

Greiner

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SCS RWCD FLOODWAY
REACH 6
BID SCHEDULE AND
CONTRACT SPECIFICATIONS

FEBRUARY, 1987

BID SCHEDULE

RWCD FLOODWAY, REACH 6

Property of
Flood Control District of MC Library
Please Return to
2801 W. Durango
Phoenix, AZ 85008

Bid Item No.	Work or Material	Spec. No.	Quantity	Unit
1.	Clearing and Grubbing	2	57	AC
2.	Mobilization	8	1	LS
3.	Water	10	34,000	MG
			over 34,000	MG
4.	Channel Excavation, Common	21	299,500	CY
5.	Str. Excavation, Common	21	26,542	CY
6.	Trench Excavation	21	618	CY
7.	Earthfill	23	37,600	CY
8.	Str. Backfill	23	330	CY
9.	Drainfill	23	66	CY
10.	Conc. Channel Lining	31	155	CY
11.	Concrete Structures	31	221	CY
12.	Cement	31	13,900	bbls.
13.	Concrete for Minor Structures	31	25	CY
14.	Steel Reinforcement	34	53,100	lb.
15.	54" Conc. Culvert Pipe	42	108	LF
16.	Collector Channel Inlets	51	43	ea.
17.	Metal Fabrication	81	1	LS
18.	Identification Plaque	93	2	ea.
19.	Geotextile Fabric	203	8,875	SF
20.	Drain Pipes	207	1,775	LF
21.	Surveys	7	1	LS
22.	Soil-cement	462	12,200	CY

RWCD FLOODWAY, REACH-6

2. CLEARING AND GRUBBING

1. SCOPE

The work shall consist of the clearing and grubbing of designated areas by removal and disposal of trees, snags, logs, stumps, shrubs and rubbish.

2. MARKING

The limits of the areas to be cleared and grubbed will be marked by means of stakes, flags, tree markings or other suitable methods. Trees to be left standing and uninjured will be designated by special markings placed on the trunks at a height of about six feet above the ground surface.

3. REMOVAL

All trees not marked for preservation and all snags, logs, brush, stumps, shrubs and rubbish shall be removed from within the limits of the marked areas. Unless otherwise specified, all stumps, roots and root clusters having a diameter of one inch or larger shall be grubbed out to a depth of at least two feet below subgrade elevation for concrete structures and one foot below the ground surface at embankment sites and other designated areas.

4. DISPOSAL

Unless otherwise specified, all materials removed from the cleared and grubbed areas shall be burned or buried at locations approved by the Engineer or otherwise disposed of as approved by the Engineer.

5. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the cleared and grubbed area will be measured to the nearest 0.1 acre. Payment for clearing and grubbing will be made for the total area within the designated limits at the contract unit price. Such payment will constitute full compensation for all labor, equipment, tools and all other items necessary and incidental to the completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 6 of this specification.

6. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 1, Clearing and Grubbing

- (1) This item shall consist of clearing and grubbing of all areas shown on the drawings and staked in the field.
- (2) All materials removed from the cleaned and grubbed areas shall be disposed of at the waste site or refuse sites as shown on the drawings. If refuse materials are disposed of by burying, they shall be buried a minimum of 24 inches below the existing ground surface in the refuse disposal areas shown on the drawings and as staked in the field. When disposal is complete, the refuse disposal site areas shall be smoothed and graded to blend into the surrounding terrain.
- (3) Refuse materials are to be no larger than 2' - 0" in width or diameter and no longer than 2' - 0".
- (4) If materials removed from the cleared and grubbed area are to be burned, burning must be carried out in accordance with Maricopa County Health Department regulations.
- (5) Measurement and payment will include compensation for Subsidiary Item, Structure Removal and Removal of Water.

RWCD FLOODWAY, REACH-6

3. STRUCTURE REMOVAL

1. SCOPE

The work shall consist of the removal, salvage and disposal of structures (including fences) from the designated areas.

2. MARKING

The limits of the areas from which structures must be removed will be marked by means of stakes, flags or other suitable methods. Structures to be preserved in place or salvaged will be designated by special markings.

3. REMOVAL

Within the areas so marked all visible structures and attachments and all buried structures located and identified by survey stakes shall be removed to the specified extent and depth.

4. SALVAGE

Structures that are designated to be salvaged shall be carefully removed and neatly placed in the specified storage areas. Salvaged structures that are capable of being disassembled shall be dismantled into individual members or sections. Such structures shall be neatly match marked with paint prior to disassembly. All pins, nuts, bolts, washers, loose parts shall be marked or tagged to indicate their proper locations in the structure and shall be fastened to the appropriate structural member or packed in suitable containers. Materials from fences designated to be salvaged shall be placed outside the work area on the property from which they were removed. Wire shall be rolled into uniform rolls of convenient size. Posts and rails shall be neatly piled.

5. DISPOSAL OF REFUSE MATERIALS

Unless otherwise specified, refuse materials resulting from structure removal shall be burned or buried at locations approved by the Engineer or otherwise disposed of as specified or as approved by the Engineer.

6. MEASUREMENT AND PAYMENT

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

7. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Subsidiary Item, Structure Removal

- (1) This item shall consist of removing and disposing of the existing headwalls, gunite, riprap, gabion structure, concrete, reinforced concrete pipe and trash rack as shown on the drawings and marked for removal.
- (2) The existing turnout gate and 36" CMP at University Drive are to be removed, salvaged and stored at the location where removed.
- (3) Refuse materials shall be buried a minimum of 24 inches below the existing ground surface in the refuse areas shown on the drawings and staked in the field. When disposal is complete, the refuse sites shall be smoothed and graded to blend into the surrounding terrain.
- (4) Refuse materials are to be no larger than 2' - 0" in width or diameter and no longer than 2' - 0".
- (5) No separate payment will be made for this item. Compensation for this work will be included in the payment for Bid Item 1, Clearing and Grubbing.

RMCD FLOODWAY, REACH-6

5. POLLUTION CONTROL

1. SCOPE

The work shall consist of installing measures or performing work to control erosion and minimize the production of sediment and other pollutants to water and air during construction operations in accordance with these specifications.

2. MATERIALS

All materials furnished shall meet the requirements of the Material Specifications listed in Section 8 of this specification.

3. EROSION AND SEDIMENT CONTROL MEASURES AND WORKS

The work and measures shall include but not be limited to the following, as shown on the drawings or as specified in Section 8 of this specification.

Staging of Earthwork Activities - The excavation and moving of soil materials shall be scheduled so that the smallest possible areas will be unprotected from erosion for the shortest time feasible.

Seeding - Seeding to protect disturbed areas shall be used as specified on the drawings or in Section 8 of this specification.

Mulching - Mulching shall be used to provide temporary protection to soil surfaces from erosion.

Diversions - Diversions shall be used to divert water away from work areas and/or to collect runoff from work areas for treatment and safe disposition.

Stream Crossings - Stream crossings shall be used where fording of streams by equipment is necessary.

Sediment Basins - Sediment basins shall be used to settle and filter out sediment from eroding areas to protect properties and streams below the construction site.

Straw Bale Filters - Straw bale filters shall be used to trap sediment from areas of limited runoff. Bales are temporary and shall be removed when permanent measures are installed.

Waterways - Waterways shall be used for the safe disposal of runoff from fields, diversions and other structures or measures.

4. CHEMICAL POLLUTION

The Contractor shall provide watertight tanks or barrels or construct a sump sealed with plastic sheets to be used to dispose of chemical pollutants produced as a by-product of the project's work such as drained lubricating or transmission oils, greases, soaps, asphalt, etc. At the completion of the construction work, the sump shall be covered or filled as directed by the Engineer. Storage tanks or barrels shall be removed from the site.

Sanitary facilities such as pit toilets, chemical toilets, or septic tanks shall not be placed adjacent to live streams, wells, or springs. They shall be located at a distance sufficient to prevent contamination of any water sources.

5. AIR POLLUTION

Local and state regulations concerning the burning of brush or slash or disposal of other materials shall be adhered to.

Fire prevention measures shall be taken to prevent the start or the spreading of fires which result from project work. Fire breaks or guards shall be constructed at locations as shown on the drawings.

All public access or haul roads used by the Contractor during construction of the project shall be sprinkled as required to fully suppress dust.

6. MAINTENANCE REMOVAL AND RESTORATION

All measures and works shall be adequately maintained in a functional condition as long as needed during the construction operation. All temporary measures shall be removed and the site restored as nearly to original conditions as practicable as directed by the Engineer.

7. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract each item will be measured to the nearest unit applicable. Payment for each item will be made at the contract unit price for that item. Such payment will constitute full compensation for all labor, equipment, tools, and all other items necessary and incidental to the completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items, and the items to which they are made subsidiary, are identified in Section 8 of this specification.

8. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Subsidiary Item, Pollution Control

- (1) This item shall consist of all work and materials required to control or reduce pollution.
- (2) This specification shall apply to all construction activities within the Floodway Right-of-Way and construction easements, within the designated waste and refuse areas, and along approved haul roads between the designated waste areas and construction limits shown on the drawings.
- (3) The Contractor is required to adhere to all applicable local, State and Federal laws and regulations pertaining to the control of pollution as may result from construction of this project. These laws and regulations include but are not limited to:
 - (a) The "Policy on construction and related activities in water" adopted April 13, 1977, by the Water Quality Control Council of Arizona.
 - (b) The Clean Air Act (42 U.S.C. 1857 et seq. as amended by Pub. L. 91-604) Section 114, and Section 308 of the Federal Water Pollution Control Act (33 U.S.C. 1251 et seq., as amended by Pub. L. 92-500) relating to inspection, monitoring, entry, reports, and information as well as the other requirements of these sections.
- (4) The Contractor is responsible for maintaining air, water, and vegetative quality within the work area. Methods include, but are not limited to:
 - (a) Establishing turn areas, haul roads, work site access roads, temporary building sites, equipment yards, etc., in approved locations best suited to prevent contamination of air and water, to minimize destruction of existing vegetation, and to minimize erosion.
 - (b) Operating mechanized equipment at the job site in a manner that will avoid destruction or removal of trees and shrubs other than as necessary for construction of the measure.

- (c) Limiting destruction of existing vegetation in the designated waste areas to that necessary to deliver and spread waste and to operate equipment.
- (5) Under Section 2, Materials, there are no material specifications required.
- (6) Under Section 3, Seeding, no seeding is required.
- (7) No separate payment will be made for this item. Compensation for this work will be included in the payment for Bid Item 3, Water, and Bid Item 4, Channel Excavation Common.

RWCD FLOODWAY, REACH-6

8. MOBILIZATION

1. SCOPE

The work shall consist of the mobilization of the Contractor's forces and equipment necessary for performing the work required under the contract.

It shall include the purchase of contract bonds; transportation of personnel, equipment, and operating supplies to the site; establishment of offices, buildings, and other necessary facilities at the site, and other preparatory work at the site.

It shall not include mobilization for any specific item of work for which payment for mobilization is provided elsewhere in the contract.

The specification covers mobilization for work required by the contract at the time of award. If additional mobilization costs are incurred during performance of the contract as a result of changed or added items of work for which the Contractor is entitled to an adjustment in contract price, compensation for such costs will be included in the price adjustment for the items of work changed or added.

2. PAYMENT

Payment will be made as the work proceeds, after presentation of invoices by the Contractor showing his own mobilization costs and evidence of the charges of suppliers, subcontractors, and others for mobilization work performed by them. If the total of such payments is less than the contract lump sum for mobilization, the unpaid balance will be included in the final contract payment. Total payment will be the lump sum contract price for mobilization, regardless of actual cost to the Contractor.

Payment will not be made under this item for the purchase costs of materials having a residual value, the purchase costs of materials to be incorporated in the project, or the purchase costs of operating supplies.

Payment of the lump sum contract price for mobilization will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to completion of the work.

3. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 2, Mobilization

- (1) This item consists of the mobilization of the Contractor's equipment and forces for construction of the Floodway and appurtenances.

RWCD FLOODWAY, REACH-6

10. WATER FOR CONSTRUCTION

1. SCOPE

The work shall consist of furnishing, transporting, and using water for construction purposes in accord with the applicable specifications.

2. FACILITIES AND EQUIPMENT

The Contractor shall build and maintain such access and haul roads as are needed, and shall furnish, operate, and maintain all pumps, piping, tanks, and other facilities needed to load, transport, and use the water as specified.

These facilities shall be equipped with meters, tanks, or other devices by which the volume of water supplied can be measured.

3. DUST ABATEMENT AND HAUL ROAD MAINTENANCE

Water for dust abatement and haul road maintenance shall be applied to haul roads and other dust-producing areas as needed to prevent excessive dust and to maintain the roads in good condition for efficient operation while they are in use.

4. EARTHFILL, DRAINFILL, ROCKFILL

Water for earthfill, drainfill, or rockfill shall be used in the fill materials as specified in the applicable construction specifications.

5. CONCRETE, MORTAR, GROUT

Water used in mixing or curing concrete, pneumatically applied mortar, or other portland cement mortar or grout shall meet the requirements of the applicable construction specifications and shall be used in conformance with those specifications.

6. MEASUREMENT AND PAYMENT

For water items for which specific unit prices are established in the contract, the volume of water furnished and used in accordance with the specifications will be measured to the nearest 1000 gallons.

Except as otherwise specified, the measurement for payment will include all water needed at the construction site to perform the work required under the contract in accordance with the specifications but will not include water wasted or used in excess of the amount needed. It will not include water used in concrete which is mixed elsewhere and transported to the site.

Payment for water will be made at the contract unit price which shall be the price per 1000 gallons shown in the Bid Schedule. Such payment will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to furnishing, transporting, and using the water.

7. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 3, Water

- (1) This item shall consist of furnishing and applying all water necessary for performance of the work described in this contract.
- (2) Each pump used shall be equipped with a water meter having an accuracy that is within three percent, plus or minus, of the true quantity. The Contractor shall provide means to check the accuracy of the water meters when requested by the Contracting Officer.
- (3) Water may be obtained from the Roosevelt Water Conservation District, Higley, Arizona (Mike Leonard Telephone 963-3414).
- (4) Measurement and payment will be based on metered quantity of water and shall include compensation for Subsidiary Item, Pollution Control.

RWCD FLOODWAY, REACH-6

11. REMOVAL OF WATER

1. SCOPE

The work shall consist of the removal of surface water and ground water as needed to perform the required construction in accordance with the specifications. It shall include (1) building and maintaining all necessary temporary impounding works, channels, and diversions, (2) furnishing, installing and operating all necessary pumps, piping and other facilities and equipment, and (3) removing all such temporary works and equipment after they have served their purposes.

2. DIVERTING SURFACE WATER

The Contractor shall build, maintain and operate all cofferdams, channels, flumes, sumps, and other temporary diversion and protective works needed to divert streamflow and other surface water through or around the construction site and away from the construction work while construction is in progress. Unless otherwise specified, a diversion must discharge into the same natural drainage way in which its head-works are located.

Unless otherwise specified, the Contractor shall furnish to the Engineer, in writing, his plan for diverting surface water before beginning the construction work for which the diversion is required. Acceptance of this plan will not relieve the Contractor of responsibility for completing the work as specified.

3. DEWATERING THE CONSTRUCTION SITE

Foundations, cutoff trenches and other parts of the construction site shall be dewatered and kept free of standing water or excessively muddy conditions as needed for proper execution of the construction work. The Contractor shall furnish, install, operate and maintain all drains, sumps, pumps, casings, wellpoints, and other equipment needed to perform the dewatering as specified. Dewatering methods that cause a loss of fines from foundation areas will not be permitted.

Unless otherwise specified, the Contractor shall furnish to the Engineer, in writing, his plan for dewatering before beginning the construction work for which the dewatering is required. Acceptance of this plan will not relieve the Contractor of responsibility for completing the work as specified.

4. DEWATERING BORROW AREAS

Unless otherwise specified in Section 8, the Contractor shall maintain the borrow areas in drainable condition or otherwise provide for timely

and effective removal of surface and ground waters that accumulate within the borrow areas from any source. Borrow material shall be processed as necessary to achieve proper and uniform moisture content for placement.

If pumping to dewater borrow areas is included as an item of work in the bid schedule, each pump used for this purpose shall be equipped with a water meter in the discharge line. Accuracy of the meters shall be such that the measured quantity of water is within 3 percent, plus or minus, of the true quantity. Means shall be provided by the Contractor to check the accuracy of the water meters when requested by the Engineer.

5. EROSION AND POLLUTION CONTROL

Removal of water from the construction site, including the borrow areas shall be accomplished in such a manner that erosion and the transmission of sediment and other pollutants are minimized.

6. REMOVAL OF TEMPORARY WORKS

After the temporary works have served their purposes, the Contractor shall remove them or level and grade them to the extent required to present a sightly appearance and to prevent any obstruction of the flow of water or any other interference with the operation of or access to the permanent works.

Except as otherwise specified, pipes and casings shall be removed from temporary wells and the wells shall be filled to ground level with gravel or other material approved by the Engineer.

7. MEASUREMENT AND PAYMENT

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 8 of this specification.

8. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Subsidiary Item, Removal of Water

- (1) This item shall consist of all removal or diversion of surface and ground water from the construction area shown on the drawings.
- (2) The diversion or dewatering plans submitted to the Contracting Officer for approval shall be specific to each structure site or section of work. Any diversions or dikes proposed in the existing floodway shall incorporate "fuse" or breakaway sections or otherwise be capable of rapid removal in the event of unusual surface water flows during construction.
- (3) No separate payment will be made for the removal of water. Compensation for this work will be included in the payment for Bid Item 1, Clearing and Grubbing; Bid Item 4, Channel Excavation, Common; Bid Item 5, Structure Excavation, Common; Bid Item 6, Trench Excavation; Bid Item 7, Earthfill; Bid Item 8, Structure Backfill; Bid Item 9, Drainfill; Bid Item 10, Concrete Channel Lining; Bid Item 11, Concrete Structures; Bid Item 13, Concrete Minor Structures; Bid Item 15, Collector Channel Inlets; and Bid Item 21, Soil-Cement.

RWCD FLOODWAY, REACH-6

21. EXCAVATION

1. SCOPE

The work shall consist of the excavation required by the drawings and specifications and disposal of the excavated materials.

2. CLASSIFICATION

Excavation will be classified as common excavation or rock excavation in accordance with the following definitions or will be designated as unclassified.

Common excavation shall be defined as the excavation of all materials that can be excavated, transported, and unloaded by the use of heavy ripping equipment and wheel tractor-scrappers with pusher tractors or that can be excavated and dumped into place or loaded onto hauling equipment by means of excavators having a rated capacity of one cubic yard and equipped with attachments (such as shovel, bucket, backhoe, dragline or clam shell) appropriate to the character of the materials and the site conditions.

Rock excavation shall be defined as the excavation of all hard, compacted or cemented materials the accomplishment of which requires blasting or the use of excavators larger than defined for common excavation. The excavation and removal of isolated boulders or rock fragments larger than one cubic yard in volume encountered in materials otherwise conforming to the definition of common excavation shall be classified as rock excavation.

Excavation will be classified according to the above definitions by the Engineer, based on his judgment of the character of the materials and the site conditions.

The presence of isolated boulders or rock fragments larger than one cubic yard in size will not in itself be sufficient cause to change the classification of the surrounding material.

For the purpose of this classification, the following definitions shall apply:

Heavy ripping equipment shall be defined as a rear-mounted, heavy duty, single-tooth, ripping attachment mounted on a tractor having a power rating of 200-300 net horsepower (at the flywheel).

Wheel tractor-scraper shall be defined as a self-loading (not elevating) and unloading scraper having a struck bowl capacity of 12-20 yards.

Pusher tractor shall be defined as a track type tractor having a power rating of 200-300 net horsepower (at the flywheel) equipped with appropriate attachments.

3. UNCLASSIFIED EXCAVATION

Items designated as "Unclassified Excavation" shall include all materials encountered regardless of their nature or the manner in which they are removed. When excavation is unclassified, none of the definitions or classifications stated in Section 2 of this specification shall apply.

4. BLASTING

The transportation, handling, storage, and use of dynamite and other explosives shall be directed and supervised by a person of proven experience and ability in blasting operations.

Blasting shall be done in such a way as to prevent damage to the work or unnecessary fracturing of the foundation and shall conform to any special requirements in Section 12 of this specification.

5. USE OF EXCAVATED MATERIALS

To the extent they are needed, all suitable materials from the specified excavations shall be used in the construction of required permanent earthfill or rockfill. The suitability of materials for specific purposes will be determined by the Engineer. The Contractor shall not waste or otherwise dispose of suitable excavated materials.

6. DISPOSAL OF WASTE MATERIALS

All surplus or unsuitable excavated materials will be designated as waste and shall be disposed of at the location shown on the drawings.

7. BRACING AND SHORING

Excavated surfaces too steep to be safe and stable if unsupported shall be supported as necessary to safeguard the work and workmen, to prevent sliding or settling of the adjacent ground, and to avoid damaging existing improvements. The width of the excavation shall be increased if necessary to provide space for sheeting, bracing, shoring, and other supporting installations. The Contractor shall furnish, place and subsequently remove such supporting installations.

8. STRUCTURE AND TRENCH EXCAVATION

Structure or trench excavation shall be completed to the specified elevations and to sufficient length and width to include allowance for

forms, bracing and supports, as necessary, before any concrete or earthfill is placed or any piles are driven within the limits of the excavation.

9. BORROW EXCAVATION

When the quantities of suitable materials obtained from specified excavations are insufficient to construct the specified fills, additional materials shall be obtained from the designated borrow areas. The extent and depth of borrow pits within the limits of the designated borrow areas shall be as directed by the Engineer.

Borrow pits shall be excavated and finally dressed in a manner to eliminate steep or unstable side slopes or other hazardous or unsightly conditions.

10. OVEREXCAVATION

Excavation in rock beyond the specified lines and grades shall be corrected by filling the resulting voids with portland cement concrete made of materials and mix proportions approved by the Engineer. Concrete that will be exposed to the atmosphere when construction is completed shall contain not less than six sacks of cement per cubic yard of concrete. Concrete that will be permanently covered shall contain not less than four and one-half sacks of cement per cubic yard. The concrete shall be placed and cured as specified by the Engineer.

Excavation in earth beyond the specified lines and grades shall be corrected by filling the resulting voids with approved compacted earthfill, except that, if the earth is to become the subgrade for riprap, rockfill, sand or gravel bedding, or drainfill, the voids may be filled with material conforming to the specifications for the riprap, rockfill, bedding or drainfill.

11. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the volume of each type and class of excavation within the specified pay limits will be measured and computed to the nearest cubic yard by the method of average cross-sectional end areas. Regardless of quantities excavated, the measurement for payment will be made to the specified pay limits, except that excavation outside the specified lines and grades directed by the Engineer to remove unsuitable material will be included. Excavation required because unsuitable conditions result from the Contractor's improper construction operations, as determined by the Engineer, will not be included for measurement and payment.

The pay limits shall be defined as follows:

- a. The upper limit shall be the original ground surface as it existed prior to the start of construction operations except that where excavation is performed within areas designated for previous excavation or fill the upper limit shall be the modified ground surface resulting from the specified previous excavation or fill.
- b. The lower and lateral limits shall be the neat lines and grades shown on the drawings.

Payment for each type and class of excavation will be made at the contract unit price for that type and class of excavation. Such payment will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to the performance of the work, except that extra payment for backfilling required overexcavation will be made in accordance with the following provisions:

Payment for backfilling overexcavation, as specified in Section 10 of this specification, will be made only if the excavation outside specified lines and grades is directed by the Engineer to remove unsuitable material and if the unsuitable condition is not a result of the Contractor's improper construction operations as determined by the Engineer.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 12 of this specification.

12. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 4, Channel Excavation, Common

- (1) This item shall consist of all excavation required to construct the floodway and appurtenances, except that designated as Structure Excavation and Trench Excavation.
- (2) Suitable materials resulting from this excavation and not required for Bid Item 8, Structure Backfill, and Bid Item 7, Earthfill, and Bid Item 22, Soil-Cement shall be wasted in the areas shown on the drawings, and as specified in Subsidiary Item, Waste Disposal.
- (3) Measurement and payment will include compensation for Subsidiary Items; Pollution Control, Removal of Water, and Waste Disposal.

b. Bid Item 5, Structure Excavation, Common

- (1) This item shall consist of the excavation required for installation of:
 - (a) The 54" headwall and outlet protection at station 35+84.50.
 - (b) The 36" headwall and outlet protection at station 92+24.00.
 - (c) Major side inlets and collection systems at the following locations:
 - 30+70
 - 35+18
 - 60+72.50
 - 64+04.50
 - 77+05.00
 - 89+11.00
 - 93+97.84
 - 119+73.56
 - 143+66.00
 - 150+66.00
 - (d) The double 6'x7' box culvert at station 128+92.
 - (e) Outlet protection for 43 collector channel inlets and three connecting pipes from adjacent subdivisions.

(f) Cutoff walls for soil-cement and concrete channel linings.

(2) Measurement and payment will include compensation for Subsidiary Item, Removal of Water.

c. Bid Item 6, Trench Excavation

(1) This item shall consist of the excavation required for installation of the 54" diameter concrete pipe at station 35+84.50 and for the PVC underdrains on the side inlet spillways and the concrete channel lining.

(2) Measurement and payment shall be according to Section 11 of this specification.

(3) Payment will include compensation for Subsidiary Item, Removal of Water.

d. Subsidiary Item, Collector Channel Inlet Excavation

(1) This item shall consist of the excavation required for installation of 43 collector channel inlets and 3 connector pipes from adjacent subdivisions at the locations shown on the drawings.

(2) Payment for collector channel inlet excavation shall be included in Bid Item 16, Collector Channel Inlets.

RWCD FLOODWAY, REACH-6

23. EARTHFILL

1. SCOPE

The work shall consist of the construction of earth embankments and other earthfills required by the drawings and specifications.

2. MATERIALS

All fill materials shall be obtained from required excavations and designated borrow areas. The selection, blending, routing and disposition of materials in the various fills shall be subject to approval by the Engineer.

Fill materials shall contain no sod, brush, roots or other perishable materials. Rock particles larger than the maximum size specified for each type of fill shall be removed prior to compaction of the fill.

The types of materials used in the various fills shall be as listed and described in the specifications and drawings.

3. FOUNDATION PREPARATION

Foundations for earthfill shall be stripped to remove vegetation and other unsuitable materials or shall be excavated as specified.

Except as otherwise specified, earth foundation surfaces shall be graded to remove surface irregularities and shall be scarified parallel to the axis of the fill or otherwise acceptably scored and loosened to a minimum depth of 2 inches. The moisture content of the loosened material shall be controlled as specified for the earthfill, and the surface materials of the foundation shall be compacted and bonded with the first layer of earthfill, as specified for subsequent layers of earthfill.

Earth abutment surfaces shall be free of loose, uncompacted earth in excess of two inches in depth normal to the slope and shall be at such a moisture content that the earthfill can be compacted against them to effect a good bond between the fill and the abutments.

Rock foundation and abutment surfaces shall be cleared of all loose materials by hand or other effective means and shall be free of standing water when fill is placed upon them. Occasional rock outcrops in earth foundations for earthfill, except in dams and other structures designed to restrain the movement of water, shall not require special treatment if they do not interfere with compaction of the foundation and initial layers of the fill or the bond between the foundation and the fill.

Foundation and abutment surfaces shall not be steeper than 1 horizontal to 1 vertical unless otherwise specified. Test pits or other cavities shall be filled with compacted earthfill conforming to the specifications for the earthfill to be placed upon the foundation.

4. PLACEMENT

Fill shall not be placed until the required excavation and foundation preparation have been completed and the foundation has been inspected and approved by the Engineer. Fill shall not be placed upon a frozen surface, nor shall snow, ice, or frozen material be incorporated in the fill.

Fill shall be placed in approximately horizontal layers. The thickness of each layer before compaction shall not exceed the maximum thickness specified. Materials placed by dumping in piles or windrows shall be spread uniformly to not more than the specified thickness before being compacted. Hand compacted fill, including fill compacted by manually directed power tampers, shall be placed in layers whose thickness before compaction does not exceed the maximum thickness specified for layers of fill compacted by manually directed power tampers.

Adjacent to structures, fill shall be placed in a manner which will prevent damage to the structures and will allow the structures to assume the loads from the fill gradually and uniformly. The height of the fill adjacent to a structure shall be increased at approximately the same rate on all sides of the structure.

Earthfill in dams, levees and other structures designed to restrain the movement of water shall be placed so as to meet the following additional requirements:

- a. The distribution of materials throughout each zone shall be essentially uniform, and the fill shall be free from lenses, pockets, streaks or layers of material differing substantially in texture, moisture content, or gradation from the surrounding material.
- b. If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified parallel to the axis of the fill to a depth of not less than two inches before the next layer is placed.
- c. The top surfaces of embankments shall be maintained approximately level during construction, except that a crown or cross-slope of approximately 2 percent shall be maintained to insure effective drainage, and except as otherwise specified for drainfill or sectional zones. If the drawings or specifications require or the Engineer directs that fill be placed at a higher level in one part of an embankment than another, the top surface of each part shall be maintained as specified above.

- d. Dam embankments shall be constructed in continuous layers from abutment to abutment except where openings to facilitate construction or to allow the passage of stream flow during construction are specifically authorized in the contract.
- e. Embankments built at different levels as described under (c) or (d) above shall be constructed so that the slope of the bonding surfaces between embankment in place and embankment to be placed is not steeper than three feet horizontal to one foot vertical. The bonding surface of the embankment in place shall be stripped of all loose material, and shall be scarified, moistened and recompactd when the new fill is placed against it as needed to insure a good bond with the new fill and to obtain the specified moisture content and density in the junction of the in place and new fills.

5. CONTROL OF MOISTURE CONTENT

During placement and compaction of fill, the moisture content of the materials being placed shall be maintained within the specified range.

The application of water to the fill materials shall be accomplished at the borrow areas insofar as practicable. Water may be applied by sprinkling the materials after placement on the fill, if necessary. Uniform moisture distribution shall be obtained by disking.

Material that is too wet when deposited on the fill shall either be removed or be dried to the specified moisture content prior to compaction.

If the top surface of the preceding layer of compacted fill or a foundation or abutment surface in the zone of contact with the fill becomes too dry to permit suitable bond it shall be scarified and moistened by sprinkling to an acceptable moisture content prior to placement of the next layer of fill.

6. COMPACTION

Earthfill shall be compacted according to the following requirements for the class of compaction specified:

Class A compaction. Each layer of fill shall be compacted as necessary to make the density of the fill matrix not less than the minimum density specified. The fill matrix is defined as the portion of the fill material finer than the maximum particle size used in the compaction test method specified.

Class B compaction. Each layer of fill shall be compacted to a mass density not less than the minimum density specified.

Class C compaction. Each layer of fill shall be compacted by the specified number of passes of the type and weight of roller or other equipment specified, or by an approved equivalent method. Each pass shall consist of at least one passage of the roller wheel or drum over the entire surface of the layer.

Fill adjacent to structures shall be compacted to a density equivalent to that of the surrounding fill by means of hand tamping if permitted by the Contracting Officer, or manually directed power tampers or plate vibrators. Unless otherwise specified, heavy equipment including backhoe mounted powertampers, or vibrating compactors and manually directed vibrating rollers, shall not be operated within 2 feet of any structure. Towed or self-propelled vibrating rollers shall not be operated within 5 feet of any structure. Compaction by means of drop weights operating from a crane or hoist will not be permitted.

The passage of heavy equipment will not be allowed: (1) over cast-in-place conduits prior to 14 days after placement of the concrete; (2) over cradled or bedded precast conduits prior to 7 days after placement of the concrete cradle or bedding; or (3) over any type of conduit until the backfill has been placed above the top surface of the structure to a height equal to one-half the clear span width of the structure or pipe or two feet, whichever is greater.

Compacting of fill adjacent to structures shall not be started until the concrete has attained the strength specified in Section 10 for this purpose. The strength will be determined by compression testing of test cylinders cast by the Engineer for this purpose and cured at the work site in the manner specified in ASTM Method C 31 for determining when a structure may be put into service.

When the required strength of the concrete is not specified as described above, compaction of fill adjacent to structures shall not be started until the following time intervals have elapsed after placement of the concrete.

<u>Structure</u>	<u>Time Interval</u>
Retaining walls and counterforts (impact basins)	14 days
Walls backfilled on both sides simultaneously	7 days
Conduits and spillway risers, cast- in-place (with inside forms in place)	7 days
Conduits and spillway risers, cast- in-place (inside forms removed)	14 days

<u>Structure</u>	<u>Time Interval</u>
Conduits, precast, cradled	2 days
Conduits, precast, bedded	1 day
Antiseep collars and cantilever outlet bents (backfilled both sides simultaneously)	3 days

7. REWORKING OR REMOVAL AND REPLACEMENT OF DEFECTIVE FILL

Fill placed at densities lower than the specified minimum density or at moisture contents outside the specified acceptable range of moisture content or otherwise not conforming to the requirements of the specifications shall be reworked to meet the requirements or removed and replaced by acceptable fill. The replacement fill and the foundation, abutment and fill surfaces upon which it is placed shall conform to all requirements of this specification for foundation preparation, approval, placement, moisture control and compaction.

8. TESTING

During the course of the work, the Engineer will perform such tests as are required to identify materials, to determine compaction characteristics, to determine moisture content, and to determine density of fill in place. These tests performed by the Engineer will be used to verify that the fills conform to the requirements of the specifications. Such tests are not intended to provide the Contractor with the information required by him for the proper execution of the work and their performance shall not relieve the Contractor of the necessity to perform tests for that purpose.

Densities of fill requiring Class A compaction will be determined by the Engineer in accordance with ASTM Method D 1556, 2167, 2922 or 2937 except that the volume and moist weight of included rock particles larger than those used in the compaction test method specified for the type of fill will be determined and deducted from the volume and moist weight of the total sample prior to computation of density or if using the nuclear gauge, added to the specified density to bring it to the measure of equivalent compaction for comparison. The density so computed will be used to determine the percent compaction of the fill matrix. Moisture content will be determined by one of the following methods: ASTM Method D 2216, D 3017 unless otherwise specified.

9. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the volume of each type and compaction class of earthfill

within the specified zone boundaries and pay limits will be measured and computed to the nearest cubic yard by the method of average cross-sectional end areas. Deduction in volume will be made for embedded conduits and appurtenances.

The pay limits shall be as defined below, with the further provision that earthfill required to fill voids resulting from over-excavation of the foundation, outside the specified lines and grades, will be included in the measurement for payment only where such over-excavation is directed by the Engineer to remove unsuitable material and where the unsuitable condition is not a result of the Contractor's improper construction operations as determined by the Engineer.

The pay limits shall be the specified pay limits for excavation and the specified neat lines of the fill surface.

Payment for each type and compaction class of earthfill will be made at the contract unit price for that type and compaction class of fill. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work, except furnishing, transporting, and applying water to the foundation and fill materials. Water applied to the foundation and fill materials will be measured and payment will be made as specified in Construction Specification 10.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 10 of this specification.

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10. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 7, Earthfill

- (1) This item shall consist of placing and compacting all earth fill required to construct the floodway as shown on the drawings except that designated as Bid Item 8, Structure Backfill; Bid Item 9, Drainfill and Subsidiary Item, Pipe Backfill.
- (2) Material included in the fill shall:
 - (a) Consist of suitable CL, ML, SC, or SM Material (Unified Soil Classification System) obtained from the required excavation.
 - (b) Have a plasticity index no greater than 15.
- (3) In Section 6, Compaction, Class A shall apply. The fill matrix shall be compacted to at least 95 percent of the maximum density obtained in compaction tests of the fill materials performed by Method A, ASTM D 698 (Standard Proctor Test) or Rapid Compaction Test (Test No. S-6) SCS National Engineering Handbook, Section 19.
- (4) The maximum size of rock fragments incorporated in the fill shall be six (6) inches.
- (5) The maximum thickness of a layer before compaction shall be nine (9) inches.
- (6) The moisture content of the material incorporated in the fill shall be maintained within the range of the optimum moisture content to three (3) percentage points below the optimum moisture content.
- (7) Measurement and payment will include compensation for Subsidiary Item, Removal of Water.

b. Bid Item 8, Structure Backfill

- (1) This item shall consist of placing and compacting backfill for the following structures as shown on the drawings:
 - (a) The 54" headwall at station 35+84.50
 - (b) The 36" headwall at station 92+24.00

- (c) The double 6'x7' box culvert at station 128+92
- (d) The 54" concrete pipe at Station 35+84.50
- (2) Backfill material shall:
 - (a) Consist of suitable CL, ML, SC, or SM Material (Unified Soil Classification System) obtained from the required excavation.
 - (b) Contain a minimum of 15 percent passing the #200 sieve when determined on a dry weight basis, in accordance with ASTM D 1140.
 - (c) Have a plasticity Index no greater than 15.
- (3) In Section 6, Compaction, Class A shall apply. The fill matrix shall be compacted to at least 95 percent of the maximum density obtained in Method A. ASTM D 698 (Standard Proctor Test) or the Rapid Compaction Test (Test No. S-6) SCS National Engineering Handbook, Section 19.
- (4) The maximum size of rock fragments incorporated in the fill shall be two (2) inches.
- (5) The maximum thickness of a layer before compaction shall be six (6) inches.
- (6) The moisture content of the material incorporated in the fill shall be maintained within the range of the optimum moisture content to three (3) percentage points below the optimum moisture content.
- (7) Measurement and payment will include the reduction in volume for the 54" concrete pipe and will include compensation for Subsidiary Item, Removal of Water.

c. Subsidiary Item, Pipe Backfill

- (1) This item shall consist of placing and compacting backfill required to construct the collector channel inlets and connector pipes from adjacent subdivisions.
- (2) Pipe backfill material shall be free of rock fragments larger than 2" in maximum dimension.
- (3) Backfill material shall:
 - (a) Consist of suitable CL's, ML's, SC's, SM's (Unified Soil Classification System) obtained from the required excavation.

(b) Not have a Plasticity index greater than 15.

- (4) In Section 6, Compaction, Class A shall apply. The fill matrix shall be compacted to at least 95 percent of the maximum density obtained in Method A. ASTM D 698 (Standard Proctor Test); the rapid compaction test (test No. S-6) SCS National Engineering Handbook, Section 19.
- (5) The maximum thickness of layer before compaction shall be six (6) inches.
- (6) The moisture content of the material incorporated in the fill shall be maintained within the range of the optimum moisture content to three percentage points below the optimum moisture content.
- (7) No separate payment will be made for pipe backfill. Compensation for this work will be included in Bid Item 16, Collector Channel Inlets.

d. Subsidiary Item, Waste Disposal

- (1) This item shall consist of transporting, placing or stockpiling all waste to the waste sites, as shown on the drawings.
- (2) Waste material shall consist of all surplus or unsuitable material resulting from the required excavations.
- (3) Section 6, Compaction, does not apply to this item.
- (4) Waste material shall be placed in layers not to exceed two (2) feet in depth. Full coverage of the waste area shall be obtained before the next two foot layer is placed.
- (5) The finished surface shall not vary more than one-half (0.5) foot, plus or minus, from the average grade, except that in the waste areas adjoining the right floodway berm, the finished surface shall not vary more than 0.2 foot, plus or minus, from the grades given on the drawings.
- (6) No special moisture content for waste material will be required.
- (7) No separate payment will be made for waste disposal. Compensation for this work will be included in the payment for bid Item 4, Channel Excavation, Common.

RWCD FLOODWAY, REACH-6

24. DRAINFILL

1. SCOPE

The work shall consist of furnishing, placing and compacting drainfill required in the construction of structure drainage systems.

2. MATERIALS

Drainfill materials shall conform to the requirements of Material Specification 521. At least 30 days prior to the delivery of the materials to the site, the Contractor shall inform the Contracting Officer in writing of the source from which he intends to obtain them. The Contractor shall provide the Engineer free access to the source for the purpose of obtaining samples for testing.

3. BASE PREPARATION

Foundation surfaces and trenches shall be clean and free of organic matter, loose soil, foreign substance, and standing water when the drainfill is placed. Earth surfaces upon or against which drainfill will be placed shall not be scarified.

4. PLACEMENT

Drainfill shall not be placed until the subgrade has been inspected and approved by the Engineer. Drainfill shall not be placed over or around pipe or drain tile until the installation of the pipe or tile has been inspected and approved.

Drainfill shall be placed uniformly in layers not more than 12 inches deep before compaction. When compaction is accomplished by manually controlled equipment, the layers shall be not more than 8 inches deep. The material shall be placed in a manner to avoid segregation of particle sizes and to insure the continuity and integrity of all zones. No foreign materials shall be allowed to become intermixed with or otherwise contaminate the drainfill.

Traffic shall not be allowed to cross over drains at random. Equipment crossovers shall be maintained, and the number and location of such crossovers shall be established and approved prior to the beginning of drainfill placement. Each crossover shall be cleaned of all contaminating materials and shall be inspected and approved by the Engineer before additional drainfill is placed.

Any damage to the foundation surface or the sides or bottoms of trenches occurring during placement of drainfill shall be repaired before drainfill placement is continued.

The upper surface of drainfill constructed concurrently with adjacent zones of earthfill shall be maintained at an elevation at least one foot above the upper surface of the adjacent fill.

Drainfill over or around pipe or drain tile shall be placed in a manner to avoid any displacement in line of grade of the pipe or tile.

Drainfill shall not be placed adjacent to structures until the concrete has attained the strength specified in Section 9 of this specification. The strength shall be determined by compression testing of test cylinders cast by the Engineer for this purpose and cured at the work site in the manner specified in ASTM-C-31 for determining when a structure may be put in service.

When the required strength of the concrete is not specified as described above, placement of drainfill adjacent to structures shall not be started until the following item intervals have elapsed after placement of the concrete.

<u>Structure</u>	<u>Time Interval</u>
Retaining walls and counterforts (impact basins)	14 days
Walls backfilled on both sides simultaneously	7 days
Conduits and galleries, cast- in-place (with inside forms in place)	7 days
Conduits and galleries, cast- in-place (inside forms removed)	14 days
Conduits, precast, cradled	2 days
Conduits, precast, bedded	1 day
Antiseep collars and cantilever outlet bents (backfilled on both sides simultaneously)	3 days

5. CONTROL OF MOISTURE

The moisture content of drainfill materials shall be controlled as specified in Section 9. When the addition of water is required, it shall be applied in such a way as to avoid excessive wetting to adjacent earth fill. Except as specified in Section 9, control of moisture content will not be required.

6. COMPACTION

Drainfill shall be compacted according to the following requirements for the class of compaction specified:

Class A compaction. Each layer of drainfill shall be compacted to a relative density of not less than 70 percent as determined by ASTM Method D-2049.

Class I compaction. Each layer of drainfill shall be compacted by at least 2 passes, over the entire surface, of a steel-drum vibrating roller weighing not less than 5 tons and exerting a vertical vibrating force of not less than 20,000 pounds at least 1200 times per minute, or by an approved equivalent method.

Class II compaction. Each layer of drainfill shall be compacted by one of the following methods or by an approved equivalent method:

- a. At least 2 passes, over the entire surface, of a pneumatic-tired roller exerting a pressure of not less than 75 pounds per square inch. A pass is defined as at least one complete coverage of the roller wheel, tire or drum over the entire surface of the layer.
- b. At least 4 passes, over the entire surface, of the track of a crawler-type tractor weighing not less than 20 tons.
- c. Controlled movement of the hauling equipment so that the entire surface is traversed by not less than one tread track of the loaded equipment.

Class III compaction. No compaction will be required beyond that resulting from the placing and spreading operations.

When compaction other than Class III compaction is specified materials placed in trenches or other locations inaccessible to heavy equipment shall be compacted by means of manually controlled pneumatic or vibrating tampers or by approved equivalent methods.

Heavy equipment shall not be operated within 2 feet of any structure. Vibrating rollers shall not be operated within 5 feet of any structure. Compaction by means of drop weights operating from cranes or hoists will not be permitted.

7. TESTING

The Engineer will perform such tests as are required to verify that the drainfill materials and the drainfill in place meet the requirements of the specifications. These tests are not intended to provide the Contractor with information he needs to assure that the materials and

workmanship meet the requirements of the specifications, and their performance will not relieve the Contractor of the responsibility of performing his own tests for that purpose.

8. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the volume of drainfill within the neat lines shown on the drawings or limits established by the Engineer will be measured and computed to the nearest cubic yard. Where the Engineer directs placement of drainfill outside the neat lines to replace unsuitable foundation material, the volume of such drainfill will be included, but only to the extent that the unsuitable condition is not a result of the Contractor's operations.

Payment for drainfill will be made at the contract unit price for each type of drainfill, complete in place. Except as otherwise specified in Section 9, such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 9 of this specification.

9. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 9, Drainfill

- (1) This item shall consist of furnishing and placing the drain fill under the R/C channel lining and under the side inlet structures for the drain pipes as shown on the drawings.
- (2) The drainfill material shall have a $d_{85} \geq 3/8$ inch.
- (3) The moisture content shall be maintained in a range that will minimize segregation.
- (4) In Section 6, Compaction, Class III compaction shall apply.
- (5) Measurement and payment shall be according to Section 8 and will include Subsidiary Item, Removal of Water.

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31. CONCRETE

1. SCOPE

The work shall consist of furnishing, forming, placing, finishing and curing portland cement concrete as required to build the structures designated in Section 26 of this specification.

2. MATERIALS

Portland cement shall conform to the requirements of Material Specification 531 for the specified type. One brand only of any type of cement shall be used in any single structure as defined in Section 26.

Aggregates shall conform to the requirements of Material Specification 522 unless otherwise specified. The grading of coarse aggregates shall be as specified in Section 26.

Water used in mixing or curing concrete shall be clean and free from injurious amounts of oil, salt, acid, alkali, organic matter or other deleterious substances.

Air-entraining admixtures shall conform to the requirements of Material Specification 532. If air-entraining cement is used, any additional air-entraining admixture shall be of the same type as that in the cement.

Pozzolan shall conform to ASTM C 618, Class F except the loss of ignition shall not exceed 3.0 percent.

Water-reducing, set-retarding admixture shall conform to the requirements of Material Specification 533.

Shear plates shall conform to the requirements of Material Specification 581 for structural quality or commercial or merchant quality steel. Structural quality shall be used if specifically designated in the drawings or specifications.

Preformed expansion joint filler shall conform to the requirements of Material Specification 535.

Waterstops shall conform to the requirements of Material Specifications 537 and 538 for the specified kinds.

Curing compound shall conform to the requirements of Material Specification 534.

3. CLASSES OF CONCRETE

Concrete shall be classified as follows:

<u>Class of Concrete</u>	<u>Water Content (gallons/bag)</u>	<u>Cement Content (bag/cu. yd.)</u>
5000X	5	7
4000X	6	6
3000X	7	5
2500X	8	4-1/2

4. AIR CONTENT AND CONSISTENCY

The air content (by volume) of the concrete at the time of placement shall be:

<u>Maximum Size Aggregate</u>	<u>Air Content (%)</u>
3/8 inch to 1/2 inch	6 to 9
Over 1/2 inch to 1 inch	5 to 8
Over 1 inch to 2-1/2 inches	4 to 7

The consistency of the concrete shall be such as to allow it to be worked into place without segregation or excessive laitance. Unless otherwise specified, the slump shall be:

<u>Type of Structure</u>	<u>Slump (inches)</u>
Massive sections, pavements, footings	2 + 1/2
Heavy beams, thick slabs, thick walls (over 12 in.)	3 + 1/2
Columns, light beams, thin slabs, thin walls (12 in. or less)	4 + 1

5. DESIGN OF THE CONCRETE MIX

At least 35 days prior to any placement of concrete, the Contractor shall inform the Contracting Officer in writing of the source and grading of aggregates and the brand and type of cement and the brand and type of admixture, if any, he proposes to use for each class of concrete, and shall furnish certifications or other evidence satisfactory to the Engineer that the proposed materials meet the requirements of the specifications.

When acceptable sources, types and gradings of aggregates are designated in the contract, certification for such aggregates will not be required.

Job mix proportions and batch weights will be determined by the Engineer. During the course of the work, the Engineer will adjust the job mix proportions and batch weights whenever necessary.

After the job mix has been designated, neither the source, character or grading of the aggregates nor the type or brand of cement or admixture shall be changed without prior notice to the Engineer.

If such changes are necessary, no concrete containing such new or altered materials shall be placed until the Engineer has designated a revised job mix.

When specified, a water-reducing, set-retarding admixture shall be used. When conditions are such that the temperature of the concrete at the time of placement is consistently above 75° F, a water-reducing, set retarding admixture may be used, at the option of the Contractor. The cement content shall be the same as that required in the mix without the admixture.

The use of calcium chloride or other accelerators or antifreeze compounds will not be allowed.

When it is anticipated that a water-reducing, set retarding admixture will be used, the Contractor shall furnish to the Engineer a sample of the admixture he proposes to use sufficient for the tests required by Material Specification 533, Section 4. Concrete containing the admixture shall not be placed until test results have been obtained showing that its performance in the job mix meets requirements of Material Specification 533, Section 4.

6. INSPECTING AND TESTING

The following tests will be performed by the methods indicated:

<u>Test</u>	<u>Method</u> <u>(ASTM Designation)</u>
Sampling	C 172 ¹
Slump Test	C 143 ¹
Air Content	C 231 ¹ or C 173 ¹
Compression Test Specimens	C 31 ¹ or C 42
Compressive Strength	C 39 ² , C 42 or C 684 ²
Unit Weight	C 138

¹ Test of a portion of a batch may be made on samples representative of that portion for any of the following purposes:

- (1) Determining uniformity of the batch.

- (2) Checking compliance with requirements for slump and air content when the batch is discharged over an extended period of time.
- (3) Checking compliance of the concrete with the specifications when the whole amount being placed in a small structure, or a distinct portion of a larger structure, is less than a full batch.

For each strength test of specimens made according to ASTM Designation C 39, 3 standard test specimens shall be made. The test result shall be the average of the strength of the 3 specimens, except that if one specimen in the test shows manifest evidence of improper sampling, molding or testing, it shall be discarded and the strengths of the remaining 2 specimens shall be averaged. Should more than one specimen representing a test show such defects, the entire test shall be discarded.

The Engineer shall have free entry to the plant and equipment furnishing concrete under the contract. Proper facilities shall be provided for the Engineer to inspect materials, equipment and processes, to obtain samples of the concrete. All tests and inspections will be conducted so as not to interfere unnecessarily with the manufacture and delivery of the concrete.

7. HANDLING AND MEASUREMENT OF MATERIALS

Aggregates shall be stored or stockpiled in such a manner that separation of coarse and fine particles of each size will be avoided and that various sizes will not become intermixed before proportioning. Methods of handling and transporting aggregates shall be such as to avoid contamination, excessive breakage, segregation or degradation, or intermingling of various sizes.

Scales for weighing aggregates and cement shall be beam type or springless dial type. They shall be accurate within one percent under operating conditions. All exposed fulcrums, clevises and similar working parts of scales shall be kept clean.

The quantities of cement and aggregates in each batch of concrete, as indicated by the scales, shall be within the following percentage of the required batch weights:

Cement	plus or minus 1.0 percent
Aggregates	plus or minus 2.0 percent

Measuring tanks for mixing water shall be of adequate capacity to furnish the maximum amount of mixing water required per batch and shall be equipped with outside taps and valves to provide for checking their calibration unless other means are provided for readily and accurately determining the amount of water in the tank.

Except as otherwise provided in Section 8, cement and aggregates shall be measured as follows:

Cement shall be measured by weight or in bags of 94 lbs. each. When cement is measured by weight, it shall be weighed on a scale separate from that used for other materials, and in a hopper entirely free and independent of the hopper used for weighing the aggregates. When cement is measured in bags, no fraction of a bag shall be used unless weighed.

Aggregates shall be measured by weight. Mix proportions shall be based on saturated, surface-dry weights. The batch weight of each aggregate shall be the required saturated, surface-dry weight corrected by the weight of surface moisture it contains.

Mixing water shall consist of water added to the batch, ice added to the batch, water occurring as surface moisture on the aggregates and water introduced in the form of admixtures. The added water shall be measured by weight or volume to an accuracy of one percent of the required total mixing water. Added ice shall be measured by weight. Wash water shall not be used as a portion of the mixing water for succeeding batches.

Dry admixtures shall be measured by weight, and paste or liquid admixtures by weight or volume, within a limit of accuracy of three percent.

8. MIXERS AND MIXING

Mixers and mixing shall be in accordance with recommended standards set forth in ACI 304, some specific interpretations of which are stated below.

Concrete may be furnished by batch mixing at the site of the work or by ready-mix methods.

Mixers shall be capable of thoroughly mixing the concrete ingredients into a uniform mass within the specified mixing time and of discharging the mix without segregation. Each mixer or agitator shall bear a manufacturer's rating plate indicating the rated capacity and recommended speeds of rotation, and shall be operated in accordance with these recommendations.

Concrete shall be uniform and thoroughly mixed when delivered to the forms. Variations in slump of more than one inch within a batch will be considered evidence of inadequate mixing and shall be corrected by changing batching procedures, increasing mixing time, changing mixers or other means. Mixing time shall be within the limits specified below unless the Contractor demonstrates by mixer performance tests that adequate uniformity is obtained by different times of mixing.

No mixing water in excess of the amount called for by the job mix shall be added to the concrete during mixing or hauling or after arrival at the delivery point. If less water than the design maximum water-cement ratio has been incorporated in the batch, water to compensate for up to one inch loss in slump may be added, up to the design maximum water cement ratio. Withholding some of the mixing water until the concrete arrives on the job, then adding the remaining water and turning the mixer 30 revolutions at mixing speed may overcome transporting conditions. When loss of slump or workability cannot be offset by these measures, complete mixing shall be performed on the job using centrally dry batched materials, or by on site batching and mixing.

Batch mixing at the site. For concrete mixed at the site of the work with paving mixers or stationary construction mixers, the time of mixing after all cement and aggregates are in the mixer drum shall be not less than 1-1/2 minutes. The batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates and all mixing water shall be introduced into the drum before one-fourth of the mixing time has elapsed.

Control shall be provided to insure that the batch cannot be discharged until the required time has elapsed.

If truck mixers are used, the requirements below for truck mixers and truck-mixed concrete shall apply.

Volumetric batching and continuous mixing at the site. Unless otherwise specified, volumetric batching and continuous mixing at the construction site will be permitted if approved by the Contracting Officer. The batching and mixing equipment shall conform to the requirements of ASTM Specification C 685 and shall be demonstrated prior to placement of concrete, by tests with the job mix, to produce concrete meeting the specified proportioning and uniformity requirements. Concrete made by this method shall be produced, inspected, and certified in conformance with Sections 6, 7, 8, 13, and 14 of ASTM Specification C 685.

Ready-mixed concrete. Ready-mixed concrete shall be mixed and delivered to the site of the work by one of the following methods:

- a. Truck-mixed concrete--Mixed completely in a truck mixer.
- b. Shrunked-mixed concrete--Mixed partially in a stationary mixer, and the mixing completed in a truck mixer.
- c. Central-mixed concrete--Completely in a stationary mixer and the mixed concrete transported to the point of delivery in a truck agitator or in a truck mixer operating at agitating speed or in nonagitating equipment.

Truck mixers and agitators shall be equipped with revolution counters by which the number of revolutions of the drum or blades may be readily verified.

When ready-mixed concrete is furnished, the Contractor shall furnish the Engineer a statement-of-delivery ticket showing the time of loading, the revolution counter reading at the time of loading and the quantities of materials used for each load of concrete.

Truck-mixed concrete. When concrete is mixed in a truck mixer loaded to its maximum capacity, the number of revolutions of the drum or blades at mixing speed shall be not less than 70 nor more than 100. If the batch is at least 1/2 cubic yard less than maximum capacity, the number of revolutions at mixing speed may be reduced to not less than 50. Mixing in excess of 100 revolutions shall be at the speed designated by the manufacturer of the equipment as agitating speed. The mixing operation shall begin within 30 minutes after the cement has been added to the aggregates and the water shall be added during mixing. When mixing is begun during or immediately after charging, a portion of the mixing water shall be added ahead of, or with, the other ingredients.

Shrink-mixed concrete. When concrete is partially mixed at a central plant and the mixing is completed in a truck mixer, the mixing time in the central plant mixer shall be the minimum required to intermingle the ingredients and shall be not less than 30 seconds. The mixing shall be completed in a truck mixer and the number of revolutions of the drum or blades at mixing speed shall be not less than 50 nor more than 100. Mixing in excess of 100 revolutions shall be at the speed designated by the manufacturer of the equipment as agitating speed.

Central-mixed concrete. For central-mixed concrete, mixing in the stationary mixer shall meet the same requirements as batch mixing at the site.

When an agitator, or truck mixer used as an agitator, transports concrete that has been completely mixed in a stationary mixer, mixing during transportation shall be at the speed designated by the manufacturer of the equipment as agitating speed.

The use of nonagitating equipment to transport concrete to the site of the work will be permitted only if the consistency and uniformity of the concrete as discharged at the point of delivery meet the requirements of this specification. Bodies of nonagitating hauling equipment shall be so constructed that leakage of the concrete mix, or any part thereof will not occur. Concrete hauled in open-top vehicles shall be protected from rain, and from more than 20 minutes exposure to the sun when the air temperature is above 75°F.

9. FORMS

Forms shall be of wood, plywood, steel or other approved material and shall be mortar tight. The forms and associated falsework shall be substantial and unyielding and shall be constructed so that the finished concrete will conform to the specified dimensions and contours. Form surfaces shall be smooth and free from holes, dents, sags or other irregularities. Forms shall be coated with a nonstaining form release agent before being set into place.

Metal ties or anchorages within the forms shall be equipped with cones, she-bolts or other devices that permit their removal to a depth of at least one inch without injury to the concrete. Ties designed to break off below the surface of the concrete shall not be used without cones. All edges that will be exposed shall be chamfered, unless finished with molding tools as specified in Section 20.

10. PREPARATION OF FORMS AND SUBGRADE

Prior to placement of concrete, the forms and subgrade shall be free of chips, sawdust, debris, water, ice, snow, extraneous oil, mortar, or other harmful substances or coatings. Any oil on the reinforcing steel or other surfaces required to be bonded to the concrete shall be removed.

Rock surfaces shall be cleaned by air-water cutting, wet sandblasting or wire brush scrubbing, as necessary, and shall be wetted immediately prior to placement of concrete. Earth surfaces shall be firm and damp. Placement of concrete on mud, dried earth, uncompacted fill or frozen subgrade will not be permitted. All ice, snow and frost shall be removed and the temperature of all surfaces to be in contact with the new concrete shall be no colder than 40°F.

Items to be embedded in the concrete shall be positioned accurately and anchored firmly.

Weepholes in walls or slabs shall be formed with nonferrous materials.

11. CONVEYING

Concrete shall be delivered to the site and discharged into the forms within 1-1/2 hours after the introduction of the cement to the aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85°F or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes.

The Engineer may allow a longer time, provided the setting time of the concrete is increased a corresponding amount by the addition of an approved set-retarding admixture. In any case, concrete shall be

conveyed from the mixer to the forms as rapidly as practicable, by methods that will prevent segregation of the aggregates or loss of mortar.

12. PLACING

Concrete shall not be placed until the subgrade, forms and steel reinforcement have been inspected and approved.

The Contractor shall have all equipment and materials required for curing available at the site ready for use before placement of concrete begins. No concrete shall be placed except in the presence of the Engineer. The Contractor shall give reasonable notice to the Engineer each time he intends to place concrete. Such notice shall be far enough in advance to give the Engineer adequate time to inspect the subgrade, forms, steel reinforcement and other preparations for compliance with specifications.

Other preparations include but are not limited to the concrete batching plant, mixing and delivery equipment and system, placing and finishing equipment and system, schedule of work, work force and heating or cooling facilities as applicable. All deficiencies are to be corrected before concrete is delivered for placing.

The concrete shall be deposited as closely as possible to its final position in the forms and shall be worked into the corners and angles of the forms and around all reinforcement and embedded items in a manner to prevent segregation of aggregates or excessive laitance. The depositing of concrete shall be regulated so that the concrete can be consolidated with a minimum of lateral movement.

Concrete shall not be dropped more than 5 feet vertically unless suitable equipment is used to prevent segregation.

13. LAYERS

Unless otherwise specified, slab concrete shall be placed to design thickness in one continuous layer. Formed concrete shall be placed in horizontal layers not more than 20 inches thick. Hoppers and chutes, pipes or "elephant trunks" shall be used as necessary to prevent splashing of mortar on the forms and reinforcing steel above the layer being placed.

Successive layers shall be placed at a fast enough rate to prevent the formation of "cold joints". If the surface of a layer of concrete in place sets to the degree that it will not flow and merge with the succeeding layer when vibrated, the Contractor shall discontinue placing concrete and shall make a construction joint according to the procedure specified in Section 15.

If placing is discontinued when an incomplete layer is in place, the unfinished end of the layer shall be formed by a vertical bulkhead.

14. CONSOLIDATING

Unless otherwise specified, concrete shall be consolidated with internal type mechanical vibrators capable of transmitting vibration to the concrete at frequencies not less than 6000 impulses per minute.

The location, manner and duration of the application of the vibrators shall be such as to secure maximum consolidation of the concrete without causing segregation of the mortar and coarse aggregate, and without causing water or cement paste to flush to the surface.

The Contractor shall provide a sufficient number of vibrators to properly consolidate the concrete immediately after it is placed in the work. Vibration shall be applied to the freshly deposited concrete by slowly inserting and removing the vibrator at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective. The vibrator shall extend into the previously placed layer of fresh concrete, at all points, to insure effective bond between layers.

Vibration shall not be applied directly to the reinforcement steel or the forms nor to concrete that has hardened to the degree that it does not become plastic when vibrated.

The use of vibrators to transport concrete in the forms or conveying equipment will not be permitted.

Vibration shall be supplemented by spading and hand tamping as necessary to insure smooth and dense concrete along form surfaces, in corners and around embedded items.

15. CONSTRUCTION JOINTS

Construction joints shall be made at the locations shown on the drawings. If construction joints are needed which are not shown on the drawings, they shall be placed in locations approved by the Engineer.

Where a feather edge would be produced at a construction joint, as in the top surface of a sloping wall, an insert form shall be used so that the resulting edge thickness on either side of the joint is not less than 6 inches.

In walls and columns as each lift is completed, the top surfaces shall be immediately and carefully protected from any condition that might adversely affect the hardening of the concrete.

Steel tying and form construction adjacent to concrete in place shall not be started until the concrete has cured at least 12 hours. Before new concrete is deposited on or against concrete that has hardened, the forms shall be retightened. New concrete shall not be placed until the hardened concrete has cured at least 12 hours.

Surfaces of construction joints shall be cleaned of all unsatisfactory concrete, laitance, coatings, stains or debris by either wet sandblasting after the concrete has gained sufficient strength to resist excessive cutting, or air-water cutting as soon as the concrete has hardened sufficiently to prevent the jet from displacing the coarse aggregates, or both. The surface of the concrete in place shall be cut to expose clean, sound aggregate but not so deep as to undercut the edges of larger particles of the aggregate. After cutting, the surface shall be thoroughly washed to remove all loose material. If the surface is congested by reinforcing steel, is relatively inaccessible, or it is considered undesirable to disturb the concrete before it is hardened, cleaning of the joint by air-water jets will not be permitted and the wet sandblasting method will be required after the concrete has hardened. The surfaces shall be kept moist for at least one hour prior to placement of new concrete. The new concrete shall be placed directly on the cleaned and washed surface.

16. EXPANSION AND CONTRACTION JOINTS

Expansion and contraction joints shall be made only at locations shown on the drawings.

Exposed concrete edges at expansion and contraction joints shall be carefully tooled or chamfered, and the joints shall be free of mortar and concrete. Joint filler shall be left exposed for its full length with clean and true edges.

When open joints or weakened plane "dummy" joints are specified, the joints shall be constructed by the insertion and subsequent removal of a wood strip, metal plate or other suitable template in such a manner that the corners of the concrete will not be chipped or broken. The edges of the concrete at the joints shall be finished with an edging tool prior to removal of the joint strips.

Preformed expansion joint filler shall be held firmly in the correct position as the concrete is placed.

17. WATERSTOPS

Waterstops shall be held firmly in the correct position as the concrete is placed. Joints in metal waterstops shall be brazed or welded. Joints in rubber or plastic waterstops shall be cemented, welded or vulcanized as recommended by the manufacturer.

18. REMOVAL OF FORMS

Forms shall be removed only when the Engineer is present and shall not be removed without his approval. Forms shall be removed in such a way as to prevent damage to the concrete. Supports shall be removed in a manner that will permit the concrete to take the stresses due to its own weight uniformly and gradually.

Forms shall not be removed sooner than the following minimum times after the concrete is placed. These periods represent the cumulative number of days and fractions of days, not necessarily consecutive, during which the temperature of the air adjacent to the concrete is above 50°F.

<u>Element</u>	<u>Time</u>
Beams, arches - supporting forms and shoring	14 days
Conduits, deck slabs - supporting (inside) forms and shoring	7 days
Columns, walls, spillway riser - with side or vertical load	7 days
Conduits (outside forms), sides of beams, small structures	24 hours
Concrete supporting more than 30 feet of wall in place above it	7 days
Concrete supporting 20 to 30 feet of wall in place above it ¹	3 days
Concrete supporting not more than 20 feet of wall in place above it ¹	24 hours

¹ Age of stripped concrete shall be at least 7 days before any load is applied other than the weight of the column or wall, forms and scaffolds for succeeding lifts.

19. FINISHING FORMED SURFACES

All concrete surfaces shall be true and even, and shall be free from open or rough spaces, depressions or projections.

Immediately after the removal of forms:

All bulges, fins, form marks or other irregularities which in the judgment of the Engineer will adversely affect the appearance or function of the structure shall be removed. All form bolts and ties shall

be removed to a depth at least one inch below the surface of the concrete. The cavities produced by form ties and all other holes of similar size and depth shall be thoroughly cleaned and, after the interior surfaces have been kept continuously wet for at least three hours, shall be carefully packed with a dry patching mortar mixed not richer than one part cement to three parts sand. Patching mortar shall be mixed in advance and allowed to stand without addition of water until it has reached the stiffest consistency that will permit placing. Manipulation of the mortar with a trowel during this period shall be performed as required to insure the proper consistency.

Holes left by form bolts or straps which pass through the wall shall be filled solid with mortar.

Patching mortar shall be thoroughly compacted into place to form a dense, well-bonded unit, and the in-place mortar shall be sound and free from shrinkage cracks.

All repaired areas shall be cured as specified in Section 21.

20. FINISHING UNFORMED SURFACES

All exposed surfaces of the concrete shall be accurately screeded to grade and then float finished, unless specified otherwise.

After placing and consolidating the concrete, all exposed surfaces shall be accurately struck off to grade. Following strike-off, the surfaces shall be immediately smoothed by darbying or bull floating before any free water has bled to the surface. The concrete will then be allowed to rest until the bleed water and water sheen has left the surface and the concrete has stiffened to where it will sustain foot pressure with only about 1/4 inch (6mm) indentation. At this time all joints and edges that will be exposed to view that are not chamfered shall be finished with edging and/or molding tools. After edging and hand-jointing is complete, all exposed surfaces shall be floated with wood or magnesium floats. The floating should work the concrete no more than necessary to remove screed, edger and jointer marks and produce a compact surface, uniform in texture.

Joints and edges on unformed surfaces shall be chamfered or finished with molding tools.

21. CURING

Concrete shall be cured in accordance with the recommended practice of ACI 308, of which some specific interpretations are set forth below.

Concrete shall be prevented from drying for a period of at least seven days after it is placed. Exposed surfaces and concrete formed in absorptive wood forms shall be kept continually wet during the entire

curing period or until the forms have been removed. After forms have been removed, the exposed surface shall be kept continuously wet until patching and repair are complete and until the curing period is completed or until a curing compound is applied.

Moisture can be maintained by sprinkling, flooding or fog spraying or by covering with continuously moistened canvas, cloth mats, straw, sand and/or an approved material. Water and/or covering shall be applied in such a way that the concrete surface is not eroded or otherwise damaged.

Curing compound may be used for exposed surfaces or formed surfaces after patching and repair have been completed. Unless otherwise specified, the curing compound shall be white pigmented and conform to ASTM C 309 Type 2, Class A or B. If surface coatings are to be applied to concrete where curing compound is used, Type 2, Class B shall be used and allowed to age a minimum of 30 days prior to the application of the coating. Clear curing compound (Type 1) or clear with fugitive dye (Type 10) may only be used when specified in Section 26.

Curing compound shall be thoroughly mixed before applying and agitated during application. It shall be applied at a uniform rate of not less than one gallon per 150 square feet of surface. It shall form a uniform continuous, adherent film that shall not check, crack or peel and shall be free from pinholes or other imperfections.

All surfaces covered with curing compound shall be continuously protected from damage to the protective film during the required curing period.

Surfaces subjected to heavy rainfall or running water within three hours after the compound has been applied, or surfaces damaged by subsequent construction operations during the curing period, shall be resprayed in the same manner as for the original application.

Unless otherwise specified in Section 26, curing compound shall not be applied to construction joints or other areas that are to receive additional concrete, paint or other material that require a positive bond.

Water for curing shall be clean and free from any substances that will cause discoloration of the concrete.

22. REMOVAL OR REPAIR

When concrete is honeycombed, damaged or otherwise defective, the Contractor shall remove and replace the structure or structural member containing the defective concrete, or correct or repair the defective parts. The Engineer will determine the required extent of removal, replacement or repair.

Prior to starting repair work the Contractor shall obtain the Engineer's approval of his plan for making the repair. Such approval shall not be considered a waiver of the Contracting Officer's right to require complete removal of defective work if the completed repair does not produce concrete of the required quality and appearance.

Repair work shall be performed only when the Engineer is present.

Repair of formed surfaces shall be started within 24 hours after removal of the forms.

Except as otherwise approved by the Engineer, the appropriate methods described in Chapter VII of the Concrete Manual, Bureau of Reclamation, U.S. Department of the Interior, shall be used. If approved in writing by the Contracting Officer, proprietary compounds for adhesion or as patching ingredients may be used. Such compounds shall be used in accordance with the manufacturer's recommendations.

Curing as specified in Section 21 shall be applied to repaired areas immediately after the repairs are completed.

23. CONCRETING IN COLD WEATHER

Concreting in cold weather shall be performed in accordance with ACI 306 Recommended Practice for Cold Weather Concreting, of which some specific interpretations are set forth below.

When the atmospheric temperature may be expected to drop below 40°F at the time concrete is delivered to the work site, during placement, or at any time during the curing period, the following provisions also shall apply:

- a. The temperature of the concrete at time of placing shall not be less than 50°F nor more than 90°F. The temperature of neither aggregates nor mixing water shall be more than 140°F just prior to mixing with the cement.
- b. When the daily minimum temperature is less than 40°F, concrete structures shall be insulated or housed and heated after placement. The temperature of the concrete and air adjacent to the concrete shall be maintained at not less than 50°F nor more than 90°F for the duration of the curing period.
- c. Methods of insulating, housing and heating the structure shall conform to "Recommended Practice for Cold Weather Concreting" ACI Standard 306.
- d. When dry heat is used to protect concrete, means of maintaining an ambient humidity of at least 40 percent shall be provided unless

the concrete has been coated with curing compound as specified in Section 21 or is covered tightly with an approved impervious material.

24. CONCRETING IN HOT WEATHER

Concreting in hot weather shall be in accordance with the recommended practice of ACI 305, of which some specific interpretations are set forth below.

For the purpose of the specification, hot weather is defined as any combination of high temperature, low relative humidity and wind velocity tending to impair the quality of fresh or hardened concrete or otherwise resulting in abnormal properties.

When climatic or other conditions are such that the temperature of the concrete may reasonably be expected to exceed 90°F at the time of delivery at the work site, during placement, or during the first 24 hours after placement, the following provisions shall apply;

- a. The Contractor shall maintain the temperature of the concrete below 90°F during mixing, conveying, and placing.
- b. The concrete shall be placed in the work immediately after mixing. Truck mixing shall be delayed until only time enough remains to accomplish it before the concrete is placed.
- c. Exposed concrete surfaces which tend to dry or set too rapidly shall be continuously moistened by means of fog sprays or other means acceptable to the Engineer to maintain adequate moisture during the time between placement and finishing, and after finishing.
- d. Finishing of slabs and other exposed surfaces shall be started as soon as the condition of the concrete allows and shall be completed without delay. The subgrade shall be prewetted or sealed with a vapor barrier and either wet cure or a white pigmented curing compound ASTM C 309 Type 2 applied promptly to the fresh concrete.
- e. Formed surfaces shall be kept completely and continuously wet for the duration of curing period (prior to, during and after form removal) or until curing compound is applied as specified in subsection g, below.
- f. Concrete surfaces, especially flat work placed with large areas of surface, shall be covered as soon as the concrete has sufficiently hardened and shall be kept continuously wet for at least 72 hours of the curing period. This protective method may be continued for the required curing period or until curing compound as specified in (g) below is applied:

- g. Moist curing may be discontinued before the end of the curing period if white pigmented curing compound is applied immediately, following the procedures specified in Section 21.
- h. In extreme conditions it may be necessary to (1) restrict placement to late afternoon or evening (2) restrict the depth of layers to assure coverage of the previous layer while it will still respond readily to vibration, (3) suspend placement until conditions improve, and (4) remove forms, repair, patch and reapply wet curing by small areas at a time.

25. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, concrete will be measured to the neat lines or pay limits shown on the drawings, and the volume of concrete will be computed to the nearest 0.1 cubic yard. No deduction in volume will be made for chamfers, rounded or beveled edges, or for any void or embedded item that is less than five cubic feet in volume. Where concrete is placed against the sides or bottom of an excavation without intervening forms, drainfill, or bedding, the volume of concrete required to fill voids resulting from over excavation outside the neat lines or pay limits will be included in the measurement for payment where such over excavation is directed by the Engineer to remove unsuitable foundation material; but only to the extent that the unsuitable condition is not a result of the Contractor's improper construction operations, as determined by the Engineer.

Payment for each item of concrete will be made at the contract unit price for that item. The payment for concrete will constitute full compensation for all labor, materials, equipment, transportation, tools, forms, falsework, bracing and all other items necessary and incidental to completion of the concrete work, such as joint fillers, waterstops, dowels or dowel assemblies and shear plates, but not including furnishing and placing reinforcing steel or furnishing and handling cement or other items listed for payment elsewhere in the contract.

Measurement and payment for furnishing and placing reinforcing steel will be made as specified in Construction Specification 34.

Cement will be measured by dividing the volume of concrete accepted for payment by the yield of the applicable job mix. The yield will be determined by the procedure specified in ASTM Designation C 138. If the amount of cement actually used per batch exceeds the amount in the job mix specified by the Engineer, the measurement will be based on the latter. One barrel of cement will be considered equal to 4 bags or 376 pounds. Payment for each type of cement will be made at the contract unit price for furnishing and handling that type of cement and such

payment will constitute full compensation for all materials, labor, equipment, storage, transportation and all other items necessary and incidental to furnishing and handling the cement.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 26 of this specification.

26. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 10, Concrete Channel Lining

- (1) This item shall consist of furnishing, forming, and placing all concrete required to construct the reinforced concrete channel lining between approximate Station 155+50.00 and station 156+51.34 and the channel lining for the side channel for the double 6'x7' box culvert at Station 128+92.
- (2) In Section 2, Materials, the materials shall be as follows:
 - (a) Portland Cement shall be Type II, IIA, or IP(MS)
 - (b) Preformed expansion joint filler shall conform to Material Specification 535 and ASTM D 1752, Type 1.
 - (c) Joint sealing compound shall be Type II, Class A conforming to Material Specification 536 and Federal Specification TT-S-227.
 - (d) Curing compound shall be clear and meet the requirements of ASTM C-309 Type 1D, Class B.
- (3) In Section 3, Classes of Concrete, the concrete shall be Class 4000X.
- (4) Coarse aggregate shall be size No. 57 in accordance with ASTM C 33.
- (5) Waterstops shall be Class II, Type B, D, or E size designation 20 with a center bulb diameter of not less than one inch. All splices except straight butt splices shall be factory made. Straight butt splices shall be made according to the manufacturer's recommendations.
- (6) Pozzolan shall be used as a partial substitute for portland cement not to exceed a maximum substitution of 20 percent based on absolute volume.
- (7) Concrete shall be integrally colored with Harvest Goldenrod additive, pigment #5084, as produced by Davis Colors or similar quality products by Colorful Admixtures of L.M. Scofield. The application rate shall be 2 pounds per sack of cement.

- (8) Measurement and payment shall include compensation for Subsidiary Item, Removal of Water.

b. Bid Item 11, Concrete Structures

- (1) This item shall consist of finishing, forming, and placing all concrete required to construct:
- (a) The 36" headwall and apron at station 92+24
 - (b) The 54" headwall and apron at station 35+84.50
 - (c) The double 6'x7' box culvert with headwalls and downstream apron at station 128+63.00
 - (d) The outlet protection for the 54" pipe at Station 35+84.50
- (2) In Section 2, Materials, the materials shall be as follows:
- (a) Portland cement shall be Type II, IIA, or IP(MS).
 - (b) Preformed expansion joint filler shall conform to Material Specification 535 and ASMD 1752, Type 1.
 - (c) Joint sealing compound shall be Type II, Class A conforming to Material Specification 536 and Federal Specification TT-S-227.
 - (d) Curing compound shall be clear and meet the requirements of Specification 534 and ASTM C-309, Type 1D, Class B.
- (3) In Section 3, Classes of Concrete; the concrete shall be Class 4000X.
- (4) Coarse aggregate shall be size No. 57 in accordance with ASTM C 33.
- (5) Water stops shall be Class II, Type B, D, or E size designation 20 with a center bulb diameter of not less than one inch. All splices except straight butt splices shall be factory made. Straight butt splices shall be made according to the manufacturer's recommendation.
- (6) In Section 19, all patched or formed surfaces that will be exposed shall have a rubbed finish.

Rubbed finishes require the surface to be rubbed with a medium coarse carborundum stone, using water for lubrication and cleaning. The rubbing shall be started as soon as possible

after the forms are removed, patching is finished, and the patching mortar has set thoroughly.

Rubbing shall be continued until all form marks, projections and irregularities have been removed and a uniform surface has been obtained. After rubbing is completed the surface shall be washed to remove loose powder and shall be left free from unsound patches, paste, power, and objectionable marks.

- (7) Pozzolan shall be used as a partial substitute for portland cement not to exceed a maximum substitution of 20 percent based on absolute volume.
- (8) Concrete shall be integrally colored with Harvest Goldenrod additive, pigment #5084, as produced by David Colors or similar quality products by Colorful Admixtures of C. M. Scofield. The application rate shall be 2 pounds per sack of cement.
- (9) Measurement and payment shall include compensation for Subsidiary Item, Removal of Water.

c. Bid Item 12, Cement

- (1) This item shall consist of furnishing and handling all cement required for construction of Bid Item 10, Concrete Channel Lining; Bid Item 11, Concrete Structures; Bid Item 13, Concrete for Minor Structures; and Bid Item 22, Soil-Cement.
- (2) Cement shall be Type II, IIA, or IP(MS).
- (3) If Type IP(MS) is used, pozzolan shall not exceed 20 percent based on absolute volume and the R factor $R = \text{CaO}_5 / \text{Fe}_2\text{O}_3$ shall be less than 1.5.
- (4) Measurement and payment will be according to Section 25 of this specification.

d. Bid Item 13, Concrete for Minor Structures

- (1) This item shall consist of furnishing, forming and placing all concrete required to construct the concrete pipe collars, the collector channel inlet base slabs and driveway entrances for the maintenance road at the locations shown in the drawings.
- (2) In Section 3, Classes of Concrete, the concrete shall be Class 2500X, and the cement shall be Type II, IIA or IP(MS). Pozzolan will replace up to 20% of the cement by weight at a rate varying from 0.75 lb. of pozzolan for 1.0 lb. cement to 1.0 lb. pozzolan to 1.0 lb. of cement. If Type IP(MS) is used, pozzolan shall not exceed 20 percent based on absolute volume and the R factor, $R = \text{CaO}_5 / \text{Fe}_2\text{O}_3$ shall be less than 1.5.

- (3) Coarse aggregate shall be size No. 57, in accordance with ASTM C33.
- (4) Curing compound shall be Type 2 conforming to Material Specification 534 and ASTM C 309.
- (5) Measurement and payment shall be according to Section 25 of this specification and shall include Subsidiary Item, Removal of Water.

e. Subsidiary Item, Pavement Replacement

- (1) This item shall consist of the pavement replacement for constructing driveway entrances for the maintenance roads at the locations shown on the drawings.
- (2) The pavement shall be replaced according to the detail shown on the drawings.
- (3) The asphalt concrete used for pavement replacement shall match the thickness and gradation of the existing pavement.
- (4) The aggregate base course shall meet the following requirements.

<u>Sieve Size</u>	<u>Percentage by Weight Passing</u>
3"	---
1-1/2"	---
1-1/8"	100
No. 4	38-65
No. 8	25-60
No. 30	10-40
No. 200	3-12

- (5) Compaction of the subgrade shall be Class A.
- (6) The existing pavement shall be trimmed to a neat true line with straight vertical edges free from irregularities with a saw specifically designed for this purpose.
- (7) The existing pavement shall be cut and trimmed after placement of the required ABC and just prior to placement of the asphalt concrete and the trimmed edges shall be painted with a light coating of asphalt cement or emulsified asphalt immediately prior to constructing the new abutting asphalt concrete pavement.
- (8) No separate payment for pavement replacement will be made. Compensation will be included in Bid Item 13, Concrete for Minor Structures.

f. Subsidiary Item, Manhole Adjustment

- (1) This item shall consist of adjusting to grade the manholes at the locations shown on the drawings.
- (2) The manhole shall be constructed of precast manhole rings in accordance with the details shown on the drawings and shall meet the requirements of ASTM C-478.
- (3) In Specification 21, Section 8 shall apply.
- (4) In Specification 23, Section 6, Compaction Class C shall apply.
- (5) No separate payment will be made for manhole adjustment. Compensation for this work will be included in the payment for Bid Item 13, Concrete for Minor Structures.

g. Subsidiary Item, Plug for Abandoned Pipe

- (1) This item shall consist of plugging the abandoned 36" pipe at Brown Road.
- (2) Bricks shall conform to the requirements of ASTM C-32, Grade MM.
- (3) Masonry Cement used shall conform to ASTM C-207, Type S.
- (4) Fine aggregate for mortar shall conform to ASTM C-404.
- (5) No separate payment will be made for the pipe plug. Compensation will be included in Bid Item 13, Concrete for Minor Structures.

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34. STEEL REINFORCEMENT

1. SCOPE

The work shall consist of furnishing and placing steel reinforcement for reinforced concrete or pneumatically applied mortar.

2. MATERIALS

Steel reinforcement shall conform to the requirements of Material Specification 539. Before reinforcement is placed, the surfaces of the bars and fabric and any metal supports shall be cleaned to remove any loose, flaky rust, mill scale, oil, grease or other coatings or foreign substances. After placement, the reinforcement shall be maintained in a clean condition until it is completely embedded in the concrete.

3. BAR SCHEDULE, LISTS AND DIAGRAMS

Any supplemental bar schedules, bar lists or bar-bending diagrams required to accomplish the fabrication and placement of reinforcement shall be provided by the Contractor. Prior to placement of reinforcement, the Contractor shall furnish three prints or copies of any such lists or diagrams to the Contracting Officer. Acceptance of the reinforcement will not be based on approval of these lists or diagrams but will be based on inspection of the reinforcement after it has been placed.

4. BENDING

Reinforcement shall be cut and bent in compliance with the requirements of the American Concrete Institute Standard 315. Bars shall not be bent or straightened in a manner that will injure the material. Bars with kinks, cracks or improper bends will be rejected.

5. SPLICING BAR REINFORCEMENT

Splices of reinforcement shall be made only at locations shown on the drawings and provided by the steel schedule. Placement of bars at the lap splice locations shown, when not in contact, shall not be farther apart than one-fifth the shown lap length and in any case no greater than 6 inches.

6. SPLICING WELDED WIRE FABRIC

Unless otherwise specified, welded wire fabric shall be spliced in the following manner:

- a. Adjacent sections shall be spliced end to end (longitudinal lap) by overlapping a minimum of one full mesh plus two inches plus the length of the two end overhangs. The splice length is measured from the end of the longitudinal wires in one piece of fabric to the end of the longitudinal wires in the lapped piece of fabric.
- b. Adjacent sections shall be spliced side to side (transverse lap) a minimum of one full mesh plus two inches. The splice length shall be measured from the centerline of the first longitudinal wire in one piece of fabric to the centerline of the first longitudinal wire in the lapped piece of fabric.

7. PLACING

Reinforcement shall be accurately placed and secured in position in a manner that will prevent its displacement during the placement of concrete. Tack welding of bars will not be permitted. Metal chairs, metal hangers, metal spacers and concrete chairs may be used to support the reinforcement. Metal handers, spacers and ties shall be placed in such a manner that they will not be exposed in the finished concrete surface. The legs of metal chairs or side form spacers that may be exposed on any face of slabs, walls, beams or other concrete surfaces shall have a protective coating or finish by means of hot dip galvanizing, epoxy coating, plastic coating, or by stainless steel. Metal chairs and spacers not fully covered by a protective coating or finish shall have a minimum cover of 3/4 inch of concrete over the unprotected metal portion except for those with plastic coatings may have a minimum cover of 1/2 inch of concrete over the unprotected metal portion. Precast concrete chairs shall be manufactured of the same class of concrete as that specified for the structure and shall have tie wires securely anchored in the chair or a V-shaped groove at least 3/4 inch in depth molded into the upper surface to receive the steel bar at the point of support. Precast concrete chairs shall be moist at the time concrete is placed.

Reinforcement shall not be placed until the prepared site has been inspected and approved by the Engineer. After placement of the reinforcement, concrete shall not be placed until the reinforcement has been inspected and approved by the Engineer.

TABLE 34-1 STANDARD REINFORCING BARS

Bar Size No.	Wt. (lb./ft.)
3	0.376
4	0.668
5	1.043
6	1.502
7	2.044
8	2.670
9	3.400
10	4.303
11	5.313
14	7.65
18	13.60

TABLE 34-2 RECTANGULAR WELDED WIRE FABRIC¹

By Steel Wire Gauge	Style Designation		Weight, lb. Per 100 Sq. Ft.
		By W-Number	
6 x 6 - 10 x 10	6 x 6 -	W1.4 x W1.4	21
6 x 6 - 8 x 8	6 x 6 -	W2.1 x W2.1	30
6 x 6 - 6 x 6	6 x 6 -	W2.9 x W2.9	42
6 x 6 - 4 x 4	6 x 6 -	W4.0 - W4.0	58
4 x 4 - 10 x 10	4 x 4 -	W1.4 x W1.4	31
4 x 4 - 8 x 8	4 x 4 -	W2.1 x W2.1	44
4 x 4 - 6 x 6	4 x 4 -	W2.9 x W2.9	62
4 x 4 - 4 x 4	4 x 4 -	W4.0 x W4.0	85
² 4 x 12 - 8 x 12	4 x 12 -	W2.1 x W0.9	25
² 4 x 12 - 7 x 12	4 x 12 -	W2.5 x W1.1	31

¹Style designation is defined in ACI Standard 315 of the American Concrete Institute.

²Welded smooth wire fabric with wires smaller than Size W1.4 is manufactured from galvanized wire.

8. STORAGE

Steel reinforcement stored at the work site shall be placed above the ground surface on platforms, skids or other supports and protected from mechanical damage or corrosion.

9. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the weight of reinforcement placed in the concrete in accordance with the drawings will be determined to the nearest pound by computation from the placing drawings. Measurement of hooks and bends will be based on the requirements of ACI Standard 315. Computation of weights of reinforcement will be based on the unit weights established in Tables 34-1 and 34-2. Computation of weights for welded wire fabric not shown in Table 34-2 shall be based on ACI Standard 315. The area of welded wire fabric reinforcement placed in the concrete in accordance with the drawings will be determined to the nearest square foot by computation from the placing drawings with no allowance for laps. The weight of steel reinforcing in extra splices or extra-length splices approved for the convenience of the Contractor or the weight of supports and ties will not be included in the measurement for payment.

Payment for furnishing and placing reinforcing steel will be made at the contract unit price. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work including preparing and furnishing bar schedules, lists or diagrams; furnishing and attaching ties and supports; and furnishing, transporting, storing, cutting, bending, cleaning and securing all reinforcements.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items to which they are made subsidiary are identified in Section 10 of this specification.

10. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 14, Steel Reinforcement

- (1) This item shall consist of furnishing and installing all steel reinforcement required for constructing:
 - (a) The 36" headwall and apron at Station 92+24
 - (b) The 54" headwall apron and outlet protection at Station 35+84.50
 - (c) The double 6'x7' box culvert with headwalls and apron at Station 128+63.00
 - (d) The concrete channel lining for the side inlet at Station 128+92
 - (e) The concrete channel lining between station 155+50.00 and station 156+51.34
 - (f) The concrete pipe collars as shown on the drawings
- (2) In Section 3, Bar Schedule Lists and Diagrams, the Contractor shall provide any such bar schedules a minimum of 15 working days prior to placement of the subject reinforcing steel.
- (3) In Section 5, Splicing for Reinforcement, splices of reinforcement shall be made at the locations shown on the drawings and as permitted in the notes on the drawings. Placement of bars at the lap splice locations shown, where not in contact, shall not be farther apart than one-fifth of the shown lap length and in any case no greater than 6 inches.
- (4) All steel bars shall be Grade 40 shall be used if it is immediately available. If Grade 40 is not immediately available, Grade 60 may be used exclusively or in combination with Grade 40 provided that the conditions under which the grades are used in combination are acceptable to the Engineer and further provided that there is no additional cost.
- (5) Measurement and payment for steel reinforcement shall be according to Section 9 of this specification.

RWCD FLOODWAY, REACH-6

42. CONCRETE PIPE CONDUITS AND DRAINS

1. SCOPE

The work shall consist of furnishing and installing concrete pipe or concrete drain tile and the necessary fittings as shown on the drawings.

2. MATERIALS

Reinforced concrete pressure pipe shall conform to the requirements of Material Specification 541 for the type and strength specified.

Concrete culvert pipe shall conform to the requirements of Material Specification 542 for the kind of pipe specified.

Concrete irrigation pipe, drainage pipe and drain tile shall conform to the requirements of Material Specification 543 for the kind of pipe or tile specified.

Pipe fittings shall conform to the requirements of the applicable pipe specifications.

Sealing compound for filling rubber gasket joints shall conform to the requirements of Material Specification 536.

Hot-pour joint sealer shall conform to the requirements of Material Specification 536.

Cold-applied sealing compound shall conform to the requirements of Material Specification 536.

Preformed sealing compound shall conform to the requirements of Material Specification 536.

Joint packing shall be commercial grade oakum.

Preformed expansion joint filler shall conform to the requirements of Material Specification 535.

3. LAYING AND BEDDING

Pipe and tile shall be laid to the line and grade shown on the drawings. Pipe shall be laid with the bell or groove at the upstream end of each Section.

- a. Concrete Cradles or Bedding. Pipe to be cradled or bedded on concrete shall be set to the specified line and grade and temporarily supported on precast concrete blocks or wedges until the cradle or bedding concrete is placed. Concrete blocks or wedges used to temporarily support the pipe during placement of bedding or cradle shall be of a class of concrete equal to or better than that used in the bedding or cradle.
- b. Earth, Sand, or Gravel Bedding. The pipe shall be firmly and uniformly bedded throughout its entire length to the depth and in the manner specified on the drawings. The pipe shall be loaded sufficiently during backfilling around the sides to prevent its being lifted from the bedding.

Perforated pipe shall be laid with the perforations down and oriented symmetrically about a vertical centerline. Perforations shall be clear of any obstructions when the pipe is laid.

Elliptical pipe and pipe with elliptical or quadrant reinforcement shall be layed so that the vertical axis, as indicated by markings on the pipe, is in a vertical position.

4. JOINTS

Pipe joints shall conform to the details shown on the drawings and to the requirements of Section 5 and 6 of this specification applicable to the type of joint specified. Except where unsealed joints are indicated, pipe joints shall be sound and watertight at the pressure specified.

5. JOINTING BELL AND SPIGOT PIPE

- a. Rubber Gasket Joint, Pressure Pipe. Just before the joint is connected the connecting surfaces of the spigot and the bell or coupling band, sleeve or collar shall be thoroughly cleaned and dried, and the rubber gasket and the inside surface of bell or coupling band, sleeve or collar shall be lubricated with a light film of soft vegetable soap compound (flax soap). The rubber gasket shall be stretched uniformly as it is placed in the spigot groove to insure a uniform volume of rubber around the circumference of the pipe.

The joint shall be connected in accordance with the manufacturer's recommendations.

When the spigot has been seated to within seated 1/2 inch of its final position, the position of the gasket in the joint shall be checked around the entire circumference of the pipe by means of metal feeler gauge. In any case where the gasket is found to be displaced, the joint shall be disengaged and properly reconnected.

After the position of the gasket has been checked, the spigot shall be completely pulled into the bell and the Section of the pipe shall be adjusted to line and grade.

b. Rubber Gasket Joints, Sewer and Culvert Pipe or Irrigation Pipe. The pipe shall be joined in accordance with the gasket manufacturer's recommendations except as otherwise specified.

c. Mastic Sealed Joints. At the time of assembly the inside surfaces of the bell and the outside surfaces of the spigot shall be clean, dry and primed as recommended by the manufacturer of the sealing compound. A closely twisted gasket of joint packing of the diameter required to support the spigot at the proper grade and to make the joint concentric shall be made in one piece of sufficient length to pass around the pipe and lap at the top. The gasket shall be laid in the bell throughout the lower third of the circumference. The end of the spigot shall be laid in the bell throughout the lower third of the circumference. The end of the spigot shall be laid on the gasket and the spigot shall be fully inserted into the bell so that the pipe sections are closely fitted and aligned. The gasket then shall be lapped at the top of the pipe and thoroughly packed into the annular space between the bell and the spigot.

(1) Hot-Pour Joint Sealer. The sealing compound shall be heated to within the temperature range recommended by the manufacturer and shall not be overheated or subjected to prolonged heating. After the joint is assembled, with the pipe in its final location, a suitable joint runner shall be placed around the joint with an opening left at the top. Molten sealing compound shall be poured into the joint as rapidly as possible without entrapping air until the annular space between bell and spigot is completely filled. After the compound has set, the runner may be removed. Alternate joints may be poured before the pipe is lowered into the trench. In this case, the joint shall be poured with the pipe in a vertical position without the use of the runner. The compound shall have thoroughly set before the pipe is placed in the trench, and the pipe be handled so as to cause no deformation of the joint during placement.

(2) Cold-Applied Sealing Compound. The annular space between bell and spigot shall be completely filled with the sealing compound. The compound shall be mixed on the job in accordance with the manufacturer's recommendations and in relatively small quantities so that setting will not be appreciable before application.

(3) Preformed Sealing Compound. Joint packing will not be required, except as recommended by the manufacturer of the

sealing compound. Preformed strips or bands of the sealing compound shall be applied to the bell and spigot prior to assembly of the joint in accordance with the manufacturer's recommendations. Any compound extruded from the interior side of the joint during assembly shall be trimmed even with the interior surface of the pipe.

d. Cement Mortar Sealed Joints. Cement mortar for joints shall consist of one part by weight of portland cement and two parts by weight of fine sand with enough water added to produce a workable consistency. At the time of assembly the inside surface of the bell and the outside surface of the spigot shall be clean and moist.

(1) With Packing. A closely twisted gasket of joint packing of the diameter required to support the spigot at the proper grade and to make the joint concentric shall be made in one piece of sufficient length to pass around the pipe and lap at the top. The gasket shall be saturated with neat cement grout, laid in the bell throughout the lower third of the circumference and covered with mortar. The end of the spigot shall be fully inserted into the bell so that the pipe sections are closely fitted and aligned. A small amount of mortar shall be placed in the annular space throughout the upper two-thirds of the circumference. The gasket then shall be lapped at the top of the pipe and thoroughly packed into the annular space between the bell and the spigot. The remainder of the annular space then shall be filled completely with mortar and beveled off at an angle of approximately forty-five (45) degrees with the outside of the bell. If the mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint thus made shall be wrapped with cheesecloth. After the mortar has set slightly, the joint shall be wiped inside the pipe. In pipe too small for a man to work inside, wiping may be done by dragging an approved swab through the pipe as the work progresses.

(2) Without Packing. The lower portion of the bell shall be filled with stiff mortar of sufficient thickness to make the inner surface of the abutting sections flush. The spigot end of the pipe to be joined shall be fully inserted into the bell so that the sections are closely fitted and aligned. The remaining annular space between the bell and spigot shall then be filled mortar and the mortar neatly beveled off at an angle of approximately forty-five (45) degrees with the outside of the bell. After the mortar has set slightly, the joint shall be wiped inside the pipe. In pipe too small for a man to work inside, wiping may be done by dragging an approved swab through the pipe as the work progresses.

- e. Unsealed Joints. When unsealed joints are specified, they shall conform to the details shown on the drawings.

6. JOINING TONGUE AND GROOVE PIPE

- a. Cement Mortar Sealed Joint. Mortar shall be as specified for bell and spigot joints. The tongue end of the Section being placed shall be covered with mortar and firmly pressed into the groove of the laid Section in such a manner that the tongue fits snugly and truly in the groove and that mortar is squeezed out both on the interior and exterior of the joint. Care shall be taken that no mortar falls from the groove end during the abutting operation. Immediately after the pipe sections have been abutted, exposed external surface mortar shall be pressed into the joint and any excess mortar removed, after which the interior surface of the joint shall be carefully pointed and brushed smooth, and all surplus mortar removed.
- b. Mastic Sealed Joints. Strips or bands of preformed sealing compound shall be applied to the tongue and groove prior to assembly of the joint in accordance with the manufacturer's recommendations. Any compound extruded from the interior side of the joint during assembly shall be trimmed even with the interior surface of the pipe.
- c. Rubber Gasket Joints. The pipe shall be joined in accordance with the gasket manufacturer's recommendations except as otherwise specified.
- d. Unsealed Joints. When unsealed joints are specified, they shall conform to the details shown on the drawings.

7. BANDING

When external mortar bands are specified, they shall conform to the details shown on the drawings.

8. CURING MORTAR JOINTS AND BANDS

The external surfaces of mortar joints shall be covered with moist earth, sand, canvas, burlap or other approved materials and shall be kept moist for 10 days or until the pipe is backfilled.

Water shall not be turned into the conduit within 24 hours after the joints are finished. Hydrostatic pressure shall not be applied to the conduit prior to 14 days after the joints are finished.

9. PRESSURE TESTING

Pressure testing of the completed conduit will not be required.

10. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the quantity of each kind, size, and class pipe will be determined to the nearest foot by measurement of the laid length of pipe along the invert centerline of the conduit. Payment for each kind, size, and class of pipe will be made at the contract unit price for that kind, size and class of pipe. Such payment will constitute full compensation for furnishing, transporting and installing the pipe complete in place.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 11 of this specification.

11. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 15, 54" Diameter Concrete Culvert Pipe

- (1) This item shall consist of furnishing and installing the 54" diameter rubber gasket reinforced concrete pipe as shown on the drawings.
- (2) The pipe shall be installed to the elevations shown on the drawings.
- (3) The 54" diameter pipe shall conform to Material Specification 542, Concrete Culvert Pipe for ASTM C-76 Class III concrete pipe bell and spigot with rubber gasket joint per ASTM C-443.
- (4) The type of cement for the concrete pipe shall be Type II or IIA.
- (5) Measurement and payment shall be according to Section 10 of this specification.

RWCD FLOODWAY REACH-6

51. CORRUGATED METAL PIPE CONDUITS

1. SCOPE

The work shall consist of furnishing and placing circular, arched or elliptical corrugated metal pipe and the necessary fittings.

2. MATERIALS

Pipe and fittings shall conform to the requirements of Material Specification 551 or Material Specification 552, whichever is specified.

3. LAYING AND BEDDING THE PIPE

Unless otherwise specified, the pipe shall be installed in accordance with the manufacturer's recommendations. The pipe shall be laid with the outside laps of circumferential joints pointing upstream and with longitudinal laps at the sides at about the vertical midheight of the pipe. Field welding of corrugated galvanized iron or steel pipe will not be permitted. Unless otherwise specified, the pipe sections shall be joined with standard coupling bands. The pipe shall be firmly and uniformly bedded throughout its entire length to the depth and in the manner specified on the drawings.

Perforated pipe shall be laid with the perforations down and oriented symmetrically about a vertical center line. Perforations shall be clear of any obstructions at the time the pipe is laid.

The pipe shall be loaded sufficiently during backfilling around the sides to prevent its being lifted from the bedding.

4. STRUTTING

When required, struts or horizontal ties shall be installed in the manner specified on the drawings. Struts and ties shall remain in place until the backfill has been placed to a height of five feet above the top of the pipe, or has been completed if the finished height is less than five feet above the top of the pipe, at which time they shall be removed by the Contractor.

5. HANDLING THE PIPE

The Contractor shall furnish such equipment as is necessary to place the pipe without damaging the pipe or coatings. The pipe shall be transported and handled in such a manner as to prevent bruising, scaling, or breaking of the spelter coating or bituminous coating.

6. REPAIR OF DAMAGED COATINGS

Any damage to the zinc coating shall be repaired by thoroughly wire brushing the damaged area, removing all loose and cracked coating, removing all dirt and greasy material with solvent, and painting with two coats of zinc dust-zinc oxide primer conforming to the requirements of Federal Specification TT-P-641, Type III, or zinc dust paint conforming to the requirements of Military Specification MIL-P-21035. If the coating is damaged in any individual area larger than 12 square inches, or if more than 0.2 percent of a total surface area of a length of pipe is damaged, the length will be rejected.

Breaks or scuffs in bituminous coatings that are less than 36 square inches in area shall be repaired by the application of two coats of hot asphaltic paint or a coating of cold-applied bituminous mastic. The repair coating shall be at least 0.05 inches thick after hardening and shall bond securely and permanently to the pipe. The material shall meet the physical requirements for bituminous coatings contained in the references cited in Material Specifications 551 and 552. Whenever individual breaks exceed 36 square inches in area or when the total area of breaks exceeds 0.5 percent of the total surface area of the pipe, the pipe will be rejected.

Bituminous coating damaged by welding of coated pipe or pipe fittings shall be repaired as specified in this Section for breaks and scuffs in bituminous coatings.

7. MEASUREMENT AND PAYMENT

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 8 of this specification.

8. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 16, Collector Channel Inlets

1. This item shall consist of furnishing and installing all collector channel inlets and pipes connecting to adjacent subdivisions including the pipe and dropshaft to the lines, grades and elevations shown on the drawings.
2. The pipe and fittings shall conform to Material Specification 551. The pipe shall be close riveted Class I, Shape 1 with coating G in accordance with Federal Specification WW P-405. Coupling bands shall be watertight. Fiber bonding may be substituted for asbestos bonding in the coating.
3. In Section 7, Measurement and Payment, the following method shall apply. The quantity of pipe and other material will not be measured for payment. Payment for each inlet will be made at the contract unit price for one inlet. Payment for one inlet will include compensation for all material, labor, equipment, tools, subsidiary items, excavation, backfill, removal of water and all other items necessary and incidental to the completion of the work.

RWCD FLOODWAY, REACH-6

81. METAL FABRICATION AND INSTALLATION

1. SCOPE

The work shall consist of furnishing, fabricating and erecting metal-work, including the metal parts of composite structures.

2. MATERIALS

Unless otherwise specified, materials shall conform to the requirements of Metal Specification 581. Steel shall be structural quality unless otherwise specified. Castings shall be thoroughly cleaned and subjected to careful inspection before installation. Finished surfaces shall be smooth and true to assure proper fit. Galvanizing shall conform to the requirements of Material Specification 582.

3. FABRICATION

Fabrication of structural steel shall conform to the requirements of Section 1.23 of the "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings (Riveted, Bolted and Arc-Welded Construction)," American Institute of Steel Construction.

Fabrication of structural aluminum shall conform to the requirements in the Aluminium Construction Manual, "Specifications for Aluminum Structures," Section 6 and Section 7, The Aluminum Association, November 1976.

4. ERECTION

The frame of metal structures shall be carried up true and plumb. Temporary bracing shall be placed wherever necessary to resist all loads to which the structure may be subjected, including those applied by the installation and operation of equipment. Such bracing shall be left in place as long as may be necessary for safety.

As erection progresses the work shall be securely bolted up, or welded, to resist all dead load, wind and erection stresses. The Contractor shall furnish such fitting up bolts, nuts and washers as may be required.

No riveting or welding shall be done until as much of the structure as will be stiffened thereby has been properly aligned.

Rivets driven in the field shall be heated and driven with the same care as those driven in the shop.

All field welding shall be done in conformance to the requirements for shop fabrication, except those that expressly apply to shop conditions only.

Galvanized items shall not be cut, welded or drilled after the zinc coating is applied.

5. PROTECTIVE COATINGS

Items specified to be galvanized shall be completely fabricated for field assembly before the application of the zinc coatings.

Items specified to be painted shall be painted in conformance to the requirements of Construction Specification 82 for the specified paint systems.

6. MEASUREMENT AND PAYMENT

The work will not be measured. Payment for metal fabrication and installation will be made at the contract lump sum price. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work, including connectors and appurtenances such as rivets, bolts, nuts, pins, studs, washers, hangers and weld metal.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

7. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 17, Metal Fabrication

- (1) This item shall consist of providing and fabricating the structural steel trash racks for the collector channel inlets, the steel barriers for the 54" pipe at Station 35+84.50 and the 36" pipe at Station 92+24.00, and the pipe handrail for the double 6'x7' box culvert at Station 128+63.00.
- (2) In Section 2, Materials, the materials shall be as follows:
 - (a) Steel shall conform to the requirements of ASTM Specification A575, Grade M1015 to Grade M1031.
 - (b) Bolts, nuts, washers and assembly (including tightening) shall conform to ASTM Specification A307. Washers shall be case hardened.
- (3) In Section 3, Fabrication, all welds shall conform to the American Welding Society Standards (AWS) A5.1 and A5.5. Electrodes shall be E70XX.
- (4) In Section 5, Protective Coatings, the trash racks, steel barriers and handrails shall be galvanized to conform to the requirements of Material Specification 582.
- (5) Any damage to the galvanizing or zinc coating shall be repaired by thoroughly brushing the damaged area removing all loose and cracked coating and removing all dirt and greasy material with solvent. The area shall then be painted with two coats of zinc dust oxide primer conforming to the requirements of Federal Specification TT-P-641, Type III, or zinc dust paint conforming to the requirements of Military Specification MIL-P-21035. If the coating is damaged in any individual area larger than 12 square inches or if more than 0.2 percent of a total surface area is damaged, the item will not be accepted.
- (6) The handrails shall be standard weight galvanized pipe and fittings conforming to the requirements of ASTM A120 and Federal Specification WW-P-521. All posts shall be embedded in a high strength, non-shrink, non-settling mortar.
- (7) Measurement and payment shall be according to Section 6 of this specification.

b. Subsidiary Item, Animal Guards

- (1) This item shall consist of furnishing and installing the metal animal guards in the plastic drain pipes as shown on the drawings.
- (2) Materials shall conform to Specification 581, Metal.
- (3) No separate payment will be made for animal guards. Compensation for this item will be included in the payment for Bid Item 17, Metal Fabrication.

c. Subsidiary Item, Watertight Manhole Frame and Cover

- (1) This item shall consist of furnishing and installing 30" watertight manhole frames and covers conforming to ASTM A-48, Class 30A at the locations shown on the drawings.
- (2) Installation shall be according to the detail shown on the drawings.
- (3) The frame and cover shall be cast iron and the frame shall weigh approximately 210 lbs. and the cover shall weigh approximately 276 lbs. The weight of the casting can be no more than 2% less than the specified weight.
- (4) No separate payment will be made for watertight manhole frames and covers. Compensation for this item will be included in Bid Item 17, Metal Fabrication.

CONSTRUCTION SPECIFICATION

82. CLEANING AND PAINTING METALWORK

1. SCOPE

The work shall consist of cleaning metal surfaces and applying paints and protective coatings.

2. PAINTS

For the purposes of this specification paints shall be designated by types as defined below:

Type 1 paint shall conform to the requirements of Federal Specification TT-P-86, Type IV, Red Lead Base Paint.

Type 2 paint shall conform to the requirements of Federal Specification TT-P-86, Type II or Type III, Red Lead Base Paint.

Type 3 paint shall conform to the requirements of Federal Specification TT-P-86, Type I, Red Lead Base Paint.

Type 4 paint shall conform to the requirements of Federal Specification TT-P-636, Synthetic Primer.

Type 5 paint shall be prepared by mixing aluminum paste conforming to the requirements of Federal Specification TT-P-320, Type II, Class 2 with phenolic resin spar varnish conforming to the requirements of Federal Specification TT-V-119 at the rate of two pounds of aluminum paste per gallon of varnish. The paints shall be mixed at the time of use.

Type 6 paint shall be prepared by mixing aluminum paste conforming to Federal Specification TT-P-320, Type II, Class 2 with mixing varnish conforming to the requirements of Federal Specification TT-V-81, Type II, Class B (Class 2) at the rate of two pounds of aluminum paste per gallon of varnish. The paint shall be mixed at the time of use.

Type 7 paint shall conform to the requirements of Federal Specification TT-E-489, Class A Alkyd Semi Gloss Enamel.

Type 8 paint shall conform to the requirements of Federal Specification TT-E-529, Alkyd Semi Gloss Enamel.

Type 9 paint shall conform to the requirements of Federal Specification TT-P-641, Type I or Type II, Zinc Dust-Zinc Oxide Primer.

Type 10 paint shall conform to the requirements of Federal Specification TT-P-641, Type III Zinc Dust-Zinc Oxide Primer.

Type 11 paint shall conform to the requirements of Material Specification 583. The paint shall be mixed at the time of use.

Paints of Types 1, 2, 3, 5 and 6 may be thinned with mineral spirits as necessary for proper application but the amount of thinner used shall not exceed one pint per gallon of paint. Other paints may be thinned in accordance with the manufacturer's instructions only if such thinning is approved by the Engineer.

When tinting is required, it shall be accomplished by the addition of pigment-in-oil tinting colors conforming to the requirements of Federal Specification TT-P-381.

Mineral spirits shall conform to the requirements of Federal Specification TT-T-291, Grade 1, Light Thinner.

3. SURFACE PREPARATION

Surfaces to be painted shall be thoroughly cleaned prior to the application of the paint. For the purposes of this specification methods of surface preparation shall be designated as defined below:

Method 1 surface preparation shall consist of the removal of all grease and oil by means of steam cleaning or solvent cleaning methods and removal of all dirt, rust, mill scale and other coatings by means of sandblasting, grit blasting or pickling. The finished surface shall uniformly expose the base metal and shall present an etched, but not polished or peened, appearance. Not more than five percent of the surface may exhibit very light shadows, light streaks, or slight discolorations caused by rust stain, mill scale oxides, or slight, tight residues of paint or coating.

Method 2 surface preparation shall consist of the removal of all grease and oil by means of steam cleaning or solvent cleaning and the removal of all dirt, surface rust and loose scale by means of wire brushing, flame cleaning, use of rotary abrading tools or light sandblasting.

Method 3 surface preparation shall consist of the treatment of the surface with a dilute acid solution. The surface shall be thoroughly wetted with a dilute (about five percent strength) phosphoric acid solution. After the acid has dried, the surface shall be thoroughly rinsed with clear water and allowed to dry. Dirt, grease and oil shall be removed from the surface by solvent cleaning prior to the acid treatment.

Cleaning solvent shall be mineral spirits. Cleaning cloths and solvents shall be discarded before they become contaminated to the extent that a greasy film would remain on the surface being cleaned.

The final cleaning and wiping shall be done with clean solvent and clean cloths. Grit blasting shall be accomplished using compressed air blast nozzles and grit made of steel, malleable iron or cast iron crushed shot. Abrasives used shall have a maximum particle size that will pass the No. 16 sieve (U.S. Standard) and a minimum size that will be retained on the No. 50 sieve (U.S. Standard). The equipment used for sandblasting shall be equipped with adequate separators and traps to insure that the compressed air shall be free of detrimental amounts of water and oil. Blast cleaned surfaces shall be brushed, blown or vacuum cleaned to remove any trace of blast products or abrasives prior to painting.

Surfaces that are not to be painted immediately after cleaning shall be treated with one brush coat of metal conditioner conforming to the requirements of Military Specification MIL-M-10578, except that surfaces cleaned by pickling in phosphoric acid solution shall not require such treatment.

Surfaces shall be thoroughly dry when paint is applied.

No field coats of paint shall be applied until the prepared surfaces have been inspected and approved by the Engineer.

4. PAINT SYSTEMS

For the purposes of this specification, systems of preparing and painting metalwork will be designated as defined below:

Paint System A shall consist of the preparation of the surfaces to be painted by Method 1 and the application of two priming coats of Type 1 paint and two or more top coats of Type 5 paint as necessary to provide a total dry paint film thickness of 6 mils.

Paint System B shall consist of the preparation of the surfaces to be painted by Method 1 and the application of one priming coat of Type 1 paint and two top coats of Type 5 paint.

Paint System C shall consist of the preparation of the surfaces to be painted by Method 2 and the application of one priming coat of Type 2, Type 3 or Type 4 paint and two top coats of Type 6 paint.

Paint System D shall consist of the preparation of the surfaces to be painted by Method 2 and the application of one priming coat of Type 2 paint and two top coats of Type 7 paint.

Paint System E shall consist of the preparation of the surfaces to be painted by Method 2 and the application of one priming coat of Type 2 paint and two top coats of Type 8 paint.

Paint System F shall consist of the preparation of the surfaces to be painted by Method 3 and the application of two coats of Type 9 paint.

Paint System G shall consist of the preparation of the surfaces to be painted by Method 3 and the application of two coats of Type 10 paint.

Paint System H shall consist of the preparation of the surfaces to be painted by Method 1 and the application of four or more coats of Type 1 paint as necessary to provide total dry paint film thickness of 6 mils.

Paint System I shall consist of the preparation of the surfaces to be painted by Method 1 and the application of two or more coats of Type II paint as necessary to provide a total dry paint film thickness of at least 16 mils.

5. APPLICATION OF PAINT

Surfaces shall be painted immediately after preparation (or within two days after preparation and treatment with metal conditioner) with at least one coat of the type of priming paint required by the specified paint system. Surfaces not required to be painted shall be protected against contamination and damage during the cleaning and painting operation.

Paints shall be thoroughly mixed at the time of application.

After erection or installation of the metalwork, all damage to shop applied coats shall be repaired and all bolts, nuts, welds and field rivet heads shall be cleaned and painted with one coat of the specified priming paint.

Except on surfaces accessible only to spray equipment, initial priming coats shall be applied by brush. All other coats may be applied by brush or spray. Each coat shall be applied in such a manner as to produce a paint film of uniform thickness with a rate of coverage within the limits recommended by the paint manufacturer.

The drying time between coats shall be prescribed by the manufacturer of the paint but not less than that required for the paint film to dry through. The elapsed time between the application of the first and second prime coats of Paint System A shall not exceed 60 hours. In the application of Paint System I, if, for any reason, the first dries hard before the second coat is applied or the elapsed time between coats exceeds 48 hours, the method of application must be modified in any of the following ways: (1) the first coat must be wiped down with MIBK with the application of the second coat following the wipedown by not more than 6 feet; or (2) the first coat must be lightly brush blasted or given a fog coat of the paint before application of the full second coat; or (3) a special bonding additive supplied by the paint manufacturer must be mixed with the paint applied in the second coat.

The finished surface of each coat shall be free from runs, drops, ridges, laps or excessive brushmarks and shall present no variation in color, texture and finish.

The surface of each dried coat shall be cleaned as necessary before application of the next coat.

Except for Paint System I, the first coat of each two-coat system shall be tinted for contrast. The first coat of red-lead paint shall be tinted by the addition of 3 ounces per gallon of 1B black pigment. The first coat of machinery paint shall be tinted off color with three ounces per gallon of a pigment suitable to the color of the paint.

6. ATMOSPHERIC CONDITIONS

Paint shall not be applied with the temperature of the item to be painted or if the surrounding air is less than 50°F. For Paint System I, the temperature of the coated surface must be maintained at not less than 50°F for 6 hours after the application of each coat. Painting shall be done only when the humidity and temperature of the surrounding air and the temperature of the metal surfaces are such that evaporation rather than condensation will result during the period of time required for application and drying. Surfaces protected from adverse atmospheric conditions by special cover, heating or ventilation shall remain so protected until the paint is dry.

7. TESTS

Acceptance of dry paint film thickness for Paint Systems A, H, and I will be based on the measurement of paint film thickness by means of an Elcometer or other suitable dry film thickness gauge.

8. PAYMENT

For items of work for which specific lump sum prices are established in the contract, payment for painting metalwork will be at the contract lump sum price. Such payment will constitute full compensation for furnishing, preparing and applying all materials and for the cleaning, painting and coating of metal work including labor, tools, equipment and all other items necessary and incidental to the completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 9 of this specification.

9. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and construction details are:

a. Subsidiary Item Cleaning and Painting Metalwork

- (1) This item shall consist of cleaning and painting the identification plaque.
- (2) Paint System D shall be used for the identification plaque. The paint for System D shall be white with the lettering on the plaque painted with dark green enamel.
- (3) Payment for cleaning and painting the identification plaque shall be included in Bid Item 18, Identification Plaque.

RWCD FLOODWAY, REACH-6

93. IDENTIFICATION MARKERS OR PLAQUES

1. SCOPE

The work shall consist of furnishing and installing identification markers or plaques at the designated locations.

2. MATERIALS

The markers or plaques shall be constructed of the specified materials, and shall meet all requirements for lettering, painting, finishing, and related items as shown on the drawings or as specified in Section 6 of this specification.

3. CONSTRUCTION METHODS

The markers or plaques shall be installed at locations and in the manner or condition specified.

4. MONUMENTS

Unless otherwise specified, the markers or plaques shall be mounted on concrete monuments or on existing structures. The monuments shall be of the type, kind, and size and located as specified.

5. MEASUREMENT AND PAYMENT

For items of work which specific unit prices are established in the contract, payment for each type, kind, and size of marker or plaque complete in place, will be made at the contract unit price for that type, kind, and size.

Such payment will constitute full compensation for all labor, equipment, tools, and all other items necessary and incidental to the completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 6 of this specification.

6. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and construction details are:

Bid Item 18, Identification Plaque

- (1) This item shall consist of providing two (2) identification plaques and appurtenances as shown on the drawings.
- (2) Cleaning and painting shall meet the requirements of Specification 82.
- (3) The location of the identification plaques shall be as determined by the Engineer.
- (4) Payment for each type, kind, and size of identification plaque complete in place, will be made at the contract unit price for that type, kind, and size and shall include compensation for Subsidiary Item; Cleaning and Painting Metalwork.

RWCD FLOODWAY, REACH-6

203. GEOTEXTILE, FABRIC, WOVEN AND NONWOVEN

FOR EROSION CONTROL

1. SCOPE

This work shall consist of furnishing all materials, equipment and labor necessary for the installation of geotextile fabric under stone filling, preformed concrete blocks, riprap, or similar applications.

2. MATERIALS

Geotextile fabrics shall be manufactured from synthetic long chain or continuous polymeric filaments or yarns such as polypropylene, polyethylene, polyester, polyamide, or polyvinylidene-chloride. The fabric shall be formed into a stable network of filaments or yarns that retain their relative position to each other, are inert to commonly encountered chemicals, and are resistant to ultraviolet light exposure, heat, hydrocarbons, mildew, rodents and insects. The fabric shall be free of any chemical treatment or coating that might significantly reduce its permeability and shall have no flaws or defects that would significantly alter its physical properties. Specific requirements for materials are as follow:

a. Woven Fabric. Woven fabric shall conform to the physical properties listed in Table 1. The woven fabrics shall be manufactured from monofilament yarn that is woven into a uniform pattern with distinct and measurable openings. Yarn composition shall be at least 85 percent by weight of propylene, ethylene or vinylidene-chloride, and shall contain stabilizers and/or inhibitors added to the base plastic to enhance its resistance to deterioration due to ultraviolet or heat exposure. The fabric shall be calendered or otherwise finished so that the yarns will retain their relative position with regard to each other. The edges of the fabric shall be selvaged or otherwise finished to prevent the outer yarn from unraveling.

The seams of the fabric shall be sewn with thread of a material meeting the chemical requirements given for polymeric plastic yarn. Sheets of fabric shall be sewn together at the factory or other approved location to form panels of the specified size.

b. Nonwoven Fabric. Nonwoven fabric shall conform to the physical properties listed in Table 2, based on the average roll minimum value. Nonwoven fabric shall be manufactured from randomly oriented fibers bonded together by the needle punched process. Staple fabrics shall not be acceptable for use.

3. MATERIAL COMPLIANCE

Prior to installation of any fabric, the Contractor shall furnish the Contracting Officer, in duplicate, a mill certificate or affidavit that includes the following information:

- a. Name of product and manufacturer.
- b. Product description, chemical composition, and copies of typical laboratory test values.
- c. Statement of compliance attesting that the fabric meets the chemical, physical, and manufacturing requirements stated in the contract.
- d. Signature of legally authorized official attesting to validity of information provided.

4. SHIPMENT AND STORAGE

The geotextile fabric shall be supplied in rolls wrapped with a protective covering to keep out mud, dirt, dust, debris, and direct sunlight. The fabric shall be free of defects which measurably alter its physical properties and planned function. Each roll of fabric shall be clearly marked to identify the individual production run.

5. PLACEMENT

The geotextile fabric shall be placed on the approved prepared surface at the locations and in accordance with the details shown on the drawings. The fabric shall be unrolled along the placement area and loosely laid (not stretched) in such a manner that it will conform to the surface irregularities when the stone or other material is placed. No cuts will be permitted in the fabric panel unless otherwise specified. The panel may be folded and overlapped to permit proper placement in the designated areas. The fabric will be rejected at the time of placement if it has defects, rips, holes, flaws, deterioration or damage that occurred during manufacture, transportation, storage, or installation.

The orientation of the width and length of the fabric panels shall be as shown on the drawings. The fabric length shall be placed parallel to the direction of water flow unless otherwise indicated on the drawings. The overlaps of panels and end roll details shall be as specified in Section 7. The minimum overlap shall be 18 inches (24 inches for installation under gabions). When specified in Section 7, the seams of the cloth shall be machine sewn with thread of a material meeting the chemical requirements given for plastic yarn. The sheets of fabric shall be sewn together at the factory or another approved location to form panels of the specified size.

Securing pins, approved and provided by the fabric manufacturer, shall be placed along the edge of the panel to adequately secure the engineering fabric during placement. At vertical laps, securing pins shall be inserted through both layers along a line through the approximate midpoint of the overlap. At horizontal laps, securing pins shall be inserted through the bottom layer only. Securing pins shall be placed along a line approximately two inches in from the edge of the outer limits of the completed filter cloth area at intervals not greater than 12 feet (6 feet for installation under gabions). Additional pins shall be installed as necessary to prevent any slippage of the fabric, regardless of location. The use of securing pins will be held to the minimum necessary. The fabric may be secured with other methods when specified.

Pins shall be steel or fiberglass formed as a "U", "L", or "T" shape or contain "ears" to prevent total penetration. Steel washers shall be provided on all but the "U" shaped pins.

The geotextile fabric shall not be placed until riprap or other material can be used to cover it within the same working day.

Temporary cover may be used as approved by the Engineer. Riprap shall be placed in a manner that prevents damage to the fabric. In no case will riprap be dropped on uncovered fabric from a height greater than three feet.

6. MEASUREMENT AND PAYMENT

For items of work described in Section 7 of this specification for which specific unit prices are established in the contract, the quantity of geotextile fabric placed within the specified limits will be determined to the nearest square yard by computing the area of the specified panels including overlaps and anchorages as shown on the drawings. Payment for the geotextile fabric will be made at the contract unit price. Such payment will be considered full compensation for all labor, materials, equipment, and other items necessary and incidental to the completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 7 of this specification.

TABLE 1
REQUIREMENTS FOR WOVEN GEOTEXTILE FABRIC
FOR EROSION CONTROL

Test	Method	Requirement
Tensile Strength (unaged fabric)*	ASTM D1682 Grab Test Method using 1 inch square jaws and a travel rate of 12 inches per minute	200 lbs. Min. in any principal direction
Elongation at Failure	ASTM D1682	Between 10 percent and 35 percent
Bursting Strength (unaged fabric)*	ASTM D751 Diaphragm Bursting strength Tester	500 psi Min.
Abrasion Resistance	ASTM D1682 as above, after abraded as in ASTM D1175 Rotary Platform, Double Head Method; rubber-base abrasive wheels equal to CS-17 "Calibrase" by Taber Instruments Co., 1 kilogram load per wheel; 1,000 revolutions	55 lbs. Min. in any principal direction
Seam Breaking Strength	ASTM D1683, one inch square jaws, constant rate of traverse 12 inches per minute	180 lbs. Min.
Equivalent Opening Size (EOS)	Corps of Engineers standard CW-02215	U.S. Standard Sieve sizes as specified in Section 7
Percent Open Area**	Summation of open area divided by the total area of filter fabric expressed as a percent	As specified in Section 7

*. Unaged fabric is defined as fabric in the condition received from the manufacturer or distributor.

** A percent open area less than 4.0 percent will not be accepted.

TABLE 2
REQUIREMENTS FOR NONWOVEN GEOTEXTILE FABRIC
FOR EROSION CONTROL

Property	Method	Requirements
Tensile Strength*	ASTM D1682 Grab Test Method, using 1 inch X 2 inch jaws and travel rate of 12 inches/min.	200 lbs. Min.
Elongation at Failure	ASTM D1682	50 percent Min.
Bursting Strength*	ASTM D3786 Diaphragm Bursting Strength Tester Method	500 psi Min.
Permeability Coefficient	K value (Falling head-10 inch max. head)	0.15 cm/sec. Min.
Trapezoidal Tear* Strength	ASTM D1117 2 inch x 3 inch jaws	70 lbs. Min.
Equivalent Opening Size (EOS)	Corps of Engineers Standard CW-02215	U.S. Standard Sieve Sizes as specified in Section 7

* Average roll minimum value - weakest principal direction.

7. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 19, Geotextile Fabric

1. This item shall consist of furnishing and installing the geotextile fabric as part of the construction of the PVC drains for the side inlets and the concrete channel lining as shown on the drawings.
2. The fabric shall be lightweight, nonwoven with an equivalent opening size (EOS) of No. 60 U.S. standard sieve.
3. The panels shall be placed in the trench for the PVC drain pipe outlets as shown on the drawings.
4. Measurement and payment for geotextile fabric shall be according to Section 6 of this specification.

RWCD FLOODWAY, REACH-6

207. PLASTIC PIPE DRAINS

1. SCOPE

The work shall consist of the furnishing and installing plastic pipe and the necessary fittings as shown on the drawings.

2. MATERIALS

The poly (vinyl chloride)(PVC) pipe and fittings shall conform to the requirements of the following American Society for Testing and Materials (ASTM) Standard Specifications:

- a. D 1785 Poly (Vinyl Chloride)(PVC) Plastic Pipe, Schedules 40, 80, and 120.
- b. D 2241.
- c. D 2466 Poly (Vinyl Chloride)(PVC) Plastic Pipe Fittings, Schedule 40.
- d. D 2467 Socket-Type Poly (Vinyl Chloride)(PVC) Plastic Pipe Fittings, Schedule 80.
- e. D 2672.
- f. D 3034 Type PSM Poly (Vinyl Chloride)(PVC) Sewer Pipe and Fittings.
- g. D 2729.
- h. AWWA C900.

The Acrylonitrile-Butadiene-Styrene (ABS) plastic pipe and fittings shall conform to the requirements of the following ASTM Standard Specifications:

- a. D 2282 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe (SDR-PR).
- b. D 1527 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80.
- c. D 2468 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40.
- d. D 2469 Socket-type Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 80.

Rubber gasket joints shall conform to ASTM Specification D 3139 or D 3212, as appropriate for PVC pipe.

Solvent for cemented joints shall conform to ASTM Specification D 2564 (PVC) or D 2235 (ABS) as appropriate.

Perforations for perforated pipe shall be as provided by ASTM C 508 unless otherwise specified in Section 9.

The compound used in manufacturing the pipe shall meet the requirements of one of the following materials:

1. Poly (vinyl chloride)(PVC) as specified in ASTM D 1784.

Material	Code	Classification
Type I, Grade 1.....		12454-B
Type I, Grade 2.....		12454-C
Type II, Grade 1.....		14333-D
Sewer Pipe and Fittings.....		13364-B, C, or D

2. Acrylonitrile-butadiene-styrene (ABS) as specified in ASTM D 1788.

Material	Code	Classification
Type 1, Grade 3.....		3-5-5
Type 2, Grade 1.....		4-5-5

The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign matter, or other defects. The pipe shall be as uniform in color, opacity, density, and other physical properties as is commercially practicable.

3. HANDLING THE PIPE

Pipe stored outdoors for prolonged periods shall be covered with a material that will provide protection from ultraviolet light damage. Pipe must be delivered to the job site and handled by means that shall provide adequate support and not subject it to undue stresses or damage. The individual loads of pipe shall be limited in height and supported such that the bottom rows of pipe are not crushed. All special handling, stacking and storage requirements of the manufacturer

shall be strictly observed. Pipe shall be unloaded carefully and stored as close as practical to the final point of placement. When handling and placing the pipe, care shall be taken to prevent severe impact blows, abrasion damage, and gouging or cutting any hard or sharp objects such as by metal surfaces or rocks.

4. LAYING AND BEDDING THE PIPE

Pipe shall be laid to the lines and grades shown on the drawings and as specified in Section 9. Construction shall progress in the upstream direction with the bell ends pointed upstream. The spigot ends shall be pulled into the bell ends of previously laid sections. The ends of pipes and fittings shall be free of all foreign material when assembled.

Perforated pipe shall be laid with the perforations down and oriented symmetrically about the vertical centerline. Perforations shall be clear of any obstructions when the pipe is laid.

Care shall be taken to prevent permanent distortion and damage when handling the pipe during unusually warm or cold weather. The pipe shall be firmly and uniformly bedded throughout its entire length to the specified depth with the material and in the manner specified in Section 9, or as shown on the drawings. Blocking or mounding shall not be used to bring the pipe to final grade.

For pipe with bell joints, the bedding material shall be excavated at the locations of the bells to provide continuous equal support for the bells as well as for the entire length of pipe.

5. JOINTS

Pipe joints shall conform to the requirements specified in Section 9 and the details shown on the drawings. Except where unsealed joints are indicated, joints shall be sound, watertight, and shall equal or exceed the strength requirements of the pipe specified. Joints and connections shall leave the inside of the line free of any obstructions that may tend to reduce its capacity. When a lubricant is required to facilitate joint assembly, it shall have no deleterious effect on the gasket or pipe materials.

Pipe shall be installed and joined in accordance with the manufacturer's recommendations except as otherwise specified in Section 9.

6. PRESSURE TESTING

Pressure testing of the completed drain pipe will not be required.

7. STRUCTURE BACKFILL

Backfill shall be in accordance with Construction Specification 23 or 24, and/or Section 9 of this specification, as appropriate, and as shown on the drawings.

8. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the quantity of each kind, size, and class of pipe will be determined to the nearest foot by measurement of the laid length of pipe along the invert centerline of the drain pipe.

Payment of each kind, size, and class of pipe will be made at the contract unit price for that kind, size, and class of pipe. Such payment will constitute full compensation for furnishing, transporting, and placing the pipe, including excavation, backfill, fittings, and other appurtenances or items necessary and incidental to installing the drain pipe complete in place.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 9 of this specification.

9. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 20, Drain Pipe

- (1) This item shall consist of furnishing and installing the drain pipe and fittings under the soil-cement side inlets and concrete channel linings shown on the drawings.
- (2) The pipe shall be 4 inch diameter; SDR 35, Type PSM PVC Sewer Pipe conforming with ASTM D 3034.
- (3) In Section 5, Joints, the pipe and fittings shall be furnished with solvent cement joints in accordance with ASTM D 3034 and ASTM D 2855.
- (4) Pipe shall be perforated as provided by ASTM C-508 where called for on the plans.
- (5) In Section 8, Measurement and Payment, payment will include full compensation for all pipe and fittings for the drain outlet pipes.

CONSTRUCTION SPECIFICATION

7. SURVEYS

1. SCOPE

This work shall consist of performing all surveys required for layout of the work, for conducting quantity surveys and completing quantity computations for progress payment estimates. Work shall include the furnishing of all necessary equipment, labor, and materials for laying out all work from government-established base lines and benchmarks and performing quantity surveys and related computations.

2. EQUIPMENT AND MATERIALS

Equipment for surveys shall be of a quality and condition that will provide the accuracy specified. Equipment shall be maintained in proper adjustment and records of calibration tests or adjustments shall be available to the government for inspection at all times.

Materials shall include all field notebooks, stakes, templates, platforms, equipment, spikes, steel pins, tools and other accessories as may be required for layout of any part of the work from the government-established base lines and bench marks indicated on the drawings.

3. QUALITY OF WORK

Surveys shall be certified by a land surveyor or engineer licensed by the State unless otherwise specified. The work shall be performed to a degree of accuracy and detail appropriate for the location and type of job.

All work shall be skillfully performed in a workmanlike manner. Notes, sketches, and other data shall be complete, recorded neatly, and organized in a manner that will allow reproduction of copies and incorporation in the job documentation with a minimum of editing and revision.

All differential levelling circuits shall be closed. Precision shall be third order with the error of closure (in feet) not to exceed plus or minus 0.1 times the square root of the distance (in miles). The elevations of bench marks and temporary bench marks shall be determined and recorded to the nearest 0.01 foot.

Transit traverses shall be third order with such precision that: (1) the linear error of closure shall not exceed one foot in 3,000 feet and (2) the angular error of closure shall not exceed 1.0 minute times the square root of the number of angles turned.

Surveys will be reviewed periodically and be subject to random spot checks by the government to assure that the specified quality is being maintained.

4. PRIMARY CONTROL

The base lines and bench marks for primary control necessary to establish the lines and grades needed for construction will be furnished by the government. They will be shown on the drawings and placed on the ground prior to construction. Information regarding the primary control will be provided to the Contractor following receipt of the notice to proceed.

The base lines and bench marks shall be used as the origin of all surveys needed to establish lines and grades for construction.

Base line reference points and bench marks damaged or destroyed by the Contractor's forces will be replaced by the government at the Contractor's expense. The actual cost to the government of replacing them will be deducted from the payments due the Contractor.

5. CONSTRUCTION SURVEY AND MEASUREMENT RECORDS

All survey data except that for construction layout or grade stakes above or below slope stakes shall be recorded in properly identified and marked bound field notebooks meeting industry standards and approved by the Contracting Officer. Pages shall be numbered consecutively. These books shall be turned over to and become the property of the government upon completion of the construction work and the Contractor's final invoice. All entries shall be legible, reproducible, and follow the format in Soil Conservation Service TR-62, Engineering Layout, Notes, Staking and Calculations. The bound field notebooks shall be available to the engineer at all times during the progress of the work for examination and use by the government. Copies of field book notes shall be made available to the Contracting Officer upon request.

Field notes generated by electronic methods shall be assembled in a bound volume with pages numbered and cross referenced to bound field book entries. Electronic printout data shall evidence review by a checker and other notes so as to fully identify the work, when it was performed and by whom.

Surveys and measurements shall be performed by the Contractor to document the quantities for all progress payments. Only those items supported by surveys or measurements, complete field notes and quantity computations will be included on the progress payments. All cross sections taken to document progress payments shall be taken at the stations established by the original survey and at right angles to the centerline.

All surveys and computations to support progress payments shall be provided to the government on the established cut off date for progress payments. Quantities supported by surveys or computations with significant errors will not be included in the progress payment.

All surveys, measurements, and computations for the final quantities and payment will be made by the government.

6. STAKING

The location and marking of all stakes shall be as shown in Soil Conservation Service TR-62 and as indicated below to clearly define both the required layout and future needs for quantity measurements for payment.

- a. Clearing and Grubbing - The boundary of the clearing and grubbing areas shall be staked or flagged at 200 foot intervals or less if needed to clearly mark the limits of work to be done.
- b. Excavation - Cut stakes shall be placed on the centerline and at the intersection of the side slopes and natural ground line. All stakes shall be marked to indicate the required cut, horizontal distance, slopes and stationing. Offset reference stakes and hubs shall also be provided.
- c. Earthfill - Fill stakes shall be placed on the centerline and at the toes of the slopes and shall be marked with the fill, horizontal distance, slope, and stationing. Offset reference stakes and hubs shall also be provided.

Earthwork slope stake shall be placed at full stations, breaks in the original ground surface and at other intermediate stations as necessary to ensure accurate location of construction as well as to provide the necessary information for quantity measurements. Slope stakes and cross sections shall be established at right angles to the centerline. Distances shall be measured horizontally and rod readings shall be taken vertically and shall be recorded to the nearest 0.1 foot for earthwork and 0.01 foot for structures.

7. MEASUREMENT AND PAYMENT

Payment will be made as the work proceeds, after presentation of invoices by the contractor showing his or her subcontractor's surveying costs, and cost of supplies. If the total of such payments is less than the contract lump sum for surveys, the unpaid balance will be included in the final contract payments. Total payment will be the lump sum contract price for surveys, regardless of actual cost to the contractor.

Payment will not be made under this item for the purchase cost of materials and equipment having a residual value.

Payment of the lump sum contract price for surveys will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to completion of the work.

Compensation for any item of work described in the contract, but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 8 of this specification.

8. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 21, Surveys

- (1) This item shall consist of furnishing personnel, equipment, materials and performing surveys required for:
 - (a) Construction layout
 - (b) Computation of quantities
 - (c) "As-Built" construction drawings
- (2) The Contractor shall provide the Government Representative a statement of qualifications, including specific experience of each of the survey personnel assigned to the job.
- (3) The Contractor shall provide the Government Representative a schedule of surveys to be performed each month.
- (4) In Section 1, Scope, the last sentence does not apply.
- (5) Primary control will be located on the left side of the right-of-way approximately at every 500 foot stations.

CONSTRUCTION SPECIFICATION

462. SOIL-CEMENT

1. SCOPE

The work shall consist of the furnishing, placing, compacting, and curing a mixture of soil material, Portland cement and water. The mixture shall be uniformly mixed, blended, compacted, finished and cured as specified. It shall conform to the lines, grades, thicknesses, and typical cross section(s) shown on the plans.

2. MATERIALS

Soil materials shall be select material obtained from the required excavations or designated borrow locations.

Deleterious materials such as sod, brush, or roots shall be separated from soil materials during the selection, blending, and routing operations. Maximum size of rock particles shall be 2 inches. Soil materials, cement content, and moisture content other than those specified in Section 15 may be used as approved by the Engineer. Proposed alternatives must meet one of the following requirements to be considered:

- (a) If the soil material to be used has similar gradation and Atterberg limits as the soils specified, the same cement content and water content shall be used. The Contractor shall provide gradation and Atterberg test data from a reputable commercial soil testing laboratory verifying gradation and Atterberg limits.
- (b) If the soil materials do not have the same gradation and Atterberg limits as the soils specified, the Contractor shall provide soil-cement durability tests, moisture-density relations data, Atterberg limits and gradation tests from a reputable commercial soil testing laboratory. The soil-cement mix ratio and water content shall also be provided by the lab. As a minimum the following durability tests shall be provided; ASTM D 559 and ASTM D 560. The moisture-density relations are to be in accordance with ASTM D 558. The tests must indicate a soil-cement of a quality equal to or exceeding the quality specified.

Portland cement shall conform to the requirements of Material Specification 531 for the specified Type. Mixing of different brands or Types of cement will not be allowed.

Portland cement shall be furnished in sacks, barrels, or bulk. Sacked cement that is stored at the job site shall be used in the same order as the deliveries to the site. Each shipment of sacked cement shall be stored so that it may be readily distinguished from other shipments.

Emptied cement sacks shall be burned or buried in accordance with Construction Specification 5 unless otherwise specified.

Water used in mixing or curing soil-cement shall be clean and free from injurious amounts of oil, acid, alkali, organic matter or other deleterious substances and shall meet the requirements for water as specified in ASTM C 94.

Pozzolanic Materials, if used, shall comply with the requirements of ASTM C 618 Class F, Specifications for Fly Ash, and Raw or Calcined Natural Pozzolan, except the loss of ignition shall not exceed 3.0 percent.

Curing compounds shall conform to the requirements of Material Specification 534 for the type of curing compound specified. A liquid petroleum asphalt curing material may be used as specified in Section 15. Application of the curing compound shall be in accordance with Section 12 of this specification and the manufacturer's recommendations.

3. OPERATIONS OF PITS OR STOCKPILES OF SOIL MATERIALS

All work involved in the opening and operation of borrow pits or stockpiles shall be performed by the Contractor. The pits or stockpiles shall be opened in such a manner as to expose a near vertical face of the soil material for a suitable working depth.

Material shall be excavated in successive vertical cuts extending across the pit or stockpile. When approved by the Engineer, successive horizontal cuts on a horizontal oriented working face may be permitted in homogeneous soils. All pockets or strata of unsuitable materials overlying or occurring in the borrow pit shall be wasted. The method of operating the pit or stockpile and the blending of materials shall be changed when such action is necessary to obtain material conforming to the specifications. Upon completion of the work, the pits shall be graded and dressed in such a manner as to be non-erosive and drain freely.

4. FOUNDATION PREPARATION

Before soil-cement processing begins, the foundation area shall be graded, shaped, and compacted in conformance with the lines and grades shown on the plans. The foundation shall firmly support the construction equipment. Immediately prior to the placement of the soil-cement, the compacted surface shall be moistened to essentially the same moisture content as specified for the soil-cement, and shall be kept moist until the soil-cement is placed.

5. DESIGN OF SOIL-CEMENT MIXTURE

General. The materials and proportions of the soil-cement mixture shall constitute the "job-mix". After a job-mix has been designated and approved, neither the source, character or grading of the soil nor the type, brand, or quantity of cement or pozzolanic material shall be changed without prior notice to the Engineer. A change in materials or proportions requires the establishment of a new job-mix supported by evidence, as required for the initial job-mix, that the proposed new materials and mix proportions will produce soil-cement of the quality, consistency and strength specified.

The use of calcium chloride or other accelerators or antifreeze compounds will not be allowed unless approved by the Engineer.

Method 1. The Contractor shall determine the mix proportions and submit the job-mix design along with the supporting test results to the Engineer for his approval prior to incorporating any of the material into the work. The brand of cement and the location of the soil material source shall be included with the job-mix design data. The mix design shall be such that the soil-cement meets or exceeds the minimum compressive strength specified. A new mix design shall be submitted for approval any time the Contractor requests a change in materials or a proportioning of materials from that given in the approved mix design. In no case will the Engineer's review and approval of a mix design relieve the Contractor of his responsibility to provide soil-cement having the specified properties.

A maximum of fifteen (15) percent of the total weight of cement may be replaced with fly ash at a rate of 1.2 pounds per pound of cement replaced.

Method 2. The Contractor shall use the soil, fly ash, cement, and moisture content as determined by the Engineer in accordance with laboratory tests. During the course of the work, the Engineer shall adjust the job-mix proportions as needed to achieve the minimum compressive strength specified.

All Methods. The percent of cement to be used in the mix will be determined by dividing the weight of cement by the oven dry weight of the soil material. The cement content required to obtain the minimum compressive strength specified shall be increased an additional two (2) percent for erosion resistance. Any strength gain resulting from the two (2) percent durability enhancement will not be used to alter the minimum strength for acceptance.

6. MIXING

The mixing plant shall be capable of producing a uniform mixture of soil, cement, and water. The plant shall be equipped with measurement devices that will proportion the mix in the specified quantities.

Prior to use, all measurement devices shall be calibrated and certified by a technician approved by the Engineer. The actual quantities of the mix shall not vary more than 2 percent from the specified quantities, unless otherwise specified. The water content will be the percentage of moisture in the mixture at the time of compaction.

The Engineer shall have free access to the mixing plant at all times for inspection of the plant's operation and for sampling the soil-cement mixture and its components.

Method 1. Mixing of the soil, cement, and water shall be accomplished in a stationary mixing plant. The plant may be either a batch type or a continuous flow type design. The plant may use either weight or volume proportioning. The scale or metering devices shall be sensitive to one percent (1%) of the maximum load that may be required or imposed. The mixer shall be a pugmill, revolving-blade or rotary-drum system. Facilities for efficiently storing, handling and proportioning unixed materials shall be provided at the plant.

Method 2. Mixing of the soil, cement, and water shall be accomplished in a truck mixer. The mixer shall meet the requirements for truck mixers contained in ASTM C 94.

Method 3. Mixing of the soil-cement shall be accomplished in place. Mixing of the soil, cement, and water shall be accomplished by a single of multiple transverse shaft mixer, a traveling pugmill, or similar equipment approved by the Engineer. A motor grader or similar equipment shall not be used in lieu of the mixing equipment specified.

Soil material to be mixed in place shall be formed into windrows or divided into known grid areas. If windrows are used they shall be prepared to a known size with a sizing device. The tops of the windrows shall be flattened or slightly trenched to receive the cement.

The cement quantity necessary to meet the specified ratio of cement to soil, shall be distributed uniformly on the windrowed soil or over the prepared grid areas. After spreading, cement that has been displaced or is found to be less than that specified shall be properly adjusted or replaced prior to starting mixing operations.

The mixing operation shall be accomplished in such a manner that there are no unixed seams of soil between layers. Excessive striking of the soil-cement below the layer being mixed will not be allowed.

All Methods. The following provisions apply to all methods of mixing. The mixing time shall be controlled so that all ingredients shall be mixed for at least 30 seconds or longer as may be necessary to insure a thorough, uniform and homogeneous mixture of soil, cement, pozzolanic materials (if used) and water. Mixing time may be adjusted based on tests and field determinations. The mixing time shall be considered as

the interval between the time the cement contacts the soil and water and the time the mixture leaves the mixing unit or the mixer speed is reduced to the agitating speed. The soil and cement shall be mixed sufficiently to prevent cement balls from forming before the water is added. The water may be applied through the mixing machine or separately by approved pressure distributing equipment.

Soils containing plastic silt or clay lumps larger than 1-inch shall be pulverized or screened out of the raw soil prior to mixing.

7. TRANSPORTING

The soil-cement mixture shall be transported from the mixing plant to the site of placement in vehicles having tight, clean and smooth beds or mixer trucks. Haul time shall not exceed 30 minutes. Haul time shall be the elapse time from when the water and cement are mixed together and the mixture is spread onto the foundation or soil-cement surface.

The Contractor shall protect the soil-cement mixture if transported during unfavorable weather. Any material excessively wet by precipitation will be subject to rejection.

Equipment shall not be operated on a finished and compacted layer of the soil-cement, except where specifically permitted. Any damage resulting to the finished surfaces of the soil-cement from such operation shall be repaired by the Contractor at no cost to the Government.

Earth ramps crossing over completed soil-cement must have a minimum compacted thickness of two (2) feet. Where ramps are constructed over soil-cement that is not to finished grade, all foreign materials and the uppermost one (1) inch of the top layer of soil-cement must be removed prior to the continuation of the soil-cement construction.

8. PLACEMENT

Soil-cement shall not be placed until the required excavations and preparation of the foundation are completed and the foundation has been inspected and approved by the Engineer.

Equipment for spreading the soil-cement mixture shall be suitable for the purpose and shall be operated in such a manner as to produce a reasonably smooth, uniform surface. The equipment shall be controllable so as to produce uniform layers not more than the specified maximum thickness. The layer of soil-cement, or each successive lift when layering is required, shall be spread and compacted as soon as possible after the preceding layer is completed and approved. Soil-cement shall be placed in horizontal layers or layers conforming to the plane of the subgrade.

If the time elapsed between completion of compaction on a layer and start of placement of the next layer is greater than two (2) hours, the Contractor shall scarify the surface to a depth of one (1) inch. The Contractor shall clean off the scarified surface thoroughly by power brooming or other approved methods prior to proceeding. The broomed surface shall then be thoroughly moistened over its entire surface before the next layer of soil-cement is placed.

Soil-cement shall not be mixed or placed when the air temperature is below 45 degrees Fahrenheit (F). Soil-cement shall not be placed on a frozen foundation or if the soil to be processed is frozen, or if weather conditions are such that the material being processed cannot be completely compacted and protected before the onset of damaging weather (such as overnight lows below 40 degrees F, cold fronts, rainstorms, etc.). The use of accelerators or antifreeze compounds will not be allowed, unless otherwise specified. The temperature of new soil-cement shall not be allowed to drop below 32 degrees F for a period of seven (7) days. If temperatures are expected to be below 45 degrees F, the Contractor's method for protection shall be approved by the Engineer prior to placement of any soil-cement.

9. COMPACTION

- (a) Equipment - The Contractor may use any type of compaction equipment to obtain the specified density of the soil-cement mixture, provided such equipment does not have any projections or tamping feet which penetrate to previously compacted layers. Wheel rolling with only the hauling equipment shall not be an acceptable method of compaction.
- (b) Compaction Requirements - Soil-cement shall be uniformly compacted to a density not less than the minimum density specified. Optimum moisture and maximum density shall be determined by ASTM D 558. Soil Conservation Service Test No. S-6, Rapid Compaction Control Method, as referenced in NEH-19, may be used as equivalent to ASTM D 558. The compaction shall begin on all areas within 30 minutes after the addition of water to the soil-cement mixture. The compaction shall proceed in such a manner that the length of time between spreading of the soil-cement mixture and completion of compaction shall not exceed one (1) hour for each layer.
- (c) Other Requirements - If the surface of a layer of soil-cement has been rutted or compacted unduly by hauling or other equipment, the Contractor shall scarify and recompact such surfaces. When required to maintain uniformity of the layer surface, blading in connection with compaction operations shall be employed. If blading is required, raw unmixed soil shall not be bladed onto the mixed soil-cement.

10. CONSTRUCTION JOINTS

At the end of each workday, or when the adjacent placing operation is shut down for a period longer than 2 hours, a vertical construction joint shall be made along all unfinished edges of the thoroughly compacted soil-cement. Just before placing operations are resumed, the construction joint shall be shaved to remove all dry soil-cement and all curing compound from the face of the joint.

11. REMOVAL AND REPLACEMENT

Rejected or defected soil-cement shall be removed and replaced in accordance with these specifications, when:

- (a) Compaction operations are interrupted for any reason prior to the completion of compaction and the soil-cement mixture is left undisturbed for more than thirty (30) minutes.
- (b) The soil-cement mixture, prior to completion of compaction, becomes excessively wet so that the moisture content exceeds the specified limits.
- (c) The compacted soil-cement does not meet the density and moisture requirements; except that when the moisture is lower than required, the soil-cement mixture may be reworked, thoroughly mixed and compacted within the one (1) hour time limit as stated in Section 9, (b), Compaction Requirements.
- (d) The finished surface is rough or below grade such that a thin 'scab' section would be required to smooth the surface or bring the surface to grade.

12. PROTECTING AND CURING

- (a) Moistening Bonding Surfaces - Compacted surfaces of soil-cement that are to receive an overlying layer of soil-cement or concrete shall be kept moist, until placement of the overlying or adjacent layer of soil-cement or concrete. The Contractor will not be required to keep such surfaces moistened for longer than seven (7) days.
- (b) Curing Finished Exposed Surfaces

Method 1. Liquid petroleum asphalt curing materials conforming to Material Specification 301, shall be applied at the specified temperature range for each type, and shall be applied to the soil-cement surface by pressure spray equipment. The curing compound shall be applied in one (1) coat to provide a continuous, uniform membrane over the entire surface. The curing compound shall be applied at a minimum rate of 0.2 gallons per square yard.

Method 2. Concrete curing conforming to ASTM C 309 of the type specified shall be applied at a rate of not less than one (1) gallon per 150 square feet of surface using constantly agitating, pressure spray equipment. It shall form a uniform, continuous, adherent film that shall not check, crack, or peel.

Method 3. Curing moisture may be maintained by sprinkling, flooding, fog spraying or covering with continuously moistened canvas, cloth mats, straw, sand, or other approved material. Water and/or covering shall be applied in such a way that the soil-cement surface is not eroded or otherwise damaged.

All Methods. Any curing membrane that is removed from the surface or damaged within seven (7) days after application shall be repaired immediately. The surfaces of each section of soil-cement to be treated with curing compound shall be moistened with a light spray of water immediately after the section has been compacted. As soon as the surface film of moisture disappears but while the surface still has a damp appearance the curing compound shall be applied. Special care shall be taken to insure ample coverage with the compound at edges, corners and around rough spots. After application of the curing compound has been completed and the coating is dry to the touch, any required repair of the soil-cement surfaces shall be performed. Each repair, after being finished, shall be moistened and coated with curing compound in accordance with the foregoing requirements. The Contractor shall have all equipment and materials required for curing at the site ready for use before placement of soil-cement begins.

13. INSPECTION AND TESTING

The Engineer shall make such inspections and tests as necessary to verify that the soil-cement materials and soil-cement in place meet the specified requirements.

All testing of soil-cement or its individual components, unless otherwise specified, shall be in accordance with the latest applicable ASTM specifications. These tests are not intended to provide the Contractor with information he needs to assure that the material and workmanship meets the requirements of the specifications and their performance will not relieve the Contractor of the responsibility of performing tests for that purpose.

Tests for compaction shall be performed at any location chosen by the Engineer. If the soil-cement does not pass the minimum moisture density requirements specified, it shall be reworked or removed at the Contractor's expense. The Contractor shall not place any additional soil-cement until the rejected material has been reworked, retested and meets the density requirements or has been removed.

14. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the quantity of soil-cement will be measured within the specified limits and computed to the nearest cubic yard by the method of average cross-sectional end areas. The quantity of soil-cement required to fill voids resulting from overexcavation outside the neat lines or pay limits will be included in the measurement and payment where such overexcavation is directed by the Engineer to remove unsuitable foundation material, but only to the extent that the unsuitable condition is not a result of the Contractor's improper construction operations, as determined by the Engineer.

Method 1. Payment for soil-cement will be made at the contract unit price per cubic yard. The payment will constitute full compensation for all labor, materials, equipment, transportation, tools and all other items necessary and incidental to completion of the work, but not including other items listed for payment elsewhere in the contract.

Method 2. Payment for soil-cement will be made at the contract unit price per cubic yard. The payment will constitute full compensation for all labor, materials, equipment, transportation, tools and all other items necessary and incidental to completion of work, but not including furnishing and handling cement or other items listed for payment elsewhere in the contract.

Measurement for payment of cement will be made to the nearest 100 pounds by actual weight. For each load of cement delivered the Contractor shall furnish to the Engineer a statement or delivery ticket showing the weight of the cement in the load. Payment for cement will be made at the contract unit price for furnishing and handling the cement and such payment will constitute full compensation for all materials, labor, equipment, storage, transportation and all other items necessary and incidental to furnishing and handling the cement. No payment will be made for cement used in wasted soil-cement, cement used in replacement of damaged or defective soil-cement, cement used in extra soil-cement required as a result of overexcavation and cement used in soil-cement placed by the Contractor in excavations intentionally performed to facilitate his operation.

All Methods. Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for items of work to which it is made subsidiary. Such payment and the items to which they are made subsidiary are identified in Section 15 of this specification.

15. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 22, Soil-Cement

(1) This item shall consist of the placement of soil-cement required for installation of:

(a) Major side inlets and collection systems in the following locations:

Station 30+70.00
Station 35+18.00
Station 60+72.50
Station 64+04.50
Station 89+11.00
Station 93+97.84
Station 119+73.56
Station 143+66.00
Station 150+66.00

(b) Erosion protection for 36" pipe at Station 92+24.00.

(c) Outlet protection for 43 collector channel inlets and 3 pipes connecting to adjacent subdivisions.

(d) Erosion protection in the main floodway between the following stations:

Station 118+74.00 to Station 121+10.64
Station 126+71.23 to Station 129+98.28
Station 154+20.00 to Station 155+00.00
Station 156+51.34 to Station 158+19.00

(2) The subgrade area shall be compacted to a minimum density of 95% as specified in Specification 23, Earthfill. The subgrade in cut areas shall have the top loose layer compacted to a minimum density of 95%.

(3) The minimum design requirement for the soil-cement shall be such that it has a compressive strength of 750 psi at the end of 7 days. The amount of cement determined by laboratory testing shall be monitored throughout construction of the project with modifications as required to meet field conditions.

(4) Soils to be used for soil-cement shall meet the following gradation:

<u>Sieve Size</u>	<u>Percent Passing (Dry Weight)</u>
1-1/2"	98-100
#4	60- 90
#200	5- 15

The Plasticity Index shall be a maximum of five (5). Materials may be obtained from off site borrow sources as the Contractor chooses.

- (5) At the time of compaction, the moisture content shall not be below optimum and shall not be more than 2 percentage points above optimum when the mean air temperature during construction hours does not exceed 90 degrees F.
- (6) The compacted layers of soil-cement shall not exceed eight (8) inches in thickness, nor be less than four (4) inches in thickness.
- (7) Soil-cement shall be uniformly compacted to a minimum of 98% of maximum density as determined by field density tests.
- (8) Curing compound shall be liquid petroleum asphalt conforming to Material Specification 301.
- (9) Portland cement shall be Type II, IIA or IP(MS).
- (10) Measurement and payment shall be in accordance with Method 2 of Section 14 of this specification and shall include payment for Subsidiary Item, Removal of Water.

MATERIAL SPECIFICATION

301. ASPHALT LIQUID SLOW, MEDIUM AND RAPID CURING

1. SCOPE

This specification covers the quality of liquid petroleum asphalt cut-back material used for the curing of concrete and soil-cement work.

2. MATERIALS

Asphaltic materials shall be loaded and shipped in sealed tank cars, tank trucks, or barrels, completely free from all foreign matters. Asphaltic material contaminated by any foreign matter will be rejected by the Engineer.

- (a) Slow Curing Asphalt. Slow curing asphalt, designated by the letters 'SC', shall consist of natural, uncracked residual oils processed from asphaltic or semi-asphaltic base crude petroleum, or a blend of such oils with uncracked gas-oil type distillates which do not volatilize readily. Slow curing asphalt shall not foam when heated to 225 degrees F. The residue of specified penetration shall be smooth and homogeneous in appearance and the material shall conform to Federal Specification SS-A-671 and ASTM D 2026.
- (b) Medium Curing Cutback Asphalt. Medium curing cutback asphalt, designated by the letters 'MC', shall consist of an uncracked petroleum asphalt base stock produced by the processing of asphaltic or semi-asphaltic base crude petroleum that has been blended with a Kerosene type solvent. The base stock for all MC materials shall be straight run asphalt produced within the penetration range of 100 to 300, and the end point of the kerosene type solvent shall not exceed 525 degrees F. Medium curing cutback shall be free from water, shall show no separation, and shall conform to Federal Specifications SS-A-671 and ASTM D 2027.
- (c) Rapid Curing Cutback Asphalt. Rapid curing cutback asphalt, designated by the letters 'RC', shall consist of an uncracked petroleum asphalt base stock produced by the processing of asphaltic or semi-asphaltic base crude petroleum that has been blended with a naphtha or gasoline type solvent. The base stock for all 'RC' materials shall be straight run asphalt produced within the penetration range of 70 to 150. Rapid curing cutback asphalts shall be free from water, shall show no separation, and shall conform to Federal Specifications SS-A-671 and ASTM D 2028.

3. INSPECTION, TESTING AND CERTIFICATION

All tests performed on asphaltic materials (SC, MC, RC) shall conform to ASTM specifications D 2026, D 2027, or D 2028, respectively, and any other ASTM specification cited therein.

The materials certificate shall include manufacturer's certified statement that the materials supplied conform to the appropriate ASTM and federal specifications.

MATERIAL SPECIFICATION

521. AGGREGATES FOR DRAINFILL AND FILTERS

1. SCOPE

This specification covers the quality of mineral aggregates for the construction of drainfill and filters.

2. QUALITY

Drainfill and filter aggregates shall be sand, gravel or crushed stone or mixtures thereof. They shall be composed of clean, hard, durable mineral particles free from organic matter, clayballs, soft particles or other substances that would interfere with their free-draining properties.

Aggregates of crushed limestone shall be thoroughly washed and screened. Coarse aggregate containing crushed limestone shall have not more than three percent by weight of particles finer than the No. 4 sieve. Crushed limestone shall not be used for fine aggregates except in combination with other materials such that not more than five percent of the portion finer than the No. 4 sieve shall be crushed limestone.

Aggregates shall be tested for soundness according to ASTM Method C 88, and shall have a weighted average loss in five cycles of not more than 12 percent when sodium sulfate is used or 18 percent when magnesium sulfate is used.

3. GRADING

Drainfill and filter aggregates shall conform to the specified grading limits after being placed in the work, and after being compacted if compaction is specified. Grading shall be determined by ASTM Method C 136, but the percentage of material finer than a No. 200 sieve shall be not more than 5 percent when determined by ASTM Method C-117.

4. STORING AND HANDLING

Drainfill and filter aggregates shall be stored and handled by methods that prevent segregation of particle sizes or contaminating by mixing with other materials.

MATERIAL SPECIFICATION

522. AGGREGATE FOR PORTLAND CEMENT CONCRETE

1. SCOPE

This specification covers the quality of fine aggregate and coarse aggregate for use in the manufacture of portland cement concrete.

2. QUALITY

Aggregate shall conform to the requirements of ASTM Specification C 33 for the specified sizes. Aggregates that fail to meet any requirement may be accepted only when: (1) the specified alternate conditions of acceptance can be proved prior to the use of the aggregates on the job and within a period of time such that no work under the contract will be delayed by the requirements of such proof; or, (2) the specification for concrete expressly contains a provision of special mix requirements to compensate for the effects of the deficiencies.

3. REACTIVITY WITH ALKALIES

The potential reactivity of aggregates with the alkalies in cement shall be evaluated by petrographic examination and, where applicable, the chemical method of test, ASTM Designation C 289, or by the results of previous tests or service records of concrete made from similar aggregates from the same source. The standards for evaluating potential reactivity shall be as described in ASTM Specification C 33, Appendix A1.

Aggregates indicated by any of the above to be potentially reactive shall not be used, except under one of the following conditions:

- a. Applicable test results of mortar bar tests, made according to ASTM Method C 227, are available which indicate an expansion of less than 0.10 percent at six months in mortar bars made with cement containing not less than 0.8 percent alkalies expressed as sodium oxide; or
- b. Concrete made from similar aggregates from the same source has been demonstrated to be sound after three years or more of service under conditions of exposure to moisture and weather similar to those anticipated for the concrete under these specifications.

Aggregates indicated to be potentially reactive, but within acceptable limits as determined by mortar bar test results or service records, shall be used only with "low alkali" cement, containing less than 0.60 percent alkalies expressed as sodium oxide.

4. STORING AND HANDLING

Aggregate of each class and size shall be stored and handled by methods that prevent segregation of particles sizes or contamination by intermixing with other materials.

MATERIAL SPECIFICATION

531. PORTLAND CEMENT

1. SCOPE

This specification covers the quality of portland cements.

2. QUALITY

Portland cement shall conform to the requirements of ASTM Specification C 150 for the specified types of cement, except that, when Type I portland cement is specified, Type IS portland blast-furnace slag cement or Type IP portland-pozzolan cement conforming to the requirements of ASTM Specification C 595 may be used unless prohibited in the specifications.

If air-entraining cement is to be used, the Contractor shall furnish the manufacturer's written statement giving the source, amount and brand name of the air-entraining addition.

3. STORAGE AT THE CONSTRUCTION SITE

Cement shall be stored in such a manner as to be protected from weather, dampness or other destructive agencies. Cement that is partially hydrated or otherwise damaged will be rejected.

MATERIAL SPECIFICATION

532. AIR-ENTRAINING ADMIXTURES
(FOR CONCRETE)

1. SCOPE

This specification covers the quality of air-entraining admixtures for concrete.

2. QUALITY

Air-entraining admixtures shall conform to the requirements of ASTM Specification C 260, except that the relative durability factor in the freezing and thawing test shall be not less than 95.

MATERIAL SPECIFICATION

533. WATER-REDUCING AND SET-RETARDING ADMIXTURES FOR PORTLAND CEMENT CONCRETE

1. SCOPE

This specification covers the quality of water-reducing and set-retarding admixtures for portland cement concrete.

2. QUALITY

Water-reducing and set-retarding admixtures shall conform to the requirements of ASTM Specification C 494, except that resistance to freezing and thawing shall be determined in all cases, and the minimum relative durability factor shall be 95.

3. TYPES

Admixtures shall be Type A, Water-Reducing or Type D, Water-Reducing and Retarding, as defined in ASTM Specification C 494.

4. PERFORMANCE IN THE JOB MIX

When added in the manner and amount recommended by the manufacturer to the concrete used on the job, with no change in the cement content or proportions of the aggregates, admixtures shall have the following effects:

Type A or Type D: The water content at the required slump shall be at least five percent less with the admixture than without. The air content shall remain within the range specified, but shall not exceed eight percent in any case.

Type D: The time of initial setting, determined as prescribed in ASTM C 494, shall be from one to three hours longer with the admixture than without.

MATERIAL SPECIFICATION

534. CURING COMPOUND (FOR CONCRETE)

1. SCOPE

This specification covers the quality of liquid membrane-forming compounds suitable for spraying on concrete surfaces to retard the loss of water during the curing process.

2. QUALITY

The curing compound shall meet the requirements of ASTM Specification C 309.

Unless otherwise specified the compound shall be Type 2.

3. DELIVERY AND STORAGE

All curing compound shall be delivered to the site of the work in the original container bearing the name of the manufacturer and the brand name. The compound shall be stored in a manner to prevent damage to the containers and to protect water-emulsion types from freezing.

MATERIAL SPECIFICATION

535. PREFORMED EXPANSION JOINT FILLER

1. SCOPE

This specification covers the quality of preformed expansion joint fillers for concrete.

2. QUALITY

Preformed expansion joint filler shall conform to the requirements of ASTM Specification D 1752, Type I, Type II or Type III, unless bituminous type is specified. Bituminous type preformed expansion joint filler shall conform to the requirements of ASTM Specification D 994, or D 1751.

MATERIAL SPECIFICATION

536. SEALING COMPOUND FOR JOINTS IN CONCRETE AND CONCRETE PIPE

1. SCOPE

This specification covers the quality of sealing compound for filling joints in concrete pipe and concrete structures.

2. TYPE

The compound shall be a cold-application mastic, single component or multiple component type.

The single component type shall be a ready-mixed non-drying compound furnished in troweling consistency or in preformed rope or strip form.

The multiple component type shall be composed of two or more substances that are to be mixed prior to application.

3. QUALITY

Sealing compound shall conform to the requirements of one of the following specifications:

ASTM Specification D 1850; Concrete Joint Sealer, Cold-Application Type. Penetration, determined as specified in ASTM D 1850, shall be not greater than 120.

Federal Specification SS-S-210A; Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints.

ASTM Specification D-1190 concrete joint sealer, hot poured elastic type.

Federal Specification TT-S-227; Sealing Compound; Rubber Base, Two Component (for Caulking, Sealing and Glazing in Building Construction), Type II.

The compound shall be capable of being applied at a temperature of 70°F and shall be of such nature that it will adhere to dry, dust free concrete when applied either directly or over a suitable primer. After curing it shall be a resilient, adhesive material that is capable of filling joints and firm enough to prevent the entry of subsequently placed concrete or of earth during the bedding, cradling, or back-filling operations.

7. COMPOSITION AND PROPERTIES

The compound, if used for pipe having rubber gaskets, shall have a composition such that it will not cause deterioration of the rubber gaskets.

MATERIAL SPECIFICATION

537. NON-METALLIC WATERSTOPS

1. SCOPE

This specification covers non-metallic waterstops for use in joints of concrete structures.

2. CLASSIFICATION

- a. Classes. Non-metallic waterstops shall be of the following classes, as specified:

Class I shall be made of either natural or synthetic rubber.

Class II shall be made of vinyl chloride polymer or copolymer.

- b. Types. Non-metallic waterstops may be either split or solid and shall conform to the following types, as specified (see Figure 1):

Type A shall have ribbed anchor flanges and a smooth web. Flanges may be of uniform thickness or may have either a converging or a diverging taper toward the edges.

Type B shall have ribbed anchor flanges and a smooth web containing a hollow tubular center bulb having: (1) a wall thickness equal to at least one-half the web thickness and (2) the inside diameter (D) specified in the contract. Flanges may be of uniform thickness or may have either a converging or a diverging taper toward the edges.

Type C shall have a single, circular, bulb-type anchor flange at each edge and a smooth web.

Type D shall have a single, circular, bulb-type anchor flange at each edge and a smooth web containing a hollow tubular center bulb having: (1) a wall thickness equal to at least one-half the thickness of the web and (2) the inside diameter (D) specified in the contract.

Type E shall have ribbed anchor flanges and a web molded or extruded in the form of a round or U-shaped bulb of the dimensions specified in the contract. The web bulb shall be connected at the open end of the "U" by a thin membrane (having a thickness of not less than 1/64-inch or more than 1/5 the web thickness) designed to: (1) prevent infiltration of wet concrete into the bulb and (2) tear when expansion of the joint occurs. Flanges may be of uniform thickness or may have either a converging or a diverging taper toward the edges. Auxiliary positioning or nailing flanges may be

provided so long as they do not interfere with the functioning of the web bulb.

Type F shall have ribbed anchor flanges with at least two extra heavy ribs (designed to resist displacement of the waterstop during placement of concrete) on each flange and a smooth web having a positioning or nailing flange attached at the center.

Type G shall be of special design conforming to the details shown on the drawings.

- c. Sizes. Waterstops of Types A through F shall be of the sizes listed herein, as specified (see Table 1). Type G waterstops shall have the dimensions shown on the drawings.

3. PHYSICAL REQUIREMENTS

The extruded or molded materials shall exhibit the properties specified herein when tested by the methods specified in Section 4 of this specification.

a. Class I Waterstops

- (1) The hardness (Shore A durometer) shall be not less than 60.
- (2) The specific gravity shall be not more than 1.2.
- (3) The tensile strength shall be not less than 2500 pounds per square inch.
- (4) The ultimate elongation shall be not less than 450 percent.
- (5) The compression set shall be not more than 30 percent.
- (6) The water absorption (by weight) shall be not more than five percent.
- (7) The decrease in tensile strength and ultimate elongation after aging shall be not more than 20 percent.
- (8) There shall be no sign of failure due to brittleness at a temperature of minus 35°F.

b. Class II Waterstops

- (1) The hardness (Shore A durometer) shall be not less than 60.
- (2) The specific gravity shall be not more than 1.4.
- (3) The tensile strength shall be not less than 1400 pounds per square inch.

- (4) The ultimate elongation of the web shall be not less than 280 percent and that of the flanges shall be not less than 200 percent.
- (5) The water absorption (by weight) shall be not more than one percent.
- (6) There shall be no sign of failure due to flange brittleness at a temperature of 0°F nor of web brittleness at a temperature of minus 35°F.
- (7) The decrease in either tensile strength or ultimate elongation after accelerated extraction shall be not greater than 15 percent.
- (8) As a result of the effects of alkalies:
 - (a) After immersion for seven days, the sample shall exhibit no loss of weight and not more than 0.25 percent increase in weight, and the hardness (Shore A) of the treated sample shall differ from that of the untreated sample by not more than plus five points or minus five points.
 - (b) After immersion for 30 days, the sample shall exhibit no loss of weight and not more than 0.40 percent increase in weight, and the dimensions of the treated sample shall not differ from those of the untreated sample by more than one percent.

4. TEST METHODS

Testing shall be done by the methods cited herein. All cited test methods are included in Federal Test Method Standard No. 601.

- a. Hardness shall be determined by Method 3021.
- b. Specific gravity shall be determined by Method 14011.
- c. Tensile strength shall be determined by Method 4111.
- d. Ultimate elongation shall be determined by Method 4121.
- e. Compression set shall be determined by Method 3311.
- f. Water absorption shall be determined by Method 6631.
- g. Tensile strength and ultimate elongation after aging shall be determined by Method 7111.
- h. Brittleness shall be determined by Method 5311.

i. Accelerated extraction shall be accomplished by Method 6111 under the following conditions:

- (1) Samples shall be not less than 1/16-inch nor more than 1/8-inch in thickness;
- (2) The immersion medium shall be a solution made by dissolving five grams of chemically pure sodium hydroxide and five grams of chemically pure potassium hydroxide in one liter of distilled water;
- (3) The samples shall be immersed in the medium for 14 days at a temperature of $145^{\circ} \pm 5^{\circ}\text{F}$;
- (4) During the immersion period, air shall be gently bubbled through the medium from a 1/4-inch glass tube at a rate of about one bubble per second;
- (5) Fresh medium shall be substituted every day;
- (6) Samples need not be dipped in acetone.

j. The effects of alkalies shall be determined by Method 6251 under the following conditions:

- (1) Sample shall be not more than 1/4-inch in thickness;
- (2) The immersion medium shall be as described in (i), above;
- (3) Fresh medium shall be substituted every 7 days.
- (4) The samples shall be immersed in the medium for a period of 30 days;
- (5) Samples need not be dipped in acetone.

5. CONDITION

Waterstops shall be extruded or molded in such a manner that the material is dense and homogeneous throughout and free from voids, tears, thins, indentations, or other imperfections. Unless otherwise specified, waterstops shall be symmetrical in shape and uniform in dimensions and shall be furnished in continuous strips at least 50 feet long. Factory splices shall have a tensile strength equal to at least one-half that of the unspliced section.

6. PACKAGING AND STORING

Waterstops shall be packaged and stored by methods that will protect them from prolonged exposure to direct sunlight or excessive heat.

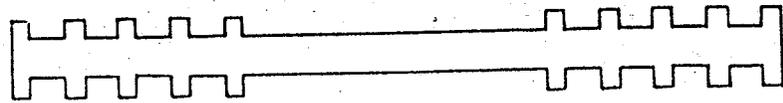
TABLE 1. SIZES OF WATERSTOPS

<u>Size Designation</u>	<u>Web Thickness (T) (Inches)</u>	<u>Width (W) (Inches)</u>
1	1/16	5 1/4
2	3/32	3 3/4
3	3/32	4
4	3/32	5 1/4
5	3/32	6
6	1/8	4
7	1/8	5 1/4
8	1/8	6
9	5/32	4
10	5/32	4 1/2
11	5/32	9
12	3/16	4
13	3/16	5
14	3/16	6
15	3/16	9
16	1/4	6
17	1/4	9
18	3/8	5
19	3/8	6
20	3/8	9
21	1/2	6
22	1/2	9
23	1/2	12

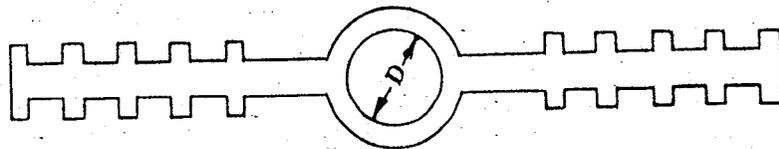
FIGURE 1

TYPES OF NON-METALLIC WATERSTOPS

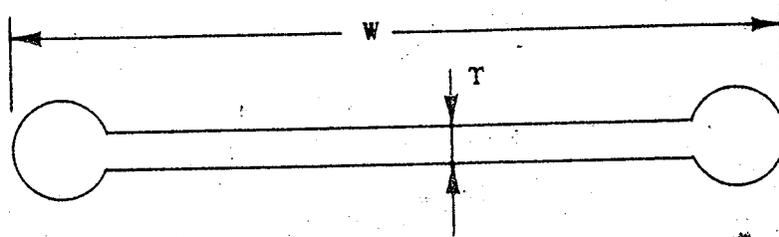
TYPE A



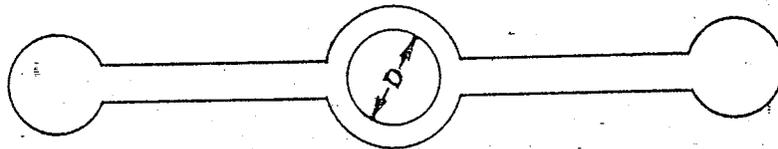
TYPE B



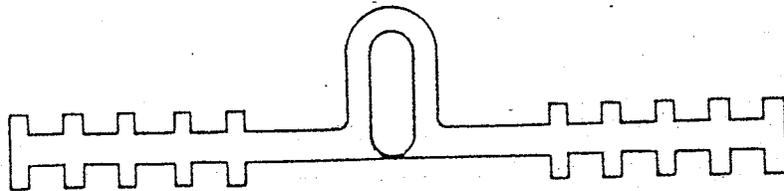
TYPE C



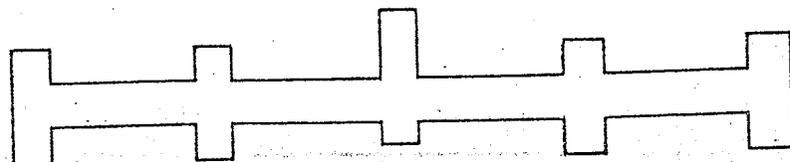
TYPE D



TYPE E



TYPE F



MATERIAL SPECIFICATION

539. STEEL REINFORCEMENT (FOR CONCRETE)

1. SCOPE

This specification covers the quality of steel reinforcement for reinforced concrete.

2. QUALITY

All reinforcement shall be free from rust, oil, grease, paint or other deleterious matter.

Steel bars for concrete reinforcement requiring bends shall be deformed billet-steel bars conforming to ASTM Specification A 615, Grade 40 or Grade 60.

Straight steel bars shall be deformed bars conforming to one of the following specifications:

Deformed Billet-Steel Bars for Concrete Reinforcement (Grade 40 or Grade 60) - ASTM Designation A 615.

Rail-Steel Deformed Bars for Concrete Reinforcement (Grade 50 or Grade 60) - ASTM Designation A 616.

Axle-Steel Deformed Bars for Concrete Reinforcement (Grade 40 or Grade 60) - ASTM Designation A 617.

Fabricated steel bar mats shall conform to the requirements of ASTM Specification A 184.

Welded steel wire fabric reinforcement shall conform to the requirements of ASTM Specification A 185.

Welded deformed steel wire fabric for concrete reinforcement shall conform to the requirements of ASTM Specification A 497.

Cold-drawn steel wire reinforcement shall conform to the requirements of ASTM Specification A 82.

Deformed steel wire for concrete reinforcement shall conform to the requirements of ASTM Specification A 496.

3. DIMENSIONS OF WELDED WIRE FABRIC

Gauges, spacing and arrangement of wires in welded steel wire fabric shall be as defined in ACI Standard 315 of the American Concrete Institute for the specified style designations.

4. STORAGE

Steel reinforcement stored at the site of the work shall be stored above the ground surface on platforms, skids or other supports and shall be protected from mechanical injury and corrosion.

MATERIAL SPECIFICATION

542. CONCRETE CULVERT PIPE

1. SCOPE

This specification covers the quality of nonreinforced and reinforced concrete culvert pipe.

2. NONREINFORCED PIPE

Nonreinforced concrete culvert pipe shall conform to the requirements of ASTM Specification C 14 for the class of pipe specified.

3. REINFORCED PIPE

a. Round pipe. Round reinforced concrete culvert pipe shall conform to the requirements of ASTM Specification C 76 or ASTM C 655 for the class of pipe specified.

b. Arch pipe. Reinforced concrete arch culvert pipe shall conform to the requirements of ASTM Specifications C 506 for the class of pipe specified.

c. Elliptical pipe. Reinforced concrete elliptical culvert pipe shall conform to the requirements of ASTM Specification C 507 for the class of pipe specified.

4. REINFORCED BOX SECTIONS

Reinforced concrete box sections shall conform to the requirements of ASTM Specifications C 789 or C 850 for the design specified.

5. RUBBER GASKET JOINTS

When rubber gasket joints are specified, the joints and gaskets shall conform to the requirements of ASTM Specification C 443.

MATERIAL SPECIFICATION

551. ZINC-COATED OR STEEL CORRUGATED PIPE

1. SCOPE

This specification covers the quality of zinc-coated iron or steel corrugated pipe and fittings.

2. PIPE

Zinc-coated iron or steel corrugated pipe and fittings shall conform to the requirements of Federal Specification WW-P-405 for the specified classes and shapes of pipe, and to the following additional requirements:

- a. Unless otherwise specified, circumferential shop riveted seams shall have a maximum rivet spacing of six inches, except that six rivets will be sufficient for 12-inch diameter pipe.
- b. When close riveted pipe is specified: (1) the pipe shall be fabricated so that the rivet spacing in the circumferential seams shall not exceed three inches, except that 12 rivets will be sufficient to secure the circumferential seams in 12-inch pipe, and (2) in those portions of the longitudinal seams that will be covered by the coupling bands the rivets shall have finished flat heads or the rivets and holes shall be omitted and the seams shall be connected by welding to provide a minimum of obstruction to the seating of the coupling bands.
- c. Double riveting or double spot welding of pipe less than 42 inches in diameter may be required. When double riveting or double spot welding is specified, the riveting or welding shall be done in the manner specified for pipe 42 inches or greater in diameter.

3. COATINGS

Coatings shall conform to the requirements of Federal Specification WW-P-405 for the specified types of coatings.

MATERIAL SPECIFICATION

581. METAL

1. SCOPE

This specification covers the quality of steel and aluminum alloys.

2. STRUCTURAL STEEL

Structural steel shall conform to the requirements of ASTM Specification A 36.

High-strength low-alloy structural steel shall conform to ASTM Specification A 242 or A 588.

Carbon steel plates of structural quality to be bent or formed cold shall conform to ASTM Specification A 283, Grade C.

Carbon steel sheets of structural quality shall conform to ASTM Specification A 570, Grade D or A611, Grade D.

Carbon steel strip of structural quality shall conform to ASTM Specification A 570, Grade C.

3. COMMERCIAL OR MERCHANT QUALITY STEEL

Commercial or merchant quality steel shall conform to the requirements of the applicable ASTM specifications listed below:

<u>Product</u>	<u>ASTM Specification</u>
Carbon steel bars	A 575, Grade M 1015 to Grade M 1031
Carbon steel sheets	A 569
Carbon steel strip	A 569
Zinc-coated carbon steel sheets	A 526

4. ALUMINUM ALLOY

Aluminum alloy products shall conform to the requirements of the applicable ASTM specifications listed below. Unless otherwise specified, alloy 6061-T6 shall be used.

MATERIAL SPECIFICATION

582. GALVANIZING

1. SCOPE

This specification covers the quality of zinc coatings applied to iron and steel products.

2. QUALITY

Zinc coatings shall conform to the requirements of the following specifications.

Zinc coatings on products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strip, 1/8 inch thick and heavier shall conform to ASTM Specification A 123.

Zinc coatings on assembled steel products shall conform to the requirements of ASTM Specification A 386 and shall be applied in conformance with the Recommended Practice for Providing High Quality Zinc Coatings (Hot-Dip) on Assembled products (ASTM Designation A 385).

Zinc coatings on iron and steel hardware shall conform to the requirements of ASTM Specification A 153 except that bolts, screws and other fasteners - 1/2 inch or less in diameter may be coated with electrodeposited zinc or cadmium coating conforming to the requirements of ASTM Specification A 165, Type TS, or ASTM Specification B 633, Service Condition SC-3 unless otherwise specified.