to fit the lower part of the structure exterior for at least 15% of its overall height. Selected material from excavation or borrow shall then be placed along both sides of the structure equally in layers not more than six (6) inches thick and compacted by mechanical tampers or rammers for the remainder of the lower 30% of the overall height of the structure.

**D-21.10 BACKFILLING:** As soon as practicable, all portions of excavation not occupied by the permanent structure shall be backfilled. Backfill material shall be free from large or frozen lumps, wood or other extraneous material, placed in successive layers of not more than 6 inches in depth (loose measurements) for the full width of the cross section. The material and the layers shall have the proper moisture content before tamping or rolling. Wetting or drying of the material and manipulations to secure a uniform moisture content throughout the layer will be required. Should the material be too wet to permit proper compaction or rolling, all work on all positions of the fill thus affected shall be corrected. Unless otherwise provided by the plans or special provisions, hand tamping will not be accepted as an alternate for mechanical compaction.

As a general rule, material used in filling or backfilling the portions described in this paragraph shall be an earth free of any appreciable amount of gravel or stone particles more than 4 (four) inches in greatest dimension and of a graduation that permits thorough compaction. When, in the opinion of the Public Works Director and/or City Engineer, such material is not readily available, the use of rock or gravel mixed with earth will be permitted provided no particle larger than 12 (twelve) inches in the greatest and 6 (six) inches in the least dimensions may be used. The percentage of fines shall be sufficient to fill all voids and insure a uniform and tho-
roughly compacted mass of proper density. No backfill shall be placed adjacent to or over single and multiple boxes until the top slab has attained 500 psi flexural strength.

All backfill as specified above shall be compacted to not less than 95% of the maximum density at optimum moisture content as determined by procedures set out under TEX-113-E. This compaction shall extend to the entire depth of each layer and the backfill, when completed, shall be a homogenous and uniformly compacted mass. Water jetting in backfill operations will not be permitted.

D-21.11 CLEANING AND RESTORATION OF SITE: After the backfill is completed, the Contractor shall dispose of all surplus material, dirt, and rubbish from the site and shall restore all disturbed areas to their original condition. After all work is completed, the Contractor shall remove all tools and other equipment used by him, leaving the entire site free, clear, and in good condition.
SECTION D
TECHNICAL PROVISIONS
SECTION 22
CONCRETE BOX CULVERTS

D-22.01 DESCRIPTION: This item shall govern for the materials furnished, and for constructing, furnishing, and placing concrete box culverts, at the locations shown, and in accordance with the details on the plans of this item. Unless otherwise shown on the plans, the Contractor shall have the option of furnishing cast-in-place, pre-cast (formed) or precast (machine made) box culverts.

D-22.02 MATERIALS: All materials shall conform to the pertinent requirement of the following items:

Section D-5, “Concrete Structure”
Section D-2, “Concrete”
Section D-7, “Reinforcing Steel”
Section D-19, “Reinforced Concrete Storm Drain Pipe”

Concrete for precast (machine-made) concrete boxes shall conform to ASTM C789 or C850.

When precast (machine-made) boxes are furnished and portland cement is partially replaced, blended, or otherwise modified by pozzolan, the pozzolan shall be fly ash conforming to the Departmental Materials Specification D-9-8900, “Fly Ash”. Copies of Departmental Materials Specifications are available from the Texas Department of Transportation, Division of Materials and Tests, 125 East 11th Street, Austin, Texas 78701-2483.

D-22.03 TYPES: Cast-in-place concrete boxes shall conform to the details shown on the plans and to the requirements of Section 2 “Concrete” and Section 5 “Concrete Structures”.

Precast (formed) concrete boxes shall conform to the details shown of the plans and the requirement of (TxDOT Standard Specification-1995 Edition) Item 424, “Precast Concrete Structure (Fabrication)”.

Precast (machine-made) concrete boxes shall conform to the requirements of ASTM C789 or C850, which is applicable.

D-22.04 FABRICATION:

(1) General. All fabrication of concrete boxes including forming, casting, and curing shall conform to the following requirements.
(a) Cast-in-place concrete boxes shall be produced in accordance with Section 17, Concrete Structures”.

(b) Precast (formed) concrete boxes shall be produced in accordance with Item 424, “Precast Concrete Structure (Fabrication)” (TxDOT Standard Specification-1995 Edition).

(c) Precast (machine-made) concrete boxes shall be produced by a process which will provide for uniform placement of the concrete in the forms and compaction by mechanical devices which will assure dense concrete. Concrete shall be mixed in a central batch plant or other approved batching facility from which the quality and uniformity of the concrete can be assured. Ready-mix concrete will not be acceptable for use in precast (machine-made) concrete boxes. Curing shall be in accordance with ASTM C789 or C850 whichever is applicable.

(2) Testing. Test specimens for testing of cast-in-place concrete boxes sections shall be in accordance with Section 14, “Concrete”. Test specimens for precast (formed) concrete box sections shall be in accordance with Test Method TEX 704-I. Test specimens for precast (machine-made) shall be test cylinders made at the same time and in the same manner as the box sections they represent.

For precast concrete boxes (machine-made), a minimum of four (4) test cylinders shall be made for each day’s production run of each size and class of box section. Test cylinders for machine-made concrete boxes shall be cured in the same manner and for the same time as the boxes they represent.

Equipment required for testing concrete boxes produced in a precasting plant shall be furnished by the producer.

(3) Lifting Holes. For precast concrete boxes, not more than four (4) lifting holes may be provided in each section to facilitate handling. Lifting holes may be cast, cut into fresh concrete after form removal, or drilled. Lifting holes shall be so sized as to provide for adequate lifting devices based on the size and weight of the box section but shall not be larger than three (3) inches in diameter. Spalled areas around the holes shall be repaired.

(4) Marking. Precast concrete boxes produced in a precasting plant shall bear the following markings:

(a) The name of trademark of the producer.

(b) The date of manufacture.

(c) The box size and height of fill.
(d) When lifting holes are not provided, one end of each box section shall be clearly marked on the inside and outside walls to indicated the top or bottom as it will be installed.

(e) When required under “Fabricating Tolerances”, matchmarks shall be use for proper installation.

Markings shall be indented into the box section or may be painted thereon with waterproof paint.

(5) Fabricating Tolerances. Tolerances for precast sections of either type shall conform to the following:

The inside vertical and horizontal dimensions shall not vary from plan requirement by more than ½ inch.

The horizontal or vertical plane at each end of the box section shall not vary from perpendicular by more than ½ inch, measured on the inside faces of the section.

The sides of a section at each end shall not vary from being perpendicular to the top and bottom by more than ½ inch, measured on the inside faces of the section.

The thickness of walls and slabs shall not be less than that shown on the plans, except than an occasional deficiency not greater than 1/4 inch will be acceptable. If proper jointing is not affected, thickness in excess of plan requirements are acceptable.

The straightness of the tongue and groove, at the mating surface shall not vary by more than 1/4 inch.

Deviations from the above tolerances will be acceptable if the sections can be fitted at the plant or job site and it is demonstrated that an acceptable joint can be made. For this condition an acceptable joint is:

When two sections are fitted together on a flat surface, in proper alignment and in the position the sections will be installed, the joint opening at any point shall not exceed one (1) inch. Sections fitted together at the plant and accepted in this manner shall be matchmarked for installation.

(6) Defects and Repair. Fine cracks on the surface of the member which do not extend to the plane of the nearest reinforcement will not be cause for rejection unless the cracks are numerous and extensive. Cracks which extend into the plane of the reinforcing steel shall be repaired in an approved manner.
Small damaged or honey combed areas which are purely surface in nature shall be repaired to the satisfaction of the Project Engineer. Excessive damage, honeycomb or cracking will be subject to structural review. When fine cracks on the surface indicate poor curing practices, further production of precast sections shall be discontinued until corrections are made and proper curing provided.

(7) Storage and Shipment. Precast sections shall be sorted on level blocking in a manner acceptable to the Project Engineer. No load shall be placed upon the section until design strength is reached and curing completed. Shipment of sections may be made when the design strength is reached and curing requirements have been met.

**D-22.05 CONSTRUCTION METHODS:** Excavation, bedding and backfill shall be in accordance with the requirements of Section 21, "Excavation and Backfill for Structures", and "Backfilling" except where tunneling or jacking methods are required or permitted by the plans.

Unless otherwise shown on the plans, the Contractor may use any of the jointing material in accordance with the jointing requirements specified in Section 19, "Laying Procedure-Storm Sewer".

When precast box culverts are used to form multiple barrel structures, the box sections shall be placed in conformance with the details shown on the plans.

Connections of precast sections to cast-in-place culverts or to any required headwalls, wingwall, riprap, or other structure shall conform to the details on the plans. Lifting holes shall be filled with mortar or concrete and cured to the satisfaction of the Public Works Director and/or City Engineer. Precast concrete or mortar plugs may be used when approved by the Public Works Director and/or City Engineer.
DIVISION E
TECHNICAL PROVISIONS
SECTION I
MISCELLANEOUS

E-1.01 TRAFFIC STRIPE PAINTING, NO PARKING AND FIRE ZONES.
CROSSWALKS: ADA SIGNAGE

All major streets will have their centerline stripped; all curbs at street intersection will be painted, traffic yellow to denote “No Parking”. All fire hydrants will have a “Fire Zone”, painted red on the curb. Crosswalks, if required shall be painted white. ADA Signage, if required will be done by the Contractor.

Materials:

All traffic paint shall be a chlorinated rubber, red, yellow, white or handicap blue.

Application:

Stripe of paint shall be applied (105 sq. ft. per gallon ± 5%) with a pavement stripping machine approved by the Public Works Director and/or City Engineer.

E-1.02 STREET NAME SIGNS/OTHER TRAFFIC SIGNS: Street Name Signs/Other Traffic Signs within the City Limits and within the City’s (5) five miles extra territorial jurisdiction, street name signs and the block number shall be installed at all intersections. Traffic control sign, including speed limit signs shall also be installed by the Contractor.

All traffic signs must meet requirements as shown on the Texas Manual on Uniform Traffic Control Devices.

E-1.03 STREET OPENING: The pavement shall be opened to the public when directed by the Public Works Director and/or City Engineer, after approval of the final inspection.

E-1.04 STREET EXCAVATION REPAIRS: No person shall open any part of any street, alley or sidewalk without first applying to the Public Works Director and/or City Engineer in writing for an excavation permit. A condition of each excavation permit is that the applicant shall protect and save harmless the City of Eagle Pass, its agents, servants, and employees from any and all liability for injuries to persons or property resulting from or caused by any activities associated with and authorized by the issuance of such permit. Plans and profile of the proposed excavation shall be presented at the time of requesting the excavation permit. Depending on the age of the street, the City may require boring instead of an open cut.
CITY DEPARTMENT, UTILITY COMPANIES: City Departments, City of Eagle Pass Water Works System, Utility Companies and other companies having a franchise agreement with the City are required to obtain an excavation permit before any excavation is begun. Whenever a cut or excavation is necessary for the protection of public health and safety, and must be performed outside the normal City working hours, the required permit shall be obtained within (3) three working days of performing the excavation. Utility companies are required to install utilities before streets are paved or arrange to install casing for later installation. Open cuts will not be allowed on new streets.

SAFETY PRECAUTIONS:

A. BARRICADES TO BE ERECTED AND MAINTAINED:
When an excavation is made in any street, alley, sidewalk, or public place in the City, the person by or for whom such excavation is made shall cause that barricades, or fence to be placed and fixed so as to enclose such excavation and the dirt, ground or other material, that is excavated. Barricades must be in place during the whole time the excavation is open. Warning signs must also be put up by the Contractor to warn the public.

B. BARRICADES MUST BE LIGHTED AT NIGHT:
At night a sufficient number of marker lights shall be fixed to some part of the barricades, or placed in some other manner over or near the excavation site to warn pedestrians and drivers of the existence of such obstructions.

The lights shall be kept lighted from twilight through sunrise, and shall be continued until all repairs have been completed.

Persons making excavation shall cause the perimeter of the excavation site to be spray painted as follows:

<table>
<thead>
<tr>
<th>COLOR:</th>
<th>TYPE:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>Water</td>
</tr>
<tr>
<td>Green</td>
<td>Sanitary Sewer</td>
</tr>
<tr>
<td>Yellow</td>
<td>Natural gas, oil, stream</td>
</tr>
<tr>
<td>Red</td>
<td>Electric</td>
</tr>
<tr>
<td>Orange</td>
<td>Telephone/Television</td>
</tr>
<tr>
<td>Pink</td>
<td>Temporary Survey Marks</td>
</tr>
<tr>
<td>White</td>
<td>Proposed Excavation</td>
</tr>
</tbody>
</table>

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No excavation will start until all required safety warning signs, barricades, etc., have been erected at the excavation site, and the excavation permit is in place, except in case of emergency.

After the excavation has been performed and the necessary repairs/construction is finished the excavation site will be repaired as follows:

1. No debris, pavements, rocks or contaminated soil will be allowed as backfill.
2. Backfill will be placed in layers not exceeding (12") twelve inches and hand or machine tamped as needed.
3. A minimum of (8") eight inches of Type F Material (caliche) will be placed and compacted to 95% density.
4. The existing pavement will be saw cut a minimum of (12") twelve inches laterally on each side of the excavation.
5. Two-and-a-half inches (2-1/2") of Type CC Asphalt will be placed and compacted to match the grade on the existing pavement. Grade will be checked by the Public Works Director and/or City Engineer using a straight edge.
6. The Public Works Director and/or City Engineer will inspect and approve the repairs. After approval, all barricades may be removed.

TOTAL RESTORATION REQUIRED:
In the cases where an excavation disturbs more than twenty-five percent (25%) of the pavement width, as determined by the Public Works Director and/or City Engineer, restoration will include a one-and-one-half inch (1-1/2") Type CC overlay of the entire cross section of the road for the entire length of the excavation. In the case of sidewalk excavations, the same requirements shall apply, except that the reconstructed surface shall be equal or better material as previously existed, as determined by the Public Works Director and/or City Engineer.

ALTERNATE CONSTRUCTION METHOD:
Streets may be paved in alternate manner provided the design is prepared by a Registered Professional Engineer, approved by our Public Works Director and/or City Engineer and is based on subsurface soil investigations provided by an Independent Testing Laboratory.

OTHER CONCERNS:
Any concerns not addressed in the City of Eagle Pass Construction Specifications will have to meet the Texas Department of Transportation Standard Specifications - 1995 Edition.
DIVISION F
SECTION I
TECHNICAL PROVISIONS
OSHA’S REVISED STANDARDS
FOR EXCAVATION
FACT SHEET: OSHA'S REvised STANDARD FOR EXCAVATIONS

I. SCOPE

Covers all open excavations; defines excavation to include trenches.

II. General Requirements

**Protection of employees in excavations** against cave-ins except when the excavation is in stable rock or less than five feet deep and examination by a competent person provides no evidence that a cave-in should be expected; and against falling rock, soil or material by use of an "adequate" system. The latter operation includes scaling to remove loose rock or soil, installation of protective barricades and other "equivalent protection." Material or equipment which might fall or roll into an excavation must be kept at least two feet from the edge of excavations, or have retaining devices, or be prevented from falling with a combination of both precautions.

Daily inspections of excavations, adjacent areas, and protective systems by a competent person and the removal of exposed employees if evidence of possible cave-ins, failure of protective systems, hazardous atmospheres, or other hazardous conditions until necessary precautions have been taken.

Removal of or neutralization of *surface encumbrances* which may create a hazard.

Estimate location of *underground installations* (sewer, telephone, electrical, fuel and other lines; storage tanks, etc.) prior to digging; pinpoint actual locations as estimated locations are approached.

Ramps, runways, ladders or stairs as means of **access/egress** must be within 25 feet of an employee work area if a trench is four feet or more deep.

**Warning system for mobile equipment** including barricades, hand or mechanical signals, or stop logs.

Testing and Controls for *hazardous atmospheres* including emergency rescue equipment and daily inspections for potentially hazardous conditions by a "competent person." Controls include respirators or additional ventilation, if needed, and individually attended lifelines during descent into bell-bottom pier holes or similar excavations.

Support systems such as shoring, bracing, or underpinning to ensure the stability of adjacent structures such as buildings, walls or sidewalks.
III. Requirements for Protective Systems

Sloping and benching systems -- four options:

-- A slope of 14 degrees or less, in lieu of soil classification. A slope of this gradation or less is considered safe for any type of soil.

-- Maximum allowable slopes and allowable configurations for sloping and benching systems will be determined through use of Appendices A (Soil classification) and B (Sloping and Benching).

-- Designs of sloping or benching shall be selected from and be in accordance with data provided in written form, the text to identify: Criteria that affect the selection, the limits of use of the data and sufficient explanatory data as necessary to assist in making a correct choice of a protective system.

At least one copy of the tabulated data identifying the Registered Professional Engineer who approved the information shall be maintained at the jobsite during the time the work is being carried out.

-- Excavations can be designed by a Registered Professional Engineer, put in written form and kept at the worksite, but must include, at least, the magnitude and configuration of the slopes determined to be safe for the project and the name of the RPE who approved the plan.

Support, shield and other protective systems -- four options:

-- Designs for timber shoring in trenches set in accordance with the conditions and requirements determined by using Appendices A and C (timber shoring for trenches). For aluminum hydraulic shoring, Appendices A and D can be used if manufacturers' tabulated data is not available.

-- Designs using manufacturers' tabulated data may be used, deviation allowed only with specific, written approval of the manufacturer.

-- Designs using other tabulated data may be used provided the data is in writing and includes: Explanatory information to aid the user in making a selection, the criteria determining the selection, and the limits on the use of the data. At least one copy of the information, including the identity of the RPE, kept at the worksite during construction of the protective system.

-- Design by a Registered Professional Engineer. Design systems not using any of the three previously cited options must be approved by a RPE, shall be in writing and include the identity of the RPE and details such as sizes, types and configurations of the materials to be used. At least one copy of the plan to be at the job site during construction.
The standard allows an employer to use a trench box or shield that is either designed or approved by a registered professional engineer (RPE) or is based on tabulated data prepared or approved by an RPE.

The standard allows construction workers to remain inside trench shields that are being repositioned, provided that the shields are moved horizontally only and the shields are not lifted.

According to the new standard, information necessary for the safe installation, placement, use and removal of any trench support system must be available at the work site at all times, but a written log or record of inspections is not necessary.

This final standard goes into effect 60 days after publication in the Federal Register.
PART 1926—[AMENDED]

Subpart M—[Amended]

1. By revising the authority citation for subpart M of part 1926 to read as follows:

Authority: Sec. 107, Contract Work Hours and Safety Standards Act (Construction Safety Act) [40 U.S.C. 333]; Secs. 4 & 5, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12-71 (36 FR 8754), 8-76 (41 FR 25059), or 9-83 (48 FR 35736), as applicable, and 29 CFR part 1911.

2. By revising subpart P of part 1926 to read as follows:

Subpart P—Examinations

Sec.
1926.650 Scope, application, and definitions applicable to this subpart.
1926.651 General requirements.
1926.652 Requirements for protective systems.

Appendix A to Subpart P—Soil Classification
Appendix B to Subpart P—Sloping and Benching
Appendix C to Subpart P—Timber Shoring for Trenches
Appendix D to Subpart P—Aluminum Hydraulic Shoring for Trenches
Appendix E to Subpart P—Alternatives to Timber Shoring
Appendix F to Subpart P—Selection of Protective Systems

Subpart P—Excavations

Authority: Sec. 107, Contract Worker Hours and Safety Standards Act (Construction Safety Act) [40 U.S.C. 333]; Secs. 4 & 5, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12-71 (36 FR 8754), 8-76 (41 FR 25059), or 9-83 (48 FR 35736), as applicable, and 29 CFR part 1911.

§ 1926.650 Scope, application, and definitions applicable to this subpart.

(a) Scope and application. This subpart applies to all open excavations made in the earth’s surface. Excavations are defined to include trenches.

(b) Definitions applicable to this subpart.

Accepted engineering practices means those requirements which are compatible with standards of practice required by a registered professional engineer.

Aluminum Hydraulic Shoring means a pre-engineered shoring system comprised of aluminum hydraulic cylinders (crossbraces) used in conjunction with vertical rails (uprights) or horizontal rails (waler). Such system is designed, specifically to support the sidewalls of an excavation and prevent cave-ins.

Bell-bottom pier hole means a type of shaft or footing excavation, the bottom of which is made larger than the cross section above to form a belled shape.

Benching (Benching system) means a method of protecting employees from cave-ins by excavating the sides of an excavation to form one or a series of horizontal, or steps, usually with vertical or near-vertical surfaces between levels.

Cave-in means the separation of a mass of soil or rock material from the side of an excavation, or the loss of soil from under a trench shield or support system, and its sudden movement into the excavation, either by falling or sliding, in sufficient quantity so that it could entrap, burden, or otherwise injure and immobilize a person.

Competent person means one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are un sanctioned, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Cross braces mean the horizontal members of a shoring system installed perpendicular to the sides of the excavation, the ends of which bear against either uprights or wales.

Excavation means any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal.

Foces or sides means the vertical or inclined earth surfaces formed as a result of excavation work.

Failure means the breakage, displacement, or permanent deformation of a structural member or connection so as to reduce its structural integrity and its supportive capabilities.

Hazardous atmosphere means an atmosphere which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness, or injury.

Kickout means the accidental release or failure of a cross brace.

Protective system means a method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

Ramp means an inclined walking or working surface that is used to gain access to one point from another, and is constructed from earth or from structural materials such as steel or wood.

Registered Professional Engineer means a person who is registered as a professional engineer in the state where the work is to be performed. However, a professional engineer, registered in any state is deemed to be a "registered professional engineer" within the meaning of this standard when designing systems for "manufactured protective systems" or "tabulated data" to be used in interstate commerce.

Sheeting means the members of a shoring system that retain the earth in position and in turn are supported by other members of the shoring system.

Shield (Shield system) means a structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses. Additionally, shields can be either premanufactured or job-built in accordance with § 1926.652 (c)(3) or (c)(4). Shields used in trenches are usually referred to as "trench boxes" or "trench shields."

Shoring (Shoring system) means a structure such as a metal hydraulic, mechanical or timber shoring system that supports the sides of an excavation and which is designed to prevent cave-ins.

Sides. See "Faces."

Sloping (Sloping system) means a method of protecting employees from cave-ins by excavating to form sides of an excavation that are inclined away from the excavation so as to prevent cave-ins. The angle of incline required to prevent a cave-in varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads.

Stable rock means natural solid mineral material that can be excavated with vertical sides and will remain intact while exposed. Unstable rock is considered to be stable when the rock material on the side or sides of the excavation is secured against caving-in or movement by rock bolts or by another protective system that has been designed by a registered professional engineer.

Structural ramp means a ramp built of steel or wood, usually used for vehicle access. Ramps made of soil or rock are not considered structural ramps.

Support system means a structure such as underpinning, bracing, or shoring, which provides support to an adjacent structure, underground.
installation or the sides of an excavation.

Tabulated data means tables and charts approved by a registered professional engineer and used to design and construct a protective system.

Trench (Trench excavation) means a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet (4.6 m). If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet (4.6 m) or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

Trench box. See "Shield." Trench shield. See "Shield."

Uprights means the vertical members of a trench shoring system placed in contact with the earth and usually positioned so that individual members do not contact each other. Uprights placed so that individual members are closely spaced, in contact with or interconnected to each other, are often called "sheeting."

Wales means horizontal members of a shoring system placed parallel to the excavation face whose sides bear against the vertical members of the shoring system or earth.

§ 1926.651 General requirements.
(a) Surface encumbrances. All surface encumbrances that are located so as to create a hazard to employees shall be removed or supported, as necessary, to safeguard employees.
(b) Underground installations. (1) The estimated location of utility installations, such as sewer, telephone, fuel, electric, water lines, or any other underground installations that reasonably may be expected to be encountered during excavation work, shall be determined prior to opening an excavation.
(2) Utility companies or owners shall be contacted within established or customary local response times, advised of the proposed work, and asked to establish the location of the utility underground installations prior to the start of actual excavation. When utility companies or owners cannot respond to a request to locate underground utility installations within 24 hours (unless a longer period is required by state or local law), or cannot establish the exact location of these installations, the employer may proceed, provided the employer does so with caution, and provided detection equipment or other acceptable means to locate utility installations are used.
(3) When excavation operations approach the estimated location of underground installations, the exact location of the installations shall be determined by safe and acceptable means.
(4) While the excavation is open, underground installations shall be protected, supported or removed as necessary to safeguard employees.
(c) Access and egress—(1) Structural ramps. (i) Structural ramps that are used solely by employees as means of access or egress from excavations shall be designed by a competent person. Structural ramps used for access or egress of equipment shall be designed by a competent person qualified in structural design, and shall be constructed in accordance with the design.
(ii) Ramps and runways constructed of two or more structural members shall have the structural members connected together to prevent displacement.
(iii) Structural members used for ramps and runways shall be of uniform thickness.
(iv) Cleats or other appropriate means used to connect runway structural members shall be attached to the bottom of the runway shall be attached in a manner to prevent tripping.
(v) Structural ramps used in lieu of steps shall be provided with cleats or other surface treatments on the top surface to prevent slipping.
(2) Means of egress from trench excavations. A stairway, ladder, ramp or other safe means of egress shall be located in trench excavations that are 4 feet (1.22 m) or more in depth so as to require no more than 7 feet (2.13 m) of lateral travel for employees.
(d) Exposure to vehicular traffic. Employees exposed to public vehicular traffic shall be provided with, and shall wear, warning vests or other suitable garments marked with or made of reflectorized or high-visibility material.
(e) Exposure to falling loads. No employee shall be permitted underhand loads handled by lifting or digging equipment. Employees shall be required to stand away from any vehicle being loaded or unloaded to avoid being struck by any spillage or falling materials. Operators may remain in the cabs of vehicles being loaded or unloaded when the vehicles are equipped, in accordance with § 1926.601(b)(6), to provide adequate protection for the operator during loading and unloading operations.
(f) Warning system for mobile equipment. When mobile equipment is operated adjacent to an excavation, or when such equipment is required to approach the edge of an excavation, and the operator does not have a clear and direct view of the edge of the excavation, a warning system shall be utilized such as barriers, hand or mechanical signals, or stop logs. If possible, the grade should be away from the excavation.
(g) Hazardous atmospheres—(1) Testing and controls. In addition to the requirements set forth in subparts D and E of this part (29 CFR 1926.50--1926.107) to prevent exposure to harmful levels of atmospheric contaminants and to assure acceptable atmospheric conditions, the following requirements shall apply:
(i) Where oxygen deficiency (atmospheres containing less than 19.5 percent oxygen) or a hazardous atmosphere exists or could reasonably be expected to exist, such as in excavations in landfill areas or excavations in areas where hazardous substances are stored nearby, the atmospheres in the excavation shall be tested before employees enter excavations greater than 4 feet (1.22 m) in depth.
(ii) Adequate precautions shall be taken to prevent employee exposure to atmospheres containing less than 19.5 percent oxygen and other hazardous atmospheres. These precautions include providing proper respiratory protection or ventilation, in accordance with subparts D and E of this part respectively.
(iii) Adequate precaution shall be taken such as providing ventilation, to prevent employee exposure to an atmosphere containing a concentration of a flammable gas in excess of 20 percent of the lower flammable limit of the gas.
(iv) When controls are used that are intended to reduce the level of atmospheric contaminants to acceptable levels, testing shall be conducted as often as necessary to ensure that the atmosphere remains safe.
(2) Emergency rescue equipment. (i) Emergency rescue equipment, such as breathing apparatus, a safety harness and line, or a basket stretcher, shall be readily available where hazardous atmospheric conditions exist or may reasonably be expected to develop during work in an excavation. This equipment shall be attended when in use.
(ii) Employees entering bell-bottom pier holes, or other similar deep and confined footing excavations, shall wear a harness with a life-line securely attached to it. The life-line shall be separate from any line used to handle materials, and shall be individually
attended at all times while the employee
wearing the lifeline is in the excavation.
(b) Protection from hazards
associated with water accumulation. (1)
Employees shall not work in
excavations in which there is
accumulated water, or in excavations in
which water is accumulating, unless
adequate precautions have been taken
to protect employees against the
hazards posed by water accumulation.
The precautions necessary to protect
employees adequately vary with each
situation, but could include special
support or shield systems to protect
from cave-ins, water removal to control
the level of accumulating water, or use
of a safety harness and lifeline.
(2) If water is controlled or prevented
from accumulating by the use of water
removal equipment, the water removal
equipment and operations shall be
provided to a competent person to
ensure proper operation.
(3) If excavation work interrupts
the natural drainage of surface water (such
as streams), diversion ditches, dikes, or
other suitable means shall be used to
prevent surface water from entering the
excavation and to provide adequate
drainage of the area adjacent to the
excavation. Excavations subject to
runoff from heavy rains will require an
inspection by a competent person and
compliance with paragraphs (b)(1) and
(b)(2) of this section.
(i) Stability of adjacent structures. (1)
Where the stability of adjoining
buildings, walls, or other structures is
endangered by excavation operations,
support systems such as shoring,
bracing, or underpinning shall be
provided to ensure the stability of such
structures for the protection of
employees.
(2) Excavation below the level of the
base or footing of any foundation or
retaining wall that could be reasonably
expected to pose a hazard to employees
shall not be permitted except when:
(i) A support system, such as
underpinning, is provided to ensure the
safety of employees and the stability of
the structure;
(ii) The excavation is in stable rock;
(iii) A registered professional engineer
has approved the determination that the
structure is sufficiently removed from the
excavation so as to be unaffected by the
excavation activity; or
(iv) A registered professional engineer
has approved the determination that
such excavation work will not pose a
hazard to employees.
(5) Sidewalks, pavements, and
appurtenant structure shall not be
undermined unless a support system or
another method of protection is
provided to protect employees from the
possible collapse of such structures.
(j) Protection of employees from
loose rock or soil. (1) Adequate protection
shall be provided to protect employees
from loose rock or soil that could pose a
hazard by falling or rolling from an
excavation face. Such protection shall
consist of scaling to remove loose
material; installation of protective
barricades at intervals as necessary on
the face to stop and contain falling
material; or other means that provide
equivalent protection.
(2) Employees shall be protected from
excavated or other materials or
equipment that could pose a hazard by
falling or rolling into excavations.
Protection shall be provided by placing
and keeping such materials or
equipment at least 2 feet (.61 m) from the
edge of excavations, or by the use of
retaining devices that are sufficient to
prevent materials or equipment from
falling or rolling into excavations, or by
a combination of both if necessary.
(k) Inspections. (1) Daily inspections
of excavations, the adjacent areas, and
protective systems shall be made by a
competent person for evidence of a
situation that could result in possible
cave-ins, indications of failure of protective
systems, hazardous atmospheres, or other hazardous
conditions. An inspection shall be
conducted by the competent person
prior to the start of work and as needed
throughout the shift. Inspections shall
also be made after every rainstorm or
other hazard increasing occurrence.
These inspections are only required
when employee exposure can be
reasonably anticipated.
(2) Where the competent person finds
evidence of a situation that could result
in a possible cave-in, indications of
failure of protective systems, hazardous
atmospheres, or other hazardous
conditions, exposed employees shall be
removed from the hazardous area until
the necessary precautions have been
taken to ensure their safety.
(l) Fall protection. (1) Where
employees or equipment are required or
permitted to cross over excavations,
walkways or bridges with standard
guardrails shall be provided.
(2) Adequate barrier physical
protection shall be provided at all
remotely located excavations. A II walls,
pits, shafts, etc., shall be barricaded or
covered. Upon completion of
exploration and similar operations,
temporary wells, pits, shafts, etc., shall
be backfilled.
§ 1926.652 Requirements for protective
systems.
(a) Protection of employees in
excavations. (1) Each employee in an
excavation shall be protected from cave-
ins by an adequate protective system
designed in accordance with paragraph
(b) or (c) of this section except when:
(i) Excavations are made entirely in stable rock;
(ii) Excavations are less than 5 feet (1.52 m) in depth and examination of the
ground by a competent person provides
no indication of a potential cave-in.
(2) Protective systems shall have the
capacity to resist without failure all
loads that are intended or could
reasonably be expected to be applied or
transmitted to the system.
(b) Design of sloping and benching
systems. The slopes and configurations of
sloping and benching systems shall be
selected and constructed by the
employer or his designee and shall be in
accordance with the requirements of
paragraph (b)(1); or, in the alternative,
paragraph (b)(2); or, in the alternative,
paragraph (b)(3); or, in the alternative,
paragraph (b)(4), as follows:
(1) Option (1)—Allowable
configurations and slopes. (i)
Excavations shall be sloped at an angle
not steeper than one and one-half
horizontal to one vertical (34 degrees
measured from the horizontal), unless
the employer uses one of the other
options listed below.
(ii) Slopes specified in paragraph
(b)(1)(i) of this section, shall be
excavated to form configurations that
are in accordance with the slopes shown
for Type C soil in Appendix B to this
subpart.
(2) Option (2)—Determination of
slopes and configurations using
Appendices A and B. Maximum
allowable slopes, and all allowable
configurations for sloping and benching
systems, shall be determined in
accordance with the conditions and
requirements set forth in appendices A
and B to this subpart.
(3) Option (3)—Designs using other
tabulated data. (i) Designs of sloping or
benchung systems shall be selected from
and be in accordance with tabulated
data, such as tables and charts.
(ii) The tabulated data shall be in
written form and shall include all of the
following:
(A) Identification of the parameters
that affect the selection of a sloping or
benchung system drawn from such data.
(B) Identification of the limits of use of
the data, to include the magnitude and
configuration of slopes determined to be
safe;
(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) At least one copy of the tabulated data which identifies the registered professional engineer who approved the data, shall be maintained at the job site during construction of the protective system. After that time the data may be stored off the job site, but a copy of the data shall be made available to the Secretary upon request.

(4) Option (4)—Design by a registered professional engineer. (i) Sloping and benching systems not utilizing Option (1) or Option (2) or Option (3) under paragraph (b) of this section shall be approved by a registered professional engineer.

(ii) Designs shall be in written form and shall include at least the following:

(A) The magnitude of the slopes that were determined to be safe for the particular project;

(B) The configurations that were determined to be safe for the particular project;

(C) The identity of the registered professional engineer approving the design.

(iii) At least one copy of the design shall be maintained at the job site while the slope is being constructed. After that time the design need not be at the job site, but a copy shall be made available to the Secretary upon request.

(c) Design of support systems, shield systems, and other protective systems. Designs of support systems, shield systems, and other protective systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of paragraphs (c)(1); or, in the alternative, paragraph (c)(2); or, in the alternative, paragraph (c)(3); or, in the alternative, paragraph (c)(4) as follows:

(1) Option (1)—Designs using appendices A, C and D. Designs for timber shoring in trenches shall be determined in accordance with the conditions and requirements set forth in appendices A and C to this subpart. Designs for aluminum hydraulic shoring shall be in accordance with paragraph (c)(2) of this section, but if manufacturer's tabulated data cannot be utilized, designs shall be in accordance with appendix D.

(2) Option (2)—Designs Using Manufacturer's Tabulated Data. (i) Design of support systems, shield systems, or other protective systems that are derived from manufacturer's tabulated data shall be in accordance with all specifications, recommendations, and limitations issued or made by the manufacturer.

(ii) Deviation from the specifications, recommendations, and limitations issued or made by the manufacturer shall only be allowed after the manufacturer issues specific written approval.

(iii) Manufacturer's specifications, recommendations, and limitations, and manufacturer's approval to deviate from the specifications, recommendations, and limitations shall be in written form at the job site during construction of the protective system. After that time this data may be stored off the job site, but a copy shall be made available to the Secretary upon request.

(3) Option (3)—Designs using other tabulated data. (i) Designs of support systems, shield systems, or other protective systems shall be selected from and be in accordance with tabulated data, such as tables and charts.

(ii) The tabulated data shall be in written form and include all of the following:

(A) Identification of the parameters that affect the selection of a protective system drawn from such data;

(B) Identification of the limits of use of the data;

(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) At least one copy of the tabulated data, which identifies the registered professional engineer who approved the data, shall be maintained at the job site during construction of the protective system. After that time the data may be stored off the job site, but a copy of the data shall be made available to the Secretary upon request.

(4) Option (4)—Design by a registered professional engineer. (i) Support systems, shield systems, and other protective systems not utilizing Option 1, Option 2 or Option 3, above, shall be approved by a registered professional engineer.

(ii) Designs shall be in written form and shall include the following:

(A) A plan indicating the sizes, types, and configurations of the materials to be used in the protective system; and

(B) The identity of the registered professional engineer approving the design.

(iii) At least one copy of the design shall be maintained at the job site during construction of the protective system. After that time, the design may be stored off the job site, but a copy of the design shall be made available to the Secretary upon request.

(d) Materials and equipment. (1) Materials and equipment used for protective systems shall be free from damage or defects that might impair their proper function.

(2) Manufactured materials and equipment used for protective systems shall be used and maintained in a manner that is consistent with the recommendations of the manufacturer, and in a manner that will prevent employee exposure to hazards.

(3) When material or equipment that is used for protective systems is damaged, a competent person shall examine the material or equipment and evaluate its suitability for continued use. If the competent person cannot assure the material or equipment is able to support the intended loads or is otherwise suitable for safe use, then such material or equipment shall be removed from service and shall be evaluated and approved by a registered professional engineer before being returned to service.

(e) Installation and removal of support—(1) General. (i) Members of support systems shall be securely connected together to prevent sliding, falling, kickouts, or other predictable failure.

(ii) Support systems shall be installed and removed in a manner that protects employees from cave-ins, structural collapses, or from being struck by members of the support system.

(iii) Individual members of support systems shall not be subjected to loads exceeding those which those members were designed to withstand.

(iv) Before temporary removal of individual members begins, additional precautions shall be taken to ensure the safety of employees, such as installing other structural members to carry the loads imposed on the support system.

(v) Removal shall begin at, and progress from, the bottom of the excavation. Members shall be released slowly so as to note any indication of possible failure of the remaining members of the structure or possible cave-in of the sides of the excavation.

(vi) Backfilling shall progress together with the removal of support systems from excavations.

(2) Additional requirements for support systems for trench excavations. (i) Excavation of material to a level no greater than 2 feet (.61 m) below the bottom of the members of a support system shall be permitted, but only if the system is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind, or below the bottom of the support system.
[ii] Installation of a support system shall be closely coordinated with the excavation of trenches.

(i) Sloping and benching systems. Employees shall not be permitted to work on the faces of sloped or benched excavations at levels above other employees except when employees at the lower levels are adequately protected from the hazard of falling, rolling, or sliding material or equipment.

(g) Shield systems—(1) General. (i) Shield systems shall not be subjected to loads exceeding those which the system was designed to withstand.

(ii) Shields shall be installed in a manner to restrict lateral or other hazardous movement of the shield in the event of the application of sudden lateral loads.

(iii) Employees shall be protected from the hazard of cave-ins when entering or exiting the areas protected by shields.

(iv) Employees shall not be allowed in shields when shields are being installed, removed, or moved vertically.

(2) Additional requirement for shield systems used in trench excavations. Excavations of earth material to a level not greater than 2 feet (.61 m) below the bottom of a shield shall be permitted, but only if the shield is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the shield.

Appendix A to Subpart P

Soil Classification

(a) Scope and application—(1) Scope. This appendix describes the requirements set forth in § 1926.652(b)(2) as a method of protection for employees from cave-ins. This appendix also applies when timber shoring for excavations is designed as a method of protection from cave-ins in accordance with appendix C to subpart P of part 1926, and when aluminum hydraulic shoring is designed in accordance with appendix D. This Appendix also applies if other protective systems are designed and selected for use from data prepared in accordance with the requirements set forth in § 1926.652(c), and the use of the data is predicated on the use of the soil classification system set forth in this appendix.

(b) Definitions. The definitions and examples given below are based on, in whole or in part, the following: American Society for Testing Materials (ASTM) Standards D553-45 and D2486: The Unified Soils Classification System. The U.S. Department of Agriculture (USDA) Textural Classification Scheme; and The National Bureau of Standards Report B55-121.

Cemented soil means a soil in which the particles are held together by a chemical agent, such as calcium carbonate, such that a hand-size sample cannot be crushed into powder or individual soil particles by finger pressure.

Cohesive soil means clay (fine grained soil), or soil with a high clay content, which has cohesive strength. Cohesive soil does not crumble, can be excavated with vertical side slopes, and is plastic when moist.

Cohesive soil is hard to break up when dry, and exhibits significant cohesion when submerged. Cohesive soils include clayey silt, sandy clay, silty clay, clay and organic clay.

Dry soil means soil that does not exhibit visible signs of moisture content.

Fissured means a soil material that has a tendency to break along definite planes of fracture with little resistance, or a material that exhibits open cracks, such as tension cracks, in exposed surfaces.

Granular soil means gravel, sand, or silt, (coarse grained soil) with little or no clay content. Granular soil has no cohesive strength. Some moist granular soils exhibit apparent cohesion. Granular soil cannot be molded when moist and crumbles easily when dry.

Layered system means two or more distinctly different soil or rock types arranged in layers. Lacustrine soils or weakly cemented layers in rock or shale are considered layered.

Moist soil means a condition in which a soil looks and feels damp. Moist cohesive soil can easily be shaped into a ball and rolled into small diameter threads before crumbling. Moist granular soil that contains some cohesive material will exhibit signs of cohesion between particles.

Plastic means a property of a soil which allows the soil to be deformed or molded without cracking, or appreciable volume change.

Saturated soil means a soil in which the voids are filled with water. Saturation does not require flow. Saturation, or near saturation, is necessary for the proper use of instruments such as a pocket penetrometer or shear vane.

Soil classification system means, for the purpose of this subpart, a method of categorizing soil and rock deposits in a hierarchy of Stable Rock, Type A, Type B, and Type C, in decreasing order of stability. The categories are determined based on an analysis of the properties and performance characteristics of the deposits and the environmental conditions of exposure.

Stable rock means natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.

Submerged soil means soil which is underwater when excavating.

Type A means cohesive soils with an unconfined compressive strength of 1.5 tons per square foot (tsf) (144 kPa) or greater. Examples of cohesive soils are: clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam. Cemented soils such as caliche and hardpan are also considered Type A. However, no soil is Type A if:

(i) The soil is fissured; or

(ii) The soil is subject to vibration from heavy traffic, pile driving, or similar effects; or

(iii) The soil has been previously disturbed; or

(iv) The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater; or

(v) The material is subject to other factors that would require it to be classified as a less stable material.

Type B means:

(i) Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa); or

(ii) Granular cohesionless soils including: angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases, silty clay loam and sandy clay loam.

(iii) Previously disturbed soils except those which would otherwise be classified as Type C.

(iv) Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or

(v) Dry rock that is not stable; or

(vi) Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.

Type C means:

(i) Cohesive soil with an unconfined compressive strength of 0.8 tsf (46 kPa) or less;

(ii) Granular soils including gravel, sand, and loamy sand; or

(iii) Submerged rock or soil from which water is freely seeping; or

(iv) Submerged rock that is not stable; or

(iv) Material in a sloped, layered system where the layers dip into the excavation or a slope of four horizontal to one vertical (4H:1V) or steeper.

Unconfined compressive strength means the load per unit area at which a soil will fail in compression. It can be determined by laboratory testing, or estimated in the field using a pocket penetrometer, by thumb penetration tests, and other methods.

Wet soil means soil that contains significant more moisture than moist soil, but in such a range of values that cohesive material will slump or begin to flow when vibrated. Granular material that would exhibit cohesive properties when moist will lose those cohesive properties when wet.

(c) Requirements—(1) Classification of soil and rock deposits. Each soil and rock deposit shall be classified by a competent person as Stable Rock, Type A, Type B, or Type C in accordance with the definitions set forth in paragraph (b) of this appendix.

(2) Basis of classification. The classification of the deposits shall be made based on the results of at least one visual and at least one manual analysis. Such analyses
shall be conducted by a competent person using tests described in paragraph (d) below, or in other recognized methods of soil classification and testing such as those adopted by the American Society for Testing Materials, or the U.S. Department of Agriculture textural classification system.

(3) Visual and manual analyses. The visual and manual analyses, such as those noted as being acceptable in paragraph (d) of this appendix, shall be designed and conducted to provide sufficient qualitative and quantitative information as may be necessary to identify properly the properties, factors, and conditions affecting the classification of the deposits.

(4) Layered systems. In a layered system, the system shall be classified in accordance with its weakest layer. However, each layer may be classified individually where a more stable layer lies under a less stable layer.

(f) Reclassification. If, after classifying a deposit, the properties, factors, or conditions necessitating its classification change in any way, the change shall be evidenced by a competent person. The deposit shall be reclassified as necessary to reflect the changed circumstances.

(5) Acceptable visual and manual tests. Manual analysis of soil samples is conducted to determine qualitative information regarding the excavation site in general, the soil adjacent to the excavation, the soil forming the sides of the open excavation, and the soil taken as samples from excavated material.

(i) Observe samples of soil that are excavated and soil in the sides of the excavation. Estimate the range of particle sizes and the relative amounts of the particle sizes. Soil that is primarily composed of fine-grained material is cohesive material. Soil composed primarily of coarse-grained sand or gravel is granular material.

(ii) Observe the soil as it is excavated. Soil that remains in clumps when excavated is cohesive. Soil that breaks up easily and does not stay in clumps is granular.

(iii) Observe the sides of the opened excavation. Estimate the surface area adjacent to the excavation. Crack-like openings such as tension cracks could indicate fissured material. If chunks of soil spill off a vertical side, the soil could be fissured. Small spills are evidence of moving ground and are indications of potentially hazardous situations.

(iv) Observe the area adjacent to the excavation and the excavation itself for evidence of existing utility and other underground structures, and to identify previously disturbed soil.

(v) Observe the opened side of the excavation to identify layered systems. Examine layered systems to identify if the layers slope toward the excavation. Estimate the degree of slope of the layers.

(vi) Observe the area adjacent to the excavation and the sides of the opened excavation for evidence of surface water. Estimate the location of the sides of the excavation, or the location of the level of the water table.

(vii) Observe the area adjacent to the excavation and the area within the excavation for sources of vibration that may affect the stability of the excavation face.

(2) Manual tests. Manual analysis of soil samples is conducted to determine qualitative as well as qualitative properties of soil and to provide more information in order to classify soil properly.

(i) Plasticity. Mold a moist or wet sample of soil into a mud and attempt to roll it into threads as thin as possible. Cohesive material can be successfully rolled into threads without crumbling. For example, if at least a two inch (50 mm) length of 1⁄4 inch threads can be held on one end without tearing, the soil is classified as a plastic cohesion. (Dry strength. If the soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder, it is granular.)

(3) Definitions. Actual slope means the slope to which an excavation face is excavated. Distress means that the soil is in a condition where a cave-in is imminent or is likely to occur. Distress is evidenced by such phenomena as the development of fissures in the face of or above an open excavation; the subsidence of the face of an excavation; the slumping of material from the face of an excavation; the bulging or heaving of material from the bottom of an excavation; the spilling of material from the face of an excavation; and the ejection of material such as pebbles or little clumps of material suddenly separating from the face of an excavation and trickling or rolling down into the excavation.

Maximum allowable slope means the steepest incline of an excavation face that is acceptable for the most favorable site conditions as protection against cave-ins, and is expressed as the ratio of horizontal distance to vertical rise (H/V).

Short term exposure means a period of time less than or equal to 24 hours that an excavation is open.

(c) Requirements. Soil classification, soil and rock deposit shall be classified in accordance with appendix A to subpart P of part 1926. (2) Maximum allowable slope. The maximum allowable slope for a soil or rock deposit shall be determined from Table B-1 of this appendix.

(3) Actual slope. (i) The actual slope shall not be steeper than the maximum allowable slope.

(ii) The actual slope shall be less steep than the maximum allowable slope, when there are signs of distress. If that situation occurs, the slope shall be cut back to an actual slope which is at least 1⁄4 horizontal to one vertical (14½:1) less steep than the maximum allowable slope.

(iii) When surface loads from stored material or equipment, operating equipment, or traffic are present, a competent person shall determine the degree to which the actual slope must be reduced below the maximum allowable slope, and shall ensure that such reduction is achieved. Surface loads from adjacent structures shall be evaluated in accordance with § 1926.503(l).

(4) Configurations. Configurations of sloping and benching systems shall be in accordance with Figure B-1.
TABLE 8-1
MAXIMUM ALLOWABLE SLOPES

<table>
<thead>
<tr>
<th>SOIL OR ROCK TYPE</th>
<th>MAXIMUM ALLOWABLE SLOPES (H:V) (^{[1]}) FOR EXCAVATIONS LESS THAN 20 FEET DEEP (^{[2]})</th>
</tr>
</thead>
<tbody>
<tr>
<td>STABLE ROCK</td>
<td>VERTICAL (90°)</td>
</tr>
<tr>
<td>TYPE A (^{[2]})</td>
<td>3/4 : 1 (53°)</td>
</tr>
<tr>
<td>TYPE B</td>
<td>1:1 (45°)</td>
</tr>
<tr>
<td>TYPE C</td>
<td>1(\frac{1}{4}) : 1 (34°)</td>
</tr>
</tbody>
</table>

NOTES:

1. Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.

2. A short-term maximum allowable slope of 1/2H:1V (63°) is allowed in excavations in Type A soil that are 12 feet (3.67 m) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 m) in depth shall be 3/4H:1V (53°).

3. Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

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Figure 8-1

Slope Configurations

(All slopes stated below are in the horizontal to vertical ratio)

B-1.1 Excavations made in Type A soil.

1. All simple slope excavation 20 feet or less in depth shall have a maximum allowable slope of ¾:1.

Simple Slope—General

Exception: Simple slope excavations which are open 24 hours or less (short term) and which are 12 feet or less in depth shall have a maximum allowable slope of ¾:1.
Simple Slope—Short Term

2. All bench excavations 20 feet or less in depth shall have a maximum allowable slope of 1/4 to 1 and maximum bench dimensions as follows:

Simple Bench

2. All excavations 6 feet or less in depth which have unsupported vertically sided lower portions shall have a maximum vertical side of 3½ feet.
Unsupported Vertically Sided Lower Portion—Maximum 8 Feet in Depth

All excavations more than 8 feet but not more than 12 feet in depth which unsupported vertically sided lower portions shall have a maximum allowable slope of 1:3 and a maximum vertical side of 3½ feet.

Unsupported Vertically Sided Lower Portion—Maximum 12 Feet in Depth

All excavations 20 feet or less in depth which have vertically sided lower portions that are supported or shielded shall have a maximum allowable slope of 3:4. The support or shield system must extend at least 18 inches above the top of the vertical side.

Supported or Shielded Vertically Sided Lower Portion

4. All other simple slope, compound slope, and vertically sided lower portion excavations shall be in accordance with the other options permitted under §1926.652(b).

B-1.2 Excavations Made in Type B Soil

1. All slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1:3.
Simple Slope

2. All beched excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1 and maximum bench dimensions as follows:

Single Bench

This bench allowed in cohesive soil only.

Multiple Bench

3. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1:1.
2. All other sloped excavations shall be in accordance with the other options permitted in § 1926.652(b).

Appendix C to Subpart P
Timber Shoring for Trenches

(a) Scope. This appendix contains information that can be used timber shoring is provided as a method of protection from cave-ins in trenches that do not exceed 20 feet (6.1 m) in depth. This appendix must be used when design of timber shoring protective systems is to be performed in accordance with § 1926.652(c)(1). Other timber shoring configurations; other systems of support such as hydraulic and pneumatic systems; and other protective systems such as sloping, benching, shielding, and freezing systems must be designed in accordance with the requirements set forth in § 1926.652(b) and § 1926.652(c).

(b) Soil Classification. In order to use the data presented in this appendix, the soil type or types in which the excavation is made must first be determined using the soil
classification method set forth in appendix A of subpart P of this part.
(c) Presentation of Information. Information is presented in several forms as follows:
(1) Information is presented in tabular form in Tables C-1.1, C-1.2, and C-1.3, and Tables C-2.1, C-2.2 and C-2.3 following paragraph (a) of this appendix. Each table presents the minimum sizes of timber members to use in a shoring system, and each table contains data only for the particular soil type in which the excavation or portion of the excavation is made. The data are arranged to allow the user flexibility to select from among several acceptable configurations of members based on varying the horizontal spacing of the crossbraces. Stable rock is exempt from shoring requirements and therefore, no data are presented for this condition.
(2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix, and in the tables themselves.
(3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.
(4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.
(5) Miscellaneous notations regarding Tables C-1.1 through C-1.3 and Tables C-2.1 through C-2.3 are presented in paragraph (g) of this Appendix.
(d) Roots and limitations of the data.—(1) Dimensions of timber members. (i) The sizes of the timber members listed in Tables C-1.1 through C-1.3 are taken from the National Bureau of Standards (NBS) report, "Recommended Technical Provisions for Construction Practice in Shoring and Sloping of Trenches and Excavations." In addition, where NBS did not recommend specific sizes of members, member sizes are based on an analysis of the sizes required for use by existing codes and on empirical practice.
(ii) The required dimensions of the members listed in Tables C-1.1 through C-1.3 refer to actual dimensions and not nominal dimensions of the timber. Employers wanting to use nominal sizes shoring are directed to Tables C-2.1 through C-2.3, or have this choice under §1928.652(c)(3), and are referred to The Corps of Engineers, The Bureau of Reclamation or data from other acceptable sources.
(2) Limitation of application. (i) It is not intended that the timber shoring specification apply to every situation that may be encountered in the field. This data were developed to apply to the situations that are most commonly encountered in current trenching practices. Shoring systems for use in situations that are not covered by the data in this appendix must be designed as specified in §1928.652(c).
(ii) When any of the following conditions are present, the members specified in the tables are not considered adequate. Either an alternate timber shoring system must be designed or another type of protective system designed in accordance with §1928.652.
(A) When loads imposed by structures or by stored material exceed the trench, weight in excess of the load imposed by a two-foot soil surcharge. The term "adjacent" as used here means the area within a horizontal distance from the edge of the trench equal to the depth of the trench.
(B) When vertical loads imposed on crossbraces exceed a 240-pound gravity load distributed on a one-foot section of the center of the crossbrace.
(C) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.
(D) When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.
(e) Use of Tables. The members of the shoring system to be selected using this information are the crossbraces, the uprights, and the wales, where wales are required. Minimum sizes of members are specified for use in different types of soil. There are six tables of information, two for each soil type. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is then made. The selection is based on the depth and width of the trench where the members are to be installed and, in most instances, the selection is also based on the horizontal spacing of the crossbraces. Instances where a choice of horizontal spacing of crossbracing is available, the horizontal spacing of the crossbraces must be chosen by the user before the size of any member can be determined. When the soil type, the width and depth of the trench, and the horizontal spacing of the crossbraces are known, the size and vertical spacing of the crossbraces, the size and vertical spacing of the wales, and the size and horizontal spacing of the uprights can be read from the appropriate table.
(f) Examples to Illustrate the Use of Tables C-1.1 through C-1.3.
(i) Example 1. A trench dug in Type A soil is 13 feet deep and five feet wide. From Table C-1.1.1, for acceptable arrangements of timber can be used.
Arrangement #1
Space 4 x 4 crossbraces at six feet horizontally and four feet vertically. 
Wales are not required.
Space 3 x 8 uprights at six feet horizontally. 
This arrangement is commonly called "skipping shoring."
Arrangement #2
Space 4 x 8 crossbraces at eight feet horizontally and four feet vertically. 
Space 8 x 8 wales at four feet vertically.
Space 2 x 8 uprights at four feet horizontally.
Arrangement #3
Space 6 x 6 crossbraces at 10 feet horizontally and four feet vertically. 
Space 8 x 10 wales at four feet vertically.
Space 2 x 8 uprights at five feet horizontally.
Arrangement #4
Space 6 x 6 crossbraces at 12 feet horizontally and four feet vertically. 
Space 10 x 10 wales at four feet vertically. 
Spaces 3 x 8 uprights at six feet horizontally.
(2) Example 2. A trench dug in Type B soil is in 13 feet deep and five feet wide. From Table C-1.3 two acceptable arrangements of members are listed.
Arrangement #1
Space 6 x 6 crossbraces at six feet horizontally and five feet vertically. 
Space 8 x 8 wales at five feet vertically. 
Space 2 x 8 uprights at two feet horizontally.
Arrangement #2
Space 8 x 8 crossbraces at eight feet horizontally and five feet vertically. 
Space 10 x 10 wales at five feet vertically. 
Space 2 x 8 uprights at two feet horizontally.
(3) Example 3. A trench dug in Type C soil is 13 feet deep and five feet wide. From Table C-1.3 two acceptable arrangements of members can be used.
Arrangement #1
Space 8 x 8 crossbraces at 10 feet horizontally and five feet vertically. 
Space 10 x 12 wales at five feet vertically. 
Space 2 x 8 uprights at two feet vertically.
Arrangement #2
Space 8 x 8 crossbraces at six feet horizontally and five feet vertically. 
Space 10 x 12 wales at five feet vertically. 
Position 2 x 8 uprights as closely together as possible. 
If water must be retained use special tongue and groove uprights to form tight sheeting.
Arrangement #3
Space 8 x 10 crossbraces at eight feet horizontally and five feet vertically. 
Space 12 x 12 wales at five feet vertically. 
Position 2 x 8 uprights in a close sheeting configuration unless water pressure must be resisted. Tight sheeting must be used where water must be retained.
(4) Example 4. A trench dug in Type C soil is 20 feet deep and 11 feet wide. The size and spacing of members for the excavation of trench that is over 15 feet in depth is determined using Table C-1.3. Only one arrangement of members is provided.
Space 8 x 10 crossbraces at six feet horizontally and five feet vertically. 
Space 12 x 12 wales at five feet vertically. 
Use 3 x 8 tight sheeting. 
Use of Tables C-2.1 through C-2.3 would follow the same procedures.
(g) Notes for all Tables.
1. Member sizes and spacings other than indicated are to be determined as specified in §1928.652(c). "Design of Protective Systems."
2. When conditions are saturated or submerged use Tight Sheet. Tight Sheet refers to the use of specially-edged timber planks (e.g., tongue and groove) at least three inches thick, steel sheet piling, or similar construction that when driven or placed in position provide a tight wall to resist the lateral pressure of water and to prevent the loss of backfill material. Close Sheet refers to the placement of planks side-by-side allowing as little space as possible between them.

3. All spacing indicated is measured center to center.

4. Wales to be installed with greater dimension horizontal.

5. If the vertical distance from the center of the lowest crossbrace to the bottom of the trench exceeds two and one-half feet, uprights shall be firmly embedded or a mudsill shall be used. Where uprights are embedded, the vertical distance from the center of the lowest crossbrace to the bottom of the trench shall not exceed 36 inches. When mudsills are used, the vertical distance shall not exceed 42 inches. Mudsills are wales that are installed at the toe of the trench side.

6. Trench jacks may be used in lieu of or in combination with timber crossbraces.

7. Placement of crossbraces. When the vertical spacing of crossbraces is four feet, place the top crossbrace no more than two feet below the top of the trench. When the vertical spacing of crossbraces is five feet, place the top crossbrace no more than 2.5 feet below the top of the trench.

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**TABLE C-1.1**

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE A \( P_{a} = 25 \times H + 72 \text{ psf} \) (2 ft Surcharge)

<table>
<thead>
<tr>
<th>DEPTH OF TRENCH (FEET)</th>
<th>CROSS BRACES</th>
<th>WALES</th>
<th>UPRIGHTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HORIZ. SPACING (FEET)</td>
<td>WIDTH OF TRENCH (FEET)</td>
<td>VERT. SPACING (FEET)</td>
</tr>
<tr>
<td></td>
<td>UP TO 6</td>
<td>UP TO 9</td>
<td>UP TO 12</td>
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<td>5 TO 10</td>
<td>UP TO 8</td>
<td>4X4</td>
<td>4X4</td>
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<td>UP TO 12</td>
<td>4X6</td>
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<tr>
<td>10 TO 15</td>
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<td>UP TO 12</td>
<td>8X8</td>
<td>8X8</td>
</tr>
</tbody>
</table>

OVER 20 SEE NOTE 1

* Mixed oak or equivalent with a bending strength not less than 850 psi.

** Manufactured members of equivalent strength may be substituted for wood.
### Table C-1.2

**Timber Trench Shoring -- Minimum Timber Requirements**

SOIL TYPE B \( P_a = 45XH + 72 \text{ psf (2 ft. Surcharge)} \)

<table>
<thead>
<tr>
<th>Depth of Trench (Feet)</th>
<th>Size (Actual) and Spacing of Members**</th>
<th>Uprights</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Cross Braces</strong></td>
<td><strong>Wales</strong></td>
</tr>
<tr>
<td></td>
<td><strong>HORIZ. SPACING (FEET)</strong></td>
<td><strong>VERT. SPACING (FEET)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>WIDTH OF TRENCH (FEET)</strong>: UP TO 4</td>
<td>UP TO 6</td>
</tr>
<tr>
<td>5 TO 10</td>
<td>6X6</td>
<td>6X6</td>
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<td></td>
<td>Up to 8</td>
<td>6X6</td>
</tr>
<tr>
<td></td>
<td>Up to 10</td>
<td>6X6</td>
</tr>
</tbody>
</table>

See Note 1

| 10 TO 15               | 6X6 | 6X6 | 6X6 | 6X8 | 6X8 | 6X8 | 6X8 | 5 | 8X8 | 5 | 2X6 |
|                        | Up to 8 | 6X8 | 6X8 | 6X8 | 8X8 | 8X8 | 8X8 | 5 | 10X10 | 5 | 2X6 |
|                        | Up to 10 | 8X8 | 8X8 | 8X8 | 8X8 | 8X8 | 8X10 | 5 | 10X12 | 5 | 2X6 |

See Note 1

| 15 TO 20              | 6X8 | 6X8 | 6X8 | 8X8 | 8X8 | 8X8 | 8X8 | 5 | 8X10 | 5 | 3X6 |
|                        | Up to 8 | 8X8 | 8X8 | 8X8 | 8X8 | 8X10 | 5 | 10X12 | 5 | 3X6 |
|                        | Up to 10 | 8X10 | 8X10 | 8X10 | 8X10 | 10X10 | 5 | 12X12 | 5 | 3X6 |

See Note 1

| OVER 20              | SEE NOTE 1

* Mixed oak or equivalent with a bending strength not less than 850 psi.
** Manufactured members of equivalent strength may by substituted for wood.
<table>
<thead>
<tr>
<th>DEPTH OF TRENCH (FEET)</th>
<th>CROSS BRACES</th>
<th>SIZE (ACTUAL) AND SPACING OF MEMBERS**</th>
<th>UPRIGHTS</th>
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</thead>
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<td>HORIZ. SPACING (FEET)</td>
<td>WIDTH OF TRENCH (FEET)</td>
<td>VERT. SPACING (FEET)</td>
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<tr>
<td>OVER 20</td>
<td>SEE NOTE 1</td>
<td>SEE NOTE 1</td>
<td>SEE NOTE 1</td>
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</tbody>
</table>

* Mixed Oak or equivalent with a bending strength not less than 850 psi.
** Manufactured members of equivalent strength may be substituted for wood.
<table>
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<tr>
<th>DEPTH OF TRENCH (FEET)</th>
<th>HORIZ. SPACING (FEET)</th>
<th>WIDTH OF TRENCH (FEET)</th>
<th>CROSS BRACES</th>
<th>WALES</th>
<th>UPRIGHTS</th>
<th>MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)</th>
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<td>SIZE (IN)</td>
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<td>OVER 20</td>
<td>SEE NOTE 1</td>
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</tbody>
</table>

* Douglas fir or equivalent with a bending strength not less than 1500 psi.

** Manufactured members of equivalent strength may be substituted for wood.
**TABLE C-2.2**

**TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS**

SOIL TYPE B P = 45 X H + 72 psf (2 ft. Surcharge)

<table>
<thead>
<tr>
<th>DEPTH OF TRENCH (FEET)</th>
<th>SIZE (S&amp;G) AND SPACING OF MEMBERS **</th>
<th>WALE SPACING</th>
<th>UPRIGHTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CROSS BRACES</td>
<td>WIDTH OF TRENCH (FEET)</td>
<td>VERT. SPACING (FEET)</td>
</tr>
<tr>
<td></td>
<td>HORIZ. SPACING (FEET)</td>
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<tr>
<td>OVER 20</td>
<td>SEE NOTE 1</td>
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</tbody>
</table>

* Douglas fir or equivalent with a bending strength not less than 1500 psi.
** Manufactured members of equivalent strength may be substituted for wood.
<table>
<thead>
<tr>
<th>DEPTH OF TRENCH (FEET)</th>
<th>CROSS BRACES</th>
<th>WALE</th>
<th>UPRIGHTS</th>
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<tr>
<td>OVER 20</td>
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</tbody>
</table>

* Douglas fir or equivalent with a bending strength not less than 1500 psi.
** Manufactured members of equivalent strength may be substituted for wood.
Appendix D to Subpart P

Aluminum Hydraulic Shoring for Trenches

(a) Scope. This appendix contains information that can be used when aluminum hydraulic shoring is provided as a method of protection against cave-ins in trenches that do not exceed 20 feet (6.1m) in depth. This appendix must be used when design of the aluminum hydraulic protective system cannot be performed in accordance with § 1926.652(c).

(b) Soil Classification. In order to use data presented in this appendix, the soil type or types in which the excavation is made must first be determined using the soil classification method set forth in appendix A of subpart P of part 1926.

(c) Presentation of Information. Information is presented in several forms as follows:

(1) Information is presented in tabular form in Tables D-1.1, D-1.2, D-1.3 and E-1.4. Each table presents the maximum vertical and horizontal spacings that may be used with various aluminum member sizes and various hydraulic cylinder sizes. Each table contains data only for the particular soil type and in which the excavation or portion of the excavation is made. Tables D-1.1 and D-1.2 are for vertical shoring of Types A and B soil. Tables D-1.3 and D1.4 are for horizontal water systems in Types B and C soil.

(2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix.

(3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.

(4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.

(5) Miscellaneous notations (footnotes) regarding Table D-1.1 through D-1.4 are presented in paragraph (g) of this appendix.

(6) Figures, illustrating typical installations of hydraulic shoring, are included just prior to the Tables. The illustrations page is entitled “Aluminum Hydraulic Shoring: Typical Installations.”

(d) Basis and limitations of the data.

(1) Vertical shore rails and horizontal wales are those that meet the Section Module requirements in the D-1 Tables. Aluminum material is 6061-T6 or material of equivalent strength and properties.

(2) Hydraulic cylinders specifications. (i) 2-inch cylinders shall be a minimum 2-inch inside diameter with a minimum safe working capacity of no less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe working capacity of not less than 30,000 pounds axial compressive load at maximum extension as recommended by product manufacturer.

(iii) 4-inch cylinders shall be a minimum 4-inch inside diameter with a safe working capacity of not less than 60,000 pounds axial compressive load at maximum extension as recommended by product manufacturer.

(3) Limitation of application.

(i) It is not intended that the aluminum hydraulic specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice.

(ii) Shoring systems for use in situations that are not covered by the data in this appendix must be otherwise designed as specified in § 1928.852(c).

(iii) When any of the following conditions are present, the members specified in this Tables are not considered adequate. In this case, an alternative aluminum hydraulic shoring system or other type of protective system must be designed in accordance with § 1926.652(c).

(A) When vertical loads imposed on cross braces exceed a 100 Pound gravity load distributed on a one foot section of the center of the hydraulic cylinder.

(B) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(C) When only the lower portion or a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.

(e) Use of Tables D-1.1, D-1.2, D-1.3 and D-1.4. The members of the shoring system that are to be selected using this information are the hydraulic cylinders, and either the vertical shores or the horizontal wales. When a waler system is used the vertical timber sheeting to be used is also selected from these tables. The Tables D-1.1 and D-1.2 for vertical shores are used in Type A and B soils that do not require sheeting. Type C soils that may require sheeting, and Type C soils that always require sheeting are found in the horizontal wale Tables D-1.3 and D-1.4. The soil type must first be determined in accordance with the soil classification system described in Appendix A to Subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is made. The selection is based on the depth and width of the trench where the members are to be installed. In these tables the vertical shore is held constant at four feet on center. The table shows the maximum horizontal spacing of cylinders allowed for each size of wale in the water system table, and in the vertical shore tables, the hydraulic cylinder horizontal spacing is the same as the vertical shore spacing.

(f) Example to Illustrate the Use of the Tables:

(1) Example 1: A trench dig in Type A soil is 8 feet deep and 3 feet wide. From Table D-1.1: Find vertical shores and 2 inch diameter cylinders spaced 8 feet on center (o.c.) horizontally and 4 feet on center (o.c.) vertically. (See Figures 1 & 3 for typical installations.)

(2) Example 2: A trench is dug in Type B soil that does not require sheeting, but does experience some minor revealing of the trench face. The trench is 16 feet deep and 8 feet wide. From Table D-1.2: Find vertical shores and 2 inch diameter cylinder (with special oversleeves as designated by footnote #2) spaced 8.5 feet o.c. horizontally and 4 feet o.c. vertically.

(3) Plywood (per footnote (g) to the D-1 Table) should be used behind the shores. (See Figures 2 & 3 for typical installations.)

(4) Example 4: A trench is dug in previously disturbed Type B soil, with characteristics of a Type C soil, and will require sheeting. The trench is 18 feet deep and 12 feet wide. 8 foot horizontal spacing between cylinders is desired for working space. From Table D-1.3:

(A) Find horizontal wale with a section modulus of 14.0 spaced at 4 feet o.c. vertically and 3 inch diameter cylinder spaced at 9 feet maximum o.c. horizontally. 3X12 timber sheeting is required at close spacing vertically. (See Figure 4 for typical installation.)

(B) Example 5: A trench is dug in Type C soil, 9 feet deep and 4 feet wide. Horizontal cylinder spacing in excess of 6 feet is desired for working space. From Table D-1.4:

(1) For applications other than those listed in the tables, refer to § 1926.652(c)(2) for use of manufacturer’s tabulated data. For trench depths in excess of 20 feet, refer to § 1926.652(c)(2) and § 1926.652(c)(3).

(f) Footnotes, and general notes, for Tables D-1.1, D-1.2, D-1.3, and D-1.4:

(1) For applications other than those listed in the tables, refer to § 1926.652(c)(2) for use of manufacturer’s tabulated data. For trench depths in excess of 20 feet, refer to § 1926.652(c)(2) and § 1926.652(c)(3).

(2) 2 inch diameter cylinders, at this width, shall have structural steel tubes (3.5X3.5X0.1875) oversleeves, or structural oversleeves of manufacturer’s specification, extending the full, collapsed length.

(3) Hydraulic cylinder capacities. (i) 2 inch cylinders shall be a minimum 2-inch inside diameter with a safe working capacity of not less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe working capacity of not less than 30,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(4) All spacing indicated is measured center to center.

(5) Vertical shoring rails shall have a minimum section modulus of 0.40 inch.

(6) When vertical shores are used, there must be a minimum of three shores spaced equally, horizontally, in a row.

(7) plywood shall be 1.125 in. thick softwood or 0.75 in. thick, 14 ply, arctic white birch (Finland form). Please note that plywood is not intended as a structural member, but only for prevention of local revealing (sloughing of the trench face) between shores.

Table D-1.2: Find vertical shores and 2 inch diameter cylinder (with special oversleeves as designated by footnote #2) spaced 8.5 feet o.c. horizontally and 4 feet o.c. vertically.

Plywood (per footnote (g) to the D-1 Table) should be used behind the shores. (See Figures 2 & 3 for typical installations.)

Example 4: A trench is dug in previously disturbed Type B soil, with characteristics of a Type C soil, and will require sheeting. The trench is 18 feet deep and 12 feet wide. 8 foot horizontal spacing between cylinders is desired for working space. From Table D-1.3:

Find horizontal wale with a section modulus of 14.0 spaced at 4 feet o.c. vertically and 3 inch diameter cylinder spaced at 9 feet maximum o.c. horizontally. 3X12 timber sheeting is required at close spacing vertically. (See Figure 4 for typical installation.)

Example 5: A trench is dug in Type C soil, 9 feet deep and 4 feet wide. Horizontal cylinder spacing in excess of 6 feet is desired for working space. From Table D-1.4:

Find horizontal wale with a section modulus of 7.0 and 2 inch diameter cylinders spaced at 6.5 feet o.c. horizontally. Or, find horizontal wale with a 1.40 section modulus and 3 inch diameter cylinder spaced at 10 feet o.c. horizontally. Both wales are spaced 4 feet o.c. vertically. 3X12 timber sheeting is required at close spacing vertically. (See Figure 4 for typical installation.)
(8) See appendix C for timber specifications.
(9) Where are calculated for simple span conditions.
(10) See appendix D, item (d), for basis and limitations of the data.
ALUMINUM HYDRAULIC SHORING
TYPICAL INSTALLATIONS

FIGURE NO. 1
VERTICAL ALUMINUM HYDRAULIC SHORING (SPOT SHORING)

FIGURE NO. 2
VERTICAL ALUMINUM HYDRAULIC SHORING (WITH PLYWOOD)

FIGURE NO. 3
VERTICAL ALUMINUM HYDRAULIC SHORING (STACKED)

FIGURE NO. 4
ALUMINUM HYDRAULIC SHORING WALKER SYSTEM (TYPICAL)

HORIZONTAL SPACING

VERTICAL SPACING

VERTICAL RAIL
HYDRAULIC CYLINDER

10' MAX.

4' MAX.

2' MAX.

UPRIGHT SHEETING

WALL
HYDRAULIC CYLINDER

6' MAX.

2' MAX.

4' MAX.

2' MAX.

4' MAX.
TABLE D - 1.1
ALUMINUM HYDRAULIC SHORING
VERTICAL SHORES
FOR SOIL TYPE A

<table>
<thead>
<tr>
<th>DEPTH OF TRENCH (FEET)</th>
<th>MAXIMUM HORIZONTAL SPACING (FEET)</th>
<th>MAXIMUM VERTICAL SPACING (FEET)</th>
<th>WIDTH OF TRENCH (FEET)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OVER 5 UP TO 10</td>
<td>8</td>
<td></td>
<td>UP TO 8</td>
</tr>
<tr>
<td>OVER 10 UP TO 15</td>
<td>8</td>
<td>4</td>
<td>OVER 8 UP TO 12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 INCH DIAMETER</td>
<td>OVER 12 UP TO 15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 INCH DIAMETER NOTE (2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 INCH DIAMETER</td>
<td></td>
</tr>
<tr>
<td>OVER 15 UP TO 20</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OVER 20</td>
<td>NOTE (1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)

Note (1): See Appendix D, Item (g) (1)
Note (2): See Appendix D, Item (g) (2)
# TABLE D - 1.2
ALUMINUM HYDRAULIC SHORING
VERTICAL SHORES.
FOR SOIL TYPE B

<table>
<thead>
<tr>
<th>DEPTH OF TRENCH</th>
<th>HYDRAULIC CYLINDERS</th>
<th>WIDTH OF TRENCH (FEET)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MAXIMUM HORIZONTAL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SPACING (FEET)</td>
<td>MAXIMUM VERTICAL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPACING (FEET)</td>
</tr>
<tr>
<td>OVER 5 UP TO 10</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>OVER 10 UP TO 15</td>
<td>6.5</td>
<td>4</td>
</tr>
<tr>
<td>OVER 15 UP TO 20</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>OVER 20</td>
<td>NOTE (1)</td>
<td></td>
</tr>
</tbody>
</table>

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)

Note (1): See Appendix D, Item (g) (1)

Note (2): See Appendix D, Item (g) (2)
<table>
<thead>
<tr>
<th>DEPTH OF TRENCH (FEET)</th>
<th>VERTICAL SPACING</th>
<th>SECTION MODULUS (IN^3)</th>
<th>WALES</th>
<th>HYDRAULIC CYLINDERS</th>
<th>TIMBER UPRIGHTS</th>
<th>MAX. HORIZ. SPACING (ON CENTER)</th>
<th>SOLID SHEET</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Width of Trench Channel (FEET)</td>
<td>Up to 8</td>
<td>Over 8 Up to 12</td>
<td>Over 12 Up to 15</td>
<td>2 FT.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Horiz. Spacing</td>
<td>Cylinder Diameter</td>
<td>Horiz. Spacing</td>
<td>Cylinder Diameter</td>
<td>Horiz. Spacing</td>
</tr>
<tr>
<td>OVER 5 UP TO 10</td>
<td>4</td>
<td>3.5</td>
<td>8.0</td>
<td>2 IN</td>
<td>8.0</td>
<td>2 IN</td>
<td>8.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.0</td>
<td>9.0</td>
<td>2 IN</td>
<td>9.0</td>
<td>2 IN</td>
<td>9.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14.0</td>
<td>12.0</td>
<td>3 IN</td>
<td>12.0</td>
<td>3 IN</td>
<td>12.0</td>
</tr>
<tr>
<td>OVER 10 UP TO 15</td>
<td>4</td>
<td>3.5</td>
<td>6.0</td>
<td>2 IN</td>
<td>6.0</td>
<td>2 IN</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.0</td>
<td>8.0</td>
<td>3 IN</td>
<td>8.0</td>
<td>3 IN</td>
<td>8.0</td>
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<tr>
<td></td>
<td></td>
<td>14.0</td>
<td>10.0</td>
<td>3 IN</td>
<td>10.0</td>
<td>3 IN</td>
<td>10.0</td>
</tr>
<tr>
<td>OVER 15 UP TO 20</td>
<td>4</td>
<td>3.5</td>
<td>5.5</td>
<td>2 IN</td>
<td>5.5</td>
<td>2 IN</td>
<td>5.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.0</td>
<td>6.0</td>
<td>3 IN</td>
<td>6.0</td>
<td>3 IN</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14.0</td>
<td>9.0</td>
<td>3 IN</td>
<td>9.0</td>
<td>3 IN</td>
<td>9.0</td>
</tr>
<tr>
<td>OVER 20</td>
<td></td>
<td></td>
<td>NOTE (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Notes (1): See Appendix D, item (g) (1)
Notes (2): See Appendix D, Item (g) (2)
* Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.
### TABLE D - 1.4
ALUMINUM HYDRAULIC SHORING
WALER SYSTEMS
FOR SOIL TYPE C

<table>
<thead>
<tr>
<th>Depth of Trench (Feet)</th>
<th>WALEs</th>
<th>Hydraulic Cylinders</th>
<th>Timber Uprights</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Width of Trench (Feet)</td>
<td>MAX. HORIZ SPACING (ON CENTER)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Up to 8</td>
<td>Over 8 Up to 12</td>
</tr>
<tr>
<td></td>
<td>Vertical Spacing</td>
<td>Section Modulus</td>
<td>Horiz. Spacing</td>
</tr>
<tr>
<td>Over 5 up to 10</td>
<td>4</td>
<td>3.5</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.0</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14.0</td>
<td>10.0</td>
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<tr>
<td>Over 10 up to 15</td>
<td>4</td>
<td>3.5</td>
<td>4.0</td>
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<td></td>
<td></td>
<td>7.0</td>
<td>5.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Over 15 up to 20</td>
<td>4</td>
<td>3.5</td>
<td>3.5</td>
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<tr>
<td></td>
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<td></td>
<td>14.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Over 20</td>
<td>NOTE (1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)

Notes (1): See Appendix D, item (g) (1)
Notes (2): See Appendix D, Item (g) (2)
* Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.
Appendix E to Subpart P—Alternatives to Timber Shoring

Figure 1. Aluminum Hydraulic Shoring

![Diagram of Aluminum Hydraulic Shoring]

Figure 2. Pneumatic/hydraulic Shoring

![Diagram of Pneumatic/hydraulic Shoring]
Figure 3. Trench Jacks (Screw Jacks)

Figure 4. Trench Shields
Appendix F to Subpart P—Selection of Protective Systems

The following figures are a graphic summary of the requirements contained in subpart P for excavations 20 feet or less in depth. Protective systems for use in excavations more than 20 feet in depth must be designed by a registered professional engineer in accordance with §1926.652 (b) and (c).

```
Is the excavation more than 5 feet in depth?

Is there potential for cave-in?

NO  YES

兴avation may be made with vertical sides.

NO  YES

Excavation must be sloped, shored, or shielded.

Sloping selected.

Go to Figure 2

Shoring or shielding selected.

Go to Figure 3

FIGURE 1 - PRELIMINARY DECISIONS
```
Sloping selected as the method of protection

Will soil classification be made in accordance with §1926.652 (b)?

YES

Excavation must comply with one of the following three options:

Option 1:
§1926.652 (b)(2) which requires Appendices A and B to be followed

Option 2:
§1926.652 (b)(3) which requires other tabulated data (see definition) to be followed.

Option 3:
§1926.652 (b)(4) which requires the excavation to be designed by a registered professional engineer.

NO

Excavations must comply with §1926.652 (b)(1) which requires a slope of 1 1/2H:1V (34°).

FIGURE 2 - SLOPING OPTIONS
Shoring or shielding selected as the method of protection.

Soil classification is required when shoring or shielding is used. The excavation must comply with one of the following four options:

Option 1
§1926.652 (c)(1) which requires Appendices A and C to be followed (e.g. timber shoring).

Option 2
§1926.652 (c)(2) which requires manufacturers data to be followed (e.g. hydraulic shoring, trench jacks, air shores, shields).

Option 3
§1926.652 (c)(3) which requires tabulated data (see definition) to be followed (e.g. any system as per the tabulated data).

Option 4
§1926.652 (c)(4) which requires the excavation to be designed by a registered professional engineer (e.g. any designed system).
DIVISION G
MISCELLANEOUS

City of Eagle Pass Subdivision Regulations:

(A.) Drainage Freeboard Table Design

<table>
<thead>
<tr>
<th>Depth of Flow</th>
<th>Required Freeboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 5 feet</td>
<td>0.5 foot</td>
</tr>
<tr>
<td>5 to 10 feet</td>
<td>10% of Design Depth</td>
</tr>
<tr>
<td>10 feet and over</td>
<td>1 foot</td>
</tr>
</tbody>
</table>

Note: This table applies to both concrete-lined and sodded channels.

(B.) The concrete lining shall extend to the design depth of flow plus the required freeboard. From the top of the concrete lining to the top of the ditch, a side slope not steeper than two (2) horizontal to one (1) vertical with sod shall be required.

(C.) For normal conditions, the concrete lining shall be a minimum of 4" thick and reinforced with 6" x 6" #6 gage wire mesh reinforcing or #3 round bars placed not more than 18 inches on centers both directions. Where surcharge, nature of ground, height and steepness of slope, etc., become critical, design shall be in accordance with latest structural standards. All concrete lining shall develop a minimum compressive strength of not less than 2500 pounds per square inch in 28 days.

(D.) Vertical walls will be permissible in depth not to exceed two (2) feet unless properly fenced or enclosed.

(E.) Easements or rights-of-way for concrete-lined channels shall extend a minimum of two (2) feet on both sides of the extreme limits of the channel.

(F.) The minimum "N" valve or roughness coefficient of 0.015 shall be used for a wood float type surface finish. This "N" value is as used in Manning’s formula.

(G.) Where velocities are in the supercritical range, allowance shall be made in the design for the proper handling of the water.

Sodded Channels: The design of sodded channels shall be based on a 25 year frequency, subject to the approval of the City Manager and shall comply with the following general specifications.

(A.) The depth of the sodded channel shall be for the design depth of the flow plus the required freeboard. (See table titled “Drainage Freeboard Table”).
(B.) Sodding shall be placed over the entire surface area of the channel in accordance with construction specifications for Grass Erosion Control.

(C.) The side slope shall not be steeper than three (3) horizontal to one (1) vertical.

(D.) Easements or rights-of-way for sodded channels shall extend a minimum of two (2) feet on one side and fifteen (15) feet for an access road on the opposite side of the extreme limits of the channels, when such channels do not parallel and adjoin an alley or roadway. When such channels do parallel and adjoin an alley or roadway, the easement or right-of-way shall extend a minimum of two (2) feet on both sides of the extreme limits of the channel.

Where utilities are installed in the access road of the drainage right-of-way, said right-of-way shall extend two (2) feet on one side and seventeen (17) feet on the opposite side of the design limits of the channel. These 17 feet are to provide an access-way along channel with a maximum cross-slope of a half-inch per foot toward channel.

(E.) The “N” value or roughness coefficient as used in the Manning formula shall be 0.035 for sodded channels.

(F.) Sodding shall not be required in those instances where rock exists and where, in the opinion of the City Manager, sodding would be impractical.

Velocity Control: The following velocity chart shall be used for scour protection and to determine the type drain which shall be used. Concrete-lined channels may also be used at velocities less than 8 f.p.s., if so desired by the Public Works Director and/or City Engineer.

<table>
<thead>
<tr>
<th>Velocity</th>
<th>Type Drain Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 6 F.P.S.</td>
<td>Sodded</td>
</tr>
<tr>
<td>6 to 8 F.P.S.</td>
<td>Concrete Retards Required</td>
</tr>
<tr>
<td>8 F.P.S. and over</td>
<td>Concrete lining or Drop Structures Required</td>
</tr>
</tbody>
</table>

Where velocities are in the supercritical range, allowance shall be made in the design for the proper handling of the water. For suggested method of computing retard spacing, see “Drainage Supplement: Method of Computing Retard Spacing”.

Channel Bends and Turns: Allowance for extra freeboard shall be made wherever design conditions require it. See Drainage Supplement.

Storm Sewers: Storm sewers shall be designed on a 25-year frequency and shall be subject to the approval of the City Manager.
(A.) For “N” values see “Drainage Supplement”.

(B.) For all ordinary conditions, storm sewers shall be designed on the assumption that they will flow full under the design discharge; however, whenever the system is placed under a pressure head, or there are constrictions, turns, submerged or inadequate outfall, etc., the hydraulic grade line shall be computed and plotted in profile. In all cases, adequate outlets shall be provided and the system adequately designed.

Alleys: Alleys may be designed on a 5-year frequency to carry storm water.

All-weather Crossings: All-weather crossings shall be required. All-weather crossings at streets shall be designed on a 25-year frequency.

Culverts and Bridges: Culverts and bridges shall be designed to adequately handle a 25-year frequency storm. All culverts and bridges shall be designed for a H-20-44 or H-20 S16-44 loading.

Drop Curb Opening, Drop Inlets, Curb Openings Inlets, etc.: See Drainage Supplement.

DRAINAGE SUPPLEMENT


The following formula is acceptable for design of retard spacing, when using City Standard Retard Section:

\[
L = \frac{1.0'}{S1 - S2}
\]

Where \(L\) = Minimum distance required between retards in feet.

\(S1\) = Actual slope of channel in ft./ft.

\(S2\) = Slope of proposed channel for velocity of 6 f.p.s. in ft./ft., i.e.

\(S2 = \frac{(NV)2}{(1.486 R 2/3)2}\)

Where \(V\) = 6 f.p.s.

\(N = .035\)

2. The following minimum “N” value or roughness coefficient as used in the Manning formula is acceptable:

Concrete pipe - 0.013

Corrugated metal pipe - 0.021
Corrugated metal pipe (smooth flow) - 0.011

Reinforced concrete culvert - 0.013

Any other “N” value shall be subject to approval of the City Manager.

**Drop Curb Openings:** Where drop curb openings are used to take storm water off the streets and into drains, the length of curb opening can be calculated from the weir formula using the Francis coefficient of 3.33 in the following formula.

\[
L = \frac{Q}{Ch^{3/2}}
\]

Where \(L\) = the length of drop curb openings required in feet.

\(Q\) = amount of flow in c.f.s. based on a 25-year design frequency.

\(C = 3.33\) (Francis coefficient)

\(h = \) head of weir in feet.

Gutter line depressions will be permitted where such depression will not hamper the flow of traffic.

**Drop Inlets:** The following formulas for inlet capacity are based on drop inlets in sag points. Inlet capacities on grades will be considered less, the amount of which depends on street grades, deflections, cross slopes depressions, etc.

A. **Grate Inlets:** The flow of water through grate openings may be treated as the flow of water through a rectangular orifice. The formula can be used for determining grate capacity:

\[
Q = CA \sqrt{2gh} \quad \text{or} \quad CA (2gh)^{1/2}
\]

Where: \(Q = \) the discharge in cubic feet per second.

\(C = \) the orifice coefficient of discharge (taken as 0.70)

\(g = \) the acceleration due to gravity (32.2 ft./sec.).

\(h = \) the head or the grate in feet.

\(A = \) the net area of the openings in the grate in square feet.
This formula gives the theoretical capacity of the grate inlet. Since grate inlets are subject to considerable clogging, capacity of the grate inlet will be taken as one-half \( \frac{1}{2} \) of the value given by this formula.

**B. Curb Opening Inlets:** The capacity of curb opening inlets will depend on whether or not the opening is running partially full or submerged. If the depth of flow at the curb opening inlet is such as to cause a partially full opening, a weir effect will develop and the following formula will apply:

\[
Q = CwLh^{3/2}
\]

Where: \( Q \) = the discharge of capacity in cubic feet per second.

\( Cw \) = the weir coeff. of discharge (3.087)

\( L \) = the length of curb opening in feet.

\( h \) = the head or depth of water at the opening in feet.

If the depth of flow at the curb opening inlet is such as to fully submerge the opening, the orifice effect will develop and the formula used shall be identical to that given under grate inlets with the exception that the head “\( h \)” on the curb opening orifice shall be taken as the depth from the top of the water surface to center of the orifice or opening in fact.

**GENERAL PROVISIONS**

1. Sods shall be live-growing Bermuda grass (or other acceptable sod), free of obnoxious weeds and grasses. These sods, of 3” minimum thickness, shall have a thickly matted root system and retain the native soil about the roots. They must be kept moist from time of excavation to planting.

2. Completed planting shall match finish grades, lines and cross sections in accordance with plans.

**PLANTING METHODS**

1. Broadcast sprigging shall be upon a clean disced or loose surface of 4” minimum depth at a rate of one C.Y. per 24 S.Y. of area. Sod material shall be uniformly spread and disced into the soil and firmed with a cultipacker or corrugated roller.
2. Mulch sodding, 3 inches thick, shall be uniformly distributed upon a scarified surface furrowed 4" deep and 15" on center along contour, then compacted by cultipacker or corrugated roller.

3. Sprig sodding shall consist of 3" squares planted on a minimum of 15" centers with the top of the sod at grade line. Soil shall be firmed against the sods.
# FIGURE A

**STORM DRAINAGE**

Street velocities and capacities

Flowing curb full

Manning’s N=0.018

<table>
<thead>
<tr>
<th>CROWN-SECTION</th>
<th>CROSS-SLOPE</th>
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<tbody>
<tr>
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<tr>
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<tr>
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124
# CITY OF EAGLE PASS
## EXCAVATION PERMIT

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<th>Type of Excavation (Cut)</th>
<th>Location</th>
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<td>Street</td>
<td>( )</td>
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<tr>
<td>Alley</td>
<td>( )</td>
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<tr>
<td>Curb &amp; Gutter</td>
<td>( )</td>
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<tr>
<td>Sidewalk</td>
<td>( )</td>
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<tr>
<td>Other</td>
<td>( )</td>
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</table>

Total Square Footage of Excavation: ________________________________

Date Permit Issued: ________________________________

Date Excavation will commence: ________________________________

Date Repairs Approved: ________________________________

Fee: $ ________________________________
CITY OF EAGLE PASS
SUBDIVISION REGULATIONS

ASPHALT PAVEMENT

12"  28"

4\frac{1}{2}'' EXCEPT ON EXISTING STREET

CONCRETE

CALICHÉ

MANHOLE RING ENCASEMENT DETAIL

4' x 4'

18'' DEPTH CALICHÉ COMPACTED AT 95% DENSITY

1.0' WIDTH AND 6'' DEPTH, CONCRETE

4.0'

4.0''
CITY OF EAGLE PASS
SUBDIVISION REGULATIONS

Persons making excavations shall cause the perimeter of said excavation to be spray painted according to the following schedule:

<table>
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<tr>
<th>Color</th>
<th>Type</th>
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<tr>
<td>Blue</td>
<td>Water</td>
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<tr>
<td>Green</td>
<td>Sanitary Sewer</td>
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<tr>
<td>Yellow</td>
<td>Natural Gas, Oil, Steam</td>
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<tr>
<td>Red</td>
<td>Electric</td>
</tr>
<tr>
<td>Orange</td>
<td>Telephone/Television</td>
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<tr>
<td>Pink</td>
<td>Temporary Survey Mark</td>
</tr>
<tr>
<td>White</td>
<td>Proposed Excavation</td>
</tr>
</tbody>
</table>

2\(\frac{1}{2}\)" TYPE CC ASPHALT COMPACTED TO LEVEL OF SURROUNDING PAVEMENT

EXCAVATED REPAIR AREAS WILL EXTEND 12" LATERALLY FROM EACH EDGE OF THE CUTS.

BACKFILL

PIPE WIDTH

PIPE

8" TYPE F MATERIAL (CALICHE) COMPACTED TO 95% DENSITY

NO DEBRIS, PAVEMENT, ROCKS, OR, CONTAMINATED SOIL IS ALLOWED AS BACKFILL. BACKFILL TO BE PLACED IN LAYERS NOT TO EXCEED 12" AND COMPACTED TO 95% DENSITY.
Sec. 23-15 STREETS

(1) Marginal access streets

ARterial Street

HWY

Marginal Access Street

House

Lot

House

Lot

House

Lot

House

Lot

House

Lot

House

Lot
Sec. 23-15 STREETS

(n) Curbs.

1. Combined monolithic curb and gutter shall be provided. The curb and gutter shall be of concrete and shall be eighteen (18) inches wide.
Sec. 23-15 STREETS

(n) Curbs.

1. Combined monolithic curb and gutter shall be provided. The curb and gutter shall be of concrete and shall be eighteen (18) inches wide.

![Curb & Gutter Detail Diagram]

**Curb & Gutter Detail**
(Monolithic) N.T.S.

![Driveways Diagram]

**Driveways**
N.T.S.

MIN. SLOPE 1/4" PER FT.
CITY OF EAGLE PASS
SUBDIVISION REGULATIONS

Sec. 23-15 STREETS

(d) Street Alignment.

1. Street jogs with center line off sets of less than 125 feet will not be accepted.

1. POOR
THE DANGEROUS JOG INTERSECTION
FORCING PRECARIOUS TURNING MOVEMENTS

2. MINIMUM
INTERSECTIONS WHICH CANNOT BE
ALIGNED SHOULD BE SEPARATED BY
A MINIMUM OF 125 FEET BETWEEN CENTERLINES

3. BETTER
BY SLIGHTLY CURVING ONE OF THE
UNALIGNED INTERSECTING STREETS
A DANGEROUS JOG CAN BE AVOIDED.
Figure II-60-Pothole permanent repair. (1) Untreated potholes, (2) Surface and base removed to firm support, (3) Tack coat applied, (4) Full-depth asphalt mixture placed and being compacted, (5) Finished patch compacted to level of surrounding pavement
Sec. 23-15 STREETS

(b) Relation to adjoining street system

Sec. 23-15 STREETS

(c) Projection of streets
MIN. 2" SAND OR GRAVEL CUSHION

6 x 6 #10 MESH OR
#3 # BARS 18 O.C. 2 WAYS

SIDEWALKS
4.8 Ramps

4.7.11 Islands. Any raised islands in crossings shall be cut through level with the street or have curb ramps at both sides and a level area at least 48 in (1220 mm) long between the curb ramps in the part of the island intersected by the crossings (see Fig. 15(a) and (b)).

4.8 Ramps.

4.8.1 General. Any part of an accessible route with a slope greater than 1:20 shall be considered a ramp and shall comply with 4.8.

4.8.2 Slope and Rise. The least possible slope shall be used for any ramp. The maximum slope of a ramp in new construction shall be 1:12. The maximum rise for any run shall be 30 in (760 mm) (see Fig. 16). Curb ramps and ramps to be constructed on existing sites or in existing buildings or facilities may have slopes and rises as allowed in 4.1.6(3)(a) if space limitations prohibit the use of a 1:12 slope or less.
4.8.3 Clear Width. The minimum clear width of a ramp shall be 36 in (915 mm).

4.8.4* Landings. Ramps shall have level landings at bottom and top of each ramp and each ramp run. Landings shall have the following features:

(1) The landing shall be at least as wide as the ramp run leading to it.

(2) The landing length shall be a minimum of 60 in (1525 mm) clear.

(3) If ramps change direction at landings, the minimum landing size shall be 60 in by 60 in (1525 mm by 1525 mm).

(4) If a doorway is located at a landing, then the area in front of the doorway shall comply with 4.13.6.

4.8.5* Handrails. If a ramp run has a rise greater than 6 in (150 mm) or a horizontal projection greater than 72 in (1830 mm), then it shall have handrails on both sides. Handrails are not required on curb ramps or adjacent to seating in assembly areas. Handrails shall comply with 4.26 and shall have the following features:

(1) Handrails shall be provided along both sides of ramp segments. The inside handrail on switchback or dogleg ramps shall always be continuous.

(2) If handrails are not continuous, they shall extend at least 12 in (305 mm) beyond the top and bottom of the ramp segment and shall be parallel with the floor or ground surface (see Fig. 17).

(3) The clear space between the handrail and the wall shall be 1 - 1/2 in (38 mm).

(4) Gripping surfaces shall be continuous.

(5) Top of handrail gripping surfaces shall be mounted between 34 in and 38 in (865 mm and 965 mm) above ramp surfaces.

(6) Ends of handrails shall be either rounded or returned smoothly to floor, wall, or post.

(7) Handrails shall not rotate within their fittings.

4.8.6 Cross Slope and Surfaces. The cross slope of ramp surfaces shall be no greater than 1:50. Ramp surfaces shall comply with 4.5.
4.8.7 Edge Protection. Ramps and landings with drop-offs shall have curbs, walls, railings, or projecting surfaces that prevent people from slipping off the ramp. Curbs shall be a minimum of 2 in (50 mm) high (see Fig. 17).

4.8.8 Outdoor Conditions. Outdoor ramps and their approaches shall be designed so that water will not accumulate on walking surfaces.

4.9 Stairs.

4.9.1 Minimum Number. Stairs required to be accessible by 4.1 shall comply with 4.9.

4.9.2 Treads and Risers. On any given flight of stairs, all steps shall have uniform riser heights and uniform tread widths. Stair treads shall be no less than 11 in (280 mm) wide, measured from riser to riser (see Fig. 18(a)). Open risers are not permitted.

4.9.3 Nosings. The undersides of nosings shall not be abrupt. The radius of curvature at the leading edge of the tread shall be no greater than 1/2 in (13 mm). Risers shall be sloped or the underside of the nosing shall have an angle not less than 60 degrees from the horizontal. Nosings shall project no more than 1-1/2 in (38 mm) (see Fig. 18).

4.9.4 Handrails. Stairways shall have handrails at both sides of all stairs. Handrails shall comply with 4.26 and shall have the following features:

1. Handrails shall be continuous along both sides of stairs. The inside handrail on switchback or dogleg stairs shall always be continuous (see Fig. 19(a) and (b)).

2. If handrails are not continuous, they shall extend at least 12 in (305 mm) beyond the top riser and at least 12 in (305 mm) plus the width of one tread beyond the bottom riser. At the top, the extension shall be parallel with the floor or ground surface. At the bottom, the handrail shall continue to slope for a distance of the width of one tread from the bottom riser; the remainder of the extension shall be horizontal (see Fig. 19(c) and (d)). Handrail extensions shall comply with 4.4.

3. The clear space between handrails and wall shall be 1-1/2 in (38 mm).

4.9.5 Detectable Warnings at Stairs. (Reserved).

4.9.6 Outdoor Conditions. Outdoor stairs and their approaches shall be designed so that water will not accumulate on walking surfaces.

4.10 Elevators.

4.10.1 General. Accessible elevators shall be on an accessible route and shall comply with 4.10 and with the ASME A17.1-1990, Safety Code for Elevators and Escalators. Freight elevators shall not be considered as meeting the requirements of this section unless the only elevators provided are used as combination passenger and freight elevators for the public and employees.

4.10.2 Automatic Operation. Elevator operation shall be automatic. Each car shall be equipped with a self-leveling feature that will automatically bring the car to floor landings within a tolerance of 1/2 in (13 mm) under rated loading to zero loading conditions. This self-leveling feature shall be automatic and independent of the operating device and shall correct the overtravel or undertrail.

4.10.3 Hall Call Buttons. Call buttons in elevator lobbies and halls shall be centered at 42 in (1065 mm) above the floor. Such call buttons shall have visual signals to indicate when each call is registered and when each call is answered. Call buttons shall be a minimum of 3/4 in (19 mm) in the smallest dimension. The button designating the up direction shall be on top. (See Fig. 20.) Buttons shall be raised or flush. Objects mounted beneath hall call buttons shall not project into the elevator lobby more than 4 in (100 mm).
Fig. 15
Curb Ramps at Marked Crossings
DETAIL PLACEMENT OF UNDERGROUND SERVICE LINES

WATER LINES = NORTH & WEST SIDE
NAT. GAS " = EAST & SOUTH SIDE
(a.) Utility Easements: A "utility easement" is an interest in land granted to the City and/or utility companies for installing and maintaining utilities across, over or under private land together with the right to enter thereon with machinery and other vehicles necessary for the maintenance of said utilities by the City or Utility Companies.

(b.) Vehicular non access easement: A "vehicular non access easement" is an easement established on a lot for the purpose of prohibiting ingress and egress to vehicular traffic.

(c.) Specific use easements: An easement may be permitted for a specific purpose when requested by a particular utility and shall be dedicated to the City on the plat and be a part of a platted lot or lots. Such specific purpose easements shall be paved in accordance with specifications and requirements for the paving of alleys as stipulated in Section 23.62 (Ordinance No. 83-16.1, 23-30, 8/18/83).

Property owners may fence their backyard area only up to and at the easement lines. The property owner shall be responsible for the maintenance of said utility easements even though it be located beyond the rear fence of the property. Maintenance of the easement is the responsibility of the owner of the property upon which said easement is located.
(1) Streets will be constructed in accordance with the City of Eagle Pass Plans and Specifications. Paving will consist of a single chip seal waterproofing course and one and one half (1½) inches of cold mixed, Type CC Asphaltic paving or Hot Mix Asphaltic Concrete Pavement.

(2) Streets may also be paved in alternate manners, provided that the design is based on subsurface, soil investigations, conducted by an independent Testing Laboratory. All costs will be borne by developer.

MINOR STREET SECTION

MARGINAL STREET SECTION
(1) Streets will be constructed in accordance with the City of Eagle Pass Plans and Specifications. Paving will consist of a single chip seal waterproofing course and one and one half (1½) inches of cold mixed, Type CC Asphaltic paving or Hot Mix Asphaltic Concrete Pavement.

(2) Streets may also be paved in alternate manners, provided that the design is based on subsurface soil investigations, conducted by an independent Testing Laboratory. All costs will be borne by the developer.

**ARTERIAL STREET**

- 80.0' MIN. R.O.W
- 80.0' P.L
- 8.0' Parkway
- 27.0' Back to Back Paving
- 10.0' Divider Slope 1/4' Per FT.
- 27.0' Back to Back Paving Slope 1/4' Per FT.
- 8.0' Parkway
- Walk, Min. Slope 1/4' Per FT.
- Subgrade - 95% Compacted Density 8' Compacted Caliche Base 95%
- Single Chip Seal Water Proofing Course and 1 1/2" Cold Mix, Type CC Asphaltic Paving or Hot Mix Asphaltic Concrete Pavement

**Collector Street**

- 60.0' R.O.W
- 10.5' Parkway
- 39.0' Paving
- 10.5' Parkway
- 10' 4.0' 5.5'
- Soil, Max. Slope 1/4' Per Ft.
- Min. Slope 1/4' Per Ft.
- 5" Crown
- Subgrade - 95% Compacted Density 8" Compacted Caliche Base 95%
- Single Chip Seal Water Proofing Course and 1 1/2" Cold Mix, Type CC Asphaltic Paving or Hot Mix Asphaltic Concrete Pavement.

**Note:** Median may be eliminated and Street paved 60' wide.
BORE DETAIL FOR WATER & FORCE MAIN

NOTE:
1. LENGTH OF STEEL CASING VARIES
2. DIAMETER OF STEEL CASING VARIES
D-1: DIAMETER OF PVC PIPE
D-2: DIAMETER OF STEEL CASING-TO BE TWICE THE DIAMETER OF THE PVC PIPE

SECTION AT BORING

BORE DETAIL
CITY OF EAGLE PASS
PRE-CONSTRUCTION CONFERENCE

PROJECT:

Name:
Program:
Contractor:

1. Scope of Work:
   
   A. Work Schedule
      1. Beginning: ____________________________
      2. Substantial Completion: ____________________________
      3. Final Completion: ____________________________
   
   B. Construction Sequence
      1. Total Days Calendar Days, Substantial Completion
         Calendar Days, Final Completion
      2. Order of Construction:

2. City's Authority & Responsibility:

   A. Review and approve final plans and specifications.
   B. Issue Notice to Proceed.
   C. Verify Issuance of Performance & Payment Bond.
   D. Review Plans & Specifications.
   E. Engineering Field Data for addition and/or deletion of project activities.
   F. Right of Ways (R.O.W.)/Temporary & Permanent Easements.
   H. Field Verification of Work Performed.
   I. Conduct Final Walk through and Project acceptance.
   J. Supervision/Coordination: ____________________________
   K. Daily and Periodic Inspection: ____________________________
   L. Final Inspection: ____________________________
   M. Utilities Services: ____________________________
   N. Any additional item related to Project: ____________________________
3. Contractor’s Responsibilities:

A. Full-Time Project Supervisor:
B. Identification of all Subcontractors:
C. Identification of all Major Materialmen:
D. Release of Lien Forms:
   1. General Contractor’s Affidavit, Warranty, and Lien Waiver.
   2. Subcontractor’s/Materialmen Affidavit, Warranty, and Lien Waiver.
E. Traffic Control, Barricades, Signs and Safety Requirements.
G. Coordination with Maverick County and City of Eagle Pass.
H. Obtaining Permits and Other Clearances.
I. Firearms (s) are Prohibited on the Project Site.
J. Access/inconvenience to Public during Construction.
K. Clean-up Litter.
L. Insurance & Liability (As specified with Contractor’s Contract Document).
M. Guarantee of Work (As specified with Contractor’s Contract Document).
N. Performance of Construction Work in accordance to the plans and specifications
   in the contract documents, including revised change orders as approved by the
   Public Works Director.
O. Submission of Correct Payment Estimates.
P. Submission of all close-out documentation.
Q. Submission of “Record” plans and specifications.
R. Any additions and/or Item(s) that relate to the Contractor’s Responsibilities.

4. Coordination with Other Utilities Services:

A. Utilities Service Field Data
   - Water Service - El Indio Water Supply Corporation - City of Eagle Pass
   - Sewer Service - City of Eagle Pass
   - Electrical Service - C. P. & L. Co.
   - Television Cable - TCI Cablevision of Texas
   - Railroad Right-of-Way
   - Highway Right-of-Way (Texas Department of Transportation)
   - Telephone - Southwestern Bell Tel.
   - Natural Gas/Oil Pipelines -
B. Barricades, Signs & Safety Requirements.
C. Construction Sequence.
D. Permits/Clearances.
E. Any additions Item(s) that relate with Coordination with Other Utilities Services.
5. Project Administration and Final Close-out Requirements - Planning Department:

A. Compliance with Federal, State and Local Regulations.
B. Change in Work & Price of Contract.
C. Change Order Request(s).
D. Final Quantity Adjustment.
E. Close-Out Visit.
F. Certificate of Construction Completion.
G. Final Compliance and Release of Retainage
H. Project Close-Out.
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CITY OF EAGLE PASS
PRE-CONSTRUCTION MEETING
DATE:___________

143
Construction Specifications

Amendments to Ordinance

No. 98-19
AMENDMENTS TO ORDINANCE NO. 98-19

AN ORDINANCE AMENDING CHAPTERS 2, 21, 22, AND 23 OF THE CODE ORDINANCES OF THE CITY OF EAGLE PASS, TEXAS, TO PROVIDE FOR THE ADOPTION AND INCLUSION IN SAID CODE OF ORDINANCES THE CITY OF EAGLE PASS' PUBLIC WORKS DEPARTMENT CONSTRUCTION SPECIFICATION MANUAL; AND PROVIDING FOR AN EFFECTIVE DATE.

WHEREAS, the City of Eagle Pass has enacted rules and regulations for general construction and development practices of a varied and broad nature, that are found in numerous chapters of the Code of Ordinances of the City of Eagle Pass, Texas, including Chapters 2, 21, 22, and 23; and

WHEREAS, the Public Works Department of the City of Eagle Pass (the "Public Works Department") has promulgated its Construction Specifications manual (the "Manual") to act as a supplement to these general rules and regulations regarding construction and development practices as found in the Code of Ordinances; and

WHEREAS, the City Council of the City of Eagle Pass finds that the construction specifications set forth in the Manual are well taken and will benefit the citizens of the community for years to come; and

WHEREAS, in order to implement the rules and regulations set forth in the Manual, it will be necessary to amend, in part, certain provision of the Code of Ordinances including Chapters 2, 21, 22, 23, which amendments the City Council finds are in the best interest of the community.

NOW, THEREFORE, the City Council of the City of Eagle Pass, Texas, in order to fully implement the Public Works Department's construction specifications as set forth in its Manual, does conclude as follows:


SECTION 2. Section 2-3.2(a), 21-1(b), 22-25(b), 22-37, and 23-3(b) are hereby amended to add the following language to those Sections as now written:

Notwithstanding anything to the contrary in this Chapter, the City of Eagle Pass Public Works Department's construction specifications as set forth in its Construction Specifications Manual, and any revisions thereto, are hereby adopted by reference and, as adopted, shall apply to the activities contemplated by this and any ordinance, resolution, or part thereof, in conflict with the construction specifications hereby adopted are repealed to the extent of such conflict. The construction specifications set forth in the Construction Specifications Manual shall apply not only to any
project, work of development located within the city limits of the City of Eagle Pass, but also to any such activities located within the extraterritorial jurisdiction of the City of Eagle Pass, Texas. A copy of the City of Eagle Pass Public Works Department’s Construction Specifications Manual shall be available for inspection in the following offices of the City of Eagle Pass: City Secretary, Planning Department, and Public Works Department.

SECTION 3. This ordinance shall be in full force and effect immediately from and after its final passage as provided by law.

NOW THEREFORE, BE IT ORDAINED, that the entire Exhibit "A" attached hereto and shall become a part of Division G of the Construction Specifications Manual and effective upon passage.

READ, PASSED AND APPROVED ON FIRST READING by at the CITY COUNCIL of the City of Eagle Pass, Texas, on this ________ day of _____________________, 2001.

ATTEST:

________________________________________

Presented by me to the Mayor of the City of Eagle Pass, Texas, this ________ day of _____________________, 2001.

________________________________________

Approved and signed by the Mayor of the City of Eagle Pass, Texas, this ________ day of _____________________, 2001.

________________________________________

ATTEST:
Exhibit A

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EAGLE PASS, TEXAS

A General Ordinance Establishing

Storm Drainage and Sediment Control

1. Purpose

The purpose of this Ordinance is to reduce the hazard to public health and safety caused by excessive storm water runoff, to enhance economic objectives, and to protect, conserve and promote the orderly development of land and water resources within the regulatory area. This ordinance regulates:

a. Storm water drainage improvements related to development of lands located within Eagle Pass.

b. Drainage control systems installed during new construction and grading of lots and other parcels of land.

c. Erosion and sediment control systems installed during new construction of grading of lots and other parcels of land.

d. The design, construction and maintenance of storm water drainage facilities and systems.

e. Existing storm water drainage systems where the inclusion of improvements is feasible.

It is recognized that drainage systems serving the City of Eagle Pass may not have sufficient capacity to receive and convey storm water runoff resulting when land changes from open or agricultural use to a more urbanized use. It is further recognized that deposit of sediment from developments during and after construction can reduce capacities of storm sewer and drainage systems and result in damages to receiving lakes and streams. Therefore, it shall be the policy of the City of Eagle Pass that the storage and controlled release of storm water runoff shall be required of all new development, any redevelopment and other new construction in the City of Eagle Pass as stipulated elsewhere in this ordinance. The release rate of storm water from developed lands shall not exceed the release rate from the land area in its present land use.

Because topography and the availability and adequacy of outlets for storm runoff vary with almost every site, the requirements for storm drainage tend to be an individual matter for any project. It is recommended that each proposed project be discussed with the Engineer’s office at the earliest practical time in the planning stage.

1. Storm Water Control Policy

a. Intent of Policy

1. This policy will govern the installation of storm drainage facilities with in the City of Eagle Pass.

2. It will establish the means for the development of designed storm drainage facilities within the City of Eagle Pass which in turn will help alleviate the threat of
flooding, provide better drainage of streets, help enhance and preserve the natural beauty of streams, facilitate maintenance operations, and encourage proper soil conservation practices.

b. General Conditions

1. A developer is responsible for securing the necessary easements to drain his development across land belonging to others if he has diverted the flow from its natural course and/or concentrated it. Should a developer fail to secure the necessary easements, after exhausting all reasonable means, then he may make written request to the City Council to condemn the required outfall easements, showing also what means were employed in attempting to secure the easements through negotiation. The Council, upon determining that the proposed drainage easement will be in the best public interest, and as empowered by law, may institute condemnation proceedings. The developer will bear the costs and attorney's fees.

2. The design frequency for drainage facilities shall be determined by this ordinance amendment and shall be approved by the City Public Works Director.

3. A developer may apply for a variance from any item or clause of this policy which governs design or construction of a drainage facility provided that he submits an alternate procedure that is consistent with the declared intent of this policy. The proposed alternative shall include a detailed study and/or plans prepared by a professional engineer and a method for maintenance of the proposed facility, if maintenance is a factor as determined by the Public Works director. The City Public Works Director may, at his discretion, require that the request for a variance be brought before the City Council for a ruling.

c. Enclosed Storm Drains

1. Enclosed storm drains shall be required when either of the following situations exist:
   a. When the anticipated runoff can be accommodated by any pipe having a diameter of not less than eighteen (18) inches nor more than thirty-six (36) inches.
   b. When a proposed drainage way is parallel and adjacent to a street, and anticipated runoff can be accommodated by any pipe sixty (60) inches or less in diameter.

2. When a pipe diameter outside of the limits (as prescribed in c. -1a above) is required, an open channel may be employed as outlined in the next sections.

3. The City shall not participate in the cost of enclosed storm drain systems, except where a pipe larger than that stated is required to properly drain parts of the street system outside of the limits of the subject development and the increased size is installed at the direction of the City Public Works Director. The City will assume 100% of the material and installation cost of the required increase in size, but shall not share in the cost of manholes, lead lines, headwalls or other appurtenances normally required in the installation.

d. Minor Artificial Channels
1. Minor artificial channels may be used in lieu of an enclosed storm drain, it if has been determined under Section III. "A" above that the use of artificial channels is permitted. The developer has the option, except in cases requiring continuity of design to install one of the following:

a. Concrete-lined Open Channels

i. The channel lining shall be of such dimensions that a ten-year frequency rain may be continued within it; with the balance of the design frequency contained within sodded earth on slopes not steeper that 4:1.
ii. Site improvements shall include the grading of all building sites to an elevation where (1) no building will be subject to overflow from a 100-year frequency flood, and (2) the rapid runoff of storm water will be provided for.
iii. A means of ingress and egress for men and equipment for maintenance purposes shall be provided by the developer.
iv. Minor artificial channels constructed in the above manner will be accepted by the City for maintenance upon acceptance of other utilities within the development, provided that a Bermuda grass cover, a bituminous, treated mulch, or some other protective perennial cover or equal quality has become established on the sod portion of the channel. If further sodding and/or seeding are required to provide an adequate cover, the initial developer shall deposit funds (to be determined by the City Public Works Director) to insure an established cover prior to acceptance of the other utilities.

b. Grass-lined Open Channels

i. The channel will have the minimum hydraulic capacity for the stated design frequency.
ii. If open channels with gradients sufficient to provide self-cleaning velocities (computed for a two year frequency storm) cannot be established, then concrete lining (as specified in Part 1 above) shall be installed.
iii. A concrete “mowing strip” of shape and dimensions approved by the City Public Works Director shall be installed in the flow line of a grass-lined open channel.
iv. Where channel grades are sufficient to produce an eroding velocity in any reach of the channel (as computed for a 25 year storm), ditch checks, chutes, channel lining, or drop structures of a design approve by the City Public Works Director shall be required to reduce the velocity to a non-eroding value.
v. All erodible areas (i.e., bends, unstable slopes, etc.) shall be protected by concrete, rock, masonry riprapp, or retaining walls. The developer shall submit detailed plans so all proposed methods of slope protection for the approval of the City Public Works Director.
vi. Site improvements shall provide for the grading of all building sites to an elevation where (1) no building will be subject to overflow from a 100 year frequency flood, and (2) the rapid runoff of storm water will be provided for.
vii. A means of ingress and egress for men and equipment or maintenance purposes shall be provided by the developer.
viii. Should the developer elect to construct a grass lined open channel, he and his successors (lot purchasers) shall guarantee maintenance for a
minimum period of 5 years from the date of acceptance of other utilities within the subdivision and shall so designate on the face of the final plat. The guarantee shall be in the form of a recorded covenant as prescribed by the City Attorney. The channel shall be inspected at the end of the five year period, and if the channel is found to have functioned properly during that period of time, it will be accepted by the city for permanent maintenance. If, however, it is found that the channel has not been properly maintained and is a burden to the city, the maintenance of said channel shall remain with the developer and successors without recourse.

2. City will not participate in the cost of minor open channels unless water has been diverted from property not belonging to the developer (at the direction of City Public Works Director) to the channel to improve the drainage of another area. The amount of City participation will be 100% of the cost incurred by the increase in size caused by such a diversion of water. The City will not participate in the extension of a minor artificial channel.

e. Minor Natural Channels

1. The channel will have a minimum hydraulic capacity for the design frequency based on a fully developed watershed.
2. Side slopes shall be graded, if necessary, to blend into the adjacent land, but in no case shall the slopes so constructed, or those in their natural state, be steeper than a 4:1, unless special means of slope protection are provided.
3. A concrete "mowing strip" of shape and dimensions approved by the City Public Works Director shall be installed in the flow line.
4. All erodible areas shall be protected by concrete, rock, masonry riprap or retaining walls. The developer shall submit detailed plans of all proposed methods of slope protection which plans must be approved by the City Public Works Director.
5. Where channel grades are sufficient to produce an eroding velocity in any reach of the channel (as computed for a twenty-five year storm), ditch checks, chutes, channel lining, or drop structures of a design approved by the City Public Works Director shall be required to reduce the velocity to a non-eroding value.
6. The developer shall provide a means of ingress and egress for men and equipment.
7. Site improvements shall provide for the grading of all building sites to an elevation where (1) no building will be subject to overflow from a one hundred-year frequency flood, and (2) the rapid runoff of storm water will be provided for.
8. Minor natural channels which have been constructed in the method previously described will be accepted by the City for maintenance at the end of a minimum five year period, from the date of acceptance of the other utilities within the subdivision, during which time the developer and successors shall guarantee the maintenance of the channel shall be inspected and if found to have functioned properly during that period of time will be accepted by the City for permanent maintenance. If, however, it is found that the channel has not been properly maintained and is a burden to the City, the maintenance of said channel shall remain with the developer and successors without recourse.
9. The city will not participate in the cost of any natural open channel construction.

f. Major Channels
1. Major channels are those shown on the attached map. The following subparagraphs shall apply to construction of these channels:
   a. The channel improvements shall be as determined by the City in conjunction with any federal or state governmental agency to which the City may apply for financial aid or relief as shown on the plans.
   b. Construction of these channels will be begun only on the extreme down-stream end and progress upstream.
   c. Should a developer desire to develop along an upstream reach of a channel in which the channel downstream has not been improved, he must first make application in writing to the City Council for a permit. At the time of the application, he must submit a cost estimate of improving the channel as shown on the plans. This estimate shall include the cost of all improvements (utility adjustments, drop structures, ditch checks, headwalls, rip-rap, channel entrances and other appurtenances and items incidental to a turn-key job) within the reach that he owns. The developer shall deposit with the City in a special fund marked “Major Channel Improvements” a sum of money as reflected by the above estimate that is sufficient to complete the channel and all improvements as shown on the plans less the cost of constructing a pilot channel as later defined. Upon approval of the request the City Council will cause to be constructed, either by contract or by city forces, a pilot channel with an eight foot bottom and three-to-one side slopes from the extreme downstream through the property belonging to the developer. The construction of the pilot channel will represent the City’s participation in costs for improvements to the channel. The reach of the channel within the property lines of the development will be constructed to the full section as shown on the plans to; enable the developer to utilize the excavated dirt. The City, however, at its option, may not complete all the appurtenances required, but may let another contract for their construction at a later date.

2. Property owners who have previously participated in the cost of major channel improvements prior to the extent of their participation for computing the cost to be deposited with the City in Item 3 above.

g. Culverts and Bridges – Minor, Natural, Artificial, and Major Channels

1. Where it becomes necessary for a drainage channel to cross a proposed City street, the City may participate in the cost of culverts or bridges in the following situations:

   a. When the required capacity of such culvert or bridge exceeds the capacity of a sixty (60) inch diameter pipe and is longer than forty (40) feet (measured normal to the roadway).
   b. When the runoff through the culvert or bridge is not produced by land owned by the developer, or by an unplatted area of the City.
   c. When the developer has made application in writing to the City Council for participation and shown cause as to why the particular installation will be of benefit to the City.
2. The City's participation in costs will be that amount greater than the cost of a sixty (60) inch reinforced concrete pipe that is forty (40) feet long.

3. The developer shall pay an amount equal to 100 percent of the cost of furnishing and installing a sixty inch reinforced concrete pipe forty feet long, plus 100 percent of the first cost of all channel excavation, manholes, inlets, leadlines, headwalls, and other items required to complete the installation.

4. If a bridge or culvert be required of a developer under the terms of this policy and the City Council determine that said bridge or culvert will be a direct benefit to owners of property abutting that of the developer, then City Council may apportion the cost of same among the subject owners. The cost to be apportioned shall be that normally borne by the developer and said apportionment shall be in the ratio of benefit received. The amount determined shall be assessed against the subject property owners and shall constitute a first lien.

5. If the developer wishes to install any drainage structure more expensive that the minimum requirement, he shall bear 100% of all costs of the installation of said structure.

It is recognized that the smaller streams and drainage channels serving the City of Eagle Pass may not have sufficient capacity to receive and convey storm water runoff resulting from continued urbanization. Accordingly, the storage and controlled release rate of excess storm water runoff shall be required for any development, redevelopment and new construction located within the City of Eagle Pass not exempt under this Ordinance. No improvement location permit shall be issued for the construction or extension of any proposed or existing building in Eagle Pass until the required drainage plans have been approved in writing by the City, except for the following exemptions:

(a) Construction or extension of a single family dwelling house or an extension of a single family dwelling house or an accessory use building thereto;

(b) Construction or extension of a duplex dwelling house or an accessory use building thereto;

(c) Construction or extension in that area of the City zoned Central Business District (CB); or

(d) Construction, extension or replacement of a building or buildings on a site of 30,000 square feet or less.

(e) Extension or replacement of any existing building that does not increase the existing rate of runoff.

The exceptions (a) through (e) above, however, shall not be applicable to a project if located in a previously designated Impact Area as established per Section 18 of this Ordinance.

The release rate of storm water from development, redevelopment, and new construction, as stipulated above, may not exceed the peak rate of runoff from the land area in its present state of development for a one hundred (100) year storm event. The developer must submit to the City, detailed computations of runoff before and after development, redevelopment or new construction. These computations must show the peak runoff rate after development, redevelopment or new construction, for the 100 year return period of critical duration must not
exceed the 100 year return period predevelopment peak runoff rate. The computation method used in determining storm water runoff for land areas up to and including 5 acres may be the “Rational Method.” Other proven hydrograph techniques and/or computer drainage modeling methods may be used for determining storm water runoff of both areas smaller and larger than 100 acres.

3. Conflicting Ordinances

The provisions of this Ordinance shall be deemed as additional requirements to minimum standards required by other ordinances of the City. In the case of conflicting requirements, the most restrictive shall apply.

4. Compliance with Other Ordinances

In addition to the requirements of this Ordinance, compliance with the requirements set forth in any other applicable ordinances with respect to submission and approval of preliminary and final subdivision plats, improvement plans, building and zoning permits, construction inspections, appeals, and similar matters, and compliance with applicable State of Texas statutes and regulations shall be required.

5. Definitions

For the purpose of this Ordinance, the following definitions shall apply:

City - The City of Eagle Pass, Maverick County, Texas, and any subordinate employee or agent to whom they shall specifically delegate a responsibility authorized by this Ordinance.

Capacity of a Storm Drainage Facility - The maximum flow that can be conveyed or stored by a storm drainage facility without causing damage to public or private property.

Channel - A natural or artificial watercourse which periodically or continuously contains moving water, or which forms a connecting link between two bodies of water. It has a defined bed and banks, which serve to confine the water.

Compensatory storage - An artificial volume of storage within a flood plain used to balance the loss of natural flood storage capacity when artificial fill or structures are placed within the flood plain.

Contiguous - Adjoining or in actual contact with.

Critical Duration Storm - The storm duration which requires the greatest detention storage. In the Rational Method, the critical duration storm is equal to the time of concentration being analyzed. For computer modeling, the critical duration storm is equal to or greater than the time of concentration of the watershed being modeled.

Culvert - A closed conduit used for the passage of surface drainage water under a roadway, railroad, canal, or other impediment.
Detention Basin - A facility constructed or modified to restrict the flow of storm water to a prescribed maximum rate, and to detain concurrently the excess waters that accumulate behind the outlet.

Drainage Area - The area from which water is carried off by a drainage system; a watershed or catchment area.

Drop manhole - A manhole having a vertical drop greater than two feet between the inlet pipe and the outlet pipe. A vertical drop pipe shall be located immediately outside the manhole.

Dry Bottom Detention Basin - A basin designed to be completely dewatered after having provided its planned detention of runoff during a storm event.

Duration - The time period of a rainfall event.

Engineer - A subordinate or agent of the City to whom the City has delegated responsibility.

Erosion - Wearing away of the land by running water, waves, temperature changes, ice or wind.

FEMA - Federal Emergency Management Administration - delegated with administering the Flood Insurance program and response after natural disasters. Successor to the former Flood Insurance Administration.

Flood Elevation - The elevation at all locations delineating the maximum level of high waters for a flood of given return period and rainfall duration.

Flood or Flood Waters - The water of any watercourse which is above the banks of the watercourse. Is also means the water of any lake which is above and outside the banks thereof.

Flood Hazard Area - Those flood plains which have not been adequately protected from flooding caused by the regulatory flood, and are shown on the Flood Hazard or Floodway-Flood Boundary Maps of the Federal Insurance Administration or maps provided to the City by the Texas Natural Resources Conservation Commission.

Flood Plain - The area adjoining the river or stream which has been or may hereafter be covered by flood water from regulatory floodway and floodway fringe.

Floodway - see Regulatory Floodway.

Floodway Fringe - That portion of the flood plain lying outside the floodway which is inundated by the regulatory flood.

Footing Drain - A drain pipe installed around the exterior of a basement wall foundation to relieve water pressure caused by high groundwater elevation.

Grade - The inclination or slope of a channel, canal, conduit, etc., or natural ground surface usually expressed in terms of the percentage the vertical rise (or fall) bears to the corresponding horizontal distance.
IBWC - International Boundary and Waterway Commission - delegated with administering the use and care of water resources along the common border between the United States and Mexico.

Impact Areas - Areas defined and mapped by the City which are unlikely to be easily drained because of one or more factors including but not limited to any of the following: soil type, topography, land where there is not adequate outlet, a floodway or flood plain.

Impervious - A term applied to material through which water cannot pass, or through which water passes with difficulty.

Inlet - An opening into a storm sewer for the entrance of surface storm water runoff, more completely described as a storm sewer inlet.

Junction Chamber - A converging section of conduit, usually large enough for a person to enter, used to facilitate the flow from one or more conduits into a main conduit.

Lateral Storm Sewer - A sewer that has inlets connected to it but has no other storm sewer connected.

Manhole - Storm sewer structure through which a person may enter to gain access to an underground storm sewer or enclosed structure.

Major Drainage Area - Drainage system carrying runoff from an area of more than fifty square miles Rural classification or one square mile Urban classification. Designs shall be in accordance with the Texas Department of Transportation.

Maverick County Water County Water Control & Improvement District No. 1 - delegated with the development of water resources and irrigation for citizens in Maverick County, Texas. Responsible for care and maintenance of irrigation network in Maverick County, Texas.

Minor Drainage System - Drainage system carrying runoff from an area of less than fifty square miles Rural classification or one square mile Urban classification.

Off Site - Everything not on site.

On Site - Located within the controlled or Urbanized area where runoff originates.

Outfall - The point or location where storm runoff discharges from a sewer or drain. Also applies to the outfall sewer or channel which carries the storm runoff to the point of outfall.

Peak Flow - The maximum rate of flow of water at a given point in a channel or conduit resulting from a predetermined storm or flood.

Radius of Curvature - Length of radius of a circle used to define a curve.

Rainfall Intensity - The cumulative depth of rainfall occurring over a given duration, normally expressed in inches per hour.

Reach - Any length of river, channel or storm sewer.
Regulated Area - All of the land under the jurisdiction of the City of Eagle Pass.

Regulated Drain - An open drain, a tile drain or a combination of the two whose description and limits are established by law.

Regulatory Flood - That flood having a peak discharge which can be equaled or exceed on the average of once in a one hundred (100) year period, as calculated by a method and procedure which is acceptable to the City. If a permit from FEMA for construction in the floodway is required (see Section 6), then the regulatory flood peak discharge should be calculated by a method acceptable to the City. This regulatory flood is equivalent to a flood having a probability of occurrence of one percent (1%) in any given year.

Regulatory Floodway - The channel of a river or stream and those portions of the flood plains adjoining the channel which are reasonably required to carry and discharge efficiently the peak flow of the regulatory flood of any river or stream.

Release Rate - The amount of storm water released from a storm water control facility per unit of time.

Return Period - The average interval of time within which a given rainfall event will be equaled or exceeded once. A flood having a return period of 100 years has a one percent probability of being equaled or exceeded in any one year.

Sediment - Material of soil or rock origin, transported, carried or deposited by water.

Siphon - A closed conduit or portion of which lies above the hydraulic grade line, resulting in a pressure less than atmospheric and requiring a vacuum within the conduit to start flow. A siphon utilizes atmospheric pressure to effect or increase the flow of water through a conduit. An inverted siphon is used to carry storm water flow under an obstruction such as a sanitary sewer.

Stilling Basin - A basin used to slow water down or dissipate its energy.

Storage Duration - The length of time that water may be stored in any storm water control facility, computed from the time water first begins to be stored.

Storm Sewer - A closed conduit for conveying collected storm water.

Storm Water Drainage System - All means, natural or man-made, used for conducting storm water to, through or from a drainage area to any of the following: conduits and appurtenant features, canals, channels, ditches, streams, culverts, street and pumping stations.

Storm Water Runoff - The water derived from rains falling within a tributary basin, flowing over the surface of the ground or collected in channels or conduits.

Tributary - Contributing storm water from upstream land areas.
Urbanization - The development, change or improvement of any parcel of land consisting of one or more lots for residential, commercial, industrial, institutional, recreational or public utility purposes.

Watercourse - Any river, stream, creek, brook, branch natural or man-made drainageway in or into which storm water runoff or floodwaters flow wither regularly or intermittently.

Watershed - see Drainage Area.

Wet Bottom Detention Basin (Retention Basin) - A basin designed to retain a permanent pool of water after having provided its planned detention of runoff during a storm event.

6. Permits for Construction in the Floodway

Permits for construction in a floodway require FEMA approval and of any works for flood control. This includes bridges, dams, levees, dikes, floodwalls, wharves, piers, dolphins, booms, weirs, bulkheads, jetties, groins, excavations, fills or deposits of any kind, utility lines, or other building, structure or obstruction. Also, any ditch work (new construction, deepening or modification) within one half mile of a public freshwater lake of 10 acres or more in area.

The approval of FEMA, in writing, must be obtained before beginning construction.

7. Information Requirements

The following information and data provided by a Texas licensed professional engineer or land surveyor engaged in storm drainage design shall be submitted to the City at the time of application for 1) each proposed major subdivision or planned development lying within the Regulated Area prior to Final Plat approval by the Planning Commission, or 2) a building permit for any development, redevelopment or new construction on real estate which lies within the Regulated Area which has not previously received drainage approval or is not exempt from the requirements of this Ordinance.

A. Topographic and Soils Maps

A topographic map of the land to be developed and such adjoining land whose topography may affect the layout or drainage of the development. The contour intervals shall be one foot when slopes are less than four percent and shall be two feet when the slope exceeds 10 percent and shall be five feet when the slope exceeds 10 percent. On this map, the following shall be shown:

1. The locations of streams and other flood water runoff channels, the extent of the flood plains at the established 100 year flood elevation where available (regulatory floodway), and the limits of the floodway, all properly identified.

2. The normal shoreline of lakes, ponds, swamps and detention basins, their flood plains, lines of inflow and outflow if any.
(3) The location of regulated drains, farm drains, inlets and outfall, if any of record.

(4) Storm sewers and outfall, if any of record.

(5) Septic tank systems and outlets, if any of record.

(6) Seeps, springs, flowing and other wells, that are visible or of record.

(7) Provide soils map of proposed development indicating soil name and their hydrologic classification when Soils Conservation Service (SCS) hydrologic methods are used.

B. Preliminary Drainage Plan

A comprehensive plan, in preliminary form (or in combined preliminary and final form), designed to handle safely the storm water runoff and to detain the increased storm water runoff must be submitted to the City. The plan shall provide or be accompanied by maps or other descriptive materials indicating the feasibility of the drainage plan and showing the following:

(1) The extent and area of each watershed affecting the design of detention facilities as shown on USGS Quadrangle Maps or other more detailed maps as required by the City.

(2) The preliminary layout and design of proposed storm sewers, the outfall and outlet locations and approximate elevations, the receiving stream of channel and its 100 year return period water elevation.

(3) The location and design of the proposed street system, especially including depressed pavements used to convey or temporarily store overflow from the heavier rainstorms, and the outlets for such overflow.

(4) The locations, cross sections and profiles of existing streams and flood plains to be maintained, and new channels to be constructed.

(5) The materials, elevations, waterway openings and the basis for design of proposed culverts and bridges.

(6) Existing detention ponds and basins to be maintained, enlarged or otherwise altered and new ponds or basins to be built and the basis of their design.

(7) The estimated depth and amount of storage required in the new ponds or basins.

(8) The estimated location and percentage of impervious surfaces existing and expected to be constructed when the development is completed.

(9) Any interim plan which is to be incorporated into the development pending completion of the development and the final drainage plan.

C. Valley Cross Section
One or more typical cross sections must be provided showing all existing and proposed channels or other open drainage facilities carried to a point above the 100 year high water elevation; showing the elevation of the existing land and the proposed changes thereto, together with the high water elevations expected from the 100 year storm under the controlled conditions called for by this Ordinance; and showing the relationship of structures, streets and other facilities.

D. Site Plan

A plan drawn to scale showing dimensions of the site with existing and proposed facilities must be provided. All plan views shall include, but may not be limited to, the following information when applicable:

1. A North arrow;
2. The scale used;
3. Site location map;
4. Property boundaries with bearing and distance;
5. Property owner/developer;
6. Building setback lines;
7. Location of all existing and proposed facilities/utilities;
8. Topography in the area affected by construction.

E. Final Drainage Plans

Upon approval of the preliminary drainage plans by the City, final drainage plans shall be submitted to the City. The final plans shall provide or be accompanied by calculations, maps and/or other descriptive material showing the following:

(1) The extent and area of each watershed tributary to the drainage channels in the development.

(2) The street storm sewers and other storm drains to be built, the basis of their design, outfall and outlet locations and elevations, the receiving stream or channel and its high water elevation, and the functioning of the drains during high water conditions,

(3) The parts of the proposed street system where pavements are planned to be depressed sufficiently to convey or temporarily store overflow from storm sewers and over the curb runoff resulting from the heavier rainstorms and the outlets for such overflow.

(4) Existing streams and flood plains to be maintained, and new channels to be constructed, their locations, cross sections and profiles.

(5) Proposed culverts and bridges to be built, their materials, elevations, waterway openings and basis of their design.

(6) Existing detention basins and ponds to be maintained, enlarged or otherwise altered and new basins or ponds to be built and the basis of their design.
(7) The estimated location and percentage of impervious surfaces existing and expected to be constructed when the development is completed.

(8) The slope, type and size of all sewers and other waterways.

(9) For all detention basins, a plot or tabulation of storage volumes with corresponding water surface elevations and a plot or tabulation of the basin outflow rates for those water surface elevations.

A written report must be included with each preliminary and final drainage plan. The report will contain a summary description of: (a) the significant drainage problems associated with the project; (b) the analysis procedure used to evaluate these problems and to propose solutions; (c) any assumptions or special conditions associated with the use of these procedures; (d) the proposed design of the drainage control system; and (e) the result of the analysis of the proposed drainage control system showing that is does solve the project's drainage problems.

The following additional documents should be submitted with all applications submitted for approval:

(1) A hydraulic report detailing existing and proposed drainage patterns on the subject site. The report should include a description of the present land use as well as proposed land use. Any off-site drainage entering the site should also be addressed. This report should be comprehensive and detail all the design steps which the design engineer took during the design.

(2) All hydrologic and hydraulic computations should be included in the submittal. These calculations should include, but not be limited to: runoff curve members or runoff coefficients; runoff calculation; stage-discharge relationships; times of concentration; and storage volume.

(3) Copies of all computer runs. These computer runs should include both the input and outputs. A floppy diskette with input files will expedite the review process.

(4) A set of plan drawings stamped by a Registered Professional Engineer or Registered Land Surveyor showing all proposed detention areas, storm sewers, inlets, outfall structures, open ditches, culverts and bridges.

(5) A set of exhibits should be included showing the drainage subareas and a schematic detailing of how any computer model inputs were set up.

(6) A conclusion report summarizing the hydraulic design and detailing how this design satisfies the Eagle Pass Storm Water and Sediment Control Ordinance.

F. Submittal and Consideration of Plans

The City and/or its Engineer shall approve or disapprove any preliminary plans, final plans and/or construction plans within sixty (60) days of receipt of a complete submittal unless applicant consents to a time extension. All approvals and disapproval's shall be in writing.
G. Engineering Review Fees

As a condition of and prior to approval of final drainage plans by the City, the applicant shall pay to the City of Eagle Pass the actual costs incurred by the City in respect to the review of all preliminary plans, final plans and/or construction plans by a licensed professional engineer in excess of the first ten (10) hours of such review and consultation.

The City shall furnish to the applicant in writing prior to the approval of the applicant’s final drainage plan a written statement specifying the total cost of professional engineering fees incurred by the City in connection with the review of applicant’s plans, including the total hours expended by such professional engineer, and the amount required to be paid by applicant prior to approval of final drainage plans by the City. As a condition of and prior to approval of final drainage plans, applicant shall pay to the City of Eagle Pass Clerk the sum set forth in said statement representing the cost of professional engineering services in excess of the following number of hours thereof incurred by the City in connection with the review of applicant’s preliminary and final drainage plans and accompanying information and data:

a. Ten (10) hours of individual site plans, minor subdivisions, other projects that involve storm water drainage plans and/or calculations;

b. Fifteen (15) hours for major subdivisions.

8. Determination of Runoff Quantities

Runoff quantities shall be computed for the area of the parcel under development plus the area of the watershed flowing into the parcel under development. The quantity of runoff which is generated as the result of a given rainfall intensity may be calculated as follows:

A. Areas up to and Including 100 Acres

For areas up to and including one hundred (100) acres and for sites with no depression storage, the Rational Method may be used. In the Rational Method, the peak rate of runoff, Q, in cubic feet per second is computed as:

\[ Q = CIA, \]

where

\[ C = \] runoff coefficient, representing the characteristics of the drainage area and defined as the ratio of runoff to rainfall.

\[ I = \] average intensity of rainfall in inches per hour for a duration equal to the time of concentration (\( t_c \)) for a selected rainfall frequency.

\[ A = \] tributary drainage area in acres.

Guidance to the selection of the runoff coefficient “C” is provided by Table 1 which show values for different types of surface and local soil characteristics. The composite “C” value used for a given drainage area with various surface types shall be the weighted average value for the total area calculated from a breakdown of individual area having different surface types.
Table 2 provides runoff coefficients and inlet times for different land use classifications. In the instance of undeveloped land situated in an upstream area, a coefficient or coefficients shall be used for this area in its present or existing state of development.

Rainfall intensity shall be determined from the rainfall frequency curves shown in Figure 1 or from data shown in Table 5. The time of concentration \((t_c)\) to be used shall be the sum of the inlet time and flow time in the drainage facility from the most remote part of the drainage area to the point under consideration. The flow time in the storm sewers may be estimated by the distance in feet divided by velocity of flow in feet per second. The velocity shall be determined by the Manning formula.

Inlet time is the combined time required for the runoff to reach the inlet of the storm sewer. It includes overland flow time and flow time through established surface drainage channels such as swales, ditches and sheet flow across such areas as lawns, fields and other graded surfaces. It may be computed by using Figure 2.

B. Areas in Excess of 100 acres

The runoff rate for area in excess of 100 acres shall be determined by methods described in Section 15, Subsection G.

9. Amount of Runoff to be Accommodated by Various Parts of Drainage Facility

Various parts of a drainage facility must accommodate runoff water as follow:

A. Minor Drainage System

The minor drainage system such as inlets, catch basins, street gutters, swales, sewers and small channels which collect storm water (runoff) must accommodate peak runoff from a 10-year return frequency storm.

Duration, for sizing these conveyance using the rational method shall be equal to the time of concentration. The Rational Method is acceptable for storm sewer design, as long as the TR-55 time of concentration methodology is used. Determination of hydraulic capacity for storm sewers sized by Rational Method analysis should be done using Manning’s Equation.

These minimum requirements must be satisfied:

1. The allowable spread of water on Collector Streets is limited to maintaining two clear 10 foot moving lanes of traffic. One lane is to be maintained on Local Roads, while Places can have a water spread equal to one-half of their width.

2. Open channels carrying peak flows greater than 30 cubic feet per second shall be capable of accommodating peak runoff for a 50-year return period storm within the drainage easement.
(3) Culverts shall be capable of accommodating peak runoff from a 50-year return frequency storm when crossing under roads which are part of the functional classification and are classified as primary or secondary arterial streets.

B. Major Drainage Systems

Major drainage systems are defined in Section 4, and shall be designed in accordance with Texas Department of Transportation Hydraulic Manual as described in Section 6.

10. Level of Protection for Urban Areas

First floor elevations of all buildings shall be such that all floors including basements shall have one foot of free board above the 100 year flood elevation or at the flood protection grade.

11. Storm Sewer Design Standards

All storm sewers, whether private or public, and whether constructed on private or public property shall conform to the design standards and other requirements contained herein.

A. Manning Equation

The hydraulic capacity of storm sewers shall be determined using Manning’s Equation:

\[ V = (1.489/n)(R^{2/3})(s^{1/2}) \]

where

\( V \) = mean velocity of flow in feet per second

\( R \) = the hydraulic radius in feet, \( A/P \), cross sectional area / wetted perimeter

\( s \) = the slope of the energy grade line in feet per foot

\( n \) = roughness coefficient

The hydraulic radius, \( R \), is defined as the cross sectional area of flow divided by the wetted flow surface or wetted perimeter. Typical *n* values for storm sewer materials are listed in Table 3. Roughness coefficients (n) values for other sewer materials can be found in standard hydraulics texts and references.

B. Minimum Size

The minimum size of all storm sewers shall be 12 inches. Rate of release for detention storage shall be controlled by an orifice plate or other devices, subject to approval of the City, where the 12 inch pipe will not limit rate of release as required.

C. Grade

Sewer grade shall be such that, in general, a minimum to two feet of cover is maintained over the top of the pipe. Pipe cover less than the minimum may be used only upon approval of the City. Uniform slopes shall be maintained between inlets, manholes and inlets to manholes.
minimum drop of 0.1 foot through manholes and inlets should be provided. Final grade shall be set with full consideration of the capacity required, sedimentation problems and other design parameters. Minimum and maximum allowable slopes shall be those capable of producing velocities of two and one-half and 15 feet per second, respectively, when the sewer is flowing full.

D. Alignment

Storm sewers shall be straight between manholes insofar as possible. Where long radius curves are necessary to conform to street layout, the minimum radius of curvature shall be no less than 100 feet for sewers 42 inches and larger in diameter. Deflection of pipe sections shall not exceed the maximum deflection recommended by the pipe manufacturer. The deflection shall be uniform and finished installation shall follow a smooth curve.

E. Manholes

Manholes shall be installed to provide access to continuous underground storm sewers for the purpose of inspection and maintenance. Manholes may be used as inlet or drainage structures and shall be provided at the following locations:

(1) Where one or more storm sewers converge.

(2) At the point of beginning or at the end of a curve, and at the point of reverse curvature (PC, PT, PRC).

(3) Where the pipe size changes.

(4) Where an abrupt change in alignment occurs.

(5) Where a change in grade occurs.

(6) At suitable intervals in straight sections of sewer.

The maximum distance between storm sewer manholes, unless otherwise approved by the City, shall be as follows:

Size of Pipe Maximum Distance

<table>
<thead>
<tr>
<th>(inches)</th>
<th>(feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 through 24</td>
<td>400</td>
</tr>
<tr>
<td>48 and larger</td>
<td>600</td>
</tr>
</tbody>
</table>

F. Inlets

Inlets or drainage structures shall be utilized to collect surface water through grated openings and convey it to storm sewers, channels or culverts. Inlet design and spacing shall be in accordance with the Hydraulic Design Manual of the Texas Department of Transportation or other approved design procedure. The inlet grate opening provided must be adequate to pass the design 10 year flow with 50% of the sag inlet areas clogged. An overflow channel from sag
inlets to the overflow channel or basin shall be provided at sag inlets, so that the maximum
depth of water that might be ponded in the street sag shall not exceed 7 inches. Inlets may be
used as manholes at locations where the pipe sizes do not exceed eighteen (18) inches in
diameter.

Inlet design and spacing may be done using the Rational Method. Use of the HEC-12
computer program is also an acceptable method. Gutter spread on continuous grades may be
determined using the modified Manning's equation, or by using Table 6 - Storm Drainage Street
Velocities and Capacities flowing curb full for Maverick County, Texas.

12. Workmanship and Materials

A. Workmanship

The specifications for the construction of storm sewer shall not be less stringent than those set
forth in the latest edition of the Texas Department of Transportation “Texas Standard
Specifications”.

B. Materials

Storm sewer manholes, inlets, pipe and fittings used in storm sewer construction shall conform
to the materials shown in the most recent “City of Eagle Pass Typical Construction Guidelines
and Details”.

C. Special Hydraulic Structures

Special hydraulic structures required to control the flow of water in storm runoff drainage
system include junction chambers, drop manholes, inverted siphons, stilling basins or other
special structures. The use of these structures shall be limited to those locations justified by
prudent planning and by careful and thorough hydraulic engineering analysis.

13. Open Channel Design Standards

All open channels, whether private or public, and whether constructed on private or public land,
shall conform to the design standards and other design requirements contained herein.

A. Manning Equation

The waterway for channels shall be determined using Manning's Equation.

\[ Q = AV = A \left( \frac{1.486}{n} \right) (R^{2/3})(s^{1/2}), \text{ where} \]

\[ A = \text{waterway area of channel in square feet} \]
\[ Q = \text{discharge in cubic feet per second, cfs} \]
\[ V, R, s \text{ and } n \text{ are explained above} \]
B. Channel Cross Section and Grade

The required channel cross section and grade are determined by the design capacity, the material in which the channel is to be constructed, and the requirements for maintenance. A minimum depth may be required to provide adequate outlets for subsurface drains, tributary ditches or streams. The channel grade shall be such that the velocity in the channel is high enough to prevent siltation, but low enough to prevent erosion. Velocities less than 1.5 feet per second should be avoided because siltation will take place and ultimately reduce the channel cross section. The maximum permissible velocities in vegetal-lined channel are shown in Table 4. Developments through which the channel is to be constructed must be considered in the design of the channel section.

C. Side Slopes

Earthen channel side slopes shall be no steeper than 3 to 1. Flatter slopes may be required to prevent erosion and for ease of maintenance. Where channels will be lined, side slopes shall be no steeper that 1-1/2 to 1 with adequate provisions made for weep holes. Side slopes steeper than 1-1/2 to 1 may be used for lined channels providing that the side lining and structural retaining wall are designed and constructed with provisions for live and dead load surcharge.

D. Channel Stability

(1) Characteristics of a stable channel are:

(a) It neither aggrades nor degrades beyond tolerable limits.

(b) The channel banks do not erode to the extent that the channel cross section is changed appreciably.

(c) Excessive sediment bars do not develop.

(d) Excessive erosion does not occur around culverts, bridges or elsewhere.

(e) Gullies do not form or enlarge due to the entry of uncontrolled surface flow to the channel.

(2) Channel stability shall be determined for an aged condition and the velocity shall be based on the design flow or the bank full flow, whichever is greater, using “n” values for various channel linings as shown in Table 3. In no case is it necessary to check channel stability for discharges greater than that from a 100-year return period storm.

(3) Channel stability must be checked for conditions immediately after construction. For this stability analysis, the velocity shall be calculated for the expected flow from a ten-year return period storm on the watershed, or the bank full flow, whichever is smaller. The “n” value for newly constructed channels in fine-grained soils and sands may be determined in accordance with the National Engineering Handbook 5, Supplement B, Soil Conservation Service and shall not exceed 0.025. The allowable velocity in the
newly constructed channel may be increased by a maximum of 20 percent to reflect the effects of vegetation to be established under the following conditions:

(a) The soil and site in which the channel is to be constructed are suitable for rapid establishment and support of erosion controlling vegetation.

(b) Species of erosion controlling vegetation adapted to the area, and proven methods of establishment are shown.

(c) The channel design includes detailed plans for establishment of vegetation on the channel side slopes.

E. Appurtenant Structures

The design of channels will provide all structures required for the proper functioning of the channel and the laterals thereto and travelways for operation and maintenance. Recessed inlets and structures needed for entry of surface and subsurface flow into channels without significant erosion or degradation shall be included in the design of channel improvements. The design is also to provide the necessary flood gates, water level control devices and any other appurtenance affecting the functioning of the channels and the attainment of the purpose for which they are built.

The effect of channel improvements on existing culverts, bridges, buried cables, pipelines and inlet structures for surface and subsurface drainage on the channel being improved and laterals thereto shall be evaluated to determine the need for modification or replacement. Culverts and bridges which are modified or added as part of channel improvement projects shall meet reasonable standards for the type of structure and shall have a minimum capacity equal to the design discharge or governmental agency design requirements, whichever is greater.

F. Disposition of Spoil

Spoil material resulting from clearing, grubbing and channel excavation shall be disposed in such a manner which will:

(1) Minimize overbank wash.

(2) Provide for the free flow of water between the channel and flood plain unless the valley routing and water surface profile are based on continuous dikes being installed.

(3) Not hinder the development of travelways for maintenance.

(4) Leave the right-of-way in the best condition feasible, consistent with the project purposes, for productive use by the owner,

(5) Improve the aesthetic appearance of the site to the extent feasible.

(6) Be approved by FEMA or US Army Corps of Engineers (whichever is applicable) if deposited in the floodway.
14. Construction and Materials

A. Construction

Specifications shall be in keeping with the proceeding standards and shall describe the requirements for proper installation of the project to achieve its intended purpose.

B. Materials

Materials acceptable for use as channel lining are:

1. Grass
2. Revetment riprap
3. Concrete
4. Hand-laid riprap
5. Precast cement concrete riprap
6. Grouted riprap
7. Gabions

Other lining materials may be used with prior approval of the City. Materials shall comply with the latest edition of the Texas Department of Transportation "Texas Standard Specifications".

15. Storm Water Detention

The following shall govern the design of any improvement with respect to the detention of storm water runoff.

A. Acceptable Detention Methods

The increased storm water runoff (peak rate) resulting from a proposed development should be detained on-site by the provisions of appropriate wet or dry bottom reservoirs, by storage on flat roofs, parking lots, streets, lawns or other acceptable techniques. Measures which retard the rate of overland flow and the velocity in runoff channels shall also be used to control the runoff rate partially. Detention basins shall be sized to store excess flows from storms with a one hundred (100) year return period. Control devices shall limit the discharge to a rate no greater than that prescribed by this Ordinance (see Sections 15F and 15G).

B. Time of Concentration

All storm water management projects within the City of Eagle Pass must be done using the time-of-concentration methodology outlined in the SCS TR-55 manual. The TR-55 method examines the factors which affect time of concentration including surface roughness, channel shape and flow patterns along with watershed slope. Through the examination of sheet,
shallow, concentrated and open channel flows, a more refined time of concentration may be determined. The methodology represents the best attempt of a Federal Agency to standardize times of concentration procedures.

C. Design Storm

Design of storm water detention facilities shall be based on a return period of once in 100 years. The storage volume and outflow rate shall be sufficient to handle storm water runoff from a critical duration storm, as defined in Sections 15F and 15G. Rainfall depth-duration-frequency relationships and intensity-duration-frequency relationships shall be those given in Tables 5 and 5A.

D. Allowable Release Rate

Design of storm water detention facilities shall be based on the allowable release rate of storm water originating from a proposed development and shall not exceed the amount specified in Section 5 - Storm Water Control Policy, and as described in Section 15F and 15G.

In the event the natural downstream channel or storm sewer system is inadequate to accommodate the release rate provided in Table 5A, then the allowable release rate shall be reduced to that rate permitted by the capacity of the receiving downstream channel or storm sewer system and additional detention as determined by the City shall be required to store that portion of the runoff exceeding the capacity of the receiving sewers or waterways. The area will be considered an impact drainage area subject to the provisions of Section 18 of this Ordinance.

If more than one detention basin is involved in the development of the area upstream of the limiting restriction, the allowable release rate from any one detention basin shall be in direct proportion to the ratio of its drainage area to the drainage area of the entire watershed upstream of the restriction.
E. Drainage System Overflow Design

Drainage systems shall have adequate capacity to convey the storm water runoff from all upstream tributary areas through the development under consideration for a storm of 100 year design return period calculated on the basis of upstream land in its present state of development. An allowance, equivalent to the reduction in flow rate provided, shall be made for upstream detention when such upstream detention and release rate have previously been approved by the City and evidence of its construction can be shown.

F. Determination of Storage Volume - Rational Method

The Rational Method may be used to determine the 10-year return period pre-development release rate for sites of less than five (5) acres of commonly owned contiguous property where no depression storage exists.

Step Procedure

1. Determine total drainage area in acres “A”.

2. Determine composite runoff coefficient “C_u” based on existing land use (undeveloped).

3. Determine time of concentration “T_C” in minutes based on existing conditions.

4. Determine rainfall intensity “I_u” in inches per hour, based on time of concentration and using Figure 1 or from date given in Table 5A for the ten (10) year return period.

5. Compute runoff based on existing land use (undeveloped), and ten (10) year return period:
   \[
   Q_u = C_u I_u A
   \]

6. Determine composite runoff coefficient “C_d” based on developed conditions and a one hundred (100) year return period.

7. Determine the one hundred (100) year return period rainfall intensity, “I_d” for various storm duration’s “t_d” up through the time of concentration for the developed area using Table 5A.

8. Determine developed inflow rates “Q_d” for various storm duration’s “t_d” measured in hours.
   \[
   Q_d = C_d I_d A
   \]

9. Compute a storage rate “S_{td}” for various storm duration’s “t_d” up through the time of concentration of the developed area.
   \[
   S_{td} = Q_d - Q_u
   \]
10. Compute required storage volume \( S_R \) in acre-feet for each storm duration \( t_d \). This assumes a triangular hydrograph of duration \( (2t_d) \) hours with the peak flow of \( S_{td} \) and \( t_d \) hours.

\[
S_R = S_{td} \left( \frac{t_d}{12} \right)
\]

11. Select the largest storage volume computed in step 10 for detention basin design.

G. Determination of Storage Volume - Hydrographic Methods

Methods other than the rational method for determining runoff and routing of storm water may be used to determine the storage volume required to control storm water runoff. The SCS TR-20 computer model with the SCS TR-55 time of concentration and curve number calculation methodologies, may be used to determine the 10-year return period pre-development release rate for sites of five (5) acres or more and for sites with existing depression storage. The SCS TR-20 and SCS TR-55 models are accepted by the City for appropriate use in analysis of the runoff and routing of storm water. The use of these models or other approved procedures can be defined in an eight step procedure to determine the required storage volume of the detention basin.

Step Procedure

1. Calibrate the hydrologic/hydraulic model that is to be used for prediction of runoff and routing of storm water.

2. Determine the critical storm duration. The critical duration storm for computer modeling shall be equal to or greater than the time of concentration for the watershed being modeled.

3. Determine the ten (10) year, undeveloped peak flow. Denote this flow by \( Q_u^{10} \).

4. Determine the one hundred (100) year runoff hydrograph \( (H_d^{100}) \) for developed conditions.

5. Determine the hydrograph that must be stored \( (H_s^{100}) \) by subtracting a flow up to \( Q_u^{10} \) from the hydrograph \( (H_d^{100}) \) found in step 4.

6. Determine the volume of water \( (V_s) \) to be stored by calculating the area under the hydrograph \( H_s^{100} \).

7. The detention basin must be designed to store the largest volume \( (V_s) \) found for any storm duration analyzed in step 6.

8. Approved routing techniques may be used to determine the final detention storage required.

H. General Detention Basin Design Requirements
Basins shall be constructed to detain temporarily the storm water runoff which exceeds the maximum peak flow rate authorized by this Ordinance. The volume of such storage provided in these basins, together with such storage as may be authorized in other on-site facilities shall be sufficient to control excess runoff from the one hundred (100) year storm.

The following design principles shall be observed:

1. The maximum volume of water stored and subsequently released at the design release rate shall not result in a storage duration in excess of 48 hours unless additional storms occur within the period.

2. The maximum planned depth of storm water stored (without a permanent pool) shall not exceed four feet.

3. All storm water detention facilities shall be separated by not less than 25 feet from any building or structure to be occupied.

4. All excavated excess spoil may be spread so as to provide for aesthetic and recreational features such as sliding hills, sports fields, etc. Detention pond side slopes no steeper than horizontal to 1 vertical for safety, erosion control, stability and ease of maintenance shall be permitted.

5. Safety screens having a maximum opening of 4 inches shall be provided for any pipe or opening to prevent children or large animals from crawling into the structures.

6. Danger signs shall be mounted at appropriate locations to warn of deep water, possible flooding conditions during storm periods and other dangers that exist. Fencing shall be provided if deemed necessary by the City.

7. Outlet control structures shall be designed to operate as simply as possible and shall require little or no maintenance and/or attention for proper operation. The shall limit discharges into existing or planned downstream channels or conduits so as not to exceed the predetermined maximum authorized peak flow rate.

8. Emergency overflow facilities such as a weir or spillway shall be provided for the release of exceptional storm runoffs or in emergency conditions should the normal discharge devices become totally or partially inoperative. The overflow facility shall be of such design that its operation is automatic and does not require manual attention.

9. Grass or other suitable vegetative cover shall be provided throughout the entire basin area. Grass should be cut regularly at approximately monthly intervals during the growing season or as required.

10. Debris and trash removal and other necessary maintenance shall be performed on a regular basis to assure continued operation in conformance to design.

11. Hydraulic calculations shall be submitted to substantiate all design features.

12. No residential lot or any parts thereof shall be used for the storage of water, either temporary or permanent, without approval of the City.
I. Dry Bottom Design Requirements

Detention basins which will not contain a permanent pool of water shall comply with the following requirements:

(1) Provisions shall be incorporated to facilitate complete interior drainage of dry bottom basins, to include the provisions of natural grades to outlet structures, longitudinal and transverse grades to perimeter drainage facilities, paved gutters, or the installation of subsurface drains.

(2) The detention basin shall, whenever possible, be designed to serve a secondary or multipurpose function. Recreational facilities, aesthetic qualities (open spaces) or other types of use shall be considered in planning the detention facility.

J. Wet Bottom Basin Design Requirements

Where a part of a detention basin will contain a permanent pool of water, all the items required for detention storage shall apply except that the system of drains without a positive gravity outlet required to maintain a dry bottom basin will not be required. A controlled positive outlet will be required to maintain the design water level in the wet bottom basin and provide required detention storage above the design water level. However, the following additional conditions shall apply:

(1) Basins designed with permanent pools or containing permanent ponds shall have a water area of at least one-half acre. If fish are to be maintained in the pond, a minimum depth of approximately 10 feet shall be maintained over at least 25 percent of the pond area. The remaining pond area shall have no extensive shallow areas, except as required by subsection (3) below.

(2) In excavated lakes the underwater side slopes in the lake shall be stable. In the case of valley storage, natural slopes may be considered to be stable.

(3) A safety ledge four to six feet in width is required and must be installed in all ponds approximately 30 to 36 inches below the permanent water level. In addition, a similar maintenance ledge 12 to 18 inches above the permanent water line shall be provided.

(4) A safety ramp exit from the pond is required in all cases and shall have a minimum width of 20 feet and exit slope of 6 horizontal to 1 vertical. The ramp shall be of a material that will prevent its deterioration due to vehicle use and/or wave action.

(5) Periodic maintenance is required in ponds to control weed growth and larval growth. The pond shall also be designed to provide for the easy removal of sediment which will accumulate during periods of pond operation. A means of maintaining the designed water level of the pond during prolonged periods of dry weather is also required.

(6) For emergency use, basin cleaning, or shoreline maintenance, facilities shall be provided or plan prepared for auxiliary equipment to permit emptying and drainage.
(7) Aeration facilities to prevent pond stagnation shall be provided, if required. Design calculations to substantiate the effectiveness of these aeration facilities shall be submitted with final engineering plans. Agreements for the perpetual operation and maintenance of aeration facilities shall be prepared to the satisfaction of the City.

(8) The perimeter of wet bottom detention basins, defined by the high water contour which represents the high water elevation, shall be a minimum horizontal distance of 10 feet from high voltage electric lines.

K. Roof Top Storage

Detention storage requirements may be met in total or in part by detention on flat roofs. Details of such designs are to be included in the building permit application and shall include the depth and volume of storage, details of outlet devices and downdrains and elevations of emergency overflow provisions.

L. Parking Lot Storage

Paved parking lots may be designed to provide detention storage of storm waters on all or a portion of their surfaces. Depths of storage must be limited to a maximum depth of seven (7) inches so as to prevent damage to parked vehicles and so that access to parked vehicles is not impaired. Locate the deepest ponding zones at remote and least used portions of the parking lot.

M. Facility Financial Responsibilities

The construction cost of storm water detention systems and facilities as required by this Ordinance shall be part of the cost of land development. If general public use of the facility can be demonstrated, negotiations for public participation in the cost of such development may be considered.

N. Facility Maintenance Responsibility

Maintenance of detention/retention facilities during construction and thereafter shall be the responsibility of the land developer/owner. Assignment of responsibility for maintaining facilities serving more than one lot or holding shall be documented by appropriate covenants to property deeds, unless responsibility is formally accepted by a public body. This determination shall be made before the final drainage plans are approved.

Storm water detention and retention basins may be donated to the City of Eagle Pass or other unit of government approved by the City, for ownership and permanent maintenance providing:

(1) The City or other governmental unit is willing to accept responsibility.

(2) The facility has been designed and constructed according to all applicable provisions of this Ordinance.
(3) All improvements have been constructed, approved and accepted by the City for the land area served by the basin.

(4) Retention ponds containing a permanent pool of water have all slopes between the permanent pool and high water line sodded and the remaining land area hydroseeded using a method approved by the City; are equipped with electrically driven aeration devices, if required to maintain proper aerobic conditions and sustain aquatic life; provide suitable access acceptable to the responsible government agency; and have the high water line not closer than 25 feet to any property line.

(5) Dry detention ponds shall have all slopes, bottom of the basin and areas above the high water line hydroseeded; and shall have the high water line not closer than 25 feet to any development boundary.

All public and privately owned detention storage facilities will be inspected by representatives of the City not less often than once every 2 years. A certified inspection report covering physical conditions, available storage capacity and operational condition of key facility elements will be provided to the owner.

P. Corrective Measures

If deficiencies are found by the inspector, the owner of the detention/retention facility will be required to take the necessary measures to correct such deficiencies. If the owner fails to do so, the City will undertake the work and collect from the owner using lien rights, if necessary.

Q. Joint Development of Control Systems

Storm water control systems may be planned and constructed jointly by two or more developers as long as compliance with this Ordinance is maintained. Developers are encouraged to plan and construct these systems on a joint or regional basis.

R. Installation of Control Systems

Runoff and erosion control systems shall be installed as soon as possible during the course of site development. Detention/retention basins shall be designed with an additional 6 (six) percent of available capacity to allow for sediment accumulation resulting from development and to permit the pond to function for reasonable periods between cleanings. Basins should be designed to collect sediment and debris in specific locations so that removal cost are kept to a minimum. The City will require temporary and permanent erosion control plans to be submitted as a part of the construction plans.

S. Detention Facilities in Flood Plains

If detention storage is provided within a flood plain, only the net increase in storage volume above that which naturally existed on the flood plain shall be credited to the development. No credit will be granted for volumes below the elevation of the regulatory flood at the location unless compensatory storage is also provided.

T. Off site Drainage Provision
When the allowable runoff is released in an area that is susceptible to flooding, the developer may be required to construct appropriate storm drains through such area to avert increased flood hazard caused by the concentration of allowable runoff at one point instead of the natural overland distribution. The requirement of off-site drains shall be at the discretion of the City.

U. Erosion Control

Erosion control plans shall be submitted as part of the construction plans and specifications and shall include the following:

(1) A complete copy of the Erosion and Sediment Control Plan filed with the City. The Texas Department of Transportation Guidelines for Erosion Control may be used as a reference guide in developing the erosion control plan.

(2) Temporary erosion control measures necessary during the initial construction and establishment phases up to final site grading and seeding.

(3) A permanent erosion control plan of all the graded and non-hard surface areas within the proposed development, as planned for completion, up to and including seeding of the final lot on which business or residential dwellings are to be placed.

(4) Details concerning removal of temporary erosion control devices after the initial establishment of adequate vegetative cover.

(5) Maintenance procedures, as part of the continuing plan, to keep all of the land under adequate cover and erosion at an acceptable minimum.

16. Certifications Required

After completion of the project and before final approval and acceptance can be made, a professionally prepared and certified "As Built" set of plans shall be submitted to the City for review. These plans shall include all pertinent data relevant to the completed storm drainage system and shall include:

(1) Pipe size and pipe material.

(2) Invert elevations.

(3) Top rim elevations.

(4) Lengths of all pipe structures.

(5) Data and calculations showing detention basin storage volume.

(6) Certified statement on plans stating the completed storm drainage system substantially complies with construction plans as approved by the City.
All such submitted plans shall be reviewed for compliance within 30 days after submission to the City or Engineer. If notice of non-compliance is not given within 30 days of submission of the plans, the plans shall be construed as approved and accepted.

17. Changes in Plan

Any revision to, and/or significant change or deviation from the detailed plans and specifications after formal approval by the City shall be filed in duplicate with and approved by the City prior to implementation of the revision or change. Copies of the revisions or changes, if approved, shall be attached to the original plans and specifications.

18. Determination of Impact Drainage Areas

The City is authorized, but is not required to classify certain geographical areas as Impact Drainage Areas and to enact and promulgate regulations which are generally applied. In determining Impact Drainage Areas, the City shall consider such factors as topography, soil type, capacity of existing regulated drains and distance from adequate drainage facility. The following areas shall be designated as Impact Drainage Areas, unless good reason for not including them is presented to the City:

A. A floodway or flood plain as designated by FEMA.

B. Land within 75 feet of each bank of any regulated drain.

C. Land subject to flooding and/or areas that have previously exhibited drainage deficiencies.

Land where there is not adequate outlet, taking into consideration the capacity and depth of the outlet, may be designated as an Impact Drainage Area by resolution of the City. Special requirements for development within any Impact Drainage Area shall be included in the resolution.

19. Other Requirements

A. Sump Pumps

Sump pumps installed to receive and discharge groundwaters or other storm waters shall be connected to the storm sewer where possible or discharged into a designated storm drainage channel. Sump pumps installed to receive and discharge floor drain flow or other sanitary sewage shall be connected to the sanitary sewers. A sump pump shall be used for one function only, either the discharge of storm waters or the discharge of sanitary sewage.

B. Down Spouts

All down spouts or roof drains shall discharge onto the ground or be connected to the storm sewer. No down spouts or roof drains shall be connected to the sanitary sewer.
C. Footing Drains

Footing drains shall be connected to storm sewers where possible or designated storm drainage channels. No footing drains shall be connected to the sanitary sewer.

20. Regional Drainage Plans

The City may establish a regional drainage plan or Interim Regional Drainage Plan which controls drainage requirements within a specified drainage area.

A. Regional Drainage Plan or Interim Drainage Plan shall specify:

1. A description of the region;
2. The basis for the region having a Regional Drainage Plan;
3. Potential areas of ground water discharge and recharge;
4. What modifications or waivers of this Ordinance apply in the region; and
5. What additional drainage or drainage plan requirements, beyond those in this Ordinance, apply in the region.

B. A Regional Drainage Plan or Interim Drainage Plan may provide:

1. For regional detention and/or storage of storm water;
2. For design or performance standards to ensure water quality;
3. For design requirements to ensure compatibility with the plan for regional detention and storage; and
4. For a charge, in land or dollars, based upon the size and nature of the development, for the use of regional storm water detention and/or storage facilities for new development.

21. Disclaimer of Liability

The degree of protection required by this Ordinance is considered reasonable for regulatory purposes and is based on historical records engineering and specific methods of study. Larger storms may occur or storm water runoff depths may be increased by man-made or natural causes. This Ordinance does not imply that land uses permitted will be free from storm water damage. This Ordinance shall not create liability on the part of the City of Eagle Pass or any officer or employee thereof for any damage which may result from reliance on this Ordinance or on any administrative decision lawfully made thereunder.

22. Corrective Action

Nothing herein contained shall prevent the City of Eagle Pass from taking such lawful action as may be necessary to prevent or remedy any violation. All costs connected therewith shall accrue to the person or persons responsible.

23. Repealer
All ordinances or parts thereof in conflict with the provisions of this Ordinance are repealed.

24. When Effective

This Ordinance shall become effective after its final passage, approval and publication as required by law.

25. Exempt Projects

Any residential, commercial or industrial subdivision (major or minor) or construction project thereon, which has had its drainage plan approved by the City prior to the effective date of this Ordinance shall be exempt from all of the requirements of this Ordinance.
### Table 1 - Runoff Coefficients

<table>
<thead>
<tr>
<th>Type of Drainage Area</th>
<th>Runoff Coefficient, C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lawns:</strong></td>
<td></td>
</tr>
<tr>
<td>Sandy Soil, flat, less than 2%</td>
<td>0.05-0.10</td>
</tr>
<tr>
<td>Sandy Soil, average, 2-7%</td>
<td>0.10-0.15</td>
</tr>
<tr>
<td>Sandy Soil, steep, greater than 7%</td>
<td>0.15-0.20</td>
</tr>
<tr>
<td><strong>Lawns:</strong></td>
<td></td>
</tr>
<tr>
<td>Clay Soil, flat, less than 2%</td>
<td>0.13-0.17</td>
</tr>
<tr>
<td>Clay Soil, average, 2-7%</td>
<td>0.18-0.22</td>
</tr>
<tr>
<td>Clay Soil, steep, greater than 7%</td>
<td>0.25-0.35</td>
</tr>
<tr>
<td><strong>Business:</strong></td>
<td></td>
</tr>
<tr>
<td>Downtown areas</td>
<td>0.70-0.95</td>
</tr>
<tr>
<td>Neighborhood areas</td>
<td>0.50-0.70</td>
</tr>
<tr>
<td><strong>Residential:</strong></td>
<td></td>
</tr>
<tr>
<td>Single-family areas</td>
<td>0.30-0.60</td>
</tr>
<tr>
<td>Multi-family, detached</td>
<td>0.40-0.80</td>
</tr>
<tr>
<td>Multi-family, attached</td>
<td>0.60-0.90</td>
</tr>
<tr>
<td><strong>Industrial:</strong></td>
<td></td>
</tr>
<tr>
<td>Light areas</td>
<td>0.50-0.80</td>
</tr>
<tr>
<td>Heavy areas</td>
<td>0.60-0.90</td>
</tr>
<tr>
<td>Parks, cemeteries</td>
<td>0.10-0.40</td>
</tr>
<tr>
<td>Playgrounds</td>
<td>0.20-0.35</td>
</tr>
<tr>
<td>Railroad yard areas</td>
<td>0.20-0.40</td>
</tr>
<tr>
<td>Unimproved areas</td>
<td>0.10-0.30</td>
</tr>
<tr>
<td><strong>Streets:</strong></td>
<td></td>
</tr>
<tr>
<td>Asphalitic</td>
<td>0.70-0.95</td>
</tr>
<tr>
<td>Concrete</td>
<td>0.80-0.95</td>
</tr>
<tr>
<td>Brick</td>
<td>0.70-0.85</td>
</tr>
<tr>
<td>Drives and walks</td>
<td>0.75-0.85</td>
</tr>
<tr>
<td>Roofs</td>
<td>0.75-0.95</td>
</tr>
</tbody>
</table>

**Note:**
1. These runoff coefficients were taken from, "Handbook of Applied Hydrology" by Ven Te Chow, 1964, McGraw-Hill, Chapter 14, Runoff, p. 14-8.
2. The coefficients of this tabulation are applicable to storms up to a 10-year frequency.
3. Coefficients for less frequent higher intensity storms shall be modified as follows:

<table>
<thead>
<tr>
<th>Return Period (yrs)</th>
<th>Multiply “C” by</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>1.1</td>
</tr>
<tr>
<td>50</td>
<td>1.2</td>
</tr>
<tr>
<td>100</td>
<td>1.25</td>
</tr>
</tbody>
</table>
Appendix - Tables and Figures

Table 2 - Runoff Coefficients by Land Use and Maximum recommended Inlet Times

<table>
<thead>
<tr>
<th>Zone Designation</th>
<th>Name</th>
<th>Runoff Coefficient</th>
<th>Max. Recommended Inlet Time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AG</td>
<td>Agricultural, 1ac, 2000 SF home</td>
<td>Variable</td>
<td>15</td>
</tr>
<tr>
<td>SF or RE</td>
<td>Single Family Residential</td>
<td>0.60</td>
<td>15</td>
</tr>
<tr>
<td>D</td>
<td>Duplex</td>
<td>0.60</td>
<td>15</td>
</tr>
<tr>
<td>A-1</td>
<td>Multifamily, 12 units/acre</td>
<td>0.80</td>
<td>10</td>
</tr>
<tr>
<td>A-2</td>
<td>Multifamily, 18 units/acre</td>
<td>0.85</td>
<td>10</td>
</tr>
<tr>
<td>A-3</td>
<td>Multifamily, 24 units/acre</td>
<td>0.90</td>
<td>10</td>
</tr>
<tr>
<td>PD</td>
<td>Planned Development</td>
<td>Variable</td>
<td>10</td>
</tr>
<tr>
<td>O</td>
<td>Office</td>
<td>0.85</td>
<td>10</td>
</tr>
<tr>
<td>GR</td>
<td>General Retail</td>
<td>0.85</td>
<td>10</td>
</tr>
<tr>
<td>SS</td>
<td>Service Station</td>
<td>0.95</td>
<td>10</td>
</tr>
<tr>
<td>MU</td>
<td>Mixed Use</td>
<td>Variable</td>
<td>10</td>
</tr>
<tr>
<td>CBD</td>
<td>Central Business District</td>
<td>0.90</td>
<td>10</td>
</tr>
<tr>
<td>LC</td>
<td>Light Commercial</td>
<td>0.90</td>
<td>10</td>
</tr>
<tr>
<td>C</td>
<td>Commercial</td>
<td>0.90</td>
<td>10</td>
</tr>
<tr>
<td>I</td>
<td>Industrial</td>
<td>0.90</td>
<td>10</td>
</tr>
<tr>
<td>FP</td>
<td>Flood Plain</td>
<td>1.00</td>
<td>10</td>
</tr>
<tr>
<td>H</td>
<td>Historical Landmark</td>
<td>0.40</td>
<td>15</td>
</tr>
<tr>
<td>R/PC</td>
<td>Restaurant/Private Club</td>
<td>0.90</td>
<td>10</td>
</tr>
<tr>
<td>*</td>
<td>Parking Lots</td>
<td>1.00</td>
<td>10</td>
</tr>
<tr>
<td>*</td>
<td>Church</td>
<td>0.90 Varies</td>
<td>10</td>
</tr>
<tr>
<td>*</td>
<td>School</td>
<td>0.75 Varies</td>
<td>15</td>
</tr>
<tr>
<td>*</td>
<td>Park</td>
<td>0.40 Varies</td>
<td>15</td>
</tr>
<tr>
<td>*</td>
<td>Road &amp; Interstate Hwy.</td>
<td>0.90</td>
<td>10</td>
</tr>
</tbody>
</table>

Note:

1. (*) = Indicates non-zoned usage
2. The coefficients of this tabulation are applicable to storms up to a 10-year frequency.
3. Coefficients for less frequent higher intensity storms shall be modified as follows:

   Return Period (yrs) | Multiply "C" by
   -------------------|-----------------------
   25                 | 1.1                   |
   50                 | 1.2                   |
   100                | 1.25                  |
### Table 3 - Typical Values of Manning's n

<table>
<thead>
<tr>
<th>Boundary</th>
<th>Manning roughness, n, ft$^{1/6}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very smooth surfaces such as glass, plastic, or brass</td>
<td>0.010</td>
</tr>
<tr>
<td>Very smooth concrete and planed timber</td>
<td>0.011</td>
</tr>
<tr>
<td>Smooth concrete</td>
<td>0.012</td>
</tr>
<tr>
<td>Ordinary concrete lining</td>
<td>0.013</td>
</tr>
<tr>
<td>Good wood</td>
<td>0.014</td>
</tr>
<tr>
<td>Vitrified Clay</td>
<td>0.015</td>
</tr>
<tr>
<td>Shot concrete, untroweled, and earth channels in best condition</td>
<td>0.017</td>
</tr>
<tr>
<td>Straight unlined earth channels in good condition</td>
<td>0.020</td>
</tr>
<tr>
<td>Rivers and earth channels in fair condition - some growth</td>
<td>0.025</td>
</tr>
<tr>
<td>Winding natural streams and channels in poor condition - considerable moss growth</td>
<td>0.035</td>
</tr>
<tr>
<td>Mountain streams with rocky beds and rivers with variable sections and some vegetation along banks</td>
<td>0.040-0.050</td>
</tr>
<tr>
<td>Alluvial channels, sand beds, no vegetation</td>
<td></td>
</tr>
<tr>
<td>1. Lower regime</td>
<td></td>
</tr>
<tr>
<td>Ripples</td>
<td>0.017-0.028</td>
</tr>
<tr>
<td>Dunes</td>
<td>0.018-0.035</td>
</tr>
<tr>
<td>2. Washed-out dunes or transition</td>
<td>0.014-0.024</td>
</tr>
<tr>
<td>3. Upper regime</td>
<td></td>
</tr>
<tr>
<td>Plane bed</td>
<td>0.011-0.015</td>
</tr>
<tr>
<td>Standing waves</td>
<td>0.012-0.016</td>
</tr>
<tr>
<td>Antidunes</td>
<td>0.012-0.020</td>
</tr>
</tbody>
</table>

**Note:**
### Table 4 - Maximum Permissible Velocities for Channels Lined With Grass

<table>
<thead>
<tr>
<th>Cover</th>
<th>Slope, Range, *</th>
<th>Permissible Velocity, fps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bermuda Grass</td>
<td>0-5</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>5-10</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>&gt;10</td>
<td>4</td>
</tr>
<tr>
<td>Buffalo Grass, Kentucky bluegrass, smooth brome, blue grama</td>
<td>0-5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>5-10</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>&gt;10</td>
<td>3</td>
</tr>
<tr>
<td>Grass mixture</td>
<td>0-5</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Do not use on slopes steeper than 10%.</td>
<td>5-10</td>
<td></td>
</tr>
<tr>
<td>Lespedeza sericea, weeping love grass, ischaemum (yellow blue stem), kudzu, alfalfa, crabgrass</td>
<td>0-5</td>
<td>2.5</td>
</tr>
<tr>
<td>Do not use on slopes steeper than 5%, except for side slopes in a combination channel.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annuals - used on mild slopes or as temporary protection until permanant covers are established, common lespedeza Sudan grass</td>
<td>0-5</td>
<td>2.5</td>
</tr>
<tr>
<td>Use on slopes steeper than 5% is not recommended.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Remarks: The values apply to average, uniform stands of each type of cover. Use velocities exceeding 5 fps only where good covers and proper maintenance can be obtained. Based on past experience, all soils within the city of Eagle Pass have been found to be easily eroded soils.

* Longitudinal bed slopes of the channel bottom.
Table 5 - Rainfall Depths for Various Return Periods and Storm Durations

<table>
<thead>
<tr>
<th>Duration (min.)</th>
<th>1</th>
<th>2</th>
<th>5</th>
<th>10</th>
<th>25</th>
<th>50</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0.47</td>
<td>0.56</td>
<td>0.62</td>
<td>0.71</td>
<td>0.79</td>
<td>0.86</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>0.78</td>
<td>0.93</td>
<td>1.03</td>
<td>1.19</td>
<td>1.32</td>
<td>1.44</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>1.00</td>
<td>1.19</td>
<td>1.32</td>
<td>1.52</td>
<td>1.68</td>
<td>1.84</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>1.41</td>
<td>1.76</td>
<td>2.02</td>
<td>2.36</td>
<td>2.66</td>
<td>2.94</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>1.83</td>
<td>2.37</td>
<td>2.74</td>
<td>3.27</td>
<td>3.67</td>
<td>4.08</td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>3.75</td>
<td>2.15</td>
<td>2.81</td>
<td>3.29</td>
<td>3.35</td>
<td>4.25</td>
<td>4.86</td>
</tr>
<tr>
<td>180</td>
<td>1.94</td>
<td>2.28</td>
<td>3.09</td>
<td>3.83</td>
<td>4.19</td>
<td>4.75</td>
<td>5.42</td>
</tr>
<tr>
<td>360</td>
<td>2.34</td>
<td>2.86</td>
<td>3.85</td>
<td>4.28</td>
<td>5.00</td>
<td>5.55</td>
<td>6.93</td>
</tr>
<tr>
<td>720</td>
<td>2.77</td>
<td>3.13</td>
<td>4.21</td>
<td>5.08</td>
<td>6.00</td>
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<td>3.54</td>
<td>4.49</td>
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<td>7.00</td>
<td>7.38</td>
<td>8.83</td>
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Values taken from HYDRO-35 for shorter duration storms

Values taken from TP-40 for longer duration storms.

Table 5A - Rainfall Intensities for Various Return Periods and Storm Durations

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<tr>
<th>Duration (min.)</th>
<th>1</th>
<th>2</th>
<th>5</th>
<th>10</th>
<th>25</th>
<th>50</th>
<th>100</th>
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<td>6.73</td>
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<td>2.81</td>
<td>3.53</td>
<td>4.03</td>
<td>4.75</td>
<td>5.32</td>
<td>5.88</td>
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<td>0.00</td>
<td>1.83</td>
<td>2.37</td>
<td>2.74</td>
<td>3.27</td>
<td>3.67</td>
<td>4.08</td>
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<td>0.83</td>
<td>1.08</td>
<td>1.14</td>
<td>1.64</td>
<td>1.93</td>
<td>2.18</td>
<td>2.45</td>
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<td>0.85</td>
<td>0.92</td>
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<td>0.26</td>
<td>0.33</td>
<td>0.47</td>
<td>0.50</td>
<td>0.55</td>
<td>0.62</td>
</tr>
<tr>
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<td>0.15</td>
<td>0.20</td>
<td>0.24</td>
<td>0.28</td>
<td>0.35</td>
<td>0.37</td>
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</table>

Values taken from HYDRO-35 for shorter duration storms

Values taken from TP-40 for longer duration storms.
## TABLE 6 - STORM DRAINAGE

Street velocities and capacities
- Flowing curb full
- Manning's N=0.018

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<th>Slope</th>
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<th>CROSS-SLOPE</th>
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<td>COLLECTOR STREET</td>
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<td>w = 42'</td>
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<tr>
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<td>Q cfs</td>
</tr>
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<td>1.13 13.84</td>
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<td>2.39 29.37</td>
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<td>2.52 30.96</td>
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Appendix - Tables and Figures

Figure 2 - Average Channel Velocities used to Calculate Time of Concentration