

Reference:

DACW09-87-C-0043

SPECIFICATIONS

for

ARIZONA CANAL DIVERSION CHANNEL

(Dreamy Draw to Cave Creek)

ENGINEERING DIVISION

LIBRARY

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Authority:

Public Law 89-298,
Flood Control Act of 1965

Appropriation:

Construction General
Contributed Funds, Other



**US Army Corps
of Engineers**

Los Angeles District

T A B L E O F C O N T E N T S

T E C H N I C A L P R O V I S I O N S

<u>Section</u>	<u>Title</u>
1A	General Requirements
1B	Measurement and Payment
1C	Contractor's Quality Control
1D	Environmental Protection
	By C.O.E
2A	Diversion and Control of Water
2B	Clearing Site and Removing Obstructions
2C	Excavation
2D	Fills and Subgrade Preparation
2E	Prime Coat and Weed Killer
2F	Asphalt Concrete
2G	Aggregate Base
2H	Miscellaneous Aggregates
2I	Trees, Shrubs, and Ground Covers
2J	Irrigation System
2K	Concrete Sidewalks, Curbs, Gutters, and Driveway Entrances
2L	Side Drains, Payback Water Line and Low Flow Conduits
2M	Stone Protection <i>SEE TALKS and T...</i>
2N	Grouted Stone Protection
2O	Sanitary Sewers
2P	Scour Gauges
2R	Turf
2S	Pavement Markings
2T	Water Lines
2U	Excavating, Trenching, and Backfilling for Utilities
2V	Concrete Paving Stone
2W	Plastic Filter Fabric
3A	Formwork for Concrete
3B	Expansion, Contraction and Construction Joints in Concrete
3C	Steel Bars, Steel Welded Wire Fabric, and Accessories for Concrete Reinforcement
3D	Stressing Tendons and Accessories for Prestressed Concrete
3E	Concrete
3F	Shotcrete
3G	Precast Concrete Roof Units
3H	Precast Prestressed Concrete
3I	Concrete for Building Construction
4A	Reinforced Masonry
5A	Miscellaneous Metals
7A	Built-Up Roofing
7C	Galking and Sealants
8A	Steel Doors and Frames
8C	Hardware Builders' (General Purpose)

C O N T E N T S (Continued)

<u>Section</u>	<u>Title</u>
9A	Painting, General
9B	Station Marking
10B	Toilet Accessories
11A	Miscellaneous Items of Work
15A	Plumbing, General Purpose
16A	Electrical Distribution System, Underground
16B	Electrical Work, Interior

RESTRICTIONS:

1. Arizona Canal
2. Dunlap Detour
3. Sunnyslope High School
4. Swimming Pool

1. ARIZONA CANAL. Removal and/or repair of Arizona Canal bank lining can only take place during the annual dry up period. This usually occurs during late November and early December, and lasts for approximately two weeks. Any request to perform work outside of this period will need written permission from the Salt River Project, and is not easily obtained.

2. DUNLAP DETOUR. Construction of the covered section across Dunlap Avenue will need to be accomplished in two phases. During the first phase, a three lane detour will be in place north of Dunlap Avenue. Phase One can not start prior to June 3rd and must be completed with four lanes of traffic restored, prior to September 1st.

3. SUNNYSLOPE HIGH SCHOOL. Construction between Station 677+20 and Station 693+20 must be completed between May 15th and November 15th.

3.1 Electrical power to ball field lights north of the construction easement must be maintained. The power source and lines to these lights are shown on the drawings, but must be verified by the Contractor prior to disconnection.

3.2 Temporary fencing shall be constructed across the school property as detailed on the drawings. The fence shall be of a type that will serve as a visual barrier as well as a physical barrier. The fence design shall be approved by the Contracting Officer prior to erection.

4. SWIMMING POOL. Construction of the project will require closure of the parking lot that serves the City of Phoenix swimming pool shown on the drawings. The Contractor shall maintain safe and unrestricted pedestrian access to the pool during the time it is open for operation.

4.1 Temporary fencing shall be constructed across the pool site on the construction easement as detailed on the drawings. The fence shall be of a type that will serve as a visual barrier as well as a physical barrier. The fence design shall be approved by the Contracting Officer prior to erection.

SECTION 1B

MEASUREMENT AND PAYMENT

Index

- | | |
|--|--|
| 1. Diversion and Control of Water | X Pedestrian Bridge |
| 2. Clear Site and Removing Obstructions | 15. Manhole Adjustments |
| 3. Excavation | 16. Station Markings |
| 4. Compacted Fill, Channel | X Concrete, Side Slope |
| X Backfill Toe Levee | X Conduits |
| X Compacted Fill Certification | X Intake Tower |
| X Miscellaneous Fill | X Pier Nose Extensions |
| 5. Spillways | X I-17 Underpass Ramps |
| 6. Concrete, Top Slab | X Stone |
| 7. Concrete, Invert | 17. Grout |
| 8. Concrete, Walls | 18. Portland Cement |
| X Color Admixture for Concrete and Grout | 19. Gaging Station |
| 9. Steel Reinforcement | X Scour Gages |
| 10. Asphalt Concrete Paving | 20. Shotcrete |
| 11. Steel Picket Fence | X 12-Inch Payback Line |
| 12. Side Drains | X Aesthetic Treatment |
| 13. Miscellaneous Hardware | X Recreation |
| X Moon Valley Channel and Inlet Chute | 21. Rock Excavation |
| 14. Driveway Entrance | 22. Detours and Traffic Control Facilities |

1. DIVERSION AND CONTROL OF WATER. Payment for Diversion and Control of Water will be made at the applicable contract price, which payment shall constitute full compensation for diverting and controlling the water in the channel and other work areas, complete.

2. CLEAR SITE AND REMOVING OBSTRUCTIONS.

2.1 General. Payment shall include all costs for clearing removal, replacement, and restoration work (except work by others) including all existing obstructions within the channel rights-of-way, fill sites, and the obstructions indicated for removal outside of the rights-of-way and inside the construction easements. Except as otherwise specified, payment for clearing and removal of work includes applicable earthwork; filling holes, removing and plugging abandoned lines; removal of existing

structures; removal of buildings and slabs; removal of materials for salvage; protection, replacement or restoration of utilities, fences, walls and features indicated and the disposal of all materials.

2.2 Payment for Clear Site and Remove Obstructions will be made at the applicable contract price, which payment shall constitute full compensation for clearing the site and removing obstructions, including clearing and grubbing, complete.

3. EXCAVATION.

3.1 Measurement of Excavation. A survey of the site shall be made prior to commencement of work, and all measurements will be based on this survey without regard to any changes in the site that may be made between the excavation lines and grades indicated on the drawings or staked in the field and the ground surfaces as indicated by the above mentioned survey. The actual slopes as excavated may be greater or less than those indicated or staked, depending on the materials excavated and methods used in performing the work, but such alterations shall not change the measurement for payment from the original lines as specified herein. The quantity of directed excavation necessary for the removal of unsuitable foundation material as specified shall be included in the measurement of the excavation where the unsuitable soils are encountered. Quantities will be computed in cubic yards by the average end area method and the planimeter will be considered a precise instrument for measurement of plotted cross-sections. All excavation outside of excavation lines shown on the drawings will be considered as being for the convenience of the Contractor.

3.2 Payment.

3.2.1 Payment for Excavation will be made at the applicable contract price, which payment shall constitute full compensation for excavation for channel construction (including shoring) and other areas as indicated on the drawings; shaping and trimming of areas to receive concrete; loading, hauling, placement, shaping, and grading of excess excavated material in optional disposal areas; and any costs associated with disposal of excess excavated or cleared material in the optional disposal area (as shown on the drawings) and complete. No payment will be included in this item for other earthwork requirements paid for under separate bid items.

3.2.2 Subgrade Preparation. No separate payment will be made for subgrade preparation and all costs in connection therewith shall be included in the contract prices for the items to which the work applies.

3.2.3 Excavation for Structures. No separate payment will be made for excavation for structures. All costs therefore shall be included in the applicable contract prices for the items to which the work applies.

3.2.4 Trenches. No separate payment will be made for excavation of pipeline trenches. All costs therefore shall be included in the applicable contract prices for the items to which the work applies.

4. COMPACTED FILL, CHANNEL.

4.1 Measurement of Compacted Fill for Channel will be by the cubic yard compacted as shown on the drawings, and will be made in accordance with the requirements of paragraph: QUANTITY SURVEYS of the SPECIAL CLAUSES.

4.2 Payment for Compacted Fill, Channel will be made at the applicable contract price, which payment shall constitute full compensation for construction of backfill behind vertical channel walls at the required slope (including fill outside the required prism), complete. No additional payment will be made for placement of fill outside of the required cut-slope.

4.2.1 Fill for Structures. No separate payment will be made for fill or backfill about structures. All costs therefore shall be included in the applicable contract prices for the items to which the work applies.

4.2.2 Trenches. No separate payment will be made for backfilling trenches for pipelines. All costs therefore shall be included in the applicable contract prices for the items to which the work applies.

5. SPILLWAYS.

5.1 Payment for Spillways will be at the applicable contract price, which payment shall constitute full compensation for construction of the channel spillways, and the Maintenance Road spillways, including subgrade preparation; forming; aprons; concrete curbs; and materials (excluding steel reinforcing); placing; finishing; and curing of concrete, complete.

6. CONCRETE, TOP SLAB.

6.1 Measurement of Concrete Top Slabs will be made by the cubic yards of concrete placed in the top slab above the walls, including fillets. Concrete in excess of the dimensions shown on the drawings or wasted at the convenience of the Contractor shall not be included in measurement for payment.

6.2 Payment for Concrete Top Slabs will be made at the applicable contract price, which payment shall constitute full compensation for construction of the covered section top slab, underpass top slab including headwalls, manholes (complete with covers), and fillets, and including forming; materials (excluding steel reinforcing); placing; finishing; and curing of concrete, complete.

7. CONCRETE, INVERT.

7.1 Measurement of Concrete, Invert will be made by the cubic yards of concrete placed in the invert of the rectangular channel, invert access ramp inverts (including the starter wall), underpass ramp inverts (including the starter wall), underpass and cut off wall (upstream invert) as shown on the drawings. Concrete in excess of the dimensions shown on the drawings or wasted at the convenience of the Contractor shall not be included in measurement for payment.

7.2 Payment for Concrete, Invert will be made at the applicable contract price, which payment shall constitute full compensation for construction of the rectangular channel, invert access ramp inverts, underpass ramp inverts, and cutoff wall (upstream invert) including subgrade preparation; forming; materials (including scour gauges; and excluding steel reinforcing); placing; finishing; and curing of concrete, complete.

8. CONCRETE, WALLS.

8.1 Measurement of Concrete Walls will be made by the cubic yards of concrete placed in the walls above the starter wall, including the rectangular channel walls (including haunches), the invert access ramp walls, underpass walls, covered section walls and retaining walls (including footings). Concrete in excess of the dimensions shown on the drawings or wasted at the convenience of the Contractor shall not be included in measurement for payment.

8.2 Payment for Concrete Walls will be made at the applicable contract price, which payment shall constitute full compensation for construction of concrete walls above the starter wall in the rectangular channel section, covered box section, invert access ramps, underpass ramps, underpass, and retaining walls, including forming; materials (excluding steel reinforcing); placing; finishing; and curing of concrete, complete. Costs for "blockouts" required for installation of posts for steel picket fence shall be included in this bid item.

8.3 Payment for Concrete, Transition Walls will be included in the pay item Concrete Walls.

8.4 Payment for Concrete, Retaining Walls will be included in the pay item Concrete Walls.

9. STEEL REINFORCEMENT.

9.1 Measurement of Steel Reinforcement in concrete structures, excluding conduits and side drains, will be made of the lengths of bars actually place in the completed work in accordance with the plans and specifications, approved bar schedules, or as directed. The measured lengths will be converted to weights for the bar numbers listed in ASTM A 615. Steel in laps indicated on the drawings, in the specifications, or required by the Contracting Officer will be included in measurement for payment. No steel reinforcing wasted or included for the convenience of the Contractor will be measured for payment. No steel supports or spacers will be included for payment in this item; all costs for furnishing and installing supports and spacers shall be included in the various structures requiring the reinforcement.

9.2 Payment for Steel Reinforcement will be made at the applicable contract price, which payment shall constitute full compensation for furnishing and installing steel reinforcement, complete. No payment will be included in this item for other steel reinforcement requirements paid for under separate bid items.

10. ASPHALT CONCRETE PAVING.

10.1 Measurement of Asphalt Concrete Paving to be paid for will be by the number of tons (2000 pounds) of asphalt concrete placed, compacted and accepted in the completed work.

10.2 Payment for Asphalt Concrete Paving will be made at the applicable contract price, which payment shall constitute full compensation for asphalt concrete paving, including tack coat, prime coat complete. No payment will be included in this item for asphalt concrete requirements paid for under separate bid items.

11. STEEL PICKET FENCE. Payment for Steel Picket Fence will be made at the applicable contract price, which payment shall constitute full compensation for construction, materials, and installation of steel picket fence, including posts, fence panels, reflectors, paint and picket gates, complete. No payment will be included for non-shrink grout in this item.

12. SIDE DRAINS. Payment for Side Drains will be made at the applicable contract price, which payment shall constitute full compensation for construction of side drains including materials for outlet structures, junction structures, catch basins (complete with grates), concrete swale, collars, and earthwork, complete.

13. MISCELLANEOUS HARDWARE. Payment for Miscellaneous Hardware will be made at the applicable contract price, which payment shall constitute full compensation for pipe gates, pipe gate signs, reflectors, or pipe gate stoppers, bollards, invert access ladder, concrete and earthwork, complete.

14. DRIVEWAY ENTRANCE. Payment for Driveway Entrance will be made at the applicable contract price, which payment shall constitute full compensation for the drive entrances, complete including clearing and removing obstructions (including existing curb and gutter and pavement replacement) and earthwork outside of the channel payment items limits; concrete (including steel reinforcement) for pavement, sidewalks, concrete curb and gutter and driveway.

15. MANHOLE ADJUSTMENTS. Payment for Manhole Adjustments will be made at the applicable contract price which payment shall constitute full compensation for all necessary work to adjust manholes, and placing plugs for existing utilities, complete.

16. STATION MARKING. Payment for Station Marking will be made at the applicable contract price, which payment shall constitute full compensation for obtaining materials, fabrication and installation necessary for the work, complete in place.

17. GROUT.

17.1 Measurement. The quantity of grout to be paid for will be measured to the nearest cubic yard by weighing all ingredients in trial batches of grout and converting each batch to absolute volume; the volume thus

determined and the number of batches of grout of corresponding proportions acceptable placed in the work shall be used to determine the quantity of grout.

17.2 Payment for Grout will be made at the applicable contract price, which payment shall constitute full compensation for mixing, transporting, placing, finishing, and curing grout, excluding cement, complete.

18. PORTLAND CEMENT.

18.1 Measurement. The quantity to be paid for will be the number of hundredweight (100 pounds) of Portland Cement used in the concrete paid for on a cubic yard basis unless specifically excepted, wasted or used for the convenience of the Contractor. The quantity to be paid for will be determined by multiplying the approve batch weight of Portland Cement by the number of batches of grout placed within the pay lines of the structures and dividing by 100.

18.2 Payment for Portland Cement will be made at the applicable contract price, which payment shall constitute full compensation for furnishing the Portland Cement complete, ready for use in the work. No payment will be made Portland Cement as such, which is used in concrete in structures for which payment is made on a lump sum basis.

19. GAGING STATION. Payment for Gaging Station will be made at the applicable contract price, which payment shall constitute full compensation for the gaging station, complete in place.

20. SHOTCRETE. Payment for Shotcrete will be made at the applicable contract price, which payment shall constitute full compensation for the shotcrete complete in place.

21. ROCK EXCAVATION

21.1 Measurement of Rock Excavation will be by the cubic yard as determined truck load volume of material requiring blasting to be removed. The Contractor is to remove as much material by other means as possible prior to having the area requiring blasting for removal approved by the Contracting Officer. Material removed outside of the lines shown on the drawings (including "A" and "B" line designations) will not be considered for measurement.

21.2 Payment for Rock Excavation will be at the applicable contract price, which payment shall constitute full compensation for excavation, blasting (including all costs associated therewith), loading, hauling and disposal, and preparation of the surface for Concrete Invert.

22. DETOURS AND TRAFFIC CONTROL FACILITIES

22.1 Measurement of Detours and Traffic Control Facilities will include all material, labor, and equipment necessary for the construction, maintenance and removal of the detours as shown on the drawings and as stated in the specifications.

22.2 Payment for Detours and Traffic Control Facilities will be made at the applicable contract price, which payment shall constitute full compensation for construction of the detours (including bridges); earthwork; roadway construction; removal of existing roadway (including driveways and sidewalk ramps), and reconstruction of the roadway in accordance with the drawings; installation, maintenance and removal of all traffic control facilities (including pavement markings) as shown on the drawings; installation and removal of street lights; protection and adjustments to utilities; removal of all items and restoration of the area to existing grades or as indicated on the drawings; pick-up and delivery of owner supplied materials; salvaging bridge beams upon removal and delivering them to a specified site; and all other work indicated on the drawings or in the specifications (excluding catch basins).

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SECTION 2A

DIVERSION AND CONTROL OF WATER

1. REQUIREMENT.

1.1 General. All permanent construction shall be carried on in areas free from water. Water in varying quantities may be flowing in the basin and channels during the entire period of construction as a result of either rainfall or releases from Cave Buttes Dam. Runoff from the watersheds is rapid, and, during periods of rain, intermittent freshets may be expected. The responsibility of the Contractor for protection of work against water flows is specified in paragraph: DAMAGE TO WORK of the SPECIAL CLAUSES. At all locations where construction work is at a lower elevation than the elevation of the stream or perched water at the time of doing the work, suitable cofferdams or dikes, if necessary, shall be constructed, the construction area shall be dewatered prior to commencement of work, and all subgrades, whether for earth fill, stone, or concrete, shall be kept drained and free of water throughout the working period. Within 10 days after receipt of Notice to Proceed, the Contractor shall submit plans showing the method that he proposes to use to dewater each working area and control the water from rain, sheet flow, stream flow, and any other surface water. The plans shall show the scheme of operations and a complete layout of drainage pipes, pumps, diversion channels, cofferdams, etc. The plans shall also take into consideration the following specific requirements.

1.2 Flood Flows. The Contractor shall provide for diversion of channel flows as hereinafter specified. The channel flows will include water originating from upstream of the work; urban runoff; adjacent drainages; and in addition any and all seepage and perched water originating within the work. Flood flows are defined as follows:

a. Arizona Canal Diversion Channel (~~29th Avenue to Cave Creek~~) - Any flows in excess of 4000 cfs which includes 2000 cfs from upstream of ~~project A (concurrent construction of the Arizona Canal Diversion Channel - upstream end of Project A to Dreamy Draw)~~ and from Arizona Canal.

~~b. Cave Creek Channel and Sediment Basin (Sweetwater Avenue to 29th Avenue) - Any flows in excess of 2500 cfs.~~

1.3 Contractor shall be prepared to accept flood flows diverted to project area by the Arizona Canal and/or concurrent construction (upstream end of Arizona Canal Diversion Channel (~~29th Avenue to Cave Creek~~) to ~~Dreamy Draw~~).

1.4 Drainage Ditches. The location and depth of any drainage ditch to be constructed under this contract shall be subject to the approval of the Contracting Officer. Special precautions shall be taken to avoid impairing the permanent subgrade, and any excavation below the existing streambed or invert subgrade shall be refilled with compacted fill in accordance with SECTION: FILLS AND SUBGRADE PREPARATION by and at the expense of the Contractor.

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SECTION 2B

CLEARING SITE AND REMOVING OBSTRUCTIONS

1. PROTECTION.

1.1 Environmental Protection. All work and Contractor operations shall comply with the requirements of SECTIONS: ENVIRONMENTAL PROTECTION and EXCAVATION.

2. BURNING. The use of burning at the project site for the disposal of refuse and debris will not be permitted.

3. REQUIREMENTS.

3.1 General. Except as otherwise specified, and/or indicated, areas to be cleared will be limited to actual excavation areas, areas to be landscaped, and areas on which fills and/or structures are to be placed. The removal of trees, shrubs, turf, and other vegetation outside of these areas shall be held to a minimum and care shall be exercised not to damage any trees, shrubs, turf, or vegetation which can be left in place.

3.2 Existing Structures and Obstructions. The Contractor shall clear and grub the site, fill, borrow, and excavation areas, and remove and dispose of all existing structures and obstructions for project construction, except as those structures which are identified to be protected in place as shown on the drawings. Obstructions which are designed or specified to be removed but which are not designated or specified to be removed by others shall be removed by the Contractor. Except as otherwise specified, obstructions designated to be removed by others will be removed in sufficient time to preclude interference with the Contractor's operations. Utility relocations are not considered to be obstructions.

3.2.1 Clearing. Trees smaller than 1-1/2 inches in diameter and other vegetation, except as specified, shall be cut off 6 inches below the indicated channel subgrade or ground level whichever is lower. Other vegetation shall be cut off flush or slightly below the original ground surface. Clearing operations shall be conducted so as to prevent damage to trees, structures, and installations under construction, or to remain in place, and to provide for the safety of employees and others. All rubbish, waste dumps, and debris areas shall be cleared.

3.2.2 Grubbing shall consist of removing all trees, stumps, roots, logs, and other objectionable vegetable matter in the required fills, foundation areas, and all excavation areas. In grubbing out stumps and roots, all roots or other timber more than 1-1/2 inches in diameter shall be removed to 3 feet below the depth of the required excavation or existing ground level, whichever is lower. Trees and stumps shall be pulled, not cut off.

3.3 Utilities. Prior to removing an obstruction, all applicable utility relocations shall have been coordinated. Pipes designated by owners as "abandoned" shall be removed within the limits of the project as necessary for clearing. All abandoned pipes shall be plugged at the cut ends as shown on the drawings or as directed by the Contracting Officer.

4. DISPOSAL OF CLEARED, GRUBBED, AND REMOVED MATERIAL. All material removed, except material specified and/or indicated to be salvaged, is designated as scrap, shall become the property of the Contractor, and shall be removed from the site. Unsuitable materials from clearing operations may be temporarily used for diversion and control of water. Disposal shall be in accordance with the requirements of SECTION: ENVIRONMENTAL PROTECTION.

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SECTION 2C

EXCAVATION

Index

- | | |
|------------------------------|------------------------------------|
| 1. Applicable Publications | 7. Excavation for Side Drains |
| 2. General | 8. Removal of Unsatisfactory Soils |
| 3. Blasting | 9. Disposal of Excavated Materials |
| 4. Preservation of Property | 10. Overcut |
| 5. Excavation for Structures | 11. Rock |
| 6. Excavation for Roads | |

1. **APPLICABLE PUBLICATIONS.** The American Society for Testing and Materials (ASTM) Standards listed below forms a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

D 2487-85

Classification of Soils for
Engineering Purposes

2. **GENERAL.** Excavation shall consist of the removal of every type of material encountered (except materials covered by the provisions of the SECTION: CLEARING SITE AND REMOVING OBSTRUCTIONS) in the designated areas or from areas directed. The material to be removed may include but is not limited to earth, hardpan, silt, clay, gravel, cemented sand and gravel, rock, adobe, detached pieces of stone and concrete, rock fills, existing fills of miscellaneous debris and rubbish, and other unsuitable materials. "Rock" is defined as solid bedrock, decomposed or weathered bedrock, and boulders and blocks 1/2 cubic yard or more in volume. All blasting required for excavation shall conform to the requirements specified in the paragraph: "BLASTING" after "unsuitable materials." Slope lines indicated on the drawings for temporary cuts do not necessarily represent the actual slope to which the excavation must be made to safely perform the work. Excavation for permanent cuts shall be made to the slope lines indicated. Excavation shall be performed in a manner which will not impair the subgrade. Except as otherwise specified, the finish surface of subgrades shall be smooth and shall not vary more than 1/2 inch from indicated grade.

3. **BLASTING.**

3.1 **General.** All blasting required for excavation shall conform to the requirements in the following paragraphs and shall also be in accordance with the applicable portions of Section 107 of the Maricopa Association of Governments (M.A.G.) Uniform Standard Specifications and Article 12 of the City of Phoenix, Arizona Fire Prevention Code.

3.2 Safety Requirements. For these requirements reference is made to the CONTRACT CLAUSE: ACCIDENT PREVENTION. Blasting will be permitted only when adequate precautions are taken for the protection of persons, the work, and property. Any damage to the work or property shall be repaired by the Contractor at no cost to the Government.

3.3 Permits. For these requirements reference is made to the CONTRACT CLAUSE: PERMITS AND RESPONSIBILITIES. The Contractor shall obtain all required licenses and permits for the use of explosives and shall also comply with the provisions and requirements of all applicable laws, ordinances, and regulations in the transportation, storage, handling, and use of such explosives.

3.4 Utility Notification. The Contractor shall notify each public utility company, having structures adjacent to the work, of his intention to use explosives. Such notice shall be given sufficiently in advance to enable the companies to advise the Contractor of any precautions that should be taken to protect their structures from damage.

3.5 Submittals.

3.5.1 Blasting Plan. The Contractor shall submit 3 copies of the proposed blasting plan to the Contracting Officer for approval not less than 30 calendar days prior to drilling for each blast. The proposed plan shall show the pertinent data on the location, depth, and area of the blast; the diameter, spacing, depth, overdepth, pattern, and inclination of the blast holes; the type, strength, amount, distribution, and powder factor for the explosives used per hole and per blast; the sequence and pattern of delays, and the description and purpose of controlled blasting techniques.

3.5.2 Preblast Report. The Contractor shall submit 3 copies of a preblast inspection report of adjacent properties to the Contracting Officer for approval not less than 30 calendar days prior to commencing blasting operations. The report shall document, on drawings and by photographs, the locations of all existing cracks and damages to structures within 500 feet of the blast site. The report shall also include information on any property owners who refused to cooperate and permit entry and inspection.

3.6 Approval of Blasting Plan. Approval by the Contracting Officer of a blasting plan shall not relieve the Contractor of his responsibility to produce satisfactory results as set forth in these specifications. When a drilling and blasting program results in damage to the excavation, the Contractor shall be required to modify his blasting plan, subject to approval by the Contracting Officer, to produce the desired results.

3.7 Personnel. During blasting operations the Contractor shall have on the site, and in immediate charge of the blasting and rock excavation, a blasting expert, acceptable to the Contracting Officer, who has had no less than 3 years of continuous experience in controlled blasting and rock excavation operations. Powder handlers shall have no less than one year of continuous experience in preparation and loading of powder charges.

3.8 Blasting Procedures. Drilling and blasting within the diversion channel excavation shall be in accordance with the blasting plan approved by the Contracting Officer. The Contractor shall control the blasting procedures so as not to overshoot and shall be required to remove at his own expense, any material outside the authorized lines and grades indicated on the drawings which may be shattered or loosened by such blasting.

3.8.1 Controlled Blasting. Controlled blasting techniques (i.e., presplitting, line drilling, or smooth blasting) shall be required for blasting within the diversion channel excavation. The explosives shall be of such strength and quantity and shall be used in such a manner as will neither open seams nor otherwise damage the rock outside of prescribed limits of excavation. Controlled blasting shall be performed in a manner which will produce relatively smooth and sound faces at the final excavation lines. Where blasting is performed for excavation, buffer zones are to be provided as indicated on the drawings. Within the buffer zones the depth and spacing of blast holes and the amount of explosives shall be varied with the field conditions to prevent damage to the rock faces. Whenever, in the opinion of the Contracting Officer, blasting may injure the cut slopes or rest upon which or against which concrete is to be placed, the use of explosives shall be discontinued and the excavation shall be completed by wedging, barring, channeling and broaching, or other suitable methods. Any damage to, or displacement of, blasting shall be repaired by and at the expense of the Contractor and in a manner satisfactory to the Contracting Officer.

3.9 Restrictions.

3.9.1 No blasting shall be permitted within 100 feet of concrete which has been in place less than 7 days.

3.9.2 Ammonium nitrate type explosives shall not be used along any final excavation lines or within any buffer zones where controlled blasting techniques are employed.

3.9.3 Use of non-electric blasting caps is prohibited.

3.9.4 Blasting mats shall be used at all times and shall be in good repair. Steel mats shall not be allowed within 2,000 feet of powerlines.

3.10 Records. The Contractor shall keep and furnish to the Contracting Officer accurate logs and records of all operations pertaining to the preparation, drilling, blasting, and excavation procedures for each round of blasting. The records shall be submitted daily with the Quality Control Report and shall include the following.

3.10.1 A plan view of the actual blast hole layout, located on each corner by stationing, top and bottom elevations, offset from centerline, and distances from final excavation lines. The plan sketch shall include the number, size, depth, orientation, and spacing of each drill hole utilized for each round of blasting.

3.10.2 The quantity, type, and strength of explosives, and stemming used in blasting each drill hole.

3.10.3 The type, make, and system of detonation used for each round of blasting.

3.10.4 The volume of rock excavated from each round of blasting.

3.10.5 Any unusual drilling or blasting occurrences.

3.10.6 The number, size, type, and make of all equipment used in the excavation process.

4. PRESERVATION OF PROPERTY. All excavation operations shall be conducted in such a manner that street pavements, sidewalks, curbs, utilities, or other facilities and improvements which are to remain in place permanently will not be subjected to settlement or horizontal movement. The Contractor shall furnish and install sheet piling, cribbing, bulkheads, shores or whatever means may be necessary to adequately support material carrying such improvements themselves and shall maintain such means in position until they are no longer needed. Temporary sheet piling, cribbing, bulkheads, shores or other protective means shall remain the property of the Contractor and when no longer needed shall be removed from the site. The Contractor shall submit for approval shop drawings showing proposed method of bracing which he intends to use. All shoring and bracing shall be designed so that it is effective to the bottom of the excavation, and shall be based upon calculation of pressure exerted by and the condition and nature of the materials to be retained, including surcharge imparted to the side of the trench by equipment and stored materials. Removal of shoring shall be performed in such a manner as not to disturb or damage the finished concrete.

4.1 Shoring is indicated between the following station:

<u>STATION</u>	<u>TO</u>	<u>STATION</u>	<u>RT/LT</u>
747+15		747+55	RT.

4.2 The following soil parameters can be used for the design of the temporary sheet piling cribbing, bulkheads, shores or other protective means.

Wet unit weight	=	130 lbs/ft
Angle of internal friction	=	30 degrees
Coefficient of cohesion	=	0 lbs/ft

5. **EXCAVATION FOR STRUCTURES.** Excavation within the vicinity of existing structures, utilities, and drainage pipes to remain in place shall be performed in a manner to prevent damage to the structure. Earth banks and facilities to remain in place shall be supported as necessary during excavation. In general, unless otherwise shown or specified, the actual side slopes will be at the Contractor's option.

6. **EXCAVATION FOR ROADS** will include excavation for curbs and access roads, including materials unsuitable for road subgrade. Unsuitable materials included but not limited to those materials containing roots and material classified is ASTM D 2487 as ML, CL, MH, CH, PT, OH and OL.

7. **EXCAVATION FOR SIDE DRAINS.** Excavation for culverts shall conform to the requirements of SECTION: **SIDE DRAINS AND WATER LINES.**

8. **REMOVAL OF UNSATISFACTORY SOILS.** The removal of soils which are unsatisfactory for foundations of the channel, structures, streets, and drains, will be required in certain areas. Unsatisfactory materials include but are not limited to those materials containing roots and other organic matter, trash, debris and materials classified in ASTM D 2487 as ML, CL, MH, CH, PT, OH and OL. The Contractor will be required to excavate any such areas to the depth directed and backfill the areas with compacted fill conforming to the requirements of the SECTION: **FILLS AND SUBGRADE PREPARATION.**

9. **DISPOSAL OF EXCAVATED MATERIALS.** Excavated materials suitable for compacted fill, structure fill, and other required fills, shall be placed in temporary stock piles or used directly in the work. The miscellaneous fill areas are required fills and shall be filled in accordance with the requirements of the Section: **FILLS AND SUBGRADE PREPARATION.** All excess excavated material not disposed within the optional disposal areas, excavated material not suitable for fills, and unsatisfactory material shall become the property of the Contractor and shall be removed from the site. No excavated material or waste of any kind shall be disposed of at any place beyond the limits of the work under this contract without express authority. Prior to placing fills in stock piles, miscellaneous fill, or optional disposal areas, the site shall be cleared of trash and vegetation. Vegetation shall be cut off at the existing ground line. Clearing shall conform to the applicable requirements of Section: **CLEARING SITE AND REMOVING OBSTRUCTIONS.** Stock piles and disposal fills shall be placed in a manner to preclude the ponding of water. The Contractor shall furnish notification of his intention to use optional disposal sites in accordance with the requirements of the Paragraph **Public Utilities, Notices, and Restrictions** of the Section: **GENERAL REQUIREMENTS.**

9.1 Additional requirements for disposal of excess material can be found in the **SPECIAL CLAUSES** and **SECTIONS: GENERAL REQUIREMENTS; ENVIRONMENTAL PROTECTION; and CLEARING SITE AND REMOVING OBSTRUCTIONS.**

10. **OVERCUT.** Except as otherwise specified or as may be ordered in writing, any overcut or excavation made outside the lines indicated on the drawings or directed shall be backfilled with compacted fill or concrete,

and all excavating, backfilling, compacting of backfill, and concreting occasioned thereby shall be by the Contractor at no additional cost to the Government.

11. ROCK

11.1 General. Bedrock surfaces upon or against which structural concrete or backfill materials are to be placed shall be prepared and treated as directed by the Contracting Officer and as specified herein below.

11.2 Tolerances For Rock Excavation. Excavations for concrete structures have certain reference lines designated as "A" line and "B" line. The "A" line is located 9 inches above the "B" line in all inverts. The "A" line represents the inner tolerance limit inside which no rock will be permitted to project. Any projections inside of "A" line shall be removed. The "B" line is the line to which measurement for payment of excavation will be made, and is considered to be the final excavation line indicated on the drawings. Measurement for payment will be made to this line regardless of whether the limit of the actual excavation falls inside or outside of it, but sufficient excavation inside of this line shall be performed to provide for the proper installation of steel reinforcement and placement of concrete. Any excavation beyond the "B" line shall be replaced with concrete complying with the applicable portions of these specifications without additional cost to the Government.

11.3 Equipment. Bedrock surfaces shall be cleaned using hand tools. Hand tools, where required or permitted by these specifications, include but are not limited to shovels, bars, picks, wedges, and brooms. Light power tools and rubber tired mechanical equipment may be used only when such use is approved by the Contracting Officer.

11.3.1 Air Jets. Air jets may be used only when such use is approved by the Contracting Officer. An air jet shall consist of a minimum 10 inch nozzle with a supply hose connected to a suitable source of compressed air. The compressed air shall be controllable at the nozzle. The use of water jets will not be permitted.

11.4 Surface Preparation. When the excavation has reached the approximate limits shown on the drawings, the Contractor shall perform a detailed cleanup of the bedrock surface. The work shall consist of removing loose and/or weathered rock and pockets of fines, sand, rock, rubble or gravel and other objectional material as directed from the in-place rock surfaces including depressions, large crevices, and open joints and fractures. Picking, barring, and hand excavation may be necessary to obtain a foundation surface free from loose, drummy, or shattered rock. The final rock surface shall be thoroughly cleaned by the use of hand tools or other approved methods and shall be maintained in a clean condition until the placement of structural concrete or backfill materials thereon.

11.5 Surface Treatment. Prior to the placement of structural concrete or backfill materials, all designated bedrock surfaces shall be treated with dental concrete as directed by the Contracting Officer. No dental concrete shall be placed until the foundation cleanup is approved by the Contracting Officer. No structural concrete or backfill materials shall be placed until all dental concrete has had a minimum of 2 days to cure.

11.5.1 Dental Concrete. Dental concrete shall be used to fill joints, cavities, and depressions. Prior to placement of dental concrete, the designated areas for placement shall be thoroughly cleaned using approved methods. The designated areas shall be moistened such that absorption of water from the dental concrete will be minimized, however, no standing water will be allowed. Immediately after placement, the dental concrete shall be vibrated as specified in the Section: CONCRETE. The edges of all dental concrete areas shall then be trimmed, as required, so that no thin coats of concrete are left on smooth, intact rock surfaces. Concrete, including any forming required for acceptable placement, shall conform to the applicable requirements of the Sections: CONCRETE AND FORMWORK FOR CONCRETE.

11.6 Foundation Approval. No structural concrete or backfill materials shall be placed on any part of the bedrock foundation until all foundation preparation and treatment has been completed and such areas have been inspected and approved by the Contracting Officer. The Contractor shall remove, at his own expense, any backfill material or structural concrete placed on any part of the bedrock foundation surface which has not been approved by the Contracting Officer and shall reclean such areas at his own expense to the satisfaction of the Contracting Officer. Areas approved for material or concrete placement which have been exposed for more than 5 days may require re-cleaning at no additional expense to the Government. Areas approved for immediate material or concrete placement shall then be moistened as directed. Foundation approval shall be done in sections, the limits of which shall be established by the Contracting Officer in the field.

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SECTION 2D

FILLS AND SUBGRADE PREPARATION

Index

- | | |
|---|--|
| 1. Applicable Publications | 5. Compacted Fill, Side Drains and Water Lines |
| 2. Compaction Equipment | 6. Backfills |
| 3. General Requirements for Compacted Fills and Compacted Backfills | 7. Subgrade Preparation |
| 4. Compacted Fill, Channel | 8. Optional Disposal Areas |

1. APPLICABLE PUBLICATIONS. The American Society for Testing and Materials (ASTM) Standards listed below form a part of this specification to the extent referenced. The publications are referred to in the test by the basic designation only.

D 1556-82	Density of Soil In-Place by the Sand-Cone Method
D 1557-78	Moisture-Density Relations of Soils Using a 10-Lb. Rammer and an 18-In. Drop
D 2216-80	Laboratory Determination of Water (Moisture) Content of Soil, Rock and Soil-Aggregate Mixtures.
D 2922-81	Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth)
D 3877-80	One-Dimensional Expansion, Shrinkage and Uplift Pressure of Soil-Lime Mixture

2. COMPACTION EQUIPMENT.

2.1 General. Compaction shall be accomplished by tamping rollers, steel drum rollers or vibratory compactors.

3. GENERAL REQUIREMENTS FOR COMPACTED FILLS AND COMPACTED BACKFILLS.

3.1 Control. Moisture-density relations shall be established by the Contractor. Field density tests shall be performed by the Contractor in

sufficient number and in such locations to insure that the specified density is being obtained. Moisture-density relations and field densities shall be reported on approved forms. Once copy of density data less dry weight determinations shall be provided on the day each test is taken. The completed test reports shall be provided with the Contractor Quality Control Report on the work day following the test.

3.1.1 Laboratory Control. One moisture-density relation shall be made for each classification, blend or change in classification of soil material encountered. Approval of moisture-density relations shall be obtained prior to the compacting of any material in the work. The moisture-density relations shall be determined in a laboratory in accordance with ASTM D 1557 (modified as specified hereinafter).

3.1.1.1 A separate batch of materials will be used for each compaction test specimen, mixed well, and the mixture will be placed in a container with an airtight cover and allowed to cure for 24 hours. A shorter curing time may be allowed where tests show that shortening the curing time will not affect the results.

3.1.2 Field Control. Field in-place density shall be determined in accordance with ASTM D 1556 and Field Moisture Content shall be determined in accordance with ASTM D 2216. The density tests shall be well distributed and shall average not less than one test for each 2000 cubic yards of material. At least one test shall be made in each 2 feet of compacted material processed as a unit and at least one test shall be made in each area.

3.1.3 Moisture-Density Curves for Cohesionless and Cohesive Material. Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

3.2 Settling of Fills or Backfills with Water will not be permitted, except as specified hereinafter for sand fill, filling voids behind walls, and channel R.C.P. bedding.

3.3 Material shall be obtained from the required excavations, shall be free from sod, roots, brush, debris, trash or other objectionable material, and shall contain no stone whose greatest dimension is more than 3/4 of the layer thickness.

3.4 Placement. Fill material shall not be placed against concrete which has not been in place at least 14 days or until the concrete has attained a strength of 2,500 p.s.i. when tested in accordance with the SECTION: CONCRETE. Heavy equipment shall not be operated over pipes and buried structures until at least 2 feet of fill material has been placed and compacted over them in conformance with the requirements of SECTION: SIDE

DRAINS AND WATER LINES. Compacted fill and backfill shall be placed with suitable equipment in horizontal layers which after compaction, shall not exceed 12 inches in depth for rubber-tired or vibratory rollers, 6 inches in depth for tamping rollers, and 4 inches in depth when mechanical tampers are used. The Contractor may vary the layer thickness within these limits for most efficient operations. Material containing stones shall be placed in a manner to prevent the stones from striking the concrete structures and to prevent the formation of voids.

3.5 Moisture Content. Material shall have a uniform moisture content while being placed and compacted. Water shall be added at the source, if required, or by sprinkling each layer of material during placement. Uniform distribution of moisture shall be obtained by disking, harrowing, or otherwise manipulating the soil during and after the time water is added. Material containing an excess of moisture shall be manipulated with suitable implements to facilitate maximum aeration and shall be permitted to dry to the proper consistency before being compacted. Fill shall have a maximum moisture content of not more than 3 percent below optimum.

3.6 Compaction. No layer of fill shall be compacted before the practicable uniform moisture content has been obtained. If the Contractor elects to use rubber-tired or steel drum, compaction equipment and the compacted surface of any layer of material is determined by the Contracting Officer to be too smooth to bond properly with succeeding layers, it shall be scarified by a method approved by the Contracting Officer. Scarified areas shall be compacted as specified for the fill placed thereon. Rollers will not be permitted to operate within one foot of channel or structure walls or over buried structures until the compacted fill over the top of the structures has reached a depth of 2 feet. Compaction equipment shall be so operated that structures are not damaged nor overstressed during compaction operations. Mechanical tampers shall be used for compaction of fill material adjacent to structures where rolling equipment is impracticable for use in compaction.

4. COMPACTED FILL, CHANNEL.

4.1 General

4.1.1 Material for compacted fill channel shall be obtained from the required excavations as approved by the Contracting Officer. In general, the best material available will be designated as compacted fill, channel. Compacted fill, channel may consist of sand, gravelly sand, silty sands, and clayey sands. Organic material, silt, sandy silt, clay, sandy clay, broken concrete or pavement, stone when the greatest dimension is greater than 3 inches, and other objectionable materials shall not be used.

4.1.2 Preparation for Placing. Before placing material for compacted fill, the foundation surface shall be cleared of all existing obstructions, vegetation, and debris, proofrolled by 4 passes of the compaction equipment. Unsuitable material not meeting the requirements for fill material, as defined in the above paragraph, shall be removed

and.

where directed, and the existing surfaces scarified to a depth of 6 inches before placing the fill. Sloped ground surfaces steeper than one vertical to 4 horizontal, on which fill or compacted backfill is to be placed, shall be stepped in such a manner that the compaction equipment will bear on the full depth of the fill layer.

4.1.3 Compaction. Each layer of the materials shall be compacted to not less than 90 percent of maximum density.

4.2 Behind Channel Walls.

4.2.1 Placing. Fill material as defined hereinabove, shall not be placed against any section of concrete which has not been in place at least 14 days or until the concrete has attained a strength of 2500 psi when tested in accordance with SECTION: CONCRETE. "Backfill can be placed to within 4 feet of the top of the vertical wall prior to placing the center slab. It is the Contractor's responsibility to assure that the walls do not become misaligned using this method." In addition to the foregoing, the concrete invert shall have been in place not less than 7 days, prior to placing backfill at that location. The construction sequence and backfilling operation shall be phased such that any runoff that would pool behind the walls is pumped out or flows freely from behind the walls to preclude saturating the backfill.

4.2.2 Limitations on Equipment. The gross weight of any piece of equipment, or the combined weight of any combinations of equipment coupled together, used to place, moisten and/or compact fill behind channel walls shall not exceed 35,000 pounds, including dynamic forces produced by vibratory equipment. Equipment used to compact the fill behind the channel walls shall be of such size as to be capable of operating in the area between the cut slope and the channel wall. Compaction equipment will not be require to operate at elevations lower than 2 feet above the top of the heel of the channel invert. This equipment shall be of such size as to be capable of operating in the area between the cut slope and the channel wall at any point 2 feet above the top of the heel of channel invert.

4.2.3 Compaction. Each layer of fill behind channel walls shall be compacted to not less than 90 percent of maximum density. Each layer of fill behind channel walls shall be compacted to not less than 90 percent of maximum density.

5. COMPACTED FILL, SIDE DRAINS AND WATER LINES. Bedding and backfill for side drains and storm drains shall conform to the requirements of SECTION: SIDE DRAINS AND WATER LINES.

6. BACKFILLS.

6.1 Backfill and Fill About Structures.

6.1.1 Location. Backfill and fill shall consist of all fill against and/or around structures, except backfill for side drains trenches and compacted fill channel.

designated as backfill and fill about structures. Backfill may consist of sand, gravelly sand, silty sands, and clayey sands. Organic material, silt, sandy silts, clay, sandy clays, broken concrete or pavement, stone when the greatest dimension is greater than 3 inches and other objectionable material shall not be used.

6.1.3 Placing. Fill Material shall not be placed against concrete which has not been in place at least 14 days or until the concrete has attained a strength of 2,500 p.s.i. when tested in accordance with SECTION: CONCRETE.

6.1.3 Compaction shall be not less than 90 percent of maximum density.

6.2 Backfill, Side Drain Trenches. Backfill for side drains and storm drains shall conform to the requirements of SECTION: SIDE DRAINS AND WATER LINES.

7. SUBGRADE PREPARATION.

7.1 Subgrade for Channel Invert Slab. After the channel has been excavated to rough grade in accordance with SECTION: EXCAVATION, the entire subgrade for the channel invert slab shall be proofrolled by 4 passes of the compaction equipment and trimmed to a uniform grade and smoothed with a steel-wheeled roller to make the subgrade ready to receive concrete. If the subgrade is disturbed by the Contractor's operations or is overexcavated, the subgrade shall be restored to grade and compacted to a density of 90 percent of maximum density. The finished surface of the subgrade shall not be more than 1/2 inch from the indicated grade at any point when tested with a 10-foot straightedge.

7.2 Subgrade Preparation for Spillway, Road Pavement, Curbs, and Driveways. The subgrade shall be alternately watered and scarified until the material is uniformly moistened throughout for a depth of not less than 6 inches. All stones larger than 4 inches in diameter, and hard ribs of earth shall be removed. The amount of water to be applied shall be that which is required to provide optimum results in compaction under rolling. Following the above operations, the roadbed shall be shaped to a true cross-section sufficiently higher than the specified grade to allow for subsequent compaction and then be thoroughly compacted to not less than 95 percent of maximum density as determined by ASTM D 1557. After the subgrade has been prepared and completed, the surface shall be firm, hard, and unyielding, with a true, even and uniform surface conforming to the grade and cross-section indicated on the drawings. All points of the finished subgrade shall be not more than 1/4 inch below or above true subgrade.

8. OPTIONAL DISPOSAL AREAS. Fill to be placed in the optional disposal areas shall consist of material from the required excavation.

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SECTION 2E

PRIME COAT AND WEED KILLER

Index

- | | |
|----------------------------|---------------------------------------|
| 1. Applicable Publications | 6. Equipment |
| 2. Bituminous Materials | 7. Preparation of Surface |
| 3. Sampling and Testing | 8. Weed Killer |
| 4. Quantity To Be Applied | 9. Application of Bituminous Material |
| 5. Weather Limitations | 10. Waybills and Delivery Tickets |

1. **APPLICABLE PUBLICATIONS.** The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1 American Society for Testing and Materials (ASTM) Standards.

D 140-70
(R 1981)

Sampling Bituminous Materials

D 2027-76
(R 1986)

Cutback Asphalt (Medium-Curing Type)

2. **BITUMINOUS MATERIAL.** The bituminous material for the prime coat shall be liquid asphalt, conforming to ASTM D 2027, designation MC-70.

3. **SAMPLING AND TESTING.**

3.1 **Sampling.** Samples of bituminous material, unless otherwise specified, shall be in accordance with ASTM D 140.

3.2 **Testing** shall be the responsibility of the Contractor. Testing shall be performed by an acceptable commercial testing laboratory or by the Contractor on approval of the Contracting Officer. Materials shall be tested to establish compliance with the specified requirements.

3.3 **Certified Laboratory Test Reports.** Before delivery of bituminous materials, certified copies, in triplicate, of the tests specified herein and in referenced publications shall be submitted to and approved by the Contracting Officer. The testing shall have been performed by an independent laboratory approved by the Contracting Officer.

4. **QUANTITY TO BE APPLIED.** Bituminous material for the prime coat shall be applied in quantities of not less than 0.10 gallon nor more than 0.35 gallon per squared yard of the surface to be primed. Application of prime coat shall be divided, if necessary, into 2 applications to avoid flowing off the surface. The exact quantities which may be varied to meet field conditions shall be determined by the Contractor and approved.

5. WEATHER LIMITATIONS. The prime coat shall be applied only when the prepared surface is dry or contains moisture not exceeding quantity to permit uniform distribution and desired penetrations. Prime coat shall be applied only when the ambient temperature is 50 degrees F. or above and the temperature has not been below 35 degrees F. for 12 hours immediately prior to application.

6. EQUIPMENT.

6.1 General. All equipment, tools, and machines, used in the performance of the work required by this section shall be subject to the approval of the Contracting Officer.

6.2 Bituminous Distributor shall have pneumatic tires of such width and number that the load produced on the base surface shall not exceed 650 pounds per inch of tire width. The distributor shall be designed and equipped to distribute the bituminous material uniformly at even heat on variable widths of surface at readily determined and controlled rates from 0.05 to 2.0 gallons per square yard with a pressure range of 25 to 75 pounds per square inch and with an allowable variation not to exceed 5 percent from any specified rate. Distributor equipment shall include a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating the materials to the proper application temperature, a thermometer to show the temperature of the tank contents, and a hose attachment suitable for applying bituminous material to spots unavoidably missed by the distributor. The distributor shall be equipped to circulate and agitate the bituminous material during the heating process.

6.3 Heating Equipment for Storage Tanks. Equipment for heating bituminous material shall consist of steam coils and equipment for producing steam, so designed that steam cannot get into the material. An armored thermometer with a range from 40 to 200 degrees F. shall be fixed to the tank so that the temperature of the bituminous material may be read at all times.

6.4 Brooms and Blowers shall be of the power type and shall be suitable for cleaning prepared surfaces.

7. PREPARATION OF SURFACE. Immediately before applying the weed killer and prime coat, all loose material, dirt, clay or other objectionable substance shall be removed from the surface by means of a power broom or blower supplemented with hand brooms. After the cleaning operation and prior to the application of the material, an inspection of the area to be treated shall be made by the Contractor to determine the fitness of the area to receive the material. The Contracting Officer shall be notified 24 hours in advance of application of the material. To assure a uniform spread of the material, the areas prepared for treatment, if excessively dry, shall be lightly sprinkled with water immediately before the application as directed.

8. WEED KILLER. A chemical weed killer shall be applied to all areas to receive prime coat prior to application of the prime coat. The weed killer shall be EPA-approved pre-emergent herbicide specifically formulated for the intended purpose and suitable for eradicating weed species found in the area. The weed killer shall have demonstrated satisfactory performance for a period of at least 3 years.

Application methods and rates shall be as recommended by the manufacturer. The proposed weed killer, application methods and rates shall be submitted to the Contracting Officer's Representative for approval.

9. APPLICATION OF BITUMINOUS MATERIAL. Immediately following the preparation of the surface, the bituminous materials shall be applied by means of a bituminous distributor. The bituminous material shall be applied at a pressure within the range of 25 to 75 pounds per square inch and in the amounts as directed. The bituminous material shall be so applied that uniform distribution is obtained at all points of the surface to be treated. Unless the distributor is equipped to obtain satisfactory results at the junction of the previous and subsequent application, building paper shall be spread on the surface of applied material for a sufficient distance back from the ends of each application so that flow from the sprays can be started and stopped on the paper, and all sprayers operate at full force on the surface to be treated. Immediately after the application, building paper shall be removed and destroyed. Spots unavoidably missed by the distributor shall be properly treated with bituminous material. Following the application of bituminous material, the surface shall be allowed to dry without being disturbed for a period of not less than 48 hours, or longer as necessary to attain penetration into the foundation course and evaporation of the volatiles from prime material. The Contractor shall furnish and spread enough approved sand to blot up effectively and cure any excess bituminous material. The Contractor shall maintain the primed surface until the succeeding layer of pavement is placed by protecting the surface against damage and by repairing and repriming deficient areas at no additional cost to the Government. No smoking, fires, or flames other than heaters that are a part of the equipment shall be permitted in the vicinity of heating, distributing, or transferring operations of bituminous material.

9.1 Application Temperature shall be as directed and shall provide an application viscosity between 40 and 120 centistrokes, kinematic, or 20 and 60 seconds, Saybolt-Furol. Application temperatures shall be between 120-190 degrees F., except that appropriate changes should be made when the ranges of viscosity are raised or lowered. The temperature-viscosity relationship shall be furnished to the Contracting Officer.

10. WAYBILLS AND DELIVERY TICKETS. Copies of waybills or delivery tickets shall be submitted during the progress of the work. Before the final statement is allowed, the Contractor shall file with the Contracting Officer certified waybills and/or certified delivery tickets for all bituminous material actually used in the construction of pavement covered by this section of the specification.

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SECTION 2F

ASPHALT CONCRETE

Index

- | | |
|-------------------------------------|---|
| 1. Applicable Publications | 11. Transportation of Bituminous Mixtures |
| 2. Description | 12. Placing |
| 3. Aggregates | 13. Compaction of Mixture |
| 4. Bituminous Material | 14. Tack Coat |
| 5. Sampling and Testing | 15. Joints |
| 6. Aggregate gradation | 16. Protection of Pavement |
| 7. Composition of Mixture | 17. Surface Requirements |
| 8. Mixing Plant | 18. Sampling |
| 9. Other Equipment | 19. Waybills and Delivery Tickets |
| 10. Treatment of Underlying Surface | |

1. APPLICABLE PUBLICATIONS. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1 American Association of State Highway and Transportation Officials (AASHTO) Standard.

M 226-80
(R 1986)

Viscosity Graded Asphalt

1.2 American Society for Testing and Materials (ASTM) Standards.

C 117-87

Materials Finer Than No. 200 (75um)
Sieve in Mineral Aggregates by
Washing

C 127-84

Specific Gravity and Absorption of
Coarse Aggregate

C 128-84

Specific Gravity and Absorption of
Fine Aggregate

C 136-84a

Sieve or Screen Analysis of Fine and
Coarse Aggregates

D 140-70
(R-1981)

Sampling Bituminous Materials

D 242-85

Mineral Filler for Bituminous Paving
Mixtures

D 977-86

Emulsified Asphalt

D 1559-82

Resistance to Plastic Flow of
Bituminous Mixtures Using Marshall
Apparatus

1.3 Military Standard.

MIL-STD-620A
& Notice 1

Test Methods for Bituminous Paving
Materials

2. DESCRIPTION. Asphalt concrete indicated as "A.C." shall consist of fine and coarse aggregates and mineral filler, if required, uniformly mixed with hot bituminous material, and placed and compacted on a prepared base course subgrade.

3. AGGREGATES shall consist of crushed stone, crushed or uncrushed gravel, screenings, sand, and mineral filler. Aggregates shall have a satisfactory service record in bituminous pavement construction. The source selected shall be approved by the Contracting Officer. Material passing the No. 200 sieve shall be known as mineral filler. Mineral filler shall conform to ASTM D 242. The combined aggregates and mineral filler shall meet the requirements of subsequent paragraphs entitled AGGREGATE GRADATION and COMPOSITION OF MIXTURE.

4. BITUMINOUS MATERIAL.

4.1 Bituminous material to be mixed with the mineral aggregates shall be asphalt cement conforming to AASHTO M226, viscosity grade AR-40 or AR-80, Table 3.

4.2 Bituminous material used for the tack coat shall be an asphalt emulsion conforming to the requirements of ASTM " 977, Type RS-1h.

5. SAMPLING AND TESTING.

5.1 Sampling. Samples of Bituminous material, unless otherwise specified, shall be in accordance with ASTM D 140.

5.2 Quality Control Testing shall be the responsibility of the Contractor. Testing shall be performed by an acceptable commercial testing laboratory or by the Contractor on approval of the Contracting Officer. Materials shall be tested to establish compliance with the specified requirements. Certificates of compliance shall be furnished.

5.3 Minimum Quality Control Testing. In addition to other tests specified elsewhere, the Contractor is required to perform the following tests on materials as specified hereinafter.

5.3.1 Two tests for aggregate gradation for each 500 tons of aggregate produced.

5.3.2 One determination each for stability, flow, voids total mix, and voids filled with bitumen for every 500 tons of AC produced.

6. AGGREGATE GRADATION. The aggregate gradation as determined by ASTM C.177 and C 136 shall conform to the following.

Sieve Opening

Percentage By Weight Passing

1-inch	100
3/4-inch	97-100
1/2-inch	85-100
3/8-inch	70-90

Sieve Opening

Percentage By Weight Passing

No. 4	50-75
No. 8	35-65
No. 30	20-40
No. 200	2-8

7. COMPOSITION OF MIXTURE.

7.1 Job-Mix Formula shall be submitted by the Contractor, and no bituminous mixture shall be manufactured until it has been approved. The formula will indicate the percentage of each sieve fraction of aggregate, percentage of asphalt, and temperature of the mixture as discharged from the mixer. The percentage of asphalt in the job-mix formula will be between 5.5 percent and 6.5 percent.

7.2 Test Properties of Bituminous Mixtures. The apparent specific gravity, as determined by ASTM C 127 and C 128, shall be used in computing the voids total mix and voids filled with bitumen, and the mixture shall meet the following requirements as determined by ASTM D 1559:

Test Property	50-Blow Compaction
Stability, minimum, pounds,	500
Flow, maximum, 1/100-inch	20
Voids total mix, percent	3-5
Voids filled with bitumen, percent	75-85

7.3 Retained Stability. If the index of retained stability of the job-mix formula is less than 75 when tested in accordance with Method 104 of MIL-STD-620, the aggregates shall be rejected or treated by one of the following procedures:

(1) Addition of heat-stable additives to bitumen.

(2) Addition of hydrated lime, or other cementitious material containing free lime, as a portion of the mineral filler.

8. MIXING PLANT shall be a weigh-batch or continuous-mixing type approved by the Contracting Officer and operated so as to produce a mixture within the job-mix formula.

9. OTHER EQUIPMENT.

9.1 Bituminous-Materials Spreaders shall be self-propelled, capable of producing a finished surface conforming to the smoothness requirements specified hereinafter. The use of a spreader that leaves indentations or other objectionable irregularities in the freshly-laid mix will not be permitted.

9.2 Blowers and Brooms shall be of the power type suitable for cleaning the surface to be paved.

9.3 Saws shall be of the power type, capable of rapidly cutting pavement and trimming joints and edges of pavement.

9.4 Small Tools available on the work shall consist of the following: rakes, lutes, shovels, tampers, smoothing irons, pavement cutters, portable heaters for heating small tools, wood sandals and stilt sandals of standard type, and other small tools as may be required.

9.5 Steel-Wheel Rollers shall be self-propelled, 3-wheel (tricycle) and/or tandem type, weighing not less than 20,000 pounds each. The rollers shall have adjustable wheel scrapers, water tanks, and sprinkling apparatus to keep the wheels sufficiently wet to prevent the bituminous mixture from sticking to the wheels. Rollers shall be capable of reversing without backlash and shall be free from worn parts. Roller wheels shall not have flat or pitted areas or projections that will leave marks in the pavement.

9.6 Pneumatic-Tired Rollers shall be self-propelled and shall consist of 2 axles on which are mounted multiple pneumatic-tired wheels in such a manner that the rear group of wheels will not follow in the tracks of the forward group but spaced to give essentially uniform coverage with each pass. Axles shall be mounted in a rigid frame provided with a loading platform or body suitable for ballast loading. Tires shall be smooth and capable of being inflated to at least 90 p.s.i. Construction of the roller shall be such that each wheel can be loaded to a minimum of 4,500 pounds.

10. TREATMENT OF UNDERLYING SURFACE. Prior to laying a bituminous course, the underlying surface shall be cleaned of loose and foreign matter by sweeping with power sweepers, power brooms, and hand brooms, as directed. The surface to be paved shall receive prime coat and weed killer conforming to the requirements of the SECTION: PRIME COAT AND WEED KILLER.

11. TRANSPORTATION OF BITUMINOUS MIXTURE. The bituminous mixture shall be transported from the mixing plant to the site in trucks having tight, clean, smooth bodies with a minimum coating of concentrated solution of hydrated lime and water to prevent adhesion of the mixture. Each load of mixture shall be covered with canvas or other suitable material to protect the mixture from the weather and to prevent loss of heat. Mixtures having temperatures greater than 350 degrees, mixtures having temperatures less than 235 degrees, or mixtures which form or show indications of moisture will be rejected. Hauling over freshly laid material will not be permitted.

12. PLACING. Contact surfaces of previously constructed pavement, curbs, manholes and other structures shall be sprayed with a thin coat of asphalt conforming to the requirements of paragraph: TACK COAT. The mechanical spreader shall be adjusted and its speed regulated so that the surface of the course being placed will be smooth and continuous without tears and pulling. The course will be of such depth that after compaction, the cross section, grade, and contour will be as indicated. In areas where the use of machine spreading is impractical, the mixture shall be spread by hand. Unless otherwise directed, placing shall begin on the high side of areas with a one-way slope or along the centerline of areas

with a crowned section and shall be in the direction of the main traffic flow. Placing of the mixture shall be as continuous as possible, and the speed of placing shall be adjusted, as directed, to permit proper rolling.

13. **COMPACTION OF MIXTURE** shall be accomplished by steel-wheel and pneumatic rollers. Rolling shall begin as soon after placing as the mixture will support the roller without undue displacement. Rolling of the course shall be continued until all roller marks are eliminated and at least 95 percent of the density of a laboratory specimen of the same mixture has been obtained. The speed of the rollers at all times shall be slow enough to avoid displacement of the hot mixture. The wheels of the roller shall be moistened to prevent adhesion of the mixture. In areas not accessible to the roller, the mixture shall be compacted with hot hand tampers.

14. **TACK COAT.**

14.1 **Quantities to be Applied.** Bituminous materials for the tack coat shall be applied in quantities of not less than 0.02 gallon nor more than 0.15 gallon per square yard. The exact quantities within the range specified may be varied to suit field conditions, shall be determined by the Contractor and approved by the Contracting Officer's Representative.

14.2 **Equipment.** All equipment, tools, and machines used in performance of work required by this section shall be subject to approval and shall be maintained in satisfactory working condition.

14.3 **Weather Limitations.** Tack coat shall be applied only when the surface to be treated is dry and the temperature shall not have been lower than 35 degrees F. for 12 hours immediately prior to application. It shall not be applied when the atmospheric temperature in the shade is lower than 50 degrees F.

14.4 **Preparation of Surface.** Immediately before applying the tack coat, if surface is sufficiently bonded, all loose material, dirt, clay, or other objectionable material, shall be removed from the surface to be treated with a power broom or blower supplemented with hand brooms. After the cleaning operation, and prior to application of the tack coat, an inspection of the area to be treated will be made by the Contracting Officer to assure fitness of the area to receive the bituminous coating. That portion of surface prepared for immediate treatment shall be dry and in a satisfactory condition.

14.5 **Application of Bituminous Material.** Immediately following preparation of surface, the bituminous material shall be applied at a temperature, within the range of 75 to 130 degrees F. Under no circumstances shall emulsion be heated to a temperature greater than 140 degrees F. or exposed to a temperature of less than 40 degrees F. The bituminous material shall be applied so uniform distribution is obtained over all points of the surface to be treated. Lightly coated areas and spots missed shall be properly treated with bituminous material. Following application of bituminous material, the surface shall be allowed to dry to a proper condition of tackiness to receiver surfacing. The Contractor shall furnish and spread a sufficient quantity of clean, dry sand on all areas that show an excess of bituminous material, to effectively blot up and cure the excess when directed by the Contracting Officer. The treated surface shall be maintained by the Contractor until the succeeding layer of pavement has been placed. During this interval the Contractor shall protect the treated surface against damage and shall repair all damaged spots at no additional cost to the Government.

15. JOINTS. The joints between old and new pavements or between lanes of new work shall be constructed so as to insure uniform bond, texture, density, and smoothness as in other sections of the course. Edges of existing pavements shall be cut to straight, vertical surfaces. All contact surfaces of existing pavement shall be painted with a thin, uniform coat of tack coat.

16. PROTECTION OF PAVEMENT. After final rolling, no vehicular traffic shall be permitted on the pavement for at least 6 hours after rolling.

17. SURFACE REQUIREMENTS. The finished surface shall not vary more than 1/4 inch from a 10-foot straightedge. The straight edge shall be furnished by the Contractor. Defective areas shall be corrected by the Contractor at no additional cost to the Government.

18. SAMPLING. Sampling for the determination of thickness and density of the completed pavements will be performed by the Contracting Officer. All other test necessary to determine conformance with the specified requirements will be performed by the Contractor. The Contractor shall replace the pavement where samples are removed, for his convenience, at his expense. No payment will be made for areas of pavement deficient in composition, density, or thickness until they are removed and replaced by the Contractor as directed by the Contracting Officer.

19. WAYBILLS AND DELIVERY TICKETS. Copies of waybills or delivery tickets for asphalt concrete shall be submitted during the progress of the work. Before the final statement is allowed, the Contractor shall file with the Contracting Officer certified waybills and/or certified delivery tickets for all material used in the construction of the pavement covered by this section of the specifications. The Contractor shall not remove bituminous tank cars or storage tanks until initial outage and temperature measurements have been taken, nor shall the Contractor release the car or storage tank until the final outage has been taken.

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SECTION 2G

AGGREGATE BASE

Index

- | | |
|--------------------------------------|-----------------------------------|
| 1. Applicable Publications | 9. Mixing and Placing Materials |
| 2. Materials | 10. Layer Thickness |
| 3. Sampling and Testing | 11. Compaction |
| 4. Equipment | 12. Edges of Base Course |
| 5. Operation of Pits or Quarries | 13. Smoothness Test |
| 6. Weather Limitations | 14. Thickness Control |
| 7. Preparation of Underlying Surface | 15. Maintenance |
| 8. Grade Control | 16. Waybills and Delivery Tickets |

1. APPLICABLE PUBLICATIONS

1.1 Applicable Publications. The American Society for Testing and Materials (ASTM) Standards listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

C 117-87	Materials Finer than No. 200 (75-M) Sieve in Mineral Aggregates by Washing
C 127-84	Specific Gravity and Absorption of Coarse Aggregate
C 128-84	Specific Gravity and Absorption of Fine Aggregate
C 131-81	Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine
C 136-84a	Sieve or Screen Analysis of Fine and Coarse Aggregates
D 75-82	Sampling Aggregates
D 422-63 (R 1972)	Particle-Size Analysis of Soils
D 1556-82	Density of Soil In Place by the Sand-Cone Method
D 1557-78	Moisture-Density Relations of Soils, Using 10-lb. (4.5-kg) Rammer and 18-in. (457-mm) Drop
D 2216-80	Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures

D 4318-84

Test Method for Liquid Limit, Plastic
Limit, and Plasticity Index of Soils

E 11-81

Sieves for Testing Purposes

1.2 American Association of State Highway and Transportation Officials (AASHTO) Standards listed below form part of this specification to the extent referenced.

T 180-86

Moisture - Density Relations of Soils
Using a 10-lb. (4.54 kg) Rammer and
an 18-in. (457 mm) Drop

2. MATERIALS. Aggregates shall consist of crushed stone, crushed gravel, angular sand, soil, or other sound, durable, approved materials processed and blended or naturally combined. Aggregates shall be durable and sound, free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign material. It shall be the responsibility of the Contractor to obtain materials that will meet the requirements specified herein and that can be constructed to meet the grade and smoothness requirements specified herein after all compaction requirements have been completed. The material retained on a No. 4 sieve shall be known as coarse aggregate, and the material passing the No. 4 sieve shall be known as binder material.

2.1 Coarse Aggregate conforming to the requirements specified above shall have a percentage of wear not to exceed 50 percent after 500 revolutions. Coarse aggregate shall consist of angular fragments reasonably uniform in density and quality. The amount of flat and elongated particles shall not exceed 30 percent. A flat particle is one having a ratio of width to thickness greater than 3, and an elongated particle is one having a ratio of length to width greater than 3.

2.1.1 Coarse aggregate retained on each sieve specified shall contain at least 50 percent by weight of crushed pieces having two or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest midsectional area of the piece. When two fractures are adjacent, the angle between the planes of the fractures must be at least 30 degrees to count as two fractured faces.

2.2 Binder Material shall consist of screenings, angular sand, soil, or other finely divided mineral matter processed or naturally combined with the coarse aggregate. Liquid-limit and plasticity-index requirements stated herein shall apply to any component that is blended to meet the required gradation and shall also apply to the completed course. The portion of any component or of the completed course passing the No. 40 sieve shall be either nonplastic or shall have a liquid limit not greater than 25 and a plasticity index not greater than 5.

2.3 Gradation requirements specified herein shall apply to the completed base course, and it shall be the responsibility of the Contractor to obtain materials that will meet the gradation requirements after mixing, placing, compacting, and other operations. The aggregates shall be continuously graded within the limits.

Sieve Designation	Percentage by Weight Passing Square-Mesh Sieve
1-1/8 inch	100
No. 4	38-65
No. 8	25-60
No. 30	10-40
No. 200	3-12

The values are based on aggregates of uniform specific gravity, and the percentages passing the various sieves are subject to appropriate correction by the Contracting Officer when aggregates of varying specific gravities are used.

3. SAMPLING AND TESTING shall be by and at the expense of the Contractor.

3.1 Samples shall be the size required and shall be taken by the Contractor. Copies of test results shall be submitted for approval 7 days prior to starting the work, and thereafter at regular intervals during production as specified hereinafter. These samples shall be obtained at the source, from test pits, borings, trucks, stockpiles, or from other designated locations. Samples for material gradation, liquid-limit determination, and plasticity-index tests shall be taken in conformance with ASTM D 75. After the material has been placed and compacted, samples for density tests shall be taken as specified in ASTM D 1556, and additional samples for gradation, liquid-limit, and plasticity-index tests shall be taken by an appropriate method. Where deemed necessary, the sampling will be supervised by the Contracting Officer. The Contractor shall arrange his work so that sampling and testing may be performed without interruption.

3.2 Tests.

3.2.1 Aggregate Gradation. Aggregate gradation shall be determined in accordance with ASTM C 117, C 127, C 128, C 136, and D 422. Sieves shall conform to ASTM E 11.

3.2.2 Liquid Limit shall be determined in accordance with ASTM D 4318.

3.2.3 Plasticity Index shall be determined in accordance with ASTM D 4318.

3.2.4 Wear Test shall be made in conformance with ASTM C 131.

3.2.5 Field-In Place Density shall be determined in accordance with ASTM D 1556. The Field Moisture content shall be determined in accordance with ASTM D 2216. Moisture-density relations shall be established in the laboratory in accordance with ASTM D 1557, or AASHTO T 180.

3.3 Testing Frequency. Results of tests to determine particle shape, presence of objectionable and foreign matter, percentage of wear, fracture count, gradation, liquid-limit, plasticity-index, specific gravity, and other specification requirements for determination of the acceptability of the source shall be submitted for approval at least 7 days prior to starting of manufacture of the base course material. Production testing for material gradation, liquid limit, and plasticity index shall be performed at regular intervals with at least one test being made for each 500 cubic yards or fraction thereof, of material produced and results shall be submitted on a daily basis. Deviations from specification

requirements shall be corrected immediately upon discovery. After the material has been placed and compacted, one field density test for each 1000 square yards or fraction thereof of finished base course and one additional gradation, liquid-limit, and plasticity index test for each 3000 square yards of base course or fraction thereof shall be performed. Maximum-density moisture relations shall be established for each 5000 square yards of base course material. The location of the after-placement tests shall be as directed by the Contracting Officer's Representative. One copy of density data (less dry weight determinations) shall be provided on the day each test is taken. The completed test report shall be provided with the Contractor Quality Control Report on the following work day. Results of all tests made shall be submitted for approval on a daily basis and subsequent paving operations shall not commence until final approval has been obtained. Failure of any test shall be reported verbally, by the most expeditious means and followed promptly by written report. Contractor field operations shall immediately reflect corrective measures. For every failing test, retesting after completion of corrective measures have been taken will be required.

3.4 Approval of Materials. The source of the material shall be selected 7 days in advance of the time materials will be required in the work. Tentative approval of the preliminary reports submitted by the Contractor and the source will be based on an inspection by the Contracting Officer. Tentative approval of the materials will be based on test samples as specified herein. Final approval of both the source and the materials will be based on specified tests performed on samples taken from the completed and compacted base course.

4. EQUIPMENT. All plant, equipment, and tools used in the performance of the work covered by this section will be subject to approval by the Contracting Officer before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and have the capability of producing the required compaction, meeting grade controls, thickness controls, and smoothness requirements as set forth herein and within the specified time limits.

5. OPERATION OF PITS OR QUARRIES. All work involved in clearing, stripping, and excavating in opening or operation of pits or quarries shall be performed by the Contractor. Pits or quarries shall be opened to expose vertical faces of deposit to depths suitable for working. Materials excavated from pits shall be obtained in successive vertical cuts extending through all exposed strata. All pockets or strata of unsuitable materials overlying or occurring within the deposit shall be wasted as directed. The methods of operating pits or quarries and the processing and blending of the material may be changed or modified by the Contracting Office when necessary to obtain material conforming to the specified requirements. Quarries shall be conditioned in agreement with the local laws or authorities.

6. WEATHER LIMITATIONS. Aggregate base courses shall be constructed when the atmospheric temperature is above 35 degrees F. When the temperature falls below 35 degrees F., the contractor shall protect all areas of the completed aggregate base course, by approved methods, against any detrimental effects of freezing. Areas of completed aggregate base course damaged by freezing, rainfall, or other weather conditions shall be corrected to meet specified requirements.

7. **PREPARATION OF UNDERLYING SURFACE.** Prior to constructing the aggregate base course, the previously constructed subgrade shall be cleaned of all foreign substances. The surface of the subgrade shall be inspected by the Contractor for adequate compaction and surface tolerances. The Contractor shall give the Contracting Officer a 24 hour notice to inspect the subgrade before aggregate base course is placed. The subgrade shall conform to SECTION: FILLS AND SUBGRADE PREPARATION. Ruts or soft, yielding spots that may appear in the subgrade areas having inadequate compaction, and deviations of the surface from the requirements set forth therein shall be corrected to line and grade and to all specification requirements. The finished subgrade shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the base course is placed.

8. **GRADE CONTROL.** During construction, the lines and grades, including crown and cross slope indicated for the aggregate base course, shall be maintained by means of line and grade stakes placed by the Contractor at the worksite in accordance with paragraph: LAYOUT OF WORK of the SPECIAL CLAUSES.

9. **MIXING AND PLACING MATERIALS.** The materials shall be mixed by the stationary-plant, traveling-plant or road-mix method and placed in such a manner as to obtain uniformity of the aggregate base course material and at a uniform optimum moisture content for compaction. The Contractor shall make such adjustments in mixing or placing procedures or in equipment as may be directed to obtain the true grades, to minimize segregation and degradation, to reduce to accelerate loss or increase of water, and to insure a satisfactory aggregate base course meeting all the requirements of this specification.

10. **LAYER THICKNESS.** The compacted thickness of the aggregate base course shall be as indicated on the drawings. When a compacted layer of 6 inches or less is indicated, the material may be placed in a single layer. When a compacted layer thickness of more than 6 inches is indicated, the material shall be placed in two layers of approximately equal thickness.

11. **COMPACTION.** Each layer of the aggregate base course (including shoulders) shall be compacted with approved compaction equipment. Water content shall be maintained at optimum plus or minus 2 percent. In places not accessible to the rollers, the mixture shall be compacted with mechanical tampers. Compaction shall continue until each layer through the full depth is compacted to at least 100 percent of maximum density. The Contractor shall make such adjustments in rolling or finishing procedures as may be required to obtain true grades, to minimize segregation and degradation, to reduce or accelerate loss or gain of water, and to insure a satisfactory aggregate base course. Unsatisfactory placed materials shall be reworked until they are a satisfactory material. When materials become damaged during placing they shall be removed from the work and disposed of as directed by the Contracting Officer.

12. **EDGES OF BASE COURSE.** Where the course is not placed between curbs or similar construction, approved material shall be placed along the edges of the aggregate base course in such quantities as will compact to the thickness of the course being considered, or when the course is being constructed in two layers, to the thickness of each layer of the course. Allow in each operation at least a 1-foot width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer of the base course, as directed.

13. SMOOTHNESS TEST. The surface of each layer shall not show any deviations in excess of 3/8 inch when tested with either a 10- or 12-foot straightedge applied both parallel with and at right angles to the centerline of the paved area. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting, as directed.

14. THICKNESS CONTROL. The completed thickness of the base course shall be within 1/2 inch, plus or minus, of the thickness indicated. Thickness test shall be made and recorded by the Contractor. The thickness of the base course shall be measured at intervals in such manner that there will be a thickness measurement for at least each 500 square yards of base course. The thickness measurement shall be made by test holes at least 3 inches in diameter through the base course. Where the measured thickness of the base course is more than 1/2 inch deficient in thickness, the Contractor, at no additional expense to the Government, shall correct such areas by scarifying, adding mixture of proper gradation, reblading, and recompacting, as directed. Where the measured thickness of the base course is more than 1/2 inch thicker than that indicated, it shall be considered as conforming with the specified thickness requirements plus 1/2 inch. The average job thickness shall be the average of the job measurements determined as specified above, but shall be within 1/4 inch of the thickness indicated.

15. MAINTENANCE. The Contractor shall maintain the aggregate base course in a satisfactory condition until the completed work is accepted.

16. WAYBILLS AND DELIVERY TICKETS. Copies of waybills or delivery tickets shall be attached to the Daily Contractor Quality Control Report for the day of delivery. Before the final statement is allowed, the Contractor shall file with the Contracting Officer waybills and/or certified delivery tickets for all aggregates actually used in the construction covered by the contract.

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3.7 Contractor shall submit color samples (minimum of 3) and gradations of D.G. to the Contracting Officer or his representative for approval prior to installation.

3.8 D.G. shall be spread to a depth of 2 inches thick, raked, dampened, and rolled with a 90# roller.

4. WEED BARRIER FABRIC shall be a permeable polypropylene fabric with a minimum thickness of 2 mil and shall be a product commercially manufactured as weed barrier fabric.

5. LANDSCAPE MOUNDING. Fill material for use in landscape mounding shall be representative of existing site soil and be free of all foreign material, caliche, and all organic material and stones larger than 2 inches in diameter. The source of landscape fill shall be the Contractor's responsibility. The landscape fill shall be subject to approval by the Contracting Officer.

6. PEA GRAVEL. Aggregate for "pea gravel" material shall be of clean sand, gravel or crushed rock and shall be free from lumps or balls of clay and shall not contain calcareous or clay coatings, caliche, synthetic materials, organic matter of foreign substances. The gradation shall meet the following requirements when tested in accordance with the requirements of Arizona Test Method No. 201.

Sieve Size	Percent Passing
3/8 inch	100
No. 4	0-25
No. 8	0-5
No. 200	0-2.0

7. HERBICIDE. Areas to be covered with desert gravel or sand shall be treated with Dacthol or approved equal pre-emergent herbicide (project "C" only). The pre-emergent herbicide shall be applied at the maximum manufacturer's recommended rates for pre-emergent herbicides. The subgrade shall be thoroughly compacted and the areas shall be weed free prior to application of pre-emergent herbicide. The pre-emergent herbicide shall be applied to the ground in a slurry mix through a 50 mesh screen avoiding contact with existing plant materials. The pre-emergent herbicide shall be applied in two (2) applications, prior to and immediately follow installation of desert gravel or sand.

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* f.
8. BOULDERS. BOULDERS SHALL BE APPROXIMATELY CUBICAL, QUARRIED STONE, WITH A MINIMUM SIZE OF 30 INCHES. THE GRADATION SHALL BE AS INDICATED ON THE DRAWINGS. BOULDERS MAY BE USED IN LIEU OF THE ARTIFICIAL ROCK SHOWN ON THE DRAWING EXCEPT WHERE TUNNELS ARE TO BE CONSTRUCTED.

9. River ROCK.

SECTION 2H

MISCELLANEOUS AGGREGATES

1. APPLICABLE PUBLICATIONS. The American Society for Testing and Materials (ASTM) Standards listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

C 33-86	Concrete Aggregates
C 131-81	Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C 144-84	Aggregate for Masonry Mortar

2. GRAVEL PLACEMENT AND MATERIAL. Gravel shall be placed as shown on the drawings in accordance with the following requirements: Gravel shall be clean, hard, sound, durable, uniform in quality, and free of any detrimental quantity of soft, friable, thin, elongated, or laminated pieces, disintegrated material, organic matter, oil, alkali, or other deleterious substance.

2.1 Gravel Composition. The quality and gradation requirements shall be as follows: ASTM C 33, 1/2-inch maximum size as indicated in Grading Table for coarse aggregates.

3. DESERT GRAVEL. Desert gravel shall be placed on the area as shown on the drawings to match desert gravel previously placed in channel reach area from 29th Avenue to 47th Avenue. If matching desert gravel is unobtainable, the desert gravel shall be placed in accordance with the following requirements.

3.1 Desert gravel (D.G.) shall be any granitoid igneous rock which has been weathered in place and which has as principal constituents granular fragments of quartz and feldspar. It may also contain fragments of granite rock not yet broken down into the component minerals. The material shall remain stable when saturated with water.

3.2 Material shall be free from all foreign objects, lumps, irregularities and shall be consistent in color.

3.3 Desert gravel shall have a maximum size of not more than 1/2 inch, not less than ³⁵50 nor more than ⁶⁰90 percent passing the number 4 sieve, not more than ²⁵25 percent of the material passing the No. 200 sieve, and shall have a plasticity index of less than 10 for the materials passing the No. 40 sieve.

3.4 Subgrade shall be thoroughly compacted prior to application. Weed barrier fabric shall be laid on the subgrade under all desert gravel (Project "A" only).

3.5 Coloration shall conform to the "Munsell" soil chart (1975 edition: published by the Knoll Morgen Corp., 2441 North Calvert Street, Baltimore, Maryland 21218). Hue 7.5 YR, value/chroma 6/4.

3.6 Material shall be obtained from commercial sources.

3.7 Contractor shall submit color samples (minimum of 3) and gradations of D.G. to the Contracting Officer or his representative for approval prior to installation.

3.8 D.G. shall be spread to a depth of 2 inches thick, raked, dampened, and rolled with a 90# roller.

4. WEED BARRIER FABRIC shall be a permeable polypropylene fabric with a minimum thickness of 2 mil and shall be a product commercially manufactured as weed barrier fabric.

5. LANDSCAPE MOUNDING. Fill material for use in landscape mounding shall be representative of existing site soil and be free of all foreign material, caliche, and all organic material and stones larger than 2 inches in diameter. The source of landscape fill shall be the Contractor's responsibility. The landscape fill shall be subject to approval by the Contracting Officer.

6. PEA GRAVEL. Aggregate for "pea gravel" material shall be of clean sand, gravel or crushed rock and shall be free from lumps or balls of clay and shall not contain calcareous or clay coatings, caliche, synthetic materials, organic matter of foreign substances. The gradation shall meet the following requirements when tested in accordance with the requirements of Arizona Test Method No. 201.

Sieve Size	Percent Passing
3/8 inch	100
No. 4	0-25
No. 8	0-5
No. 200	0-2.0

7. HERBICIDE. Areas to be covered with desert gravel or sand shall be treated with Dacthol or approved equal pre-emergent herbicide (project "C" only). The pre-emergent herbicide shall be applied at the maximum manufacturer's recommended rates for pre-emergent herbicides. The subgrade shall be thoroughly compacted and the areas shall be weed free prior to application of pre-emergent herbicide. The pre-emergent herbicide shall be applied to the ground in a slurry mix through a 50 mesh screen avoiding contact with existing plant materials. The pre-emergent herbicide shall be applied in two (2) applications, prior to and immediately follow installation of desert gravel or sand.

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* 8. BOULDERS. Boulders shall be approximately cubical, quarried stone, with a minimum size of 30 inches. The gradation shall be as indicated on the drawings. Boulders may be used in lieu of the artificial rock shown on the drawing except where tunnels are to be constructed.

SECTION 2I

TREES, SHRUBS, AND GROUND COVERS

Index

- | | |
|------------------------------------|--------------------------------|
| 1. Applicable Publications | 6. Materials |
| 2. Source Inspections | 7. Site Preparation |
| 3. Submittals | 8. Installation |
| 4. Delivery, Storage, and Handling | 9. Pruning |
| 5. Environmental Protection | 10. Plant Establishment Period |
| | 11. MAINTAINING EXISTING TREES |

1. APPLICABLE PUBLICATIONS. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1 Federal Specification (Fed. Specs.).

O-F-241D Fertilizers, Mixed Commercial

1.2 American National Standards Institute (ANSI) Publication.

Z60. 1-1986 American Standard for Nursery Stock

1.3 American Joint Committee on Horticultural Nomenclature (AJCHN) Publication.

Standardized Plant Names
(Second Edition-1942)

1.4 American Society for Testing and Materials (ASTM) Standard.

C 136-84a Sieve Analysis of Fine and Course
Aggregates

2. SOURCE INSPECTIONS.

2.1 Plant Materials. Plant materials will be inspected by the Contracting Officer at the growing site and tagged or otherwise approved for delivery. Such inspection does not preclude right of rejection at the project site.

2.2 Topsoil. The source of topsoil will be inspected by the Contracting Officer to determine the acceptability of the topsoil and the depth to which it is to be stripped.

3. SUBMITTALS.

3.1 Samples. The following samples shall be submitted for approval before work is started.

a. Topsoil. Representative samples shall be taken from several locations on the area under consideration.

b. Soil Amendments. Ten pounds of each type to be used in the project.

3.2 Certified Laboratory Test Reports. Testing shall be performed by an approved independent laboratory within 10 days of submittal of reports. Test reports on a previously tested material shall be accompanied by certificates from the manufacturer certifying that the material is equal in all respects to that proposed for this project. Certified copies of the reports of tests listed below shall be submitted:

a. Offsite topsoil - for pH, salts, potash, and phosphorous.

b. Organic Amendments - for classification of total nitrogen, moisture ash and organic matter, sand content, pH.

3.3 Certificates of Conformance or Compliance. Before delivery, notarized certificates attesting that the following materials meet the requirements specified, shall be submitted for approval and in accordance with SPECIAL PROVISIONS.

- a. Plant materials.
- b. Fertilizers.
- c. Herbicide.
- d. Desert gravel.
- e. Pesticides.
- f. Soil conditioners.
- g. Top soil.
- h. Agrosoke.
- i. Weed barrier fabric.

3.4 Maintenance Instruction. Written instructions for year-round care of installed plants shall be furnished.

3.5 Identification. All plants shall be identified with durable waterproof labels and weather-resistant ink. Labels shall be securely attached to plants, bundles, or containers of plants and shall state the correct plant name and size.

4. DELIVERY, STORAGE, AND HANDLING.

4.1 Delivery.

4.1.1 The Contractor shall notify the Contracting Officer of the delivery schedule in advance so the plant material may be inspected upon arrival at the jobsite by the Contracting Officer. Unacceptable plant material shall be removed from the jobsite immediately.

4.1.2 Plants shall be protected during delivery to prevent damage to the root balls or desiccation of leaves. Trees shall be protected during transportation by tying in the branches and covering all exposed branches.

4.1.3 Fertilizer shall be delivered to the site in the original, unopened containers bearing the manufacturer's guaranteed chemical analysis, name, trade name or trademark, and in conformance to state and Federal law. In lieu of containers, fertilizer may be furnished in bulk and a certificate indicating the above information shall accompany each delivery.

4.1.4 All pesticide material, including soil fumigants, shall be delivered to the site in the original unopened containers. Containers that do not have a legible label that identifies the Environmental Protection Agency registration number and the manufacturer's registered uses will be rejected.

4.1.5 Soil conditioners and amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's guaranteed chemical analysis and name. In lieu of containers, soil conditioners and amendments may be furnished in bulk and a certificate from the manufacturer indicating the above information shall accompany each delivery.

4.2 Storage.

4.2.1 Plant Storage. Plants not installed on the day of arrival at the site shall be stored and protected. Outside storage locations shall be continually shaded and protected from the wind. Plants stored on the project shall be protected from any drying at all times. Plants in containers, shall be kept in a moist condition until planted by routine watering.

4.2.2 Storage of Other Materials. Pesticide material shall be kept in dry storage and shall not contaminate adjacent material, and shall be handled and stored following manufacturer's directions. Storage of materials shall be in areas designated or as approved by the Contracting Officer.

4.3 Handling. Care shall be taken to avoid damaging plants being moved from the nursery or storage area to the planting site. Plants shall be protected from freezing or drying out by covering with burlap, tarpaulin or mulching material during transportation to planting site. Plants shall not be handled by the trunk or stems. Damaged plants will be rejected and shall be removed from the site.

5. ENVIRONMENTAL PROTECTION. All work and Contractor operations shall comply with the requirements of SECTION: ENVIRONMENTAL PROTECTION.

6. MATERIALS.

6.1 Plants.

6.1.1 Plants shall conform to the varieties specified in the plant list and be true to botanical names as listed in AJCHN Standardized Plant Names. Plants shall be in accordance with ANSI Z60.1 except as otherwise stated in the specifications or shown on the plans. Where the drawings or specifications are in conflict with ANSI Z60.1, the drawings and specifications shall prevail.

6.1.2 Planting stock shall be well-branched and well-formed, sound, vigorous, healthy, and free from disease, sun-scald, windburn, abrasion, and harmful insects or insects eggs and shall have healthy, normal and unbroken root systems. Deciduous trees and shrubs shall be symmetrically developed, of uniform habit of growth, and free from objectionable disfigurements. Plants shall have been grown under climatic conditions similar to those in the locality of the project.

6.1.3 The minimum acceptable sizes of all plants, measured before pruning and with branches in normal position, shall conform to the measurements indicated. Plants larger in size than specified may be used with the approval of the

Contracting Officer with no change in the contract price. If larger plants are used, the ball of earth or spread of roots shall be increased in accordance with ANSI Z60.1.

6.1.4 The Contractor shall facilitate inspection and identifications by labeling trees and bundles or containers of the same shrub, with a durable waterproof label and weather-resistant ink. Labels shall state the correct plant name and size as specified in the list of required plants. Labels shall be securely attached to plants, bundles, and containers of plants and shall be legible for the duration of the plant establishment period.

6.1.5 Plant material shall be nursery grown unless otherwise indicated and shall conform to the requirements and recommendations of ANSI Z60.1. Plants shall be dug and prepared for shipment in a manner that will not cause damage to branches, shape, and future development after planting.

6.1.5.1 Container grown plants shall have sufficient root growth to hold the earth intact when removed from containers but shall not be root bound. ** SEE*

6.1.6 Substitutions shall be made only when a plant (or its alternates as specified) is not obtainable and the Contracting Officer authorizes a change order providing for use of the nearest equivalent obtainable size or variety of plant having the same essential characteristics with an equitable adjustment of the contract price. *Follow up to 10/11*

6.2 Topsoil.

6.2.1 Topsoil shall be the existing surface soil stripped and stockpiled on the site after the project site has been cleared and grubbed. ** SEE follow up page*

6.2.2 Additional topsoil, if required, beyond that available from stripping operations, shall be natural, friable soil representative of productive soils at the site. It shall be obtained from well-drained areas and shall be free of any admixture of subsoil, foreign matter, objects larger than one inch in any dimension, toxic substances, and any material or substances that may be harmful to plant growth. The pH range shall be 5.3 to 6.0. Topsoil that does not meet the pH range shall be amended by the addition of pH adjusters, at a rate recommended by the County Extension Service agent, based on soil tests.

6.3 Soil Conditioners and Amendments.

6.3.1 Rotted sawdust shall have 7.5 pounds of nitrogen added uniformly to each cubic yard and shall be free of chips, stones, sticks, soil, and toxic substances.

6.3.2 Planting Soil Mixture. The planting soil mixture shall be composed of six parts topsoil, and four part rotted sawdust, two lbs. iron sulphate per cubic yard of mix and fertilizer tablets at the manufacturer's recommended rate.

6.4 Fertilizer. Fertilizer shall be commercial grade and uniform in composition.

6.4.1 Tablet form of slow release fertilizers shall be used conforming to Fed. Spec. 0-F-241 with IBDU (isobutylidene-diurea), and shall bear the manufacturer's guaranteed statement of analysis. Slow release fertilizers shall contain a minimum percentage by weight of: 14 nitrogen, 3 percent available phosphoric acid, and 3 percent potash.

SECTION 2I:

INSERT AT END OF PARAGRAPH 6.1.5.1:

Container shall be free from noxious weeds.

INSERT AT END OF PARAGRAPH 6.2.1:

The soil shall be free from nut grass, refuse, heavy clay, noxious weeds or any material toxic to plant growth.

6.5 Mulch. Mulch shall be 2 inch D.G. free from deleterious materials and shall be stored so as to prevent inclusion of foreign materials.

6.6 Agrosoke. A stable synthetic anionic polymeric (polyacrylamide) crystal, having neutral pH (7.0), shall be added to the backfill mixture at the rate of 2.5 lbs per cubic yard of soil.

6.7 Staking Material.

6.7.1 Stakes for support shall be lodge pole pine, free from knots, rot, cross grain, or other defects that would impair the strength. Standard stakes treated with pentachlorophenol, and 2-1/2 inches in diameter by 8 feet long and pointed at one end. Ground stakes shall be a minimum of 2 inches by 2 inches and 3 feet long and pointed at one end.

6.7.2 Tie wire shall be 12 gauge annealed galvanized steel.

6.7.3 Hose chafing guards shall be new 2-ply reinforced rubber or plastic hose and shall be all the same color on the project. Length shall be one and one-half times the circumference of the plant at its base.

6.8 Water. Water shall not contain elements toxic to plant life.

6.9 Tree Wound Dressing. Tree wound dressing shall be a black asphalt-base antiseptic paint, a black paint consisting of zinc oxide Bordeaux Mixture, raw linseed oil, and lamp black.

7. SITE PREPARATION.

7.1 Clearing and Grading. Clearing shall consist of the satisfactory removal and disposal of brush, snags, and rubbish occurring within the area shown or as directed by the Contracting Officer. Clearing shall be accomplished by hand within 5 feet of existing vegetation to be left standing. Grading shall conform to the lines and grades shown.

7.2 Layout. Plant material locations and bed outlines shall be staked on the project site before any plant pits or beds are dug. Plant material locations may be adjusted by the Contracting Officer to meet field conditions.

7.3 Protection of Existing Vegetation. If lawns have been established prior to planting operations, the surrounding turf shall be covered before excavations are made in a manner that will protect turf areas. Existing trees, shrubbery, and beds that are to be preserved shall be barricaded in a manner that will effectively protect them during planting operations.

7.4 Underground Obstructions to Planting. If underground utilities, construction, or solid rock ledges are encountered, other locations for planting may be selected by the Contracting Officer.

7.5 Plant Pits. Plants pits shall be dug to produce vertical sides and flat, uncompacted bottoms. When pits are dug with an auger and the sides of the pits become glazed, the glazed surface shall be scarified. The size of plant pits shall be shown on the drawings.

7.6 Herbicide and Pesticide Application. Herbicides, insecticides and fungicides shall be applied as needed and in accordance with the manufacturer's recommendations.

8. INSTALLATION.

8.1 Planting Seasons and Conditions. Planting shall not be done when the ground is in an unsuitable condition for planting as determined by the Contracting Officer.

8.2 Container grown stock shall be removed from containers in such a way so as to prevent damage to plant or root system. Planting shall be completed as specified above.

8.2.1 Container stock shall be backfilled with topsoil to approximately half the depth of the ball and then tamped and watered. The remainder of backfill of topsoil shall be tamped and watered. Earth saucers or water basins shall then be formed around isolated plants. Water holding basins shall be ample enough in size and height to hold at least 2-1/2 gallons for shrubs or 5 gallons for trees.

8.3 Watering. Depressed water basins shall be used around all plants. All watering shall be done in a manner which will provide deep penetration, but which will not cause erosion or damage to the finished surface. Sufficient water shall be applied to penetrate the planting bed to a depth of 24 inches. Frequent watering may be necessary during periods of hot weather.

8.4 Inspection. The trunks of the trees shall be inspected for physical damage or insect infestation and required treatment or rejection shall be determined.

9. PRUNING.

9.1 New plant material shall be pruned in the following manner. Dead and broken branches shall be removed. Trees and shrubs shall be pruned to reduce total amount of anticipated foliage by one fourth. Typical growth habit of individual plants shall be retained with as much height and spread as is practicable. Cuts shall be made with sharp instruments, and shall be flush with trunk or adjacent branch to insure elimination of stubs. "Headback" cuts at right angles to line of growth shall not be permitted. Trees shall not be poled or the leader removed. Trimmings shall be removed from the site. Cuts 1/2 inch in diameter and larger shall be painted with the specified tree wound dressing.

9.2 Restoration and Clean-Up. Excess and waste material shall be removed daily. When planting in an area has been completed, they shall be cleared of all debris, spoil piles, and containers.

9.3 Maintenance During Installation. Maintenance operations shall begin immediately after each plant is planted and shall continue as required until final acceptance. Plants shall be kept in a healthy, growing condition by watering, pruning, spraying, weeding, and any other necessary operations of maintenance. Plant saucers and beds shall be kept free of weeds, grass, and other undesired vegetation. Plants shall be inspected at least once per week by the Contractor during the installation period and needed maintenance performed promptly.

10. PLANT ESTABLISHMENT PERIOD. Final acceptance of all work and materials under this section shall be at the end of a period of establishment to be determined as follows.

10.1 Beginning of the Plant Establishment Period. The period of establishment shall begin on the date that an inspection by the Contracting Officer shows that all plants are in place and have been installed in accordance with the specifications and plans. Replacement of plants that were not supplied by the Contractor but were relocated under this contract and that die for any reason other than improper handling during transplanting and/or lack of proper care will not be required. Loss through Contractor negligence, however, shall require replacement in kind and size per specification and shall be at the Contractor's expense.

10.2 During the Plant Establishment Period.

10.2.1 During the plant establishment period, the Contractor shall water all plants as necessary to maintain an adequate supply of moisture within the root zone. Water shall not be applied so quickly that it cannot be absorbed by the plants.

10.2.2 Plants shall be pruned as required.

10.2.3 Stakes and eroded plant saucers shall be replaced as required.

10.2.4 Other work, such as spraying with approved insecticides and fungicides to control pests, shall be done (each day if necessary) to ensure plant survival in a healthy growing condition.

10.2.5 Dead plants shall be removed immediately at the Contractor's expense and replaced within seven (7) days. The Contractor will be responsible for theft or damage to plants by vehicles or vandalism until final project completion, approval, and acceptance of the planting contract.

10.3 Termination of the Plant Establishment Period.

10.3.1 A preliminary inspection by the Contractor and the Contracting Officer will be held 120 days from the date of the beginning of the plant establishment period to determine plant acceptability and the number of replacements. Alternate or substituted varieties of plants shall be used only if approved by the Contracting Officer.

10.3.2 A final inspection of all plants will be held after the replacement planting has been completed. No additional plant establishment period will be required for replacement plants. The establishment period will end on the date of this inspection and said inspection will be considered final acceptance provided the Contractor has complied with the following requirements.

a. Dead, missing, and defective plant material shall have been replaced as directed by the Contracting Officer otherwise, final acceptance will be delayed until such replacements have been satisfactorily accomplished.

b. Plant saucers shall be free of weeds.

c. Stakes and guys shall be in good condition.

d. Remedial measures directed by the Contracting Officer to ensure plant survival shall have been carried out.

e. Plant material shall have been fertilized as required prior to acceptance.

* * * * *

II. MAINTAINING EXISTING TREES

See following page

SECTION 2I:

INSERT:

11. MAINTAINING EXISTING TREES.

11.1 Existing trees which fall outside of the limits of excavation and within the right-of-way, and which have been marked for saving, shall be protected and maintained during the life of the contract.

11.2 Maintenance operations shall begin immediately after the Contractor has begun work and shall continue until as required until final acceptance. Plants shall be kept in a healthy, growing condition by watering, pruning, spraying, weeding, and any other necessary operations of maintenance.

11.3 Pruning shall be accomplished in the following manner. Dead and broken branches shall be removed. Trees shall be pruned to reduce total anticipated foliage by one fourth. Typical growth habits of individual plants shall be retained with as much height and spread as is practicable. Cuts shall be made with sharp instruments, and shall be flush with trunk or adjacent branch to insure elimination of stubs. "Headback" cuts at right angles to line of growth shall not be permitted. Trimmings shall be removed from the site. Cuts 1/2 inch in diameter and larger shall be painted with the specified tree wound dressing.

SECTION 2J
IRRIGATION SYSTEM

Index

- | | |
|----------------------------|---|
| 1. Applicable Publications | 7. Tests |
| 2. General | 8. Disinfection |
| 3. Excavation | 9. Cleanup |
| 4. Backfilling | 10. Variation in Arrangements
of Sprinklers and Emitters |
| 5. Materials | 11. Submittals and Guarantee |
| 6. Installation | |

1. APPLICABLE PUBLICATIONS. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1 Federal Specification (Fed. Spec.).

WW-U-531F	Unions, Pipe, Steel or Malleable Iron, Threaded Connection, 150 lbs and 250 lbs
WW-V-51F	Valve, Angle, Check, and Globe, Bronze, (125, 150 and 200 Pound, Threaded End, Flanged Ends, Solder Ends, and Brazed Ends, for Land Use)
WW-V-54D & Int. Am-3	Valve, Gate, Bronze (125, 150 and 200 Pound, Threaded Ends, Flange Ends, Solder End and Brazed Ends, for Land Use)

1.2 American National Standards Institute, Inc. (ANSI).

B16.3-1977	Malleable Iron Threaded Fittings Class 150 and 300
B16.26-1983	Cast Copper Alloy Fittings for Flared Copper Tubes

1.3 American Society for Testing and Materials (ASTM) Standards.

A 120-84	Pipe, Steel, Black and Hot-Dipped Zinc- Coated (Galvanized) Welded and Seamless, for Ordinary Uses
B 88-86	Seamless Copper Water Tube
D 1785-86	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
D 2241-86a	Poly (Vinyl Chloride) (PVC) Plastic Pipe (DDR-PR)

D 1557-78

See following page

ADD TO PARAGRAPH 1.3

D 1557 78

MOISTURE-DENSITY RELATIONS OF SOILS USING A 10-LB.
RAMMER AND 18-IN. DROP

- D 2464-76 Threaded Poly (Vinyl Chloride) (PVC)
Plastic Pipe Fittings, Schedule 80
- D 2466-78 Poly (Vinyl Chloride) (PVC) Plastic Pipe
Fittings, Schedule 40
- D 2564-84 Solvent Cements for Poly (Vinyl Chloride)
(PVC) Plastic Pipe and Fittings

1.4 American Water Works Association (AWWA) Standards.

- C 651-86 Disinfecting Water Mains

1.5 Maricopa Association of Government (M.A.G.).

- Specifications 530 and 790

1.6 Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS) Standards.

- SP-58 Pipe Hangers and Supports-Materials, Design
and Manufacture (1983)
- SP-69 Pipe Hangers and Supports-Selection and
Application (1983)

2. GENERAL. This section covers irrigation piping including connection to source of water supply, complete.

2.1 Above ground piping shall be galvanized steel, copper tubing or as shown on the drawings.

2.2 Below Ground Piping. Pipe below ground shall be plastic. Pipe for sleeving shall be corrugated metal, galvanized steel or plastic. The minimum cover for laterals shall be 12 inches and 4 inches for dripline, unless otherwise indicated on drawings. The minimum cover for pressure lines shall be 2.5 feet except under roadways, parking and paved areas where the minimum cover shall be 3 feet. The electric wire conduit may be placed above the main line in the same trench. All other irrigation lines and wire shall be placed as shown on the drawings.

2.3 Electrical Work shall conform to the applicable requirements of SECTION: ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

2.4 Sprinkler heads and control valves shall not be located within 18 inches of buildings or structure foundations.

3. EXCAVATION.

3.1 General. All excavation of every description and of whatever substances encountered shall be performed to the depths indicated or as otherwise specified. During excavation, material conforming to the requirements of paragraph: PIPE BEDDING AND BACKFILL MATERIALS shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials not required or suitable

for backfill shall be removed and wasted as indicated or as directed. Grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations, and any water accumulating therein shall be removed by pumping or by other approved methods. Sheeting and shoring shall be done as may be necessary for the protection of the work and for the safety of personnel.

3.2 Trench Excavation. *SEE FOLLOWING PAGE* Trenches shall be of the necessary width for proper laying of pipe. The banks of pipe trenches shall be as nearly vertical as practicable. Care shall be taken not to overexcavate. The bottom of the trenches shall be accurately graded to provide uniform bearing and support for each section of the pipe on undisturbed soil at every point along entire length, except for the portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints, and as hereinafter specified. Except as hereinafter specified for wet or otherwise unstable material, overdepth excavation shall be backfilled as and with materials specified for backfilling the lower portion of trenches. Whenever wet or otherwise unstable material that is incapable of properly supporting the pipe is encountered in the bottom of the trench, and overdepth is not indicated on the drawings, such material shall be overexcavated to a depth to allow for construction of a stable pipe bedding. The trench shall be backfilled to the proper grade with approved materials.

SEE FOLLOWING PAGE

4. BACKFILLING. The trenches shall not be backfilled until all required pressure tests are performed and until the irrigation systems as installed conform to the requirements specified. Material for backfill shall conform to the requirements of paragraph: PIPE BEDDING AND BACKFILL MATERIALS. After the main irrigation lines have been installed, tested, and approved, backfill material shall be placed in the trench in a 12-inch lift and settled with water. The electrical work shall then be installed with 6 inches of backfill placed over it and settled with water. The lateral lines shall be installed and backfill placed in the trench and compacted to 90 percent of ~~laboratory~~ maximum density (~~ASTM D-1557~~) with mechanical tampers or vibrators. When no lateral lines are to be installed, backfill shall be placed in maximum 12-inch lifts and compacted to 90 percent of ~~laboratory~~ maximum density (~~ASTM D-1557~~) with mechanical tampers or vibrators to match lines and grades.

5. MATERIALS. All mainline, (pressure) mainline fittings, and mainline appurtenances (valves, etc.) shall be minimum 200 psi working pressure. Materials shall conform to the respective specifications and other requirements specified below.

5.1 Pipe.

5.1.1 Galvanized Steel Pipe shall conform to ASTM A 120, standard weight.

5.1.2 Copper Tubing: ASTM 88, Type K, annealed.

5.1.3 Plastic Pipe shall conform to ASTM D 1785, schedule 40 for pipe with solvent welded joints and schedule 80 for pipe with threaded joints, or to ASTM D 2241, Type 1, grade 1, 315 psi for pressure lines and 200 psi for other lines for pipe with solvent welded joints. Pipe and fittings shall bear the seal of approval (nsf mark) of the National Sanitation Foundation's standard for plastic pipe and fittings for potable water service. Plastic pipe stored on the construction site shall be protected from sunlight and from dirt entering pipe.

SECTION 2J:

INSERT AFTER: 3.2 Trench Excavation.

- ★ Trench excavation shall follow, as much as possible, layout indicated on drawing. (CONTINUE WITH PARAGRAPH: Trenches shall be of the necessary width. . . .).

3.3 Jobsite Conditions.

3.3.1 Protection of Property. The Contractor shall be responsible for the preservation and protection of all trees, plants, monuments, structures and paved areas from damage due to this work. In the event damage does occur, all damage to inanimate items shall be completely repaired or replaced to the satisfaction of the Owner, and all injury to living plants shall be repaired by the Owner or such persons as he may employ to accomplish this work. All the costs of such work shall be charged to and paid by the Contractor. Open ditches left exposed shall be flared and barricaded by the Contractor. Damage caused by the Contractor to asphalt, concrete or other building material surfaces shall be repaired or replaced by the Contractor at his expense. Contractor shall restore disturbed areas to original condition.

3.3.2 Existing and New Plantings. All trenching or other work under the limb spread of any and all evergreens or low branching deciduous material shall be done by hand or by other methods so that no limbs or branches are damaged in any way. Where it is necessary to excavate adjacent to existing trees, use all possible care to avoid injury to trees, use all possible care to avoid injury to trees and tree roots. Excavation, in areas where 2 inch and larger roots occur, shall be done by hand. Roots 2 inch or larger in diameter, except directly in the path of pipe or conduit, shall be tunneled under and shall be heavily wrapped with burlap to prevent scarring or excessive drying. Where a trenching machine is operated close to trees having roots smaller than 2 inches in diameter, the wall of the trench adjacent to the tree shall be hand trimmed making clean cuts through roots. 1 inch and larger in diameter roots shall be painted with two coats of "tree seal" or accepted equivalent. Trenches adjacent to trees should be closed within 24 hours, and where this is not possible, the side of the trench adjacent to the tree shall be kept shaded with wetted burlap or canvas.

3.3.3 Protection and Repair of Underground Lines. The Contractor shall be responsible for requesting the proper utility company to stake the exact location of any underground electric, gas or telephone lines. The Contractor shall take whatever precautions are necessary to protect underground lines from damage, and in the event damage does occur, all damage shall be repaired by the Owner or such persons as he may employ to accomplish this work. All costs of such work shall be paid by the Contractor unless other arrangements have been made.

5.1.4 Polyethylene pipe shall be 100 percent polyethylene as follows:

1/2" I.D. .574" wall thickness .050"

Melting point- .065 grams per 10 minutes

Plastic Recovery- 30%

Tensile strength at break- 1665 pounds per square inch

Elongation- 65%

Brittleness at 76°C- zero failures from 10 samples

Stress crack in 100% Igepol solution- zero failures from 10 samples

5.1.5 Polyethylene pipe (dripline) shall have ~~a maximum length of 500 feet if the line returns to the PVC lateral, or~~ a maximum length of 300 feet if the line dead ends. Maximum flow (gpm) shall not exceed the manufacturer's recommendations for pipe size indicated. 500

5.2 Joints.

5.2.1 Plastic Pipe Joints shall be solvent welded or threaded. Solvent for welded joints shall conform to ASTM D 2564. Use of pipe dope or solvents on threaded joints will not be permitted. Polyethylene shall have compression joints.

5.2.2 Copper Tubing. Joints shall be compression-pattern flared and shall be made with fittings hereinafter specified.

5.2.3 Flanges shall conform to AWWA C207, and shall be used only in above ground installations or where shown on the drawings or when approved.

5.3 Fittings and Specials.

5.3.1 For Galvanized Steel Pipe. Steel fittings shall be galvanized. Threaded fittings shall conform to ANSI B 16.3.

5.3.2 For Plastic Pipe. Fittings shall conform to ASTM D 2464 or D 2466.

5.3.3 For Copper Tubing. Fittings and specials shall be flared and conform to ANSI B16.26.

5.4 Gate Valves shall be designed for a working pressure of not less than 200 psi. Valve connections shall be as required for the piping in which they are installed. Valves shall have a clear waterway equal to the full nominal diameter of the valve, and shall be opened by turning counterclockwise. The operating nut or wheel shall have an arrow, cast in the metal, indicating the direction of the opening.

5.4.1 Valves smaller than 3 inches shall be all bronze and shall conform to Fed. Spec. WW-V-54, Type I.

5.4.2 Valves 3 inches and larger shall be iron body, bronze mounted, and shall conform to AWWA C500.

3.5 Backflow Prevention Units.

5.5.1 General. Backflow prevention units of the types indicated shall be installed at the locations shown on the drawings. Where union connections are not provided as part of the unit, the Contractor shall provide and install a union or sleeve type coupling between the control valve and the inlet side of the unit. Pipe and fittings for backflow prevention units shall be bronze or copper.

5.5.2 Reduced Pressure Backflow Prevention Unit. The reduced pressure backflow prevention unit shall be a factory assembled unit consisting of two independently acting spring-loaded check valves with a differential pressure relief valve controlled-reduced-pressure zone in between and shall be complete with test cocks and drain. The first check valve shall reduce the supply pressure a predetermined amount so that during normal flow and the cessation of normal flow the pressure between the checks is less than the supply pressure. The pressure differential relief valve shall automatically discharge to atmosphere to maintain the pressure in the reduced pressure zone below the supply pressure. All parts shall be removeable or replaceable without removal of the unit from the line. The unit shall be suitable for a working pressure of 125 pounds per square inch and shall be the product of a manufacturer regularly engaged in the production of backflow prevention units of the reduced pressure type.

5.6 Emitters (Drip Line). Emitters shall be independent pressure compensating plastic in-line emitters, (Drip Line) capable of providing a consistent discharge rate of one gallon per hour (gph) at 3 to 60 pounds per square inch (psi). The emitter shall be constructed of heat resistant plastic and have an operating range of 3 to 60 pounds per square inch. Emitters shall be spaced as shown on plans.

5.7 Multi-Outlet Emitter shall be pressure compensating with constant flow from each outlet despite any pressure changes. The emitter housing shall be constructed of high impact plastic and shall have a minimum of five outlets. Distribution tube shall be .160 x .220 polyethylene tubing and shall have a maximum length of 8 feet from emitter to emission point. Emitters shall be installed as shown on the drawings.

5.8 Valve boxes shall be plastic or concrete except that concrete boxes may be installed only in locations not subjected to vehicular traffic. Concrete boxes shall be the standard product of manufacturer of precast concrete equipment. The words "Irrigate", for gate valves; and "RCV" for remote control valves shall be cast in covers of boxes for the irrigation system. Plastic boxes shall be a standard catalog product of a manufacturer regularly engaged in the manufacture of valve boxes. Valve boxes shall have locking or boltable covers. Plastic shall be rigid combination of polyolefin and fibrous inorganic materials having the following physical properties:

ASTM Test	Method	Value
Tensile Strength (2.0 in. Min.)	D-638	3,400 psi
Impact Strength, Izod	D-256	0.5 ft-lb/in
Shore-D Hardness	D-2240	63
Deflection Temp. @ 66 psi stress	D-648	230 degrees F.
Specific Gravity	D-792	1.15

5.8.1 SEE FOLLOWING PAGE

5.9 Remote Control Valves and Valve Accessories.

SECTION 2J:

INSERT 5.8.1:

5.8.1 Install one valve box for each type of valve installed as per details. No valve box extensions will be accepted. Gravel sump shall be installed after compaction of all trenches. Final portion of gravel shall be placed inside valve box after valve box is backfilled and compacted. Controller letter and station number are to be branded on the lid of each valve box. Letter and number size to be no smaller than 1" and no greater in size than 1 1/2", depth of branding to be no more than 1/8" and no less than 1/16" into valve box lid. Splice boxes shall be labeled with the words "low voltage electrical splice" in the same manner.

5.9.1 The remote control valves shall be an electrical actuated valve constructed of corrosion-resistant materials. The valve shall have an internal manual operation which allows the opening and closing of the valve without electrical power, or external bleed of water. The valve shall have a self-cleaning screen and a removeable housing cover for easy inline maintenance.

Materials: body - glass reinforced nylon.
diaphragm - reinforced nylon with O-ring and stainless steel pressure plate.
spring - stainless steel.

Performance: 1" valve - min. 2 gpm max. 50 gpm
(FLOW RATES) 1-1/2" valve - min. 10 gpm max. 110 gpm
2" valve - min. 25 gpm max. 200 gpm

5.9.2 The solenoid actuator shall be 24 volt A.C. 2-way type. Inrush and holding current shall be no more than 300 mA and 200 mA respectively. The solenoid shall require approximately 1/3 the inrush current as standard 24 volt A.C. solenoids.

Materials: Plunger and core - stainless steel.
housing - glass reinforced nylon, epoxy potted.
spring - stainless steel.

Performance: min. operating voltage at 150 psi shall be 20 volts.
Inrush Current (amps) .104
Holding Current (amps) .104

5.10 Tipping Bucket Rain Gauge shall be high quality accurate instrument used for measuring precipitation. Rainfall shall enter an 8-inch funnel collector and be directed to the tipping bucket assembly. The bucket shall be made of stainless steel. The funnel shall be anodized aluminum and have two screens to prevent debris from entering the gate. A level shall be provided on the base for correct positioning of unit. The rain gauge shall come with .01 inch calibration. The Contractor shall install the unit according to the manufacturers requirements and as shown on the drawings. Contract Rating: 3 watts, 28 VAC, 0.25 amps, 120 VAC.

5.11 Fertilizer Injector shall be a feeder, water operated, positive displacement proportioning chemical metering pump. The pump shall come with plastic tubing, foot valve strainer, suction valve and discharge valve. The pump minimum operating pressure shall be 15 psi and the maximum operating pressure shall be 125 psi. The fertilizer injector shall have a chemical to water ratio of 1:730 maximum. The fertilizer injector shall have the following options:

Diaphragm - Hypalon
Head - PVC
Valve - Double
Single Head Fittings - Universal Injector

The Contractor shall install the fertilizer injector according to the manufacturers requirements and as shown on the drawings.

5.12 Tensiometer shall be solid state maintenance free units, which will react to changes in soil matric potential and will not be affected by salts, fertilizer, chemical changes in the soils nor damage by freezing. The sensing range shall be

SECTION 2J:

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5.9.3 **AUTOMATIC CONTROLLERS.** Connections to items in the field unit enclosure are as follows: Drip valves are to be connected to field unit through output terminals in the order shown on plans. Tenssiometers are to be connected to hydrovisor bus and field unit as per detail. Surge protection is to be wired as detailed. Pressure control to be wired to one of the fourteen input terminals on field unit. Motorized ball valve to be wired to two of the fourteen input terminals. One for opening the valve and one for closing the valve. Total of two valves and four input terminals per point of connection. Rain gage to be connected to one of the fourteen input terminals or the field unit. Flow meter is to be connected to the flow monitor which is connected to one of the fourteen back indication on the field unit. Radio interface to be connected to field unit in enclosure and antenna mounted outside of enclosure. All wiring above grade to be installed in galvanized electrical conduit and as per local code.

factory preset and will require no adjustment or calibration. The tensiometer shall be adaptable for direct input to computer processors. The tensiometer shall be available in a minimum of three ranges to allow irrigation above a preset matric potential. The Contractor shall install the tensiometers according to the manufacturer's requirements and as shown on the drawings.

5.13 Irrigation Filter (main line) shall be a centrifugal action filter which forces incoming water through a directional nozzle plate onto the inside of the filter screen. Debris is forced down in rotating motion into a holding basin at the bottom of the filter and by opening a flush valve, the particles may be removed. The Contractor shall install the irrigation filter according to the manufacturer's requirements and as shown on the drawings.

5.13.1 Filter Housing shall be constructed of ten gauge steel, epoxy coated, and welded into a wye configuration. A threaded 1/4 inch pressure tap shall be welded into the upstream and downstream piping for connection of pressure gauges.

5.13.2 Filter Screen shall be 150/mesh stainless steel.

5.13.3 Filter Flush Valve shall be a "ball" type made of brass.

5.14 Irrigation Filter (lateral line) shall be a wye type filter with a 150/mesh screen or smaller. The filter shall be constructed of brass, threaded at both ends and come with a "ball" type flush valve connection.

5.15 Pressure Regulator (project ^A "6" only) shall be constructed of brass with double unions (or as shown on the drawings). The pressure regulator shall have integral pressure adjustments and an integral pressure gauge reading to 60 psi. The pressure regulator shall be installed according to the manufacturer's requirements and as shown on the drawings.

5.16 Automatic Irrigation Controller shall be a computer-controlled field satellite system capable of radio communication with a remote (off site) central computer. The irrigation controller shall be multiwired, stand-alone microprocessor base capable of performing up to eight independent irrigation functions simultaneously. The controller shall be connected by communication cable to the transmitter/receiver unit as shown on the drawings. The minimum station capacity shall be as indicated on the drawings. The irrigation controller shall be mounted in a metal enclosure as specified, detailed and shown on the drawings.

5.17 Automatic Irrigation Controller Components shall be compatible with the irrigation controller and shall be installed according to manufacturer's requirements and as shown on the drawings.

5.17.1 Digital Flow Monitor shall be a microprocessor based flow monitor with LCD which will display the flow rate and total flow rate at the push of a button. The flow monitor shall be capable of being calibrated in the field with the use of a front mounted keyboard.

5.17.2 Conduit Box Kit shall be a weatherproof enclosure for stand-alone mounting and shall meet NEMA 4x. An opening shall be provided for a standard 1/2" conduit fitting. Mounting brackets shall be welded to the aluminum enclosure allowing surface mounting to the irrigation enclosure.

5.17.3 Keyboard Security Kit shall prevent unauthorized or accidental resetting of total accumulated flow, pipe diameter calibration and pulse output calibration. Special security fasteners and spanner shall be provided.

5.17.4 Relay Output Kit shall provide SPDT relay. The relay shall be available in 12VDC or 24VDC coil voltages. The voltage requirement shall be as shown on the project drawings.

5.17.5 AC Power Adapter (transformer) shall be UL approved 120 VAC outlet plug-in power supply to provide 12 VDC to the flow monitor.

5.17.6 Field Satellite Tranceiver shall be a trunked radio and be of the same manufacturer as the irrigation controller used in the project. The radio shall be provided with a microprocessor control, audible status tones, and system privacy for efficient communication on a channel sharing the same trunked radio system. The radio shall be equipped with a durable 5dB gain performance antenna and be of the same manufacturer as the radio. The trunked radio and the antenna shall be installed according to the manufacturers recommendation and as shown on the drawings.

5.18 Flow Sensor (meter) shall be a 6-bladed design with a proprietary, non-magnetic sensing mechanism. The sensor shall be supplied with a two conductor, shielded cable extending out through a conduit connection on top of the sensor. The sensor shall be mounted in a threaded brass pipe tee. The flow sensor shall have a maximum pressure range of 200 psi and a flow range of 30-1 feet/second. The Contractor shall install the flow sensor according to the manufacturers requirements and as shown on the project drawings.

5.19 Quick Coupling Valves shall be two piece, spring-loaded, compression type, normally closed, opening against line pressure, and actuated by downward thrust against the valve. Body shall be of heavy duty brass construction. Machined parts shall be fabricated from red brass. Valve washers and sealers for key stems shall be of a semi-rigid, non-metallic, material and shall be easily replaceable. Inlets shall be tapped for National Standard pipe thread of the pipe riser size or sizes shown on the drawings. Valves shall be suitable for a maximum operating pressure of 125 psi and shall be the standard product of a reputable manufacturer of quick coupling valves for lawn sprinkling systems. The Contractor shall furnish coupler keys for operating the valves ~~with hose swivels~~. Rubber sleeves shall be the standard product of the manufacturer of quick coupling valves and when required they shall replace hinged cover as regularly furnished. Each sleeve shall have a cover.

AND HOSE SWIVELS (Total of 514).

5.20 Vent (air) Valve/Vacuum Breaker shall be for use on an irrigation piping system that will allow air to purge up to 125 psi during the fill process and allow air to enter during drain-down. The valve shall be installed ~~according to manufacturers requirements and as shown on the drawings~~. A 1/2-inch air vent shall be installed on the high point of each lateral line serving drip irrigation systems. *★ in accordance with manufacturer's written instructions in a 10-inch diameter valve box with boltable cover.*

Valve materials - Thermoplastic body, glass filled Polysuflone

Temperature - Max. operating temperature:
200 degrees F. under pressure
250 degrees F. unpressurized

Pressures - Max. operating pressure 100 psi
proof pressure 150 psi, minimum

5.21 Gravel shall be crushed or natural materials washed and uniformly graded between 3/8 and one-inch size.

5.22 Pipe Bedding and Backfill Materials. The bottom of trenches shall be accurately graded to provide uniform bearing and support for each section of pipe on undisturbed soil at every point along its entire length. Backfill material shall be screened to remove any stone larger than one inch and may consist of sand, gravelly sands, silty sands, and clayey sands. Organic material, trash, debris, silt, sandy silt, clay, sandy clay, broken concrete or pavement and other objectionable material shall not be used.

5.23 Pipe Straps shall conform to the applicable requirements of MSS SP 58 and SP 69.

5.24 Motorized Ball Valve. The electric actuator and the ball valve shall be of the same manufacturer. The motorized ball valve shall have manufacturer supplied micro switches for position indication. Position indications shall be wired to back indication of irrigation controller. The ball valve shall have the following options:

- Body, Pipe Ends - Brass
- Ball Stem - 316 S.S.
- Seat - TFE
- Body Seal - TFE
- Ends - Screwed Pipe Ends

The Contractor shall install the motorized ball valve according to the manufacturers requirements and as shown on the project drawings.

5.24.1 Electric actuator shall be compatible with the irrigation controller. The actuator shall have multi-function capabilities. The housing shall be NEMA IV watertight. Gearing shall be two stage planetary gear, permanently lubricated self locking train. The electric actuator shall have the following options:

- Torque in./lbs. - 600
- Voltage VAC - 115
- Duty Cycles - 100%
- 90 degree/Time Seconds - 23
- Locked Rotor Current (Amps) 115 VAC - .46
- Special Service - Feedback Single Potentiometer
- Travel Stops - Stops for 90 degree operation

5.24.3 Ball Valve shall be of three piece construction for easy installation and inline maintenance. The ball valve shall be a two-way ball valve designed to seal on the downstream side against a resilient seat.

5.25 Enclosure Box Irrigation Controller shall be a NEMA 4, 12 gauge steel, all welded enclosure 36"(W) x 18"(D) x ^{36"}~~24"~~(H) in height, having a full-gasketed hinged door, 3-point dead bolt latch mechanism, padlockable handle, and integral mounting racks compatible with specified controller, power supply and ancillary

equipment. The preferred box is manufactured by Cross Brothers, Inc. and is known as a La Max Enclosure, specifically the "Arizona Box" which has additional louvers.

5.26 Pressure Sensor (switch) shall be operated by a brass Bourdon tube actuating a mercury switch and enclosed in a weather-resistant housing. Switch shall have deadband adjustable operating range from 5-150 psig. Switch shall have calibrated dial and two pointers indicating set and reset points. Switch shall have visible on/off indication. Set points shall be adjustable without removing switch cover or shutting down process. The pressure sensor shall be enclosed in a NEMA type enclosure, and shall be lockable, size as required. The Contractor shall install the pressure sensor according to the manufacturer's requirements and as shown on the project drawings.

5.27 Sprinklers.

5.27.1 General. Sprinkler heads of the types indicated shall be installed on swing risers as indicated. Size of riser pipe, minimum spacing of heads, radius of coverage, nozzle diameter, rate of water application and the available pressure at the riser, shall be as indicated on the drawings for each type and size of head. Sprinkler units of each type shall be the product of manufacturers regularly engaged in the production of lawn sprinkler or irrigation equipment.

5.27.2 Rotor Pop-up single and dual nozzle sprinklers shall be constructed of heavy duty high impact plastic, with built-in check valve, and heavy duty stainless steel retraction spring. Pop-up height as shown on drawings. The sprinkler head shall be completely serviceable from above ground and equipped with flushing wiper seal to clean the piston containing the nozzle(s) and to prevent debris from entering the case. Maximum working pressure: 100 psi.

5.27.3 The arc of coverage for the part circle shall be adjustable from 60 degrees to 360 degrees.

5.27.4 Turf Spray Pop-up Sprinklers. Sprinkler body shall be constructed of high impact plastic, and shall have a stainless steel retraction spring. Pop-up height as shown on drawings. Bottom inlet - 1/2 inch FPT. Each nozzle shall have a serviceable screen. Sprinkler nozzles shall be constructed of plastic, equipped with a throttle screw for radius adjustment, and shall provide for balanced precipitation rates. Maximum working pressure shall be 80 psi.

5.28 Self flushing end valves with concrete or plastic boxes with locking lids, shall be provided at dead ends of all lateral lines and drip line runs.

6. INSTALLATION.

6.1 General. Unless otherwise specified, installation of emitters, backflow prevention units, control valves, meters and boxes shall conform to the standard details shown on drawing.

6.2 Handling. Pipe and accessories shall be handled so as to insure delivery to the trench in sound, undamaged condition. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved

method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material at no additional cost to the Government.

6.3 Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise recommended by the manufacturer and authorized by the Contracting Officer, cutting shall be done with an approved type mechanical cutter. Wheel cutters shall be used when practicable.

6.3.1 Plastic Pipe shall be cut square and all burrs, particles and curls shall be removed prior to jointing.

6.4 Placing and Laying. Pipe, dripline, and accessories shall be carefully lowered in to the trench. Under no circumstances shall any of the materials be dropped or dumped into the trench. The full length of each section of pipe or dripline shall rest solidly upon the pipe or dripline bed, with recesses excavated to accommodate joints. Pipe or dripline that has the grade or joint disturbed after laying shall be taken up and relaid. Pipe or dripline shall not be laid in water or when trench conditions are unsuitable for the work. Water shall be kept out of the trench until jointing is completed. When work is not in progress or left unattended, open ends of pipe, dripline, fitting, and valves shall be securely closed (water tight) so that no trench water, earth, or other substance will enter the system. Driplines shall not be placed with kinks or sharp bends; that section of dripline shall be replaced at the direction of the Contracting Officer.

6.4.1 Plastic Pipe shall be installed in accordance with the procedures recommended in ASTM D 2774 and as herein specified.

6.4.2 Tracer wire or tracer tape shall follow the main line pipe lines and terminate in the valve box with the gate valve that controls these main irrigation lines. Provide enough length of wire or tape to make a loop and attach a plastic label with the designation "Tracer Wire."

6.5 Jointing.

6.5.1 Galvanized Steel Pipe. Threaded joints shall be made tight with a stiff mixture of graphite and oil, inert filler and oil, or with an approved graphite compound, applied with a brush to the male threads only. Compounds shall not contain lead.

6.5.2 Connections between different types of pipe and accessories shall be made with transition fittings approved by the Contracting Officer.

6.6 Pipe Sleeves shall be installed with a minimum of off-set at the joints to permit easy installation and removal of the irrigation lines. All plastic lines shall be installed in sleeves under paved areas, spillways, and other structures. Sleeves shall extend at least 12 inches beyond the edges of the pavement or structure. Sizes of sleeves shall be as follows:

Pipe Size (inches)	Minimum Sleeve Size (inches)
1/2	2
3/4	2-1/2

1, 1-1/4 and 1-1/2

3

2 and 2-1/2

4

3 and 4

6

6.6.1 SEE FOLLOWING PAGE

6.7 Setting of Valves, and Boxes. Valves and valve boxes shall be installed where shown or directed, and shall be set plumb. Valve boxes shall be centered on the valves. Valves shall be located outside the area of roads and streets. Earthfill shall be carefully tamped around each valve or meter box to a distance of 4 feet on all sides of the box, or to the undisturbed trench face if less than 4 feet. Valves shall have the interiors cleaned of all foreign matter before installation. * SEE FOLLOWING PAGE

6.8 Reaction Backing.

6.8.1 Thrust blocks shall be concrete mixed not leaner than one cement: 2-1/2 sand: 5 gravel. Blocks shall be placed between solid ground and the fitting to be anchored. The area of bearing shall be as indicated on the drawings or as approved. Contractor shall submit certification of concrete mix in accordance with SECTION: CONCRETE.

6.9 Remote Control Valves.

6.9.1 Install remote control valves in locations as shown on the drawings. Fit with plastic or concrete valve box and boltable cover. Top of valve box shall be 1/2-inch above finish grade.

6.10 Wire for Remote Control Valves and Tensiometers. For wiring connections from remote control valve assemblies (RCV) and tensiometer assemblies to irrigation controller panel using type THWN/THHN dual rated wire. Wiring shall be installed in rigid PVC conduit, Class 125 (project "A" only). Pullboxes and junction boxes shall be located every 200 feet or 90 degree change in pipe direction and will be clearly marked as appropriate. All wiring connections ~~exposed to moisture~~ shall be waterproofed using components such as 3M DBY Splice Kit (Scotchlock Y Electrical Spring Connector) or Rain Bird ST-03 Snap-Tight, UL Connectors and PT-S5 Sealer or as shown on the drawings.

6.10.1 - See following page

6.11 Automatic Controller. Controller shall be mounted on embed. Connect electrical panel as shown on the drawings. Connection to control wiring shall be made within the pedestal or head of the controller. Electrical wiring shall be in a rigid conduit from controllers to panel as shown on the drawings and provided under SECTION: ELECTRICAL WORK. The work under this section shall include all wiring to the panels or elsewhere as required, in order to complete the installation of the control system.

6.12. Connection to Existing Water Lines. The Contractor shall make all necessary arrangements as specified in SECTION: GENERAL REQUIREMENTS. Water meters and taps to the City of Phoenix (COP) water mains shall be provided/installed by the City. Costs shall be paid by the Contractor. The Contractor shall install metal vault as per COP specifications. POC: Mr. Gerald Arakaki, COP (602) 261-8229.

6.13 Connection to Electrical Utility. The Contractor shall make all necessary arrangements as specified in SECTION: GENERAL REQUIREMENTS for electrical service connections. Costs of installation and connections shall be paid by the Contractor. P.O.C. Arizona Public Services, Metro Engineering Service, 2121 W.

SECTION 2J:

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6.6.1 Piping located under areas where paving, asphaltic concrete, or concrete will be installed, shall be bedded with sand (a layer six inches (6") below the pipe and three inches (3") around the pipe). Compact approved backfill material in six inch (6") lifts to 95% or maximum density determined in accordance with AASHTO T 180, using manual or mechanical tamping devices. Contractor shall set in place, cap and pressure test all irrigation piping under paving, in presence of Consultant, prior to the paving work. Provide for a minimum cover of eighteen inches (18") between the top of pipe and the bottom of the aggregate base for all pressure and non-pressure piping installed under asphaltic concrete or concrete paving. Where any cutting or breaking of sidewalks and/or concrete is necessary, it shall be done and replaced by the Contractor as part of the contract cost. Permission to cut or break sidewalks and/or concrete shall be obtained from the Government prior to commencement of any cutting. If during the warranty period there is any settling or heaving of any paved areas as a result of the piping installation, the Contractor shall immediately restore the paved area to its original condition. The damaged paving shall be removed 24" beyond the edges of the damaged area. The trench backfill shall be re-excavated, the area re-backfilled and re-compacted in lifts, according to specifications, then the paving is to be replaced.

INSERT AT THE END OF PARAGRAPH 6.7:

When valve boxes are grouped together, allow at least 12 inches between boxes.

INSERT PARAGRAPH 6.10.1:

6.10.1 Electrical wiring for remote control valves (Project "C" only). Electrical wiring from controller to control valves shall be direct burial as shown on drawings. The electrical wiring shall be solid, single conductor, copper wire, type UF, size recommended by the Controller Manufacturer except that minimum wire size shall be No. 14. Common wire shall be different color from all others and be minimum wire size of No. 12. Regardless of the number of location of valves connected to a single controller station, separate control wires shall be run from the controller station to each valve. Wiring from controllers to panel shall be installed in rigid conduit.

Cheryl Drive, Phoenix, AZ 85036, Mr. Ernest Cota, (602) 271-3576 and Flood Control District of Maricopa County, 3335 W. Durango Street, Phoenix, AZ 85009, Mr. John E. Rodriguez, (602) 262-1501.

* 6.13 see following page 120

7. TESTS.

7.1 After completion of the piping system and prior to backfilling and the installation of the sprinklers and emitters (dripline), the entire system shall be tested for leaks and thoroughly flushed under pressure to remove any dirt, scale or other material. Lines shall be tested at 125 psi for a minimum of 8 hours duration. Cracked or defective pipe, fittings, or accessories disclosed in the pressure tests shall be replaced by the Contractor with sound material at no additional cost to the Government, and the test shall be repeated until results are satisfactory to the Contracting Officer. *FOR A MINIMUM OF FIVE MINUTES*
BEFORE FINAL ACCEPTANCE, THE PRESSURE LINE MUST REMAIN PRESSURIZED FOR A PERIOD OF 48 HOURS.

7.1.1 No line shall be covered until inspection and approval has been given by the Contracting Officer.

7.1.2 Testing of plastic pipe shall not be done until all joints have had at least 24 hours to set and cure. During cold weather, 48 hours elapsed time shall be allowed for setting prior to testing. No water under pressure shall come in contact with any joint during the specified curing period. In hot weather, water shall not be permitted to stand in pipes until after backfilling is completed. Water used in testing shall be drained from pipes after completion of testing.

7.2 Coverage Test. When the sprinklers and emitters (dripline) system is completed the entire system shall be adjusted and operated to demonstrate the water coverage is complete and adequate and that the system conforms to the manufacturer's requirements and according to the plans and specifications. All deficiencies and inadequacies resulting from defective or inadequate materials and/or workmanship shall be corrected at no additional cost to the Government. In the event any modifications to the system or deviation from the approved plans and specifications are directed, an adjustment in contract price will be made.

8. DISINFECTION. The completed line from the backflow prevention unit to the connection to the existing waterline shall be disinfected as prescribed by AWWA C 651.

9. CLEANUP. Upon completion of the installation of the irrigation system and appurtenances, all debris and surplus materials resulting from the work shall be removed.

IRRIGATION EQUIPMENT

10. VARIATION IN ARRANGEMENT OF ~~SPRINKLERS AND EMITTERS (dripline)~~ from those shown on drawings will be permitted. If such variation is made, the Contractor shall submit a shop drawing for approval in accordance with the SPECIAL CLAUSES. If any conflicts occur necessitating departures from the contract drawings, details of departures, hydraulic calculation and reasons shall be submitted as soon as practicable for written approval of the Contracting Officer. Hydraulic calculations shall include application rate per hour, maximum triangular spacing of sprinkler and layout for emitters (dripline) for design flow rate and pressure, overlap including wind loss allowance and friction loss through pipe fittings, valves and accessories.

SECTION 2J:

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6.13 CANAL CROSSING. Mainline bridge crossing shown on sheets 11 and 20 to be executed as follows:

Secure piping to bridge abutment pillars with pipe straps and anchor bolts 24" O.C. Hang piping across bridge with unistrut pipe hangers anchor bolted to underside of pedestrian walkway 24" O.C. Piping to be schedule 40 galvanized steel from connection into PVC mainline across bridge to connection back into PVC mainline. Piping to be hung a minimum 6" from bridge deck edge.

11. SUBMITTALS AND GUARANTEE. The manufacturer's literature on the following materials and equipment to be furnished under this specification shall be submitted for approval with a guarantee for a period of one year from the date of acceptance thereof, either for beneficial use or final acceptance, whichever is earlier, against defective materials, design, and workmanship:

- Automatic controller, enclosure and any other components listed herein and on the project drawings.
- Backflow prevention units
- Control valves
- Emitters and drip line
- Fertilizer injector unit
- Flow sensor
- Filter units
- Flush valves
- Gate valves
- Ball valves (Electric Actuators)
- Pressure sensor
- Pressure regulator
- PVC pipe and fittings
- Quick coupling valves and keys
- Sprinklers
- Tensiometers
- Water meters

* * * * *

SECTION 2K

CONCRETE SIDEWALKS, CURBS, GUTTERS AND DRIVEWAY ENTRANCES

Index

- | | |
|--------------------------------|-------------------------------------|
| 1. Applicable Publications | 6. Subgrade Preparation |
| 2. Field Control Tests | 7. Form Setting |
| 3. Materials | 8. Concrete Placement and Finishing |
| 4. Concrete Strength and Usage | 9. Curing and Protection |
| 5. Forms | 10. Sealing Joints |

1. APPLICABLE PUBLICATIONS. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1 Federal Specification (Fed. Spec.).

SS-S-1401C

Sealing, Joint, Non-Jet-Fuel-Resistant, Hot Applied, for Portland Cement and Asphalt Pavements

1.2 American Association of State Highway and Transportation Officials (AASHTO) Publication.

M 182-60
(R 1974)

Burlap Cloth Made From Jute or Kenaf

1.3 American Society for Testing and Materials (ASTM) Standards.

C 94-86b

Ready-Mixed Concrete

C 171-69
(R 1986)

Sheet Materials for Curing Concrete

C 173-78

Air Content of Freshly Mixed Concrete by the Volumetric Method

C 231-82

Air Content of Freshly Mixed Concrete by the Pressure Method

C 309-81

Liquid Membrane-Forming Compounds for Curing Concrete

D 1751-83

Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

D 1752-84

Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

2. **FIELD-CONTROL TESTS.** Preparation of field-control samples and testing of samples shall be by the Contractor at no additional cost to the Government. The taking of samples, the making of test specimens, and the testing thereof shall be performed under the supervision of the Contracting Officer.

3. **MATERIALS.** Materials shall conform to the respective publications and other requirements specified herein.

3.1 **Concrete Curing Materials.**

3.1.1 **Burlap.** AASHTO M 182 having a weight of 14 ounces or more per square yard when dry, and shall be non-staining.

3.1.2 **Impervious Sheeting.** ASTM C 171.

3.1.3 **Liquid Membrane Curing Compound.** ASTM C 309 Type 1D. Compound shall be free of paraffin or petroleum.

3.2 **Concrete Protection Materials.** Linseed oil mixture shall be equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the Contractor, commercially prepared linseed oil mixtures formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used except that emulsified mixtures are not acceptable.

3.3 **Joint Materials.**

3.3.1 **Expansion Joint Fillers.** ASTM D 1751 or ASTM D 1752 or shall be resin impregnated fiberboard conforming to the physical requirements of ASTM D 1752.

3.3.2 **Joint Sealers.** ASTM D 1850 or Fed. Spec. SS-S-1401.

4. **CONCRETE STRENGTH AND USAGE.**

4.1 **Sidewalk Concrete.** Concrete and materials therefore shall conform to the applicable requirements of SECTION: CONCRETE and ASTM C 94, Alternative No. 2 except as specified below. Concrete shall have a minimum compressive strength of 2,500 psi. The maximum size of aggregate shall be one inch. Concrete shall have a slump of not more than 3 inches. The concrete mixtures shall have air content by volume of concrete of 5 to 7 percent, based on measurements made immediately as the concrete is placed in the forms, except in those situations in which concrete is placed by use of pumps. Where concrete is placed by pumps, air content measurements will be taken in the forms after pumping. Air content shall be determined in accordance with ASTM C 173 or ASTM C 231. ASTM C 231 shall be used with concretes and mortars made with relatively dense natural aggregates.

4.2 **Curb, Gutter, and Driveway Entrance Concrete.** Concrete and the equipment, workmanship and materials therefore shall conform to the applicable requirements of SECTION: CONCRETE and ASTM C 94, except as specified below. Concrete shall have a minimum compressive strength of 2,500 psi. The maximum size of aggregate shall be one inch. Concrete shall have a slump of not more than 3 inches.

The concrete mixtures shall have air content by volume of concrete of 5 to 7 percent, based on measurements made immediately as the concrete is placed in the forms, except in those situations in which concrete is placed by use of pumps. Where concrete is placed by pump, air content measurements will be taken in the forms after pumping.

4.3 Color. An integral color admixture shall be added to the concrete. The colors shall conform to the requirements of the SECTION: CONCRETE.

5. FORMS.

5.1 Sidewalk. Sidewalk forms shall be of wood or steel, straight of sufficient strength to resist springing during depositing and consolidating concrete, and of a height equal to the full depth of the finished sidewalk. Wood forms shall be surfaced plank, 2-inch nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Wood forms shall have a nominal length of 10 feet, with a minimum of three stakes per form, at maximum spacing of 4 feet. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Radius bends may be formed with 3/4-inch boards, laminated to the required thickness. Steel forms shall be channel-formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Form ends shall be interlocked and self-aligning. Forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Forms shall have a nominal length of 10 feet, with a minimum of two welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips, designed for use with steel forms.

5.2 Curb, Gutter, and Driveway Entrance. Curb and gutter forms shall be of wood or steel, straight, and of sufficient strength to resist springing during depositing and consolidating the concrete. The outside forms shall have a height equal to the full depth of the curb or gutter. The inside form of curb shall have batter as indicated and shall be securely fastened to and supported by the outside form. Straight forms of wood shall be surfaced plank, 2-inch nominal thickness, straight and free from warp, twist, loose knots, splits, or other defects. Wood forms shall have a nominal length of 10 feet, with a minimum of three stakes per form, at maximum spacing of 4 feet. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Radius bends may be formed with 3/4-inch boards, laminated to the required thickness. Steel forms shall be channel-formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Form ends shall be interlocked and self-aligning. Forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Forms shall have a nominal length of 10 feet, with minimum of two welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips, designed for use with steel forms. Rigid forms shall be provided for curb returns, except that benders of thin plank forms may be used for curb or curb returns with a radius of 10 feet or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 1-1/2 inch benders, for the full height of the curb, cleated together.

6. SUBGRADE PREPARATION. The subgrade shall be constructed to grade and cross section.

6.1 Sidewalk Subgrade. The subgrade shall be thoroughly wetted and then compacted with two passes of a 500-pound roller. Yielding material deflecting more than 1/2 inch under the specified roller shall be removed to a depth of not less than 4 inches below subgrade elevation and replaced with an approved granular material. The material shall then be compacted as described above. The completed subgrade shall be tested for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

6.2 Curb, Gutter, and Driveway Entrance Subgrade. The subgrade shall be of materials equal in bearing quality to the subgrade under the adjacent pavement and shall be placed and compacted to conform with applicable requirements of SECTION: FILLS AND SUBGRADE PREPARATION. The subgrade shall be tested for grade and cross section by means of a template extending the full width of the curb and gutter.

6.3 Maintenance of Subgrade. The subgrade shall be maintained in a smooth, compacted condition, in conformity with the required section and established grade until the concrete is placed. The subgrade shall be in a moist condition when concrete is placed. The subgrade shall be prepared and protected so as to produce a subgrade free from frost when the concrete is deposited.

7. FORM SETTING.

7.1 Sidewalk. Forms for sidewalks shall be set with the upper edge true to line and grade and shall be held rigidly in place by stakes placed at intervals not to exceed 4 feet. After forms are set, grade and alignment shall be checked with a 10-foot straightedge. Forms shall conform to line and grade with an allowable tolerance of 1/8 inch in any 10-foot long section. Forms shall have a transverse slope of 1/4 inch per foot with the low side adjacent to the roadway. Forms shall be coated with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory. Side forms shall not be removed for less than 12 hours after finishing has been completed.

7.2 Curbs and Driveway Entrances. Forms for curbs and driveway entrances shall be carefully set to alignment and grade and to conform to the dimensions of the curb and driveway entrances. Forms shall be held rigidly in place by the use of stakes placed at intervals not to exceed 4 feet. Clamps, spreaders, and braces shall be used where required to insure rigidity in the forms. The forms on the front of the curb shall be removed not less than 2 hours nor more than 6 hours after the concrete has been placed. Forms back of curb shall remain in place until the face and top of the curb have been finished as specified for concrete finishing. Gutter forms shall not be removed while the concrete is sufficiently plastic to slump in any direction. Forms shall be cleaned and coated with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

8. CONCRETE PLACEMENT AND FINISHING.

8.1 Sidewalk Concrete. Concrete shall be placed in the forms in one layer of such thickness that when compacted and finished the sidewalk will be of the thickness indicated. After concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted. The concrete shall be tamped and consolidated with a suitable wood or metal tamping bar, and the surface shall be finished to grade with a wood float. Finished surface of the walk shall not vary more than 3/16 inch from the testing edge of a 10 foot-straightedge. Irregularities exceeding the above shall be satisfactorily corrected. The surface shall be divided into rectangular areas by means of contraction joints spaced at not more than 5 feet on centers.

8.1.1 Concrete Finishing. After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, the surface shall be finished to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of the traffic.

8.1.1.1 Colored and Textured Finish. Contractor shall submit installation procedures for colored concrete to the Contracting Officer for approval. Finishes shall conform to the requirements for Concrete Slab Finishes, and as specified herein. All concrete will be colored with an integral color as described in SECTION: CONCRETE. All sidewalk surfaces shall be given a rough texture by brooming with a fibre-bristle broom in a direction transverse to that of the main traffic flow. The rough texture finish shall also be applied to adjacent surfaces a sufficient distance in all directions to provide adequate texture for traction in turning areas.

8.1.2 Edge and Joint Finishing. All slab edges, including those at formed joints, shall be finished carefully with an edger having a radius of 1/8 inch. Transverse joints shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corner and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.

8.1.3 Contraction Joints. The contraction joints shall be formed in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness, using a jointer to cut the groove, or by sawing a groove in the hardened concrete with a power-driven saw, unless otherwise approved. Sawed joints shall be constructed by sawing a groove in the concrete with a 1/8-inch blade to the depth indicated. The time of sawing shall be varied, depending on existing and anticipated weather conditions, and such sawing shall be at the required rate. An ample supply of saw blades shall be available on the job before concrete placement is started, and at least one standby sawing unit in good working order shall be available at the jobsite at all times during the sawing operations.

8.1.4 Expansion Joints. Transverse expansion joints shall be installed at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, transverse expansion joints shall be installed as indicated. Transverse expansion joints shall be filled with 1/2-inch joint filler strips. Joint filler shall be placed with top edge 1/4 inch below

the surface and shall be held in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, joint edges shall be rounded with an edging tool having a radius of 1/8 inch, and concrete over the joint filler shall be removed. Expansion joints shall be formed about structures and features that project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated. The filler shall be installed in such manner as to form a complete, uniform separation between the structure and sidewalk pavement. At the end of the curing period, expansion joints shall be carefully cleaned and filled with joint sealer. Concrete at the joint shall be surface dry, and the atmospheric and pavement temperatures shall be above 50 degrees F. at the time of application of joint-sealing materials. Joints shall be filled flush with the concrete surface in such manner as to minimize spilling on the walk surface. Spilled sealing material shall be removed immediately and the surface of the walk cleaned. Dummy groove joints shall not be sealed.

8.1.5 Surface Uniformity. The completed surface shall be uniform in color and free of surface blemishes and tool marks.

8.2 Curb, Gutter, and Driveway Entrance Concrete. Concrete shall be placed in layers not to exceed 6 inches. Concrete shall be thoroughly consolidated by tamping and spading or with approved mechanical vibrators.

8.2.1 Concrete Finishing. The edges of the gutter and top of the curb shall be rounded with an edging tool to a radius of 1/2-inch and the surfaces shall be floated and finished with a smooth wood float until true to grade and section and uniform in texture. Floated surfaces shall then be brushed with a fine-hair brush with longitudinal strokes. Immediately after removing the front curb form, the face of the curb shall be rubbed with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. The surface, while still wet, shall be brushed in the same manner as the gutter and curb top. The top surface of gutter and entrance shall be finished to grade with a wood float. Except at grade changes or curves, finished surfaces shall not vary, from the testing edge of 10-foot straightedge, more than 1/8 inch for gutter and entrance and 1/4 inch for top and face of curb. Irregularities exceeding the above shall be satisfactorily corrected. Visible surfaces and edges of finished curb and gutter shall be free of blemishes and form and tool marks, and shall be uniform in color, shape, and appearance.

8.2.2 Joints. Expansion joints and contraction joints shall be constructed at right angles to the line of curb and gutter.

8.2.2.1 Contraction Joints. Contraction joints shall be constructed by means of 1/8-inch thick separators, of a section conforming to the cross section of the curb and gutter. Contraction joints shall be constructed directly opposite contraction joints in abutting portland-cement-concrete pavement. Where curb and gutter do not abut portland-cement-concrete pavements, contraction joints shall be so placed that monolithic sections between curb returns will not be less than 5 feet nor greater than 15 feet in length. Separators shall be removed as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint. Separators shall be removed prior to finishing.

8.2.2.2 Expansion Joints. Expansion joints shall be formed by means of preformed expansion-joint filler material cut and shaped to the cross section of curb and gutter. Expansion joints shall be provided in curb at the end of all returns. Expansion joints shall be provided in curb and gutter directly opposite expansion joints of abutting portland-cement-concrete pavement and shall be of the same type and thickness as joints in the pavement. Where curb and gutter do not abut portland-cement-concrete pavement, expansion joints at least 1/2-inch in width shall be provided at intervals not exceeding 25 feet. Expansion joints shall be provided in non-reinforced concrete gutter at locations indicated.

9. CURING AND PROTECTION.

9.1 Curing. Immediately after the finishing operations, exposed concrete surfaces shall be cured by one of the following methods as the Contractor may elect.

9.1.1 Mat Method. The entire exposed surface shall be covered with two or more layers of burlap. Mats shall overlap each other at least 6 inches. The mat shall be thoroughly wetted with water prior to placing on concrete surface and shall be kept continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.

9.1.2 Impervious Sheeting Method. The entire exposed surface shall be wetted with a fine spray of water and then covered with impervious sheeting material. Sheets shall be laid directly on the concrete surface with the light-colored side up and overlapped 12 inches when a continuous sheet is not used. The curing medium shall not be less than 18 inches wider than the concrete surface to be cured, and shall be securely weighted down by heavy wood planks, or by placing a bank of moist earth along edges and laps in the sheets. Sheets shall be satisfactorily repaired or replaced if torn or otherwise damaged during curing. The curing medium shall remain on the concrete surface to be cured for not less than 7 days.

9.1.3 Membrane-Curing Method. The entire exposed surface shall be covered with a membrane-forming curing compound. Where type 1 curing compound is used, the concrete surface shall be shaded from the direct rays of the sun during the curing period. Curing compound shall be applied in two coats by hand-operated pressure sprayers at a coverage of approximately 200 square feet per gallon for both coats. The second coat shall be applied in a direction approximately at right angles to the direction of application of the first coat. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. Apply an additional coat to all surfaces showing discontinuity, pinholes or other defects. Concrete surfaces that are subjected to heavy rainfall within 3 hours after curing compound has been applied shall be resprayed by the above method and at the above coverage at no additional cost to the Government. Expansion-joint openings shall be sealed at the top by inserting moistened paper or fiber rope or covering with strips of waterproof paper prior to application of the curing compound, in a manner to prevent the curing compound entering the joint. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected for 7 days from pedestrian and vehicular traffic and from any other action that might disrupt the continuity of the membrane. Any area covered with curing compound and damaged by subsequent construction operations within the 7-day curing period shall be resprayed as specified above at no additional expense to the Government.

9.2 Backfilling. After curing, debris shall be removed, and the area adjoining the concrete shall be backfilled, graded, and compacted to conform to the surrounding area in accordance with lines and grades indicated.

9.3 Protection. Completed concrete shall be protected from damage until accepted. The Contractor shall repair damaged concrete and clean concrete discolored during construction. Concrete that is damaged shall be removed and reconstructed for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Removed damaged portions shall be disposed of as directed.

10. SEALING JOINTS. The approximately horizontal sections of expansion joints and the top 1-inch depth of contraction-joint openings of gutter shall be sealed with joint sealer. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing shall be done so that the material will not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 50 degrees F. at the time of application of joint-sealing materials. Excess material on exposed surfaces of the concrete shall be removed immediately and exposed concrete surfaces cleaned.

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SECTION 2L

SIDE DRAINS, ~~PAYBACK WATER LINE AND LOW FLOW CONDUITS~~

Index

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|---|--|
| 1. Applicable Publications | 8. Materials for Drainage Structures |
| 2. Submittals | 9. Joints |
| 3. Certification | 10. Excavation, Trenching and
Backfilling for Side Drains
and Payback Water Line |
| 4. Delivery, Storage, and Handling of
Materials | 11. Excavation for Low Flow Conduits |
| 5. 12-Inch Payback Water Line | 12. Placing Pipe |
| 6. Pipe for Side Drains and Low Flow
Conduits | 13. Backfilling for Low Flow Conduits |
| 7. Drainage Structures | |

1. APPLICABLE PUBLICATIONS. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1 Federal Specification (Fed. Specs.).

HH-P-117

Packing; Jute, Twisted

SS-S-210A

Sealing Compound, Preformed for
Expansion Joints and Pipe Joints

1.2 Federal Standard (Fed. Std.).

No. 601 and change
Notices 1 thru 7

Rubber: Sampling and Testing

1.3 American Association of State Highway and Transportation Officials (AASHTO) Publications.

Standard Specifications for Highway Bridges (1983) & Interim
Specifications (1984)

M 33-81

Preformed Expansion Joint Filler for
Concrete (Bituminous Type)

M 170-85

Reinforced Concrete Culvert, Storm
Drain, and Sewer Pipe

M 198-75
(R 1986)

Joints for Circular Concrete Sewer
Culvert Pipe Using Flexible
Watertight Gaskets

M 199-85

Precast Reinforced Concrete Manhole
Sections

1.4 American National Standards Institute (ANSI) Publications.

- | | |
|-----------|--|
| A 14.3-84 | American National Standard Safety Requirements for Fixed Ladders |
| B 16.1-75 | Cast Iron Pipe Flanges and Flanged Fittings |

1.5 American Society for Testing and Materials (ASTM) Publications.

- | | |
|-----------|---|
| A 36-84a | Structural Steel |
| C 76-85a | Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe |
| C 270-86b | Mortar for Unit Masonry |
| C 443-85a | Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets |
| C 478-85a | Precast Reinforced Concrete Manhole Sections |
| D 1751-83 | Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) |
| D 1752-84 | Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction |

1.6 American Water Works Association (AWWA) Publications.

- | | |
|----------------------|--|
| C 111-85 | Rubber-Gasket Joints for Ductile-Iron and Grey-Iron Pressure Pipe and Fittings |
| C 150-81
(R 1986) | Thickness Design of Ductile-Iron Pipe |
| C 508-82 | Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. NPS |
| C 509-80 | Resilient-Seated Gate Valves, 3 Through 12 NPS, for Water and Sewage Systems |

1.7 Uniform Standard Specifications (MAG Specs) and Details, Maricopa Associations of Governments, Arizona, year 1979 and the current revisions thereto.

The City of Phoenix (COP) Supplement to MAG Uniform Standard Specification.

2. SUBMITTALS.

2.1 Manufacturers Recommendations. Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Contracting Officer prior to installation. Installation of the item will not be allowed until the recommendations are received. Failure to furnish the recommendations can be cause for rejection of the material.

3. CERTIFICATION. Certified copies of test reports demonstrating conformance to applicable pipe specifications shall be delivered to the Contracting Officer before pipe is installed.

4. DELIVERY, STORAGE, AND HANDLING OF MATERIALS.

4.1 Delivery and Storage. Materials delivered to site shall be inspected for damage, unloaded, and stored with the minimum of handling. Do not store materials directly on the ground. Inside of pipes and fittings shall be kept free of dirt and debris.

4.2 Handling. Materials shall be handled in such a manner as to insure delivery to the trench in sound undamaged condition. Pipe shall be carried to the trench not dragged. Gasket materials and plastic materials that are not to be installed immediately shall not be stored in the direct sunlight.

5. ~~12-INCH PAYBACK WATER LINE.~~

5.1 Material. All water line pipe shall comply with subsection 750.2, "Ductile Iron Water Pipe," of the MAG Standard Specifications and shall be minimum Class 51, in accordance with AWWA C-150. All pipe, except where shown on plans, shall comply with AWWA C-111 for mechanical joint pipe, C1.150. Fittings shall be mechanical joints with cement mortar lining and coal-tar coated.

5.2 Ductile Iron Flanged Pipe shall be suspended from pipe supports as shown in drawings. Pipe at each end shall be flanged at one end and threaded at the other end. The threaded end shall be inserted through 15-inch steel sleeve and a screw flange added. All flanged fittings shall be faced and drilled per ANSI B16.1 125 lb template.

5.3 Gate valves and check valves shall be installed in accordance with City of Phoenix detail P1396 in the manner and at the location shown on plans. Gate valves shall be resilient wedge flanged valves conforming to requirements of AAWA C-509 with outside screw and yoke (OS&Y) design. Minimum working pressure shall be 200 psi. Flanges shall be faced and drilled to B16.1 125 pound standard and shall be fully supported.

5.3.1 Check valves shall be (plain iron body, bronze mounted flanged valves) suitable for horizontal installation with 150 psi minimum working pressure. Valves shall have a clear waterway equal to the full nominal diameter of the valve and conform to AWWA C 508 and will be approved by the Contracting Officer for backflow protection.

5.4 Polyethylene Corrosion Protection. All Ductile Iron Pipe valves and fittings installed shall be protected from corrosion by encasement in a polyethylene protective wrapping per Subsection 610.5 of the MAG Standard Specifications and Details.

5.5 Submittals. Complete shop drawings for Payback Water Line and appurtenances including all structures, utilities, elevations, grades shall be submitted for approval in accordance with the requirements of the SPECIAL CLAUSES.

6. PIPE FOR SIDE DRAINS.

6.1 Reinforced concrete pipe shall conform to requirements for the following pertinent types. Reinforced Concrete Pipe. ASTM C 76 or AASHTO M 170, Class as indicated on the drawings.

6.2 Poly (Vinyl Chloride) (PVC) Pipe and Fittings. ASTM D 3034, Type PSM with a maximum SDR of 35, size 15-inch or less in diameter, with flexible elastomeric seal joint.

7. DRAINAGE STRUCTURES.

7.1 Junction Structures and Catch Basins. Construction shall be cast-in-place reinforced concrete complete with frames and covers for gratings.

7.2 Walls and Headwalls. Construction shall be concrete as indicated.

7.3 Cradle and Encasement for Low Flow Conduits. Construction shall be cast in place concrete for cradle and reinforced concrete for encasement as shown on the drawings.

7.4 Ladders. Ladders shall be steel individual rung ladders in accordance to ANSI A14.3 or MAG Specs. Rungs shall be galvanized, solid-section rods imbedded into concrete as indicated on the drawings.

8. MATERIALS FOR DRAINAGE STRUCTURES.

8.1 Concrete. Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for 3000 psi concrete under SECTION: CONCRETE. Expansion-joint filler material shall conform to ASTM D 1751, ASTM D 1752, or AASHTO M 33, or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM D 1752. Color admixture shall be excluded for this item.

8.2 Mortar. Mortar for pipe joints and connections to other drainage structures shall conform to ASTM C 270, Type M, except the maximum placement time shall be one hour. Color admixture shall be excluded for this item.

8.2.1 The quantity of water in the mixture shall be only that sufficient to produce a stiff workable mortar. Water shall be clean and free of harmful acids, alkalis, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water.

8.2.2 The inside of the joint shall be wiped clean and finished smooth. In head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

8.3 Flap Gates, Grating and Frames. Flap gates, gratings, and frames shall conform to the requirements of SECTION: MISCELLANEOUS METALS.

9. JOINTS.

9.1 For Concrete Pipe Use Cement-Mortar Bell-and-Spigot Joint. The first pipe shall be bedded to the established gradeline, with the bell end placed upstream. The interior surface of the bell shall be carefully cleaned with a wet brush and the lower portion of the bell filled with mortar to such depth as to bring inner surfaces of abutting pipes flush and even. The spigot end of each subsequent pipe shall be cleaned with a wet brush and uniformly matched into the bell so that sections are closely fitted. After each section is laid, remainder of the joint shall be filled with mortar, and a bead shall be formed around the outside of the joint with sufficient additional mortar. Cement mortar, finish, and protection of joints shall be as specified in paragraph: MATERIALS FOR DRAINAGE STRUCTURES. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint shall be wrapped or bandaged with cheesecloth to hold mortar in place.

9.1.1 Cement-Mortar Oakum Joint for Bell-and-Spigot Pipe. A closely twisted gasket shall be made of jute or oakum in accordance to Fed. Spec. HH-P-117, of the diameter required to support the spigot end of the pipe at the proper grade and to make the joint concentric. Joint packing shall be in one piece of sufficient length to pass around the pipe and lap at top. This gasket shall be thoroughly saturated with neat cement grout. The bell of the pipe shall be thoroughly cleaned with a wet brush, and the gasket shall be laid in the bell for the lower third of the circumference and covered with mortar. The spigot of the pipe shall be thoroughly cleaned with a wet brush, inserted in the bell, and carefully driven home. A small amount of mortar shall be inserted in the annular space for the upper two-thirds of the circumference. The gasket then shall be lapped at the top of the pipe and driven home in the annular space with a calking tool. The remainder of the annular space then shall be filled completely with mortar and beveled at an angle of approximately 45 degrees with the outside of the bell. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint thus made shall be wrapped with cheesecloth. Placing of this type joint shall be kept at least five joints behind laying operations. The cement mortar, finish, and protection of joints shall be as specified in paragraph: MATERIALS FOR DRAINAGE STRUCTURES.

9.1.2 Cement-Mortar Diaper Joint for Bell-Spigot Pipe. The pipe shall be centered so that the annular space is uniform. The annular space shall be calked with jute or oakum. Before calking, the inside of the bell and outside of spigot shall be cleaned.

9.1.2.1 Diaper bands shall consist of heavy cloth fabric to hold grout in place at joints and shall be cut into such lengths that they will extend one-eighth of the circumference of pipe above the spring line on one side of the pipe and up to the spring line on the other side of the pipe. Longitudinal edges of fabric bands shall be rolled and stitched around two pieces of wire. Width of fabric bands shall be such that after fabric has been securely stitched around both edges on wires, the wires will be uniformly spaced not less than 8 inches apart. Wires shall be cut into lengths to pass around pipe with sufficient extra length for ends to be twisted at top of pipe to hold band securely in place; bands shall be accurately centered around lower portion of joint.

9.1.2.2 Grout shall be poured between band and pipe from only the high side of band, until grout rises to the top of band at the spring line of pipe, or as nearly so as possible, on the opposite side of pipe, to insure a thorough sealing of joint around the portion of pipe covered by the band. Silt, slush, water, or polluted mortar grout forced up on the lower side shall be carefully forced out by pouring and removed.

9.1.2.3 The remaining unfilled upper portion of the joint shall then be filled with mortar and a bead formed around outside of this upper portion of the joint with sufficient amount of additional mortar. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind actual laying of pipe. No backfilling around joints shall be done until the joints have been fully inspected by the Contractor and approved by the Contracting Officer. The Contractor shall notify the Contracting Officer 24 hours prior to inspecting the joints. The cement mortar, finish and protection of the joints shall be as specified in paragraph: MATERIALS FOR DRAINAGE STRUCTURES.

9.1.2.4 The inside of the joint and the annular space shall be cleaned by brooming or other approved methods. The inside of the joint and the annular space shall then be dry packed so as to supply an unbroken flow line between adjacent pipe segments.

9.1.3 Cement-Mortar Tongue-and-Curve Joint. The first pipe shall be bedded carefully to the established gradeline with the groove upstream. A shallow excavation shall be made underneath the pipe at the joint and filled with mortar to provide a bed for the pipe. The groove end of the first pipe shall be carefully cleaned with a wet brush, and a layer of soft mortar applied to the lower half of the groove. The tongue of the second pipe shall be cleaned carefully with a wet brush; while in horizontal position, a layer of soft mortar shall be applied to the upper half of the tongue. The tongue end of the second pipe then shall be inserted in the groove end of the first pipe until mortar is squeezed out on interior and exterior surfaces. Sufficient mortar shall be used to fill the joint completely and to form a bead on the outside. The cement mortar, finish, and protection of joints shall be as specified in the paragraph: MATERIALS FOR DRAINAGE STRUCTURES.

9.1.4 Cement-Mortar Diaper Joint for Tongue-and-Groove Pipe. The joint shall be of the type described for Cement-Mortar Tongue-and-Groove Joint, in this paragraph, except that the shallow excavation directly beneath the joint shall not be filled with mortar until after a gauze or cheesecloth band dipped in cement mortar has been wrapped around the outside of the joint. The cement-mortar bead at the joint shall be at least 1/2 inch thick, and the width of the diaper band shall be at least 8 inches. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind the actual laying of the pipe. No backfilling around the joints shall be done until the joints have been fully inspected and approved. The cement mortar, finish, and protection of joints shall be as specified in the paragraph: MATERIALS FOR DRAINAGE STRUCTURES.

9.1.5 Self-Centering Tongue and Groove Pipe. "Self-centering" tongue and groove pipe 36 inches or greater in diameter will not require outside grouting except where the pipe is used on curves or angle points. All joints shall be butted together. The overlap of the tongue and the groove portion of the joint shall not be less than 50 percent of the overlap measured from the manufacturer's designed full seat position. The material and layout drawings shall specify the maximum

inside annular space that satisfies these specifications. Non-conforming joints shall require outside grouting or a concrete collar as determined by the Contracting Officer.

9.1.5.1 The inside annular space between pipe sections shall be completely filled with mortar and finished smooth with the inside pipe surface. All joints shall be cleaned with a wire brush and wetted before mortaring. Joints shall not be mortared before the next two joints in advance are laid. The entire depth of the finished inside joint shall be filled with mortar in such a manner as to insure a strong tight joint.

9.1.5.2 Tongue and groove joints will not be permitted for pipe under 36 inches in diameter.

9.1.6 Rubber Gasket Joint. Design of joints and physical requirements for rubber-type gaskets shall conform to ASTM C 443 or AASHTO M 198. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber gasket type are permitted if nominal diameter of pipe being gasketed exceeds 54 inches. Material conforming to Fed. Spec. SS-S-210 is acceptable as an alternate to ASTM C 443 provided the necessary installation instructions are furnished. Gaskets or jointing materials shall not swell more than 100 percent by volume by volume immersed in accordance with Method 6211 of Fed. Std. 601, in immersion medium No. 3 for 70 hours at 212 degrees F. Certified copies of test results shall be delivered to the Contracting Officer before gaskets or jointing materials are installed. Alternate types of watertight joint may be furnished if specifically approved. Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pulled together. If, while making the joint, the gasket or jointing material becomes loose and can be seen through the exterior joint recess when joint is pulled up to within one inch of closure, the pipe shall be removed and the joint remade.

9.2 Poly (Vinyl Chloride) (PVC) Pipe: Elastomeric gasket joint in accordance with ASTM D 3212.

10. EXCAVATION, TRENCHING, AND BACKFILLING FOR SIDE DRAINS AND ~~PAYBACK WATER LINE~~ shall conform to the requirements of SECTION: EXCAVATING, TRENCHING AND BACKFILLING FOR UTILITIES.

~~11. EXCAVATION FOR LOW FLOW CONDUITS shall conform to the requirements of SECTION: EXCAVATION.~~

12. PLACING PIPE. Each pipe shall be carefully examined before being laid, and defective or damaged pipe shall not be used. Pipelines shall be laid to the grades and alinement indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe be laid in water, and no pipe shall be laid when trench conditions or weather are unsuitable

for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. All pipe in place shall be inspected before backfilling, and those damaged during placement shall be removed and replaced at no additional cost to the Government. Laying shall proceed upgrade with spigot ends of bell-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of flow.

13. ~~BACKFILLING FOR LOW FLOW CONDUITS shall conform to the requirements of SECTION: EXCAVATING, TRENCHING, AND BACKFILLING FOR UTILITIES except that the low flow conduits shall be laid on the cradle instead of bedding material.~~

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SECTION 2M

DETOURS AND TRAFFIC CONTROL FACILITIES

Index

- | | |
|------------------------|--------------------------------------|
| 1. Detours | 4. Maintenance |
| 2. Required Detours | 5. Traffic Control |
| 3. Detour Construction | 6. Removal of Detour and Restoration |

1. **DETOURS.** Detours shall be in accordance with all applicable state, county and city traffic regulations. Detailed plans shall be prepared for all requested detours indicating surfacing, signing, striping, pedestrian access provisions and hours of operation. These plans shall be approved by the City of Phoenix or other appropriate agency as a condition of approval by the Contracting Officer.

2. **REQUIRED DETOURS.** Detours shall be constructed and maintained at Central Avenue and at Dunlap Avenue to permit continuous two-way traffic use 24 hours a day. The Contractor shall keep the detour in operation until removal is authorized in writing by the Contracting Officer. See the Section Titled "Restrictions" for timing of phasing on Dunlap.

3. **DETOUR CONSTRUCTION.**

3.1 **General.** Construction of the required detours shall conform to the details and notes on the drawings and as specified herein.

3.2 **Earthwork** shall conform to the requirements of Sections: EXCAVATION and FILLS AND SUBGRADE PREPARATION.

3.3 **Asphalt Concrete** shall conform to the requirements of Section: ASPHALT CONCRETE.

3.4 **Aggregate Base** shall conform to the requirements of Section: AGGREGATE BASE.

3.5 **The Contractor** shall submit a plan for approval by the Contracting Officer, of the method of handling and transporting bridge beams to the site.

3.6 **OWNER SUPPLIED MATERIALS.** The Contractor may use beams located at Adobe Dam (43rd Avenue and Beardsley Road) in the construction of the Central Avenue detour bridge.

4. MAINTENANCE. The detour shall be maintained in a safe condition until it is removed. Installation and maintenance of traffic control facilities and detour surfaces, shall be performed by the Contractor. The surface shall be maintained without abrupt changes of grade in excess of 1/4 inch in 10 feet.

5. TRAFFIC CONTROL.

5.1 The Contractor shall furnish, install, maintain and remove all temporary barricades, lights, warning signs, flagmen and other facilities necessary to control the traffic and protect pedestrians within the limits of the construction area. All signs to be used on the project during periods of darkness shall be reflectorized. Traffic control shall conform to the City of Phoenix Barricade Manual; Section 400 of the Uniform Standard Specifications for Public Works Construction, Maricopa Association of Governments (MAG) and the State of Arizona depending on jurisdiction.

5.2 The number and type of barricades, signs, delineators, barriers and all other traffic control devices shall be subject to approval, however, approval of traffic control devices and the approval of the Contractor's method of application of all traffic control measures, shall not relieve the Contractor of the responsibility of protecting the work, the workmen and the traveling public.

6. REMOVAL OF DETOURS AND RESTORATION.

6.1 The Contractor shall remove the detour and temporary bridges, remove materials from the site, and restore the site.

6.2 The area where the detour was placed shall be completely restored to its original condition, or as indicated in the drawings. This will include removal of the detour pavement, temporary fencing, temporary barriers and embankment, temporary bridges, and abutments to 1' below finish grade.

6.3 Utilities that had been moved or adjusted to accommodate the detour will be reset to an appropriate location and grade. Signs that were moved or changed for the detour will be replaced per their original location and type.

6.4 The bridge beams will be removed from the site and delivered to the Maricopa County Highway Department storage yard at Adobe Dam (43rd Avenue and Beardsley Road). Care shall be taken so as not to damage the beams during removal or delivery. The Contractor is responsible for delivering the beams in good condition, and if the beams are seriously damaged, the Contractor will be penalized 75% of the cost of new beams, and shall remove the used beams from the site.

6.5 Street reconstruction shall be in accordance with the drawings.

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SECTION 2P

SCOUR GAUGES

1. GENERAL. The scour gauges shall be of the dimensions shown on the drawings and installed at the locations indicated.

2. MATERIAL.

2.1 Concrete. Scour gauges shall be integrally colored precast concrete. Concrete shall conform to the requirements of SECTION: CONCRETE. The maximum aggregate size may be reduced to 3/8 inch. The finish surface of the concrete shall be finished smooth and without blemish.

2.2. Color Additive shall be manufacturers' standard black pigmented color additive. Additive shall be mixed in accordance with manufacturers' written instructions and in sufficient quantities to provide vivid coloration of the concrete. The color shall be certified as non-fading by the supplier.

3. TOLERANCES. Tolerances of scour gauges shall be within 1/32 inch of the dimension shown on the drawings.

4. INSTALLATION. Scour gauges shall be installed perpendicular and flush to finish surfaces.

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SECTION 2R

TURF

Index

- | | |
|------------------------------------|-------------------------------|
| 1. Applicable Publications | 7. Seeding |
| 2. Submittals | 8. Restoration and Clean Up |
| 3. Delivery, Storage, and Handling | 9. Protection of Turfed Areas |
| 4. Materials | 10. Turf Establishment Period |
| 5. Seeding Times | 11. Final Acceptance |
| 6. Site Preparation | |

1. APPLICABLE PUBLICATIONS. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1.1 Federal Specification (Fed. Spec.).

O-F-241d

Fertilizers, Mixed, Commercial

1.2 U.S. Department of Agriculture Publication.

Federal Seed Act of August 9, 1939 (53 Stat. 1275) Rules and Regulations

1.3 American Society for Testing and Materials (ASTM).

D 2607-69

Peats, Mosses, Humus, and Related Products

2. SUBMITTALS.

2.1 Certificates of Compliance and Certified Laboratory Test Reports. Prior to the delivery of materials, certificates of compliance shall be submitted in accordance with the SPECIAL CLAUSES certifying that materials meet the requirements specified. Certified copies of the reports for the following materials shall be submitted.

2.1.1 Seed. For mixture percentage, pure live seed, weed seed content, germination.

2.1.2 Fertilizer. For chemical analysis and composition percent.

2.1.3 Chemical treatment material. For EPA registration and uses.

2.2 Manufacturer's Literature. Discussing physical characteristics, application and installation instructions for.

2.2.1 Chemical Treatment Material.

2.3 Delivery Schedule. Submittal of the schedule shall be at least 10 days before delivery.

2.4 Chemical Treatment Plan. Chemical Treatment Plan shall be submitted with proposed sequence of chemical treatment work. The common name, chemical composition, formulation, concentration, rate and method of application for all materials furnished; and the name and license of the state certified applicator(s) shall be included.

3. DELIVERY, STORAGE, AND HANDLING.

3.1 Delivery.

3.1.1 Turf material shall be inspected upon arrival at the jobsite, and unacceptable material shall be removed from the jobsite.

3.1.2 Delivery of fertilizer to the site shall be in original, unopened containers bearing manufacturer's chemical analysis. Instead of containers, fertilizer may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries.

3.1.3 Soil amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil amendments may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries.

3.1.4 Chemical treatment materials shall be delivered to the site in the original unopened containers with legible labels indicating the Environmental Protection Agency (EPA) registration number and the manufacturer's registered uses.

3.2 Storage.

3.2.1 Materials shall be stored in areas approved by the Contracting Officer.

3.2.2 Seed and fertilizer shall be stored in cool, dry locations away from contaminants.

3.2.3 Chemical treatment materials shall not be stored with other landscape materials.

3.3 Handling.

3.3.1 Materials. Except for bulk deliveries, materials shall not be dropped or dumped from vehicles.

4. MATERIALS.

4.1 Seed.

4.1.1 Seed Classification. State-certified seed of the latest season's crop shall be provided in original sealed packages bearing the producer's guaranteed analysis for mixture percentage, purity, germination, weed seed content, and inert material. Labels shall be in conformance with USDA Federal Seed Act, Rules and Regulations and applicable state seed laws.

4.1.2 Seed Mixtures. Seed mixtures shall be proportioned by weight as follows.

<u>Botanical Name</u>	<u>Common Name</u>	<u>Percent Pure Live Seed</u>
Cynodon dactylon	Common Bermuda	98%
Rye grass	Annual Rye	95%

4.1.3 Weed Seed. Weed seed shall not exceed one percent by weight of the total mixture. Wet, moldy, or otherwise damaged seed will be rejected. Perform field mixes on site in the presence of the Contracting Officer.

4.2 Soil Amendments. Consists of fertilizer and soil conditioners.

4.2.1 Fertilizer. Commercial grade, free flowing, uniform in composition and conforming to Fed. Spec. O-F-241.

4.2.1.1 Granular Fertilizer. Consists of nitrogen-phosphorus-potassium ratio: 16 percent nitrogen, 20 percent phosphorus, and 0 percent potassium.

4.2.1.2 Controlled-Release Fertilizer. Consists of nitrogen-phosphorus-potassium ratio: 18 percent nitrogen, 6 percent phosphorus, and 12 percent potassium.

4.3 Soil Conditioner. For single use or in combination to meet requirements for topsoil.

~~4.3.1 Gypsum. Commercially packaged, free flowing, minimum 95 percent calcium sulphate by volume.~~

4.3.2 Organic Soil Conditioner.

a. Rotted Manure. Well rotted, horse or cattle manure containing a maximum 25 percent by volume of straw, sawdust, or other bedding materials, free of stones, sticks, soil and containing no chemicals weed seed or ingredients harmful to plants.

b. Decomposed Wood Derivatives. Ground bark, sawdust, or other wood waste material free of stones, sticks, soil, and toxic substances harmful to plants, stabilized with nitrogen and having the following properties.

Particle Size. Minimum percent by weight passing.

	<u>Percent</u>
No. 4 mesh Screen	95
No. 8 mesh screen	80

Nitrogen Content. Minimum percent based on dry weight.

	<u>Percent</u>
Redwood Sawdust	0.5
Fir Sawdust	0.7
Fir or Pine Bark	1.0

4.4 Mulches. Free from weeds, mold, and other deleterious materials.

4.4.1 Wood Cellulose Fiber. Wood cellulose fiber shall not contain any growth or germination-inhibiting factors and shall be dyed an appropriate color to facilitate visual metering during application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 3.5 to 5.0. Use with hydroseeding application of grass seed and fertilizer. When added to water, it forms a homogenous slurry.

4.5 Water. A quality suitable for irrigation.

4.6 Chemical Treatment Material. EPA registered and approved herbicide, insecticide and fungicide.

5. SEEDING TIMES.

5.1 Seeding Time. Sow Bermuda seed from May to September for spring and summer planting or Annual Rye from October to April for fall and winter planting. Seeding times may vary depending on temperature and weather conditions.

6. SITE PREPARATION.

6.1 Preparation of Seeding Areas.

6.1.1 The Contracting Officer shall verify the finished grades are as indicated on drawings, the placing of topsoil, and the smooth grading has been completed in accordance with the paragraph: FINISH GRADING.

6.1.2 Site preparation work shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture or other unsatisfactory condition prevails, the work shall be stopped as directed by the Contracting Officer.

6.2 Application of Soil Amendments.

6.2.1 Fertilizer. Fertilizer shall be applied at the rate of 10 pounds per 1000 square feet. Fertilizer shall be incorporated into the soil to a minimum depth of 6 inches or may be incorporated as part of the tillage or hydroseeding operation.

~~6.2.2 Soil Conditioner. Soil Conditioner shall be spread uniformly over the soil to a minimum depth of 2 inches and thoroughly incorporated by tillage into the soil to a minimum depth of 6 inches.~~

6.2.2 See following Page

6.2.3 Deviations. Deviations in the ground surface in relation to the grades indicated shall be corrected prior to turfing.

6.3 Tillage.

6.3.1 Soil shall be tilled to a minimum depth of 6 inches by plowing, disking, harrowing, rototilling or other method. On slopes 2 horizontal to 1 vertical and steeper, the soil shall be tilled to a minimum depth of 2 inches by scarifying with heavy rakes, or other method. Rototillers shall be used where soil conditions and length of slope permit. On slopes 1 horizontal to 1 vertical and steeper, no tillage is required.

INSERT PARAGRAPH 6.2.2

6.2.2 SOIL CONDITIONER. SOIL CONDITIONER SHALL BE A 50/50 MIX OF ROTTED MANURE AND DECOMPOSED WOOD DERIVATIVES APPLIED AT THE RATE OF 2 CUBIC YARDS PER 1,000 SQUARE FEET AND THOROUGHLY INCORPORATED BY TILLAGE INTO THE SOIL TO A MINIMUM DEPTH OF 6 INCHES.

6.3.2 Fertilizer, as specified, may be applied during tillage.

6.4 Finished Grading.

6.4.1 Turf areas shall be filled as needed or have surplus soil removed to attain the finished grade. Drainage patterns shall be maintained as indicated on drawings. Turf areas compacted by construction operations shall be completely pulverized by tillage. Soil used for repair of erosion or grade deficiencies shall conform to requirements specified in the SECTION: FILL AND SUBGRADE PREPARATION. Finished grade shall be 2 inches below the adjoining grade of any surfaced area. New surfaces shall be blended to existing areas.

6.4.2 Lawn areas shall have debris and stones larger than one inch in any dimension removed from the surface.

6.4.3 Field areas shall have debris and stones larger than 3 inches in any dimension removed from the surface.

6.4.4 Finished graded areas shall be protected from damage by vehicular or pedestrian traffic and erosion.

6.5 Application of Soil Treatment Chemicals.

6.5.1 When soil treatment becomes necessary to remove a pest, a state certified applicator shall apply required chemicals in accordance with EPA label restrictions and recommendations. Provide hydraulic equipment for the liquid application of chemicals with a leak-proof tank, positive agitation methods, controlled application pressure and metering gauges.

6.5.2 A chemical treatment plan shall be provided to the Contracting Officer as specified in the paragraph: SUBMITTALS.

7. SEEDING.

7.1 General. Prior to seeding, any previously prepared seedbed areas compacted or damaged by interim rains, traffic, or other cause, shall be reworked to restore the ground condition previously specified. Do not hydroseed when the wind velocity is such as to prevent uniform seed distribution.

7.2 Applying Seed.

7.2.1 Seeding from October 1 to April 30. The seed and fertilizer shall be mixed in the required amount of water to produce a homogeneous slurry and then uniformly applied under pressure at the following rates (dry weight) per acre:

Annual Rye Turf

2000 lbs. wood cellulose fiber mulch
300 lbs. 16-20-0 inorganic fertilizer
650 lbs. of seed mix
300 lbs. slow release fertilizer 18-6-12

7.2.2 Seeding from May 1 to September 30. The seed and fertilizer shall be mixed in the required amount of water to produce a homogeneous slurry and then uniformly applied under pressure at the following rates (dry weight) per acre:

Bermuda Turf

2000 lbs. wood cellulose fiber mulch
300 lbs. 16-20-0 inorganic fertilizer
135 lbs. of seed mix
300 lbs. slow release fertilizer 18-6-12

7.3 Hydroseeding. Seed and fertilizer shall be added to water and thoroughly mixed at the rates specified. Wood cellulose fiber mulch shall be added at the rates recommended by the manufacturer after the seed, fertilizer and water have been thoroughly mixed to produce a homogenous slurry. Slurry shall be uniformly applied under pressure over the entire area. Adequate soil moisture shall be ensured by spraying water on the entire hydroseeded area and moisten the soil to a minimum depth of 2 inches. Do not roll the hydroseeded area.

7.4 Water Seeded Areas. Watering shall be started within one day or as directed by the Contracting Officer after completing the seeded area. Water shall be applied at the rate sufficient to ensure moist soil conditions to a minimum depth of 2 inches. Run-off and puddling shall be prevented.

8. RESTORATION AND CLEAN UP. Excess and waste material shall be removed and disposed of off the site. Adjacent paved areas shall be cleaned. Existing turf areas which have been damaged during the contract operations shall be restored to original conditions.

9. PROTECTION OF TURFED AREAS. Immediately after turfing, the area shall be protected against traffic or other use by erecting barricades and providing signage as required or as directed by the Contracting Officer.

10. TURF ESTABLISHMENT PERIOD.

10.1 Length of Period. On completion of the last day of the turfing operation, the Turf Establishment Period will be in effect for 3 months.

10.2 Stand of Turf.

10.2.1 A stand of turf from the seeding operation is defined as a minimum of 100 grass plants per square foot. Bare spots shall be no larger than one foot square. The total bare spots shall not exceed 2 percent of the total seeded area.

10.3 Maintenance During Establishment Period.

10.3.1 General. Maintenance of the turfed areas shall include eradicating weeds, protection embankments from erosion, and protecting turfed areas from traffic.

10.3.2 Repair. Turf condition shall be reestablished as specified herein for eroded areas, damaged or barren areas. Mulch shall be repaired or replaced as required.

10.3.3 Mowing. Turfed areas shall be mowed to a minimum height of 1-1/2 inches when the average height of the turf becomes 2 inches. Clippings shall be removed.

10.3.4 Watering. Watering shall be at intervals to obtain a moist soil condition to a minimum depth of 2 inches. Frequency of watering and quantity of water shall be adjusted in accordance with the growth of the turf. Run-off, puddling and wilting shall be prevented.

10.3.5 Post-Fertilization. Fertilizer (16-8-4 with trace elements) shall be applied at the rate of 5 pounds per 1000 square feet after the first month and again prior to the final acceptance.

10.3.6 Chemical Treatment.

10.3.6.1 When a pest or disease becomes apparent during the Turf Establishment Period, a state certified applicator shall apply required chemicals in accordance with EPA label restrictions and recommendations. Hydraulic equipment for the liquid application of chemicals shall be provided with a leak-proof tank, positive agitation methods, controlled application pressure and metering gauges. Pre-emergent herbicides will not be used.

10.3.6.2 A Chemical Treatment Plan shall be provided to the Contracting Officer as stated in the paragraph: SUBMITTALS.

11. FINAL ACCEPTANCE. At the end of the Turf Establishment Period, a final inspection will be made. Final acceptance of the turf will be based upon a satisfactory stand of turf as defined in the paragraph: TURF ESTABLISHMENT PERIOD. Rejected areas shall be replanted or repaired as directed by the Contracting Officer.

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SECTION 2S

PAVEMENT MARKINGS

Index

- | | |
|----------------------------|------------------------|
| 1. Applicable Publications | 4. Equipment |
| 2. Materials | 5. Surface Preparation |
| 3. Sampling and Testing | 6. Application |

1. APPLICABLE PUBLICATIONS. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1 Federal Specifications (Fed. Spec.).

TT-P-115E

Paint, Traffic, Highway, White and Yellow

1.2 Federal Standard (Fed. Std.).

No. 141a
& Change Notices
1, 2, 3, 4

Paint, Varnish, Lacquer, and Related
Materials; Methods of Inspection
Sampling, and Testing

2. MATERIALS. Paint shall be in sealed containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacturer, manufacturer's name, formulation number and directions, all of which shall be plainly legible at time of use. The paint shall be homogeneous, easily stirred to smooth consistency, and shall show no hard settlement or other objectionable characteristics during a storage period of six months.

2.1 Paints. Paints shall conform to Fed. Spec. TT-P-115. Color shall be white.

3. SAMPLING AND TESTING. Materials proposed for use shall be stored on the project site in sealed and labeled containers, or segregated at source of supply. Upon notification by the Contractor that the material is at the site or source of supply, a quart sample of each batch of paint shall be taken by random selection from sealed containers by the Contractor in the presence of a representative of the Contracting Officer. Contents of the sampled containers shall be so thoroughly mixed as to render the sample truly representative. Samples shall be clearly identified by designated name, specification number, batch number, manufacturer's formulation number, project contract number, intended use, and quantity involved. The material may be approved for use based on either the following data furnished by the Contractor:

a. A test report showing that the proposed batch meets all specified requirements.

b. A test report showing that a previous batch manufactured using the same formulation as that used in manufacturing the proposed batch met all specified requirements, and a report showing test results on the proposed batch for the following properties required in the material specification: weight per gallon, viscosity, fineness of grind, drying time, and gradation. Testing procedures and reports shall be as specified in paragraph 5 of Method 1031.2 of Fed. Std. 141.

If materials are approved based on reports furnished by the Contractor, samples will be retained by the Government for possible future testing should the material appear defective during or after application. When tested by the Government and samples fail to meet specification requirements, the materials represented by the samples shall be replaced and cost of testing will be deducted from the payments due the Contractor at the rate of \$100 per sample retested.

4. EQUIPMENT. All machines, tools, and equipment used in performance of the work shall be approved and maintained in satisfactory operating condition. Hand-operated push-type machines of a type commonly used for application of paint to pavement surfaces shall be acceptable for marking small street and parking areas. Applicator machine shall be equipped with the necessary paint tanks and spraying nozzles, and shall be capable of applying paint uniformly at coverage specified. Sandblasting equipment shall be provided as required for cleaning surfaces to be painted. Hand-operated spray guns shall be provided for use in areas where push-type machines cannot be used.

4.1 Sandblasting Equipment. Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall be capable of furnishing not less than 150 c.f.m. of air at a pressure of not less than 90 psi at the nozzle for each nozzle used.

5. SURFACE PREPARATION. New pavement surfaces shall be allowed to cure for a period of not less than 30 days before application of marking materials. All surfaces to be marked shall be thoroughly cleaned before application of the paint. Dust, dirt, and other granular surface deposits shall be removed by sweeping, blowing with compressed air, rinsing with water or a combination of these methods as required. Rubber deposits, surface laitance, existing paint markings, and other coatings adhering to the pavement shall be completely removed with scrapers, wire brushes, sandblasting, approved chemicals, or mechanical abrasion as directed. Where oil or grease are present on old pavements to be marked, affected areas shall be scrubbed with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinsed thoroughly after each application. After cleaning, oil-soaked areas shall be sealed with cut shellac to prevent bleeding through the new paint. Pavement surfaces shall be allowed to dry, when water is used for cleaning, prior to striping and marking. Surfaces shall be recleaned, when work has been stopped due to rain.

6. APPLICATION. Paint shall be applied evenly to the pavement surface to be coated at a rate of 105 plus or minus 5 square feet per gallon.

6.1 Paint shall be applied to clean, dry surfaces, and unless otherwise approved, only when air and pavement temperatures are above 40 degrees F and less than 95 degrees F. Paint temperature shall be maintained within these same limits. Paint shall be applied pneumatically with approved equipment at rate of coverage specified herein. The Contractor shall be provide guidelines and templates as necessary to control paint application. Special precautions shall be taken in marking numbers, letters, and symbols. All edges of markings shall be sharply outlined. The maximum drying time requirements of the paint specifications will be strictly enforced, to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. If there is a deficiency in drying of the markings, painting operations shall be discontinued until cause of the slow drying is determined and corrected.

6.2 Traffic Controls. Suitable warning signs shall be placed near the beginning and end of the worksite for alerting approaching traffic. Small markers shall be placed along newly painted lines to control traffic and prevent damage to newly painted surfaces.

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SECTION 2T

WATER LINES

Index

- | | |
|--|----------------------|
| 1. Applicable Publications | 5. Installation |
| 2. General | 6. Hydrostatic Tests |
| 3. Excavation, Trenching, and Backfilling
for Water Lines | 7. Disinfection |
| 4. Materials | 8. Cleanup |

1. APPLICABLE PUBLICATIONS. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1 Federal Specification (Fed. Spec.).

WW-P-325B

Pipe, Bends, Traps, Caps and Plugs;
Lead (for Industrial Pressure, and
Soil and Waste Applications)

1.2 American National Standards Institute, Inc. (ANSI) Standard.

B16.26-1983

Cast Copper Alloy Fittings for
Flared Copper Tubes

1.3 American Society for Testing and Materials (ASTM) Publication.

B 88-83a

Seamless Copper Water Tube

1.4 American Water Works Association (AWWA) Standards.

C651-81

Disinfecting Water Mains

C800-84

Underground Service Line Valves and
Fittings

2. GENERAL. This section covers water service lines, and connections to building service at a point approximately 5 feet outside buildings and structures to which service is required.

2.1 Piping for Water Service Lines. Piping for water service lines less than 3 inches in diameter shall be copper tubing, unless otherwise shown or specified.

2.2 Recommendations of the Manufacturer. The Contractor shall, as a part of the shop drawings, submit to the Contracting Officer the manufacturer's recommendations for each material or procedure to be utilized which is required to be in accordance with such recommendations. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless otherwise directed by the Contracting Officer.

3. EXCAVATION, TRENCHING, AND BACKFILLING FOR WATER LINES. Excavation, trenching, and backfilling shall be in accordance with the applicable provisions of SECTION: SIDE DRAINS, PAYBACK WATERLINE AND LOW FLOW CONDUITS except as modified herein.

4. MATERIALS shall conform to the respective specifications and other requirements specified below.

4.1 Pipe.

4.1.1 Copper Tubing. ASTM B 88, Type K, annealed.

4.2 Joints.

4.2.1 Copper Tubing. Joints shall be compression-pattern flared and shall be made with fittings hereinafter specified.

4.3 Fittings and Specials.

4.3.1 For Copper Tubing. Fittings and specials shall be flared and conform to ANSI B16.26.

4.4 Valve Boxes. Valve boxes shall be cast iron or concrete, except that concrete boxes may be installed only in locations not subjected to vehicular traffic. Cast-iron boxes shall be extension type with slide-type adjustment and with flared base. The minimum thickness of metal shall be 3/16 inch. Concrete boxes shall be the standard product of a manufacturer of precast concrete equipment. The word "WATER" shall be cast in the cover. The boxes shall be of such length as will be adapted, without full extension, to the depth of cover required over the pipe at the valve location.

4.5 Miscellaneous Items.

4.5.1 Service clamps shall have a pressure rating not less than that of the pipe to be connected and shall be either the single or double flattened strap type. Clamps shall have a galvanized malleable iron body with cadmium plated straps and nuts. Clamps shall have rubber gasket cemented to the body.

4.5.2 Corporation stops shall have standard corporation stop thread conforming to AWWA C800 on the inlet end, with flanged joints, compression pattern flared tube couplings, or wiped joints for connections to goosenecks.

4.5.3 Goosenecks. Lead pipe for gooseneck connections shall conform to the applicable requirements of Fed. Spec. WW-P-325, Class 100. Copper tubing for gooseneck connections shall conform to the applicable requirements of ASTM B 88, Type K, annealed. Length of cable requirements connections shall be in accordance with standard practice.

4.5.4 Service stops shall be water-works inverted-ground-key type, oval or round flow way, tee handle, without drain. Pipe connections shall be suitable for the type of service pipe used. All parts shall be of bronze with female iron-pipe-size connections or compression-pattern flared tube couplings, and shall be designed for a hydrostatic test pressure not less than 200 psi.

4.5.5 Tapping sleeves of the sizes indicated for connection to existing main shall be the cast gray, ductile, or malleable iron, split-sleeve type with flanged or grooved outlet, and with bolts, follower rings and gaskets on each end of the sleeve. Construction shall be suitable for a maximum working pressure of 100 psi. Bolts shall have square heads and hexagonal nuts. Longitudinal gaskets, and mechanical joints with gaskets shall be as recommended by the manufacturer of the sleeve. When using grooved mechanical tee, it shall consist of an upper housing with full locating collar for rigid positioning which engages a machine-cut hole in the pipe, encasing an elastometric gasket which conforms to the pipe outside diameter around the hole and a lower housing with positioning lugs, secured together during assembly by nuts and bolts as specified, pretorqued to 50 pound feet.

4.5.6 Service boxes shall be cast iron or concrete. Extension service boxes of the required length and having either screw or slide-type adjustment shall be installed at all service box locations. The boxes shall have housings of sufficient size to completely cover the service stop and shall be complete with identifying covers.

4.5.7 Disinfection. Chlorinating materials shall conform to the following.

5. INSTALLATION.

5.1 Handling. Pipe and accessories shall be handled so as to insure delivery to the trench in sound, undamaged condition. Particular care shall be taken not to injure the pipe coating or lining. If the coating or lining of any pipe or fitting is damaged, the repair shall be made by the Contractor at his expense in a satisfactory manner. No other pipe or material of any kind shall be placed inside a pipe or fitting after the coating has been applied. Pipe shall be carried into position and not dragged. Use of pinch bars and tongs for alining or turning pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Government. Rubber gaskets that are not to be installed immediately shall be stored in a cool and dark place.

5.2 Adjacent Facilities.

5.2.1 Sewer Lines. Where the location of the water pipe is not clearly defined in dimensions on the drawings, the water pipe shall not be laid closer horizontally than 10 feet from a sewer except where the bottom of the water pipe will be at least 12 inches above the top of the sewer pipe, in which case the water pipe shall not be laid closer horizontally than 6 feet from the sewer. Where water lines cross under gravity-flow sewer lines, the sewer pipe for a distance of at least 10 feet each side of the crossing shall be fully encased in concrete or shall be made of pressure pipe with no joint located within 3 feet horizontally of the crossing. Water lines shall in all cases cross above sewage force mains or inverted siphons and shall be not less than 2 feet above the sewer main. Joints in the sewer main, closer horizontally than 3 feet to the crossing, shall be encased in concrete.

5.2.2 Copper tubing shall not be installed in the same trench with ferrous piping materials.

5.2.3 Nonferrous Metallic Pipe. Where nonferrous metallic pipe, e.g., copper tubing, crosses any ferrous piping material, a minimum vertical separation of 12 inches must be maintained between pipes. Where non-ferrous metallic pipe is connected to ferrous pipe, an approved dielectric connector shall be used.

5.2.4 Roads. Water pipe shall be encased in a sleeve of rigid conduit for the lengths shown. A minimum clearance of at least 2 inches between the inner wall of the sleeve and the maximum outside diameter of the sleeved pipe and joints shall be provided. Sand bedding shall be provided for the water pipe through the sleeve. Sleeves of ferrous material shall be provided with corrosion protection as required for the conditions encountered at the site of installation.

5.2.5 Structures. Where water pipe is required to be installed within 3 feet of existing structures the water pipe shall be sleeved as required for roads. Care shall be exercised and proper precautions taken during installation of the water pipe and sleeve to assure that there will be no damage to the structures and no settlement or movement of foundations or footings. Any damage occurring as a result of the Contractor's operation shall be corrected and all costs connected therewith shall be borne by the Contractor.

5.3 Placing and Laying. Under no circumstances shall any of the water line materials be dropped or dumped into the trench. Care shall be taken to avoid abrasion of the pipe coating. Except where necessary in making connections with other lines or as authorized by the Contracting Officer, pipe shall be laid with the bells facing in the direction of laying. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, couplings, and joints. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. Water shall be kept out of the trench until joining is completed. When work is not in progress, open ends, of pipe, fittings, and valves shall be securely closed so that no trench water, earth, or other substance will enter the pipes or fittings. Where any part of the coating or lining is damaged, the repair shall be made by the Contractor at his expense in a satisfactory manner. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored, as shown.

5.4 Connections. Where connections are made between new work and existing mains, the connections shall be made by using specials and fittings to suit the actual conditions. Standard methods are available for making connections to various types of pipe, either under pressure or in the dewatered condition. Where made under pressure, these connections shall be installed as approved by the Contracting Officer.

5.5 Jointing.

5.5.1 Copper Tubing. Joints shall be made with flared fittings. The flared end tube shall be pulled tightly against the tapered part of the fitting by a nut which is part of the fitting, so there is metal-to-metal contact.

5.6 Service Lines. Service lines shall include the pipeline connecting building piping to water distribution lines to the connections with the building service at a point approximately 5 feet outside the building where such building service exists. Where building services are not installed, the Contractor shall terminate the service lines approximately 5 feet from the site of the proposed building at a point designated by the Contracting Officer. Such service lines shall be closed with plugs or caps. All service stops shall be provided with extension service boxes of the lengths required. Service lines shall be constructed in accordance with the following requirements.

5.6.1 Service lines 2 inches and smaller shall be connected to the main by a directly-tapped corporation stop or by a service clamp. A corporation stop and a copper gooseneck shall be provided with either type of connection. Maximum sizes for directly-tapped corporation stops and for outlets with service clamps shall be as in Table I. Where two or more gooseneck connections to the main are required for an individual service, such connections shall be made with standard branch connections. The total clear area of the branches shall be at least equal to the clear area of the service which they are to supply.

Table 1. Size of Corporation Stops and Outlets.

Pipe Size Inches	Corporation Stops, Inches	
	For Cast Iron Pipe	Outlet w/Service Single & Double Straps
3	--	1
4	1	1
6	1-1/4	1-1/2
12 and larger	2	2

6. HYDROSTATIC TESTS. Where any section of a water line is provided with concrete thrust blocking for fitting the hydrostatic tests shall not be made until at least 5 days after installation unless otherwise approved. The method proposed for disposal of waste water from hydrostatic tests and disinfection shall be submitted to the Contracting Officer for approval prior to performing hydrostatic tests.

6.1 Pressure Test. After the pipe is laid, the joints completed, and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any valved section of water service lines designated on the drawings shall be subjected for one hour to a hydrostatic pressure test of 100 psi. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced or remade as necessary. Cracked or defective pipe, joints, fittings, and valves, discovered in consequence of this pressure test shall be removed and replaced with sound material, and the test shall be repeated until the test results are satisfactory.

6.2 Leakage Test. Leakage test shall be conducted after the pressure tests have been satisfactorily completed. The duration of each leakage test shall be at least 2 hours, and during the test the water line shall be subjected to 100 psi pressure. Leakage is defined as the quantity of water to be supplied into the

newly laid pipe, or any valved or approved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled. No piping installation will be accepted until the leakage is less than the number of gallons per hour as determined by the formula.

$L = 0.0001351ND$ (P raised
to 1/2 power)

For pipe materials other than
asbestos-cement

In which L equals the allowable leakage in gallons per hour; N is the number of joints in the length of pipeline tested; D is the nominal diameter of the pipe in inches; and P is the average test pressure during the leakage test, in psi gauge.

Should any test of pipe disclose leakage greater than that specified in the foregoing table, the defective joints shall be located and repaired until the leakage is within the specified allowance, without additional cost to the Government.

6.3 Concurrent Hydrostatic Tests. The Contractor may elect to conduct the hydrostatic tests using either or both of the following procedures. Regardless of the sequence of tests employed, the results of pressure tests, leakage tests, and disinfection shall be satisfactory as specified. All replacement, repair or retesting required shall be accomplished by the Contractor at no additional cost to the Government.

6.3.1 Pressure test and leakage test may be conducted concurrently.

6.3.2 Hydrostatic tests and disinfection may be conducted concurrently, using the water treated for disinfection to accomplish the hydrostatic tests. If water is lost when treated for disinfection and air is admitted to the unit being tested, or if any repair procedure results in contamination of the unit, disinfection shall be reaccomplished.

7. DISINFECTION. Before acceptance of potable water operation, each unit of completed water line shall be disinfected as prescribed by AWWA C601 as specified herein. After pressure tests have been made, the unit to be disinfected shall be thoroughly flushed with water until all entrained dirt and mud have been removed before introducing the chlorinating material. The chlorinating material shall be either liquid chlorine, calcium hypochlorite, or sodium hypochlorite, conforming to paragraph: MATERIALS. The chlorinating material shall provide a dosage of not less than 50 ppm and shall be introduced into the water lines in an approved manner. In no case will the agent be introduced into the line in a dry solid state. The treated water shall be retained in the pipe long enough to destroy all non-spore-forming bacteria. Except where a shorter period is approved, the retention time shall be at least 24 hours and shall produce not less than 25 ppm of free chlorine residual throughout the line at the end of the retention period. All valves on the lines being disinfected shall be opened and closed several times during the contact period. The line shall then be flushed with clean water until the residual chlorine is reduced to less than 1.0 ppm. From several points in the unit, the Contracting Officer will take samples of water in proper sterilized containers for bacterial examination. The disinfection shall be repeated until tests indicate the absence of pollution for at least 2 full days. The unit will not be accepted until satisfactory bacteriological results have been obtained.

8. CLEANUP. Upon completion of the installation of the water lines, and appurtenances, all debris and surplus materials resulting from the work shall be removed.

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SECTION 2U

EXCAVATING, TRENCHING AND BACKFILLING FOR UTILITIES

Index

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|---|-------------------------|
| 1. Applicable Publications | 4. Bedding |
| 2. Excavation and Trenching for Side
Drains, and Drainage Structures | 5. Backfilling |
| 3. Materials for Bedding and Backfilling | 6. Special Requirements |

1. APPLICABLE PUBLICATIONS. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1 American Society for Testing and Materials (ASTM) Publications.

D 1556-82	Density of Soil In Place by the Sand-Cone Method
D 1557-78	Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop
D 2216-80	Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures

2. EXCAVATION AND TRENCHING FOR SIDE DRAINS, ~~PAYBACK WATER LINE~~ AND UTILITIES. Excavation of trenches for side drains, appurtenances, and utilities except the 12 inch payback water line at approximate station 581+00, shall be in accordance with the following requirements. Excavation for the 12 inch payback water line shall be in accordance to the drawings.

2.1 Trenching. All excavations shall be made by open cut unless otherwise specified. The banks of trenches shall be kept as nearly vertical as practicable. Unless otherwise indicated, the banks of trenches below the level of the top of the pipe shall be not less than 12 inches wider nor more than 16 inches wider than the outside diameter of the pipe to be laid therein, and shall be excavated true to line, so that a clear space not less than 6 inches nor more than 8 inches in width is provided on each side of the pipe. The maximum width of trench specified applies to the width at any point below the top of the pipe; the width of the trench above the top of the pipe may be made as wide as necessary for sheathing and bracing; and the proper installation of the work. Care shall be taken not to overexcavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures shall be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Government. The bottom of trenches shall be accurately graded to provide uniform bearing and support for each section of the pipe at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for the proper sealing of pipe joints.

2.2 Removal of Unstable Material. Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer, is unexpectedly encountered in bottom of trench, such material shall be removed to depth required and replaced to the proper grade with selected material, compacted as provided in paragraph: BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor in his performance of shoring and sheeting, water removal, or other specified requirements, resulting material shall be excavated and replaced. Removal of unstable material shall be done at no additional costs of the Government.

2.3 Excavation for Drainage Structures. Excavation for junction structures and catch basins shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as indicated on the drawings. Removal of unstable material shall be as specified hereinbefore. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade shall not be made until just before the concrete or masonry is to be placed.

3. MATERIALS FOR BEDDING AND BACKFILLING.

3.1 General. Bedding for side drains, payback water line and utilities shall consist of sandfill placed around the pipe in accordance with paragraph: BACKFILLING. Compacted fill above the sandfill shall be placed in accordance with the paragraph: BACKFILLING. Material for the sandfill for the side drain shall be clean sand, free of trash organic materials, debris and with 100 percent passing No. 4 sieve and not more than 10 percent passing the No. 100 sieve.

3.2 Material for compacted fill above the sandfill shall not contain any stone larger than 3/4 inch and may consist of sand, gravelly sands, silty sands and clayey sands. Organic material, trash debris, silt, sandy silt, clay, and sandy clay broken concrete or pavement and other objectionable material shall not be used.

4. BEDDING. The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe. Pipe shall be bedded carefully in a sandfill layer accurately shaped and rounded to conform to the lowest one-fourth of the outside portion of circular pipe for the entire length of pipe. The layer of sandfill material shall be at least 4 inches except for the 12-inch payback water line at approximate station 581+00 which shall be in accordance with the drawing. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall be only of such length, depth and width as required for properly making the particular type joint.

5. BACKFILLING.

5.1 Backfilling, Pipe and Utilities in Trenches. After the bedding has been prepared and the pipe and utility installed, except for the 12-inch payback water line at approximate station 581+00, sandfill material shall be placed along both sides of pipe in a single lift to the springing line (maximum horizontal dimension of a pipe). The sandfill shall be brought up evenly on both sides of pipe for the full length of pipe. Vibrating compacting equipment shall be used to obtain not less than 90 percent of maximum density. Care shall be taken to insure thorough

compaction of the sandfill under the haunches of the pipe. Above the springing line, the trench shall be filled with material conforming to paragraph: MATERIALS FOR BEDDING AND BACKFILL. The completed fill material, shall be placed along both sides of pipe in layers not exceeding 4 inches in compacted depth of pipe at a moisture content that will facilitate compaction. The compacted fill shall be brought up evenly on both sides of pipe for the full length of pipe. Each layer shall be thoroughly compacted with mechanical tampers or vibrators to not less than 90 percent of maximum density. This method of filling and compacting shall continue until the fill has reached an elevation of at least 24 inches above the top of the pipe or to the bottom of the Aggregate Base Course. The remainder of the trench shall be backfilled and compacted by spreading and rolling parallel with the pipe in layers not exceeding 6 inches or by mechanical tampers or vibrators in layers not exceeding 6 inches compacted to 90 percent of maximum density. Where it is necessary in the opinion of the Contracting Officer, any sheeting and/or portions of bracing used shall be left in place, and the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

5.1.1 Backfilling Pipe Trenches for the 12-inch payback water line at approximate station 581+00. The backfill material for the 12-inch payback water line placed in the trenches shall be in accordance with the details of the drawings, and the placement and compaction procedures shall be as specified hereinabove.

5.2 Backfilling Pipe in Fill Sections. For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified above. The fill material above the springing line shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 4 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or vibrating to obtain not less than 90 percent of maximum density. Prior to commencing normal filling operation, the crown width of the fill at a height of 24 inches above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 24 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 6 inches.

5.3 Movement of Construction Machinery. In compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a side drain at any stage of construction shall be at the Contractor's risk. Any pipe damaged thereby shall be repaired or replaced at no additional cost to the Government.

5.4 Backfilling for Drainage Structures. After the junction structure or catch basin has been constructed, backfill around and above junction structure shall be placed in accordance to the requirements of paragraph: BACKFILLS of SECTION: FILLS AND SUBGRADE PREPARATION and as specified herein.

5.4.1 The structure shall not be damaged by the shock of falling earth and the backfill shall be placed in such a manner as to prevent eccentric loading and excessive stress on the structures. Any damaged structure thereby shall be repaired or replaced at no cost to the Government.

5.5 Backfilling for Utilities. The trenches shall not be backfilled until all specified tests are performed.

5.6 Compaction.

5.6.1 Laboratory Control. The moisture-density relationships shall be determined in a laboratory in accordance with ASTM D 1557.

5.6.2 Field Control. Tests shall be well distributed and shall average not less than one test for each 200 lineal feet of trench for each 2 feet or less of backfill. At least one test shall be made in each trench. Field in place density shall be determined in accordance with ASTM D 1556 and field moisture content shall be determined in accordance with ASTM D 2216.

6. SPECIAL REQUIREMENTS for both excavation and backfill relating to the specific utilities are as follows:

6.1 Water Lines. Trenches shall be of a depth to provide a minimum cover of 2 feet or as shown on the drawing from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe.

6.2 Electrical Distribution System. Direct burial cable and conduit or duct line shall have a minimum cover of 24 inches from the finished grade, unless otherwise indicated.

6.3 Plastic Marking Tape. Warning tapes shall be installed directly above the pipe, at a depth of 18 inches below finished grade unless otherwise shown. The tape shall be acid and alkali-resistant Polyethylene film, 6 inches wide with a minimum thickness of .004 inch. Tape shall have minimum strength of 1750 psi lengthwise and 1500 psi crosswise with an elongation factor of 350 percent. Tape color shall be as specified in table 1 and shall bear a continuous printed inscription describing the specific utility.

Table 1. Tape Color.

Red:	Electric
Blue:	Water Systems
Green:	Sewer Systems

* * * * *

SECTION 2V

CONCRETE PAVING STONE

1. APPLICABLE PUBLICATIONS. The American Society for Testing and Materials (ASTM) Publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

C 33-86	Concrete Aggregates
C 140-75 (R-1980)	Method of Sampling and Testing Concrete Masonry Units
C 936-82	Solid Concrete Interlocking Paving Units

2. GENERAL. Paving units shall be precast interlocking paving units produced by a manufacturer regularly engaged in the manufacture of paving units conforming to the requirements specified herein. The Contractor, selected to install the paving stones, shall have at least five years experience in the installation of interlocking concrete paving units.

3. SUBMITTALS.

3.1 Certificates of Conformance. Before delivery of the paving units, notarized certificates attesting that materials meet the requirements specified shall be submitted in accordance with the SPECIAL CLAUSES.

3.2 Certified Laboratory Test Reports. Certified copies of the reports of all tests specified herein and required in referenced publications shall be submitted to the Contracting Officer's Representative.

4. DELIVERY, STORAGE, AND HANDLING. Handle, store, and protect paving units in a manner to avoid chipping, breakage, discoloration, or contact with contaminating materials and exposure to the elements.

5. MATERIALS.

5.1 See following page

~~5.1 Paving units shall be made from Portland Cement and normal weight aggregates in accordance with the requirements of ASTM C 936.~~

5.2 Admixtures. Admixtures, if used, shall conform to the requirements of the SECTION: CONCRETE.

5.3 Color. The color of the paving units shall be as indicated on the drawings. Coloring pigment shall be non-fading and shall conform to the requirements of the SECTION: CONCRETE.

5.4 Sand. Sand for laying course shall conform to the requirements of ASTM C 33 for washed concrete sand.

6. SAMPLING AND TESTING. All sampling and testing shall be the responsibility of the Contractor.

INSERT PARAGRAPH 5.1

5.1 PAVING STONES (PAVERS) SHALL CONFORM TO ASTM C 936, 60MM IN THICKNESS, MADE FROM NORMAL WEIGHT AGGREGATES AND PORTLAND CEMENT, AND SHALL BE THE SHAPE INDICATED ON THE DRAWINGS.

7. PREPARATION OF SAND LAYING COURSE.

7.1 The sand laying course shall be spread evenly over the area to be paved and then screeded to a level that will produce 1-inch thickness when the paving units have been placed and vibrated.

7.2 The finished sand laying course shall be protected from any damage.

8. PLACING.

8.1 Paving units shall be laid in the pattern, as indicated, and the joints between units will not exceed 1/8 inch.

8.2 Gaps at the edge of the paved surface shall be filled with standard edge unit or with units sawcut to fit. Sawcut edges shall be clean, true, and sharp. Whenever possible, units less than 1/3 of original dimension shall not be used.

8.3 Paving units shall be vibrated into the sand laying course using a vibrator capable of 3,000 to 5,000 pounds compaction force with the surface clean and joints open.

8.4 After vibration, clean sand shall be spread over the paving stone surface, allowed to dry, and vibrated into joints with additional vibrator passes and brushing so as to completely fill joints.

8.5 Surplus sand shall be swept from the surface to insure that joints have been completely filled.

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SECTION 3A

FORMWORK FOR CONCRETE

Index

- | | |
|------------------------|--------------------------|
| 1. Reference Standards | 6. Chamfering |
| 2. Submittals | 7. Coating |
| 3. Design | 8. Removal |
| 4. Materials | 9. Field Quality Control |
| 5. Installation | |

1. REFERENCE STANDARDS.

1.1 American Concrete Institute (ACI) Standards.

ACI 347-81

Recommended Practice for Concrete
Formwork

1.2 American Society for Testing and Materials (ASTM) with Corresponding CRD Standard Indicated where Available.

A 446-83

Steel Sheet, Fine-Coated (Galvanized)
by Hot Dip Process, Physical
(Structural) Quality.

C 31-84 (CRD-C 11)

Making and Curing Concrete Test
Specimens in the Field.

C 39-84 (CRD-C 14)

Compressive Strength of Cylindrical
Concrete Specimens.

1.3 U. S. Department of Commerce, National Bureau of Standards (NBS) Product Standard.

PS 1-74

For Construction and Industrial
Plywood

2. SUBMITTALS.

2.1 Shop Drawings. Drawings and computations for all formwork required shall be submitted at least 15 days before either fabrication on site or before delivery of prefabricated forms. The drawings and data submitted shall include the type, size, quantity and strength of all materials of which the forms are made, the plan for jointing of facing panels, details affecting the appearance, and the assumed design values and loading conditions.

2.2 Manufacturers Literature shall be submitted for plywood, concrete form hard board, form accessories, prefabricated forms, form coating and form lining materials.

2.3 Sample Panels and Posts. After shop drawings have been approved, sample panels and posts or Class A and F finish treatments shall be delivered to the Contracting Officer's Representative where directed. At least three sample posts shall be delivered. Panels shall be of sufficient size to contain joints and shall be not less than 6 feet long and 4 feet high. The panels shall be of typical wall thickness. Posts shall be full size. Panels and posts shall be constructed containing the full allocation of reinforcing steel that will be used and with the forming system that duplicates in every detail the one that will be used in construction of the structures. The same concrete mix design and materials, the same placement techniques and equipment, and the same finishing techniques and timing shall be used that are planned for the posts. Construction of structures with Class A and F finishes will not be permitted until sample panels and posts have been approved. Sample panels and posts shall be protected from construction operations in a manner to protect approved finish and are not to be removed until all Class A and F finish concrete has been accepted.

3. DESIGN. The design and engineering of the formwork, as well as its construction, shall be the responsibility of the Contractor. The formwork shall be designed for loads, lateral pressure and allowable stresses in accordance with Chapter 1 of ACI Standard 347. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete and shall have sufficient rigidity to maintain specified tolerances.

4. MATERIALS.

4.1 Forms shall be fabricated with facing materials that produce the specified construction tolerance requirements and the surface requirements of SECTION: CONCRETE.

4.1.1 Class "A" Finish. This class of finish shall apply to the concrete posts used in the picket fence construction. The form facing material shall be composed of new, well-matched tongue-and-groove or shiplap lumber; new plywood panels conforming to NBS PS-1 grade B-B concrete form Class I; tempered concrete hardboard or steel. Steel lining on wood sheathing will not be allowed.

4.1.1.1 All bolts, wires, and rods shall be clipped and recessed. All holes, honeycomb, rock pockets and other surface imperfections shall be cleaned out, thoroughly moistened and carefully patched with mortar. Mortar shall be composed of 1 part cement and 2 parts fine sand. Additionally, the mortar shall be colored to match the color used in manufacture of the posts. The surface shall then be promptly covered with polyethylene film, wet burlap or cotton mats. If polyethylene film is used, the film shall be held securely to the surface by means of weights, adhesive, or other suitable means. Only white polyethylene film for covering will be acceptable.

4.1.1.2 When the mortar used in patching and pointing has set sufficiently, the surface shall be uncovered and thoroughly rubbed with either a float or a carborundum stone until the surface is covered with a lather. Cork, wood or rubber floats shall be used only on a surfaces sufficiently green to work up such a lather, otherwise a carbonundum stone shall be used. During the rubbing process, a thin grout composed of 1 part cement and 1 part fine sand may be used to facilitate producing a satisfactory lather; however, this grout shall not be used in quantities sufficient to case a plaster coating to be left on the finished

surface. The grout shall be colored as required to match the color of the surrounding concrete. Rubbing shall continue until irregularities are removed and there is no excess material. At the time a light dust appears, the surface shall be brushed or sacked. Brushing or sacking shall be carried in one direction so as to produce a uniform surface.

4.1.2 Class "B" Finish. This class of finish shall apply to all surfaces except those specified to receive Class A or those to receive a formed textured finish. The sheathing shall be composed of tongue-and-groove or shiplap lumber, plywood conforming to NBS Product Standards PS-1 grade B-B concrete form, tempered concrete form hardboard, or steel. Steel lining on wood sheathing will not be permitted.

4.1.3 - See following page.

4.2 Form Accessories. Ties and other similar form accessories to be partially or wholly embedded in the concrete shall be of a commercially manufactured type. After the ends or end fasteners have been removed, the embedded portion of metal ties shall terminate not less than 2 inches from any concrete surface either exposed to view or exposed to water. Plastic snap ties may be used in locations where the surface will not be exposed to view. Form ties shall be constructed so that the ends or end fasteners can be removed without spalling the concrete.

4.3 Form Coating shall be a commercial formulation of satisfactory and proven performance that will not bond with, stain or adversely affect concrete surfaces and will not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.

5. INSTALLATION. Forms shall be mortar tight, properly aligned and adequately supported to produce concrete surfaces meeting the surface requirements and conforming to construction tolerance of SECTION: CONCRETE. Where concrete surfaces are to be permanently exposed to view, joints in form panels shall be arranged to provide a pleasing appearance. Where forms for continuous surfaces are placed in successive units, care shall be taken to fit the forms over the completed surface so as to obtain accurate alignment of the surface and to prevent leakage of mortar. Forms shall not be re-used if there is any evidence of surface wear and tear or defects which would impair the quality of the surface. All surfaces of forms and embedded materials shall be cleaned of any mortar from previous concreting and of all other foreign material before concrete is placed in them.

6. CHAMFERING. All exposed joints, edges and external corners shall be chamfered by molding placed in the forms unless the drawings specifically state that chamfering is to be omitted or as otherwise specified. Chamfered joints shall not be permitted where earth or rockfill is placed in contact with concrete surfaces. Chamfered joints shall be terminated a sufficient distance outside the limit of the earth or rockfill so that the end of the joints will be clearly visible.

7. COATING. Forms for exposed or painted surfaces shall be coated with form oil or a form-release agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's printed or written instructions. Forms for unexposed surfaces may be wet with water in lieu of coating immediately before placing concrete, except that in cold weather with probable freezing temperatures coating shall be mandatory. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

INSERT PARAGRAPH 4.1.3

4.1.3 CLASS "F" FINISH. THIS CLASS OF FINISH SHALL APPLY TO THOSE SURFACES DESCRIBED IN THE DRAWINGS AS "ROUGH LUMBER FINISH". THIS FINISH IS ROUGHLY DESCRIBED AS CEDAR GRAPESTAKE AND SHALL HAVE A MINIMUM RELIEF OF 5/8 INCH. IT SHALL BE OBTAINED BY USE OF TEXTIURED FORM LINERS. THESE LINERS MAY BE OF FORMED PLASTIC SHEET, WOOD, SHEETMETAL OR OTHER APPROVED MATERIAL.

8. REMOVAL. Forms shall not be removed without approval and all removal shall be accomplished in a manner which will prevent injury to the concrete. Forms shall not be removed before the expiration of the minimum time indicated below, except as otherwise directed or specifically authorized. When conditions of the work are such as to justify the requirement, forms will be required to remain in place for a longer period.

8.1 Unsupported Concrete. Formwork for walls, columns, sides of beams, gravity structures and other vertical type forms not supporting the weight of concrete shall not be removed in less than 24 hours, *★*The time depends on temperature, lift heights and type and amount of cementitious material in the concrete. Where forms for columns, walls and sides of beams also support formwork for slabs or beam soffits, the removal time of the latter shall govern.

8.2 Supported Concrete. Pan joist forms of the type which can be removed without disturbing shoring shall not be removed in less than 4 days. Supporting forms and shoring shall not be removed until structural members have acquired sufficient strength to support safely their own weight and any construction load to which concrete may be subjected. In no case shall forms and shoring be removed until both minimum time and sufficient strength have been attained.

Concrete with Type II Portland Cement, or Portland Pozzolan Cement (Mixes of Type II or Type IP cement)	Concrete Blends of Port- land Cement with Other Cementitious Material (Mixes of Type II cement with flyash)
---	---

Joist, beams or girder
soffits where clear
structural span
between support is
under 10 feet
10 to 20 feet
over 20 feet

4	6
7	10
14	21

In addition to minimum times above, results of control tests conducted in accordance with ASTM C-31 and C-39 will be used as evidence that concrete has attained sufficient strength to permit removal of forms. Concrete cylinders shall be stored in the structure or as near the structure as possible, shall receive insofar as possible the same curing and protection as given those portions of the structure they represent, and shall be tested within 24 hours after removal from the structure. Cylinders will be tested by and at the expense of the Government. Supporting forms shall not be removed until after minimum time and control test specimens have attained at least 80 percent of strength required for the structure in accordance with quality and location requirements of SECTION: CONCRETE.

★ SEE FOLLOWING Page

ADD WHERE INDICATED

24 HOURS, EXCEPT AS SPECIFIED HEREINAFTER. FORMS FOR WALLS NOT DESIGNED TO SUPPORT ANY OTHER WORK MAY BE REMOVED WITHIN 16 HOURS PROVIDED THE MINIMUM COMPRESSIVE STRENGTH EXCEEDS 700 PSI FOR EACH OF TWO COMPRESSIVE STRENGTH CYLINDERS TESTED IN ACCORDANCE THE ASTM C 31 AND C 39.

9. FIELD QUALITY CONTROL. Forms and embedded items shall be inspected in sufficient time prior to each concrete placement by the Contractor in order to certify to the Contracting Officer that they are ready to receive concrete. Forms for walls may be removed after 16 hours, provided that two (2) compressive strength cylinders tested in accordance with ASTM C-31 and C-39 each has a compressive strength greater than 700 psi. The cylinders will be fabricated and tested by the Contractor in the presence of the Contracting Officer's Representative. The results of each inspection shall be reported in writing.

* * * * *

SECTION 3B

EXPANSION, CONTRACTION AND CONSTRUCTION JOINTS IN CONCRETE

1. **APPLICABLE PUBLICATIONS.** The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1 American Society for Testing and Materials (ASTM) Standards. (With corresponding U.S. Army Corps of Engineers Handbook for Concrete and Cement (CRD) Specifications where indicated.)

D 1751-83 (CRD-C 508)	Performed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
D 1752-84 (CRD-C 509)	Preformed Sponge Rubber and Cork Expansion Joint Fillers and Concrete Paving and Structural Construction
D 1850-74 (R 1979)	Concrete Joint Sealer, Cold-Application Type
D 3406-85	Joint Sealant, Hot Applied, Elastomeric Type, for Portland Cement Concrete Pavements
D 2835-72 (CRD-C 532) (R 1982)	Lubricant for Installation of Preformed Compression Seals in Concrete Pavements

2. SUBMITTALS.

2.1 Test Reports. Certified manufacturer's test reports shall be provided for premolded expansion-joint filler strips, sealers, and lubricant to verify compliance with the applicable specification.

3. MATERIALS.

3.1 Expansion Joint Filler Strips, Premolded shall conform ASTM D 1751 or ASTM D 175, Type I or resin impregnated fiberboard conforming to the physical requirements of ASTM D 1752

3.2 Joint Sealants and Seals.

3.2.1 Field Molded Sealants shall conform to Fed. Spec. TT-S-227, Type II for vertical joints and Type I for horizontal joints, Class A; or ASTM D 1850 or D 3406. All sealants shall be tested in bond to 50 percent extension. Bond breaker material shall be polyethylene tape, coated paper, metal foil or similar type materials. The back-up material shall be compressible, nonshrink, nonreactive with sealant, and nonabsorptive material type such as extruded butyl or polychloroprene foam rubber.

4. INSTALLATION. Joint locations and details, including materials and methods of installation of joint fillers, shall be as specified, shown on the drawings and as directed. Joints shall be provided in the invert slabs of the channel whenever concrete placement is stopped for periods exceeding 45 minutes. In no case shall any fixed metal be continuous through an expansion or contraction joint. In vertical walls, vertical construction joints shall be provided at intervals of 30 to 60 feet measured along the walls or the centerline of the invert. On curves, the 60-foot maximum interval shall be measured along the channel wall with the greater radius. In no case shall any fixed metal be continuous through an expansion or contraction joint in a vertical wall.

4.1 Expansion Joints. Premolded filler strips shall have oiled wood strips secured to the top thereof and shall be accurately positioned and secured against displacement to clean, smooth concrete surfaces. The wood strips shall be slightly tapered, dressed and of the size required to install filler strips at the desired level below the finished concrete surface and to form the groove for the joint sealant or seals to the size shown on the drawings. Material used to secure premolded fillers and wood strips to concrete shall not harm the concrete and shall be compatible with the joint sealant or seals. The wood strips shall not be removed until after the concrete curing period. The groove shall be thoroughly cleaned of all laitence, curing compound, foreign materials, protrusions of hardened concrete and any dust which shall be blown out of the groove with oil-free compressed air.

4.1.1 Joints With Field-Molded Sealant. Joints shall not be sealed when the sealant, air or concrete temperature is less than 40 degree F. Bond breaker and back-up material shall be installed where required. Joints shall be primed and filled flush with joint sealant in accordance with the manufacturer's recommendations.

4.2 Contraction Joints. Joints requiring a bond breaker shall be coated with curing compound or with bituminous paint.

* * * * *

SECTION 3C

STEEL BARS, STEEL WELDED WIRE FABRIC, AND ACCESSORIES
FOR CONCRETE REINFORCEMENT

Index

- | | |
|----------------------------|--------------|
| 1. Applicable Publications | 4. Materials |
| 2. Certification Testing | 5. Placement |
| 3. Submittals | |

1. APPLICABLE PUBLICATIONS. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1 American Concrete Institute (ACI) Standards.

ACI 315-81	Details and Detailing of Concrete Reinforcement
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ACI 318-83	Building Code Requirements for Reinforced Concrete
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1.2 American Society for Testing and Materials (ASTM) Standards.

A 184-86	Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
----------	---

A 370-86a	Mechanical Testing of Steel Products
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A 497-86	Welded Deformed Steel Wire Fabric for Concrete Reinforcement
----------	--

A 615-86	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
----------	---

A 706-86	Low-Alloy Steel Deformed Bars for Concrete Reinforcement
----------	--

1.3 American Welding Society (AWS) Code.

D 1.4-79	Structural Welding Code-Reinforcing Steel
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2. CERTIFICATION TESTING. The Contractor shall have required material tests performed by an approved laboratory and certified to demonstrate that the materials are in conformance with the specifications. Tests shall be performed and certified at the Contractor's expense.

2.1 Reinforcement Steel Tests. Mechanical testing of steel shall be in accordance with ASTM A 370 except as otherwise specified herein or required by the material specifications. Tension tests shall be performed on full cross section

specimens using a gauge length that spans the extremities of specimens with welds or sleeves included. The ladle analysis shall show the percentages of carbon, phosphorous, manganese, and sulfur present in the steel.

3. SUBMITTALS. The Contractor shall submit the following items to the Contracting Officer for approval.

3.1 Shop Drawings shall be in accordance with specified requirements and include the following:

(1) Reinforcement steel schedules showing quantity, size, shape, dimensions, weight per foot and total weights, and bending details.

(2) Details of bar supports showing types, sizes, spacing, and sequence.

3.2 Test Reports. Certified test reports of reinforcement steel showing that the steel complies with the applicable specifications shall be furnished for each steel shipment and identified with specific lots prior to placement. Three copies of the ladle analysis shall be provided for each lot of steel and the Contractor shall certify that the steel furnished conforms to the ladle analysis.

3.3 Disposition Records. A system of identification which shows the disposition of specific lots of approved materials in the work shall be established and submitted before completion of the contract.

4. MATERIALS.

4.1 Billet-Steel Bars shall conform to ASTM A 615, deformed, with the following exceptions.

4.1.1 If Grade 40 bars are shown on the drawings but are unavailable, the Contractor may substitute Grade 60 bars of the same size and spacing as indicated for Grade 40 bars at no additional cost to the Government when authorized by the Contracting Officer.

4.1.1.1 The bend test requirements shall be based upon 180 degree bends of full size bars for all grades of steel. The bend diameters for bend test shall be as indicated in the following table and shall be measured on the inside of bars:

<u>Bar Size</u>	<u>Maximum Diameter</u>
No. 3, 4, and 5	3-1/2 bar diameters
No. 6, 7, and 8	5 bar diameters
No. 9, 10, and 11 (Grade 40)	5 bar diameters

4.1.2 Low-Alloy Bars. ASTM A 706.

4.1.3 Fabricated Bar Mats. ASTM A 184, clipped or welded mats, billet-steel bars specified herein 6.1.1.

4.2 Steel Welded Wire Fabric. ASTM A 497 wire spacing and sizes as indicated on the drawings. For wire with a specified yield strength (f_y) exceeding 60,000 psi, f_y shall be the stress corresponding to a strain of 0.35 percent.

4.3 Accessories.

4.3.1 Bar Supports. ACI 315. Supports for formed surfaces exposed to view or to be painted shall be plastic protected wire, stainless steel, or precast concrete supports. Precast concrete supports shall be wedge-shaped, not larger than 3-1/2 x 3-1/2 inches, of thickness equal to that indicated for concrete cover, and have an embedded hooked tie-wire for anchorage. If formed surface is exposed to view, precast concrete supports shall be the same quality, texture, and color as the finish surface.

4.3.2 Wire Ties shall be 16-gauge or heavier black annealed wire.

5. PLACEMENT. Reinforcement steel and accessories shall be placed as specified and as shown on contract drawings and approved shop drawings. Placement details of steel and accessories not specified or shown on the drawings shall be in accordance with ACI 315 and ACI 318 or as directed by the Contracting Officer. Steel shall be fabricated to shapes and dimensions shown, placed where indicated within specified tolerances, and adequately supported during concrete placement. At the time of concrete placement all steel shall be free from loose, flaky rust, scale (except tight mill scale), mud, oil, grease, or any other coating that might reduce the bond with the concrete.

5.1 Hooks and Bends. Steel may be mill or field bent. All steel shall be bent cold unless otherwise authorized. No steel bars shall be bent after being partially embedded in concrete unless indicated on the drawings or otherwise authorized.

5.2 Welding of steel will be permitted only where indicated on the drawings or as otherwise directed by the Contracting Officer. Welding shall be performed in accordance with AWS D 1.4 except where otherwise specified or indicated on the drawings.

5.3 Placing Tolerances.

5.3.1 Spacing. The spacing between adjacent bars and the distance between layers of bars may not vary from the indicated position by more than one bar diameter nor more than one inch.

5.3.2 Concrete Cover. The minimum concrete cover of main reinforcement steel shall be as shown on the drawings. The allowable variation for minimum cover shall be as follows:

<u>Minimum Cover</u>	<u>Variation</u>
6"	+ 1/2"
4"	+ 3/8"
3"	+ 3/8"
2"	+ 1/4"
1-1/2"	+ 1/4"
1"	+ 1/8"
3/4"	+ 1/8"

5.4 Splicing. Splices in steel shall be made only as required. Bars may be spliced at alternate or additional locations at no additional cost to the Government, subject to the approval of the Contracting Officer.

5.4.1 Lap Splices shall be used only for bars smaller than size No. 14 and welded wire fabric. Lapped bars may be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 6 inches.

* * * * *

SECTION 3E

CONCRETE

Index

- | | |
|------------------------------|--|
| 1. Deleted | 9. Conveying Equipment |
| 2. Reference Standards | 10. Preparation for Placing |
| 3. Quality Assurance | 11. Placing |
| 4. Evaluation and Acceptance | 12. Finishing |
| 5. Submittals | 13. Curing and Protection |
| 6. Materials | 14. Setting of Base Plates and
Bearing Plates |
| 7. Mixture Proportioning | 15. Contractor Quality Control |
| 8. Production Equipment | |

1. DELETED.

2. REFERENCE STANDARDS.

2.1 American Concrete Institute (ACI) Standards.

ACI 211.1-81 (R 1985)
(CRD-C99)

Standard Practice for Selecting
Proportions for Normal, Heavyweight
and Mass Concrete

ACI 214-77
(R 1983)

Recommended Practice for Evaluation of
Strength Test Results of Concrete

ACI 305 R-77
(R 1982)

Hot Weather Concreting

2.2 American Society for Testing and Materials (ASTM with Corresponding CRD
Standard Indicated Where Available.

C 31-85
(CRD-C 11)

Making and Curing Concrete Test
Specimens in the Field

C 33-86
(CRD-C 133)

Concrete Aggregates

C 39-86
(CRD-C 14)

Compressive Strength of Cylindrical
Concrete Specimens

C 70-79
(R 1985)
(CRD-C 111)

Surface Moisture of Fine Aggregate

C 94-86b
(CRD-C 31)

Ready-Mixed Concrete

C 125-85
(CRD-C 43)

Terms Relating to Concrete and
Concrete Aggregates

C 136-84a (CRD-C 103)	Sieve Analysis of Fine and Coarse Aggregates
C 143-78 (CRD-C 5)	Slump of Portland Cement Concrete
C 150-85a (CRD-C 201)	Portland Cement
C 171-69 (R 1986) (CRD-C 310)	Sheet Materials for Curing Concrete
C 172-82 (CRD-C 4)	Sampling Fresh Concrete
C 192-81 (CRD-C 10)	Making and Curing Concrete Test Specimens in the Laboratory
C 231-82 (CRD-C 41)	Air Content of Freshly Mixed Concrete by the Pressure Method
C 260-86 (CRD-C 13)	Air-entraining Admixtures for Concrete
C 494-86 (CRD-C 87)	Chemical Admixtures for Concrete
C 566-84 (CRD-C 113)	Total Moisture Content of Aggregate by Drying
C 595-86 (CRD-C 203)	Blended Hydraulic Cements
C 618-85 (CRD-C 255)	Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
C 989-85a (CRD-C 205)	Ground Iron Blast-Furnace Slag for Use in Concrete and Mortars
D 75-82 (CRD-C 155)	Sampling Aggregates
E 329-77 (R 1983) (CRD-C 500)	Inspection and Testing Agencies for Concrete, Steel and Bituminous Materials as Used in Construction

2.3 Concrete Plant Manufacturer's Bureau (CPMB).

In the CRD (6th Revision (CRD-C 95) Concrete Plant Standards

2.4 National Bureau of Standards (NBS) Handbook.

44

Specifications, Tolerance and Other
Technical Requirements for
Commercial Weighing and Measuring
Devices (4th Edition 1971 with
Replacement Sheets)

2.5 U.S. Army Corps of Engineers Handbook for Cement and Concrete (CRD).

CRD-C 55-85

Concrete Mixer Performance

CRD-C 100-75

Concrete Aggregate and Aggregate
Sources and Selection of Material
for Testing

CRD-C 112-69

Surface Moisture in Aggregate by Water
Displacement

CRD-C 143-62

Meters for Automatic Indication of
Moisture in Fine Aggregate)

CRD-C 300-77

Membrane-Forming Compounds for Curing
Concrete

CRD-C 400-63

Water for Use in Mixing or Curing
Concrete

CRD-C 621-83

Non-Shrink Grout

3. QUALITY ASSURANCE.

3.1 Preconstruction Sampling and Testing.

3.1.1 Aggregates. The aggregate sources listed in SPECIAL CLAUSES have in the past been determined to be capable of supplying aggregates of quality acceptable for use in this project. Proposed aggregates produced from similar strata, or of similar quality, will be approved. If the Contractor proposes to furnish aggregates from a source listed in SPECIAL CLAUSES, he will be required to supply not less than 1000 pounds of each size coarse aggregate and 1000 of fine aggregate taken from the proposed source under the supervision of the Contracting Officer in accordance with CRD-C 100 and shall deliver them to:

Director
South Pacific Division Laboratory
U.S. Army Corps of Engineers
Bridgeway, Foot of Spring Street
(Building directly east of 2000 Bridgeway)
Sausalito, CA 94695
Phone: (415) 332-3374

within 15 days after notice to proceed. Sampling and shipment of samples shall be at the Contractor's expense. The laboratory will require 45 days after delivery of the samples to complete evaluation of the aggregates. Testing by and at the

expense of the Government will be in accordance with the applicable CRD or ASTM test method. Tests to which aggregate may be subjected are specific gravity, absorption, freezing-and-thawing in concrete, alkali-aggregate reaction, organic impurities and any other test necessary to demonstrate that the aggregate is of a quality which is at least equivalent to those sources listed in SPECIAL CLAUSES. If the Contractor proposes to furnish aggregates from a source not listed in SPECIAL CLAUSES, samples will be obtained as described above. The aggregates suitability for use in concrete will be determined by the Government. The division laboratory will require 60 days after delivery of the samples to evaluate the aggregates. If the source elected by the Contractor fails to supply materials that are at least equivalent to the sources listed in SPECIAL CLAUSES, as determined by the Government, the Contractor will be required to propose a new source or elect a source listed in SPECIAL CLAUSES to supply aggregates for the project. If the Contractor elects to obtain aggregates from more than one source, samples of aggregates from each source to be evaluated will be obtained as described above. Any testing of additional sources or retesting of sources which fail initially, will be at the expense of the Contractor. The Government reserves the right to reject materials found to be unsuitable when produced from any source even a source that is noted in SPECIAL CLAUSES.

3.1.2 Cementitious Materials, Admixtures, Curing Compound. At least 60 days in advance of concrete placement the contractor will notify the Contracting Officer of the source of materials, along with sampling location, brand name, type and quantity to be used in the manufacture and/or curing of the concrete. Sampling and testing will be performed by and at the expense of the Government except as otherwise specified. No material shall be used until notice has been given by the Contracting Officer that test results are satisfactory and all movement of materials after sampling shall be as directed. The Government will sample and test the following.

3.1.2.1 Cement and Pozzolan. If cement or pozzolan is to be obtained from more than one source, the initial notification shall state the estimated amount to be obtained from each source and the proposed schedule of shipments.

3.1.2.2 Prequalified Cement Sources. Cement shall be delivered and used directly from a mill of a producer designated as a qualified source. Samples of cement for check testing will be taken at the project site or concrete producing plant by a representative of the Contracting Officer for testing at the expense of the Government. A list of prequalified cement sources is available from Commander and Director, U.S. Army Engineer Waterways Experiment Station, P.O. Box 631, Vicksburg, Mississippi 39180.

3.1.2.3 Prequalified Pozzolan Sources. Pozzolan shall be delivered and used directly from a producer designated as a qualified source. Samples of pozzolan for check testing will be taken at the project site by a representative of the Contracting Officer for testing at the expense of the Government. A list of prequalified pozzolan sources is available from the Commander and Director, U.S. Army Engineer Waterways Experiment Station, P.O. Box 631, Vicksburg, MS 39180.

3.1.2.4 Cement, if not from a prequalified source will be sampled at the source and stored in sealed bins pending completion of certain tests. Sampling, testing and the shipping inspection from the point of sampling, when the point is other than at the site of the work, will be made by, or under the supervision of the government and at its expense. No cement shall be used until notice has been

given by the Contracting Officer that test results are satisfactory. In the event of failure, the cement may be resampled and tested at the request of the Contractor, at his expense. When the point of sampling is other than at the site of the work, the fill gates of the sampled bin and conveyances used in shipment will be sealed under Government supervision and kept sealed until shipment from the bin has been completed. If tested cement is rehandled at transfer points the extra cost of inspection will be at the Contractor's expense. The cost of testing cement excess to the project requirements will also be at the expense of the Contractor. The charges for testing cement at the expense of the Contractor will be deducted from the payments due the Contractor at a rate of \$1.20 per ton of cement represented by the tests.

3.1.2.5 Pozzolan, if not from a prequalified source, will be sampled at the source and stored in sealed bins pending completion of certain tests. Pozzolan will also be sampled at the site when determined necessary. All sampling and testing will be by and at the expense of the Government. Release for shipment and approval for use will be based on compliance with 7-day lime-pozzolan strength requirements and other physical and chemical and uniformity requirements for which tests can be completed by the time the 7-day lime-pozzolan strength test is completed. Release for shipment and approval for use on the above basis will be contingent on continuing compliance with the other requirements of the specifications. If a bin fails, the contents may be resampled and tested at the Contractor's expense. In this event the pozzolan may be sampled as it is loaded into cars, trucks or barges provided they are kept at the source until released for shipment. Unsealing and resealing of bins and sealing of shipping conveyances will be done by or under the supervision of the Government. Shipping conveyances will not be accepted at the site of the work unless received with all seals intact. If pozzolan is damaged in shipment, handling, or storage, it shall be promptly removed from the site or the work. Pozzolan which has not been used within six months after test will be retested at the expense of the Contractor when directed by the Contracting Officer and shall be rejected if the test results are not satisfactory. If tested pozzolan is rehandled at transfer points, the extra cost of inspection will be at the Contractor's expense. The cost of testing excess pozzolan will be at the Contractor's expense at a rate of \$2.00 per ton. The amount will be deducted from payment to the Contractor.

3.2 Construction Testing By Government. The Government will sample and test aggregates and concrete to determine compliance with the specifications. The Contractor shall provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D 75. Concrete will be sampled in accordance with ASTM C 172. Slump and air content will be determined in accordance with ASTM C 143 and ASTM C 231, respectively. Compression test specimens will be made and laboratory cured in accordance with ASTM C 31 and compression test specimens tested in accordance with ASTM C 39.

4. EVALUATION AND ACCEPTANCE.

4.1 Concrete Strength. The strength of the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equal or exceed the required specified strength f'_c and no individual test result falls below the specified strength f'_c by more than 500 pounds per square inch. Additional analysis or testing may be required at the Contractor's expense when the strength of the concrete in the structure is considered potentially deficient.

Concrete work judged inadequate shall be reinforced with additional construction as directed by the Contracting Officer or shall be replaced at the Contractor's expense.

4.2 Construction Tolerances. Variation in alignment, grade and dimensions of the structures from the established alignment, grade and dimensions shown on the drawings shall be within the tolerances specified in the following tables:

Table I. Tolerances for Concrete Channel Walls and Inverts.

(1) Departure from established alignment	.....	2-inches on tangents 4-inches on curves
(2) Departure from established profile grade	.....	1-inch
(3) Footings:		
a. Variation of dimensions in plan	Minus..... Plus..... when formed or plus 3-inches when placed against unformed excavation.	1/2-inch 2-inches
b. Misplacement of eccentricity	2 percent of the footing width in the direction of misplacement but not more than 2-in.	
c. Reduction in thickness	Minus.....	5 percent of specified thickness.
(4) Reduction in thickness in lining or walls	.....	10 percent of specified thickness: provided that average thickness is maintained as determined by daily batch volumes.
(5) Variation from specified width of section at any height	.....	1/4 of 1 percent plus 1-inch.
(6) Variation from established height of lining	.....	1/2 of 1 percent plus 1-inch.
(7) Variations in surfaces	.....	Invert 5/16inch in 10 feet Side slopes and walls 1/2- inch in 10 feet.

Table II. Tolerances for Bridges, Erosion Protection Structures and Small Hydraulic Structures.

(1) Departure from established alignment	.....	1-inch
(2) Departure from established grades	.....	1-inch
(3) Variation from the plumb or the specified batter in the lines and surfaces of columns, piers, walls, and in arrises	Exposed, in 10 feet.....	1/2-inch
	Backfilled, in 10 feet.....	1-inch
(4) Variation from the level or from the grades indicated on the drawings in slabs, beams, horizontal grooves, and railing offsets	Exposed, in 10 feet.....	1/2-inch
	Backfilled, in 10 feet.....	1-inch
(5) Variation in cross-sectional dimensions of columns, piers slabs, walls, beams, and similar parts	Minus.....	1/4-inch
	Plus.....	1/2-inch
(6) Variation in thickness of bridge slabs	Minus.....	1/8-inch
	Plus.....	1/4-inch
(7) Variation in the sizes and locations of slab and wall openings	.....	1/2-inch
(8) Sills and sidewalls for radial gates and similar watertight structures	Variation from the plumb or level Not greater than 1/8 in. in 10 ft.	

4.2.1 Colors. Colors of pigmented concrete shall be considered satisfactory based on the comparative analysis of color produced from test panel(s) in accordance with paragraph: TEST PANEL, and Munsell Color samples in accordance with U.S. Department of Agriculture Handbook 18 - Soil Survey Manual. Color of concrete shall conform to Munsell Color number 10YR5/3 with respect to hue, value and chroma. Evaluation of color shall be made within the time limits prescribed in paragraph: TEST PANEL.

4.3 Surface Requirements. The surface requirements for the classes of finish required by SECTION: FORMWORK FOR CONCRETE, shall be as hereinafter specified. Allowable irregularities are designated "abrupt" or "gradual" for purposes of providing for surface variations. Offsets resulting from displaced, misplaced or mismatched forms, or sheathing, or by loose knots in sheathing, or other similar form defects, shall be considered "abrupt" irregularities. Irregularities resulting from warping, unplaneness or similar uniform variations from planeness,

or true curvature, shall be considered "gradual" irregularities. "Gradual" irregularities will be checked for compliance with the prescribed limits with a 5-ft template, consisting of a straightedge for plane surfaces and a shaped template for curved or warped surfaces. In measuring irregularities, the straight edge or template may be placed anywhere on the surface in any direction, with the testing edge held parallel to the intended surface.

Irregularities

<u>Class of Finish</u>	<u>Abrupt, inches</u>	<u>Gradual, inches</u>
A	1/8	1/4
B	1/4	1/2
F	1/8	1/4

4.4 Appearance. Permanently exposed surfaces shall be cleaned, if stained or otherwise discolored, by a method which does not harm the concrete and which is approved by the Contracting Officer.

5. SUBMITTALS.

5.1 Test Reports.

5.1.1 Concrete mixture proportions shall be determined by the contractor and submitted for approval. The proportions of all ingredients and nominal maximum coarse aggregate size that will be used in the manufacture of each quality of concrete shall be stated. Proportions shall indicate weight of cement and water and weights of aggregates in a saturated surface-dry condition. The submission shall be accompanied by test reports from a laboratory complying with ASTM E 329 which show that proportions thus selected will produce concrete of the qualities indicated. No substitution shall be made in the source or type of materials used in the work without additional tests to show that the new materials and quality of concrete are satisfactory.

5.1.2 Cement and pozzolan will be accepted on the basis of manufacturer's certification of compliance, accompanied by mill test reports that materials meet the requirements of the specification under which it is furnished. Certification and mill test reports shall identify the particular lot furnished. No cement or pozzolan shall be used until notice of acceptance has been given by the Contracting Officer. Cement and pozzolan will be subject to check testing from samples obtained at the mill, at transfer points or at the project site, as scheduled by the Contracting Officer, and such sampling will be by or under the supervision of the Government at its expense. Material not meeting specifications shall be promptly removed from the site of work.

5.1.3 Non-shrink Grout.

5.1.3.1 General. Descriptive literature of the grout proposed for use shall be furnished together with a certificate from the manufacturer stating that it is suitable for the application or exposure for which it is being considered. In addition, a detailed plan shall be submitted for approval, showing equipment and procedures proposed for use in mixing and placing the grout.

5.1.3.2 Prepackaged material requiring only the addition of water will be accepted on the basis of certified laboratory test results showing that the material meets the requirements of CRD-C 621. When fine aggregate is to be added,

the Contractor shall also furnish for approval the design mix proportions together with certified copies of laboratory test results indicating that the mix is in conformance with the requirements of CRD-C 621.

5.1.3.3 Mixture proportions using a volume-change controlling ingredient shall be submitted for approval. The submittal shall include the design mix proportions of all ingredients and certified copies of laboratory test results indicating that the materials and the mix is in conformance with the requirements of CRD-C 621.

5.2 Manufacturers' Certificate.

5.2.1 Accelerating Admixture shall be certified for compliance with all specification requirements.

5.2.2 Impervious Sheet Curing Materials shall be certified for compliance with all specification requirements.

5.2.3 Air-entraining Admixture shall be certified for compliance with all specification requirements.

5.2.4 Water-reducing Admixture shall be certified for compliance with all specification requirements.

5.2.5 Color Admixture shall be certified to be non-fading by the manufacturer.

5.3 Review of Plant, Equipment and Methods.

5.3.1 Batch Plant. Details of the data on concrete plant shall be submitted for review by the Contracting Officer for conformance with paragraph: BATCHING PLANT.

5.3.2 Mixers. The make, type and capacity of concrete mixers proposed for mixing concrete shall be submitted for review by the Contracting Officer for conformance with paragraph: MIXERS. The results of the initial mixer uniformity tests as required in paragraph: MIXER UNIFORMITY shall be submitted within five days of the initiation of placing.

5.3.3 Conveying Equipment. The methods and equipment for transporting, handling, and depositing the concrete shall be submitted for review by the Contracting Officer for conformance with paragraph: CONVEYING EQUIPMENT.

5.3.4 Placing. All placing equipment and methods shall be submitted for review by the Contracting Officer for conformance with paragraph: PLACING.

5.3.5 Joint Clean-up. The method and equipment proposed for joint clean-up and waste disposal shall be submitted for review by the Contracting Officer for conformance with paragraph: CONSTRUCTION JOINT TREATMENT.

5.3.6 Curing. The curing medium and methods to be used shall be submitted for review by the Contracting Officer for conformance with paragraph: CURING AND PROTECTION.

5.3.7 Cold-Weather Requirements. If concrete is to be placed under cold weather conditions, the proposed materials, methods and protection shall be submitted in accordance with the requirements of paragraph: HOT WEATHER PLACING and COLD WEATHER for approval by the Contracting Officer.

5.3.8 Hot-Weather Requirements. If concrete is to be placed under hot weather conditions, the proposed materials and methods shall be submitted in accordance with the requirements of paragraph: HOT WEATHER PLACING for approval by the the Contracting Officer.

6. MATERIALS.

6.1 Cementitious Materials shall be Portland cement, Portland-pozzolan cement, or Portland cement in combination with pozzolan and shall conform to appropriate specifications listed below. Usage for architectural concrete shall be restricted to one color and one type.

6.1.1 Portland Cement. ASTM C 150, Type II including false set requirements. Low alkali including heat of hydration requirement at 7 days.

6.1.2 High-Early-Strength Portland Cement. ASTM C 150, Type III with tricalcium aluminate limited to 8 percent, low alkali, used only when specifically approved in writing.

6.1.3 Portland-Pozzolan Cement. ASTM C 595 Type IP (MS). The Portland cement or clinkers shall meet the requirements of ASTM C 150 for low alkali cement; the pozzolan shall meet the requirements of ASTM C 618 table 1A, available alkali.

6.1.4 Pozzolan. Pozzolan shall conform to the requirements of ASTM C-618, Class F with the loss on ignition limited to 6 percent. The optional requirements of table 1A for available alkalies will be invoked. The optional table 2A will be invoked except that the mortar expansion at 14 days limit is amended so that the expansion of the mortar is not more than that of the cement acting alone with the selected aggregates.

6.2 Aggregates shall be produced from the sources and under the conditions described in ~~para 3-1-1~~. ^{paragraph: QUANTITY ASSURANCE} Fine and coarse aggregates shall conform to the grading requirements of ASTM C 33. The nominal maximum size shall be as listed in paragraph 7.2.

6.3 Admixtures to be used, when required or permitted shall conform to the appropriate specification listed below:

6.3.1 Air-entraining Admixture. ASTM C 260.

6.3.2 Accelerating Admixture. ASTM C-499, Type C except no calcium chloride will be allowed.

6.3.3 Water-reducing or Retarding Admixtures ASTM C 494, Type A, B or D.

6.3.4 Color Admixture. Color admixture for concrete shall be the product of a manufacturer regularly engaged in the production of colored admixtures for concrete, and shall have a history of at least 2 years of use of the material in a similar environment without substantial fading or deleterious effects on the structural qualities of the concrete. Color admixture must be capable of evenly distributing the color throughout the concrete without segregation or causing irregular concentration of color.

6.4 Curing Materials.

6.4.1 Impervious Sheet Materials ASTM C 171, type optional except polyethylene film, if used, shall be white opaque.

6.4.2 Membrane-Forming Curing Compound CRD-C 300, pigmented, tinted as specified, except that the reflectance requirement will be waived.

6.4.3 - See Following Page.

6.5 Water for mixing and curing shall be fresh, clean, drinkable, and free of injurious amounts of oil, acid, salt, and alkali, except that undrinkable water may be used if it meets the requirements of CRD-C 400.

6.6 Non-Shrink Grout shall conform to CRD-C 621. The type shall be Expansive-Cement.

7. MIXTURE PROPORTIONING.

7.1 Quality and Location. For each portion of the structure, mixture proportions shall be selected so that the following strength and water-cement ratio requirements are met.

7.1.1 Strength. Specified compressive strength f'_c for structural elements shall be as follows, except where indicated otherwise.

<u>Compressive Strength @ 28 days, psi</u>	<u>Structure or Portion of Structure</u>
4500 @ 28 days	Concrete bridge slabs
3000 @ 28 days	All elements not described below
2500 @ 28 days	Concrete for sidewalks

7.1.2 Maximum Water-Cement Ratio. Maximum water cement ratio shall be as follows:

<u>Water-Cement Ratio, by Wt</u>	<u>Structure or Portion of Structure</u>
0.45	Concrete for invert, sideslopes, and channel walls.
0.50	Concrete for structures not described above.

7.2 Coarse aggregate shall be ASTM C-33 size No. 467 for invert and footings and shall be ASTM C-33 size No. 57 for all other elements except where indicated otherwise.

7.3 Air Content as determined by ASTM C-231 shall not exceed 7 percent in all concrete. During the preparation of mix designs the Contractor shall determine the amount of air to be used in the concrete mixtures and this amount will be reported in the mix design submittal. This amount of air will be the sum of the entrapped or naturally entrained and air entrained by admixtures. Once production of concrete has commenced the amount of air will not vary more than $\pm 1\frac{1}{2}$ percent from the selected air content, nor shall it ever exceed the value stated above.

INSERT PARAGRAPH 6.4.3

6.4.3 MEMBRANE-FORMING CURING COMPOUND CRD C-300, WHITE OPAQUE. THIS COMPOUND WILL ONLY BE USED ON THE BACKS OF CHANNEL WALLS OR OTHER CONCRETE STRUCTURAL ELEMENTS WHICH WILL NOT BE EXPOSED TO PERMANENT VIEW AS APPROVED BY THE CONTRACTING OFFICER.

7.4 Slump. The slump shall be determined in accordance with ASTM C-143 and shall be within the range of 1 inch to 4 inches and shall be restricted to the ranges specified below. Where placement by pump is approved, the slump shall not exceed 6 inches and shall remain within a 3-inch band.

<u>Item</u>	<u>Maximum Slump</u>	<u>Placement Restrictions</u>
Invert and Footings	2 inches	No pumping
Side Slopes	1-1/2 inches	No pumping
Vertical Walls and Other Elements	As stated above.	

7.5 Concrete Proportioning. Trial design batches and testing requirements for various qualities of concrete specified shall be the responsibility of the Contractor. Samples of approved aggregates shall be obtained in accordance with the requirements of ASTM D 75. Samples of material other than aggregate shall be the representative of those proposed for the project and shall be accompanied by manufacturer's test reports indicating compliance with applicable specified requirements. Trial mixtures having proportions, consistencies and air content suitable for the work shall be made based on ACI Standard 211.1. The water-cement ratios required in paragraph: **MAXIMUM WATER-CEMENT RATIO** will be converted to a weight ratio of water to cement plus pozzolan or by weight equivalency as described in ACI Standard 211.1 to determine the maximum allowable water. Trial mixtures shall be designed for maximum permitted slump and air content. The temperature of concrete in each trial batch shall be reported. For each maximum aggregate size selected at each water-cement ratio at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192. They shall be tested at 7 and 28 days in accordance with ASTM C 39. From these test results a curve shall be plotted showing the relationship between water-cement ratio and strength.

7.6 Average Strength. In meeting the water-cement ratio and strength requirements specified in paragraph: **QUALITY AND LOCATION** above, the selected mixture proportion shall produce an average strength (f_{cr}) exceeding the specified strength f'_c by the amount indicated below with a water-cement ratio at or below that specified above. Where a concrete production facility has a large amount of test records, verifying that concrete of the strengths and water-cement ratios specified are being produced, a standard deviation shall be established. Test records from which a standard deviation is calculated shall represent materials, including admixtures and colors, quality control procedures, and conditions similar to those expected. Changes in materials and proportions within the test records shall not have been more restricted than those for the proposed work and shall represent concrete produced to meet a specified strength or strengths f'_c meeting or exceeding that specified for proposed work at or below water-cement ratio specified; and shall consist of at least 30 consecutive tests or two groups of consecutive tests totalling at least 30 tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at other test age designated for determination of f'_c .

7.6.1 Required average compressive strength f_{cr} used as the basis for selection of concrete proportions shall be the larger of the equations which follow using the standard deviation as determined above:

$$f_{cr} = f'_c + 1.34S \text{ where } S = \text{standard deviation}$$

$$f_{cr} = f'_c + 2.33S - 500$$

7.6.2 Where a concrete production facility does not have test records meeting requirements above but does have a record based on 15 to 29 consecutive tests, a standard deviation may be established as the product of the calculated standard deviation and a modification factor from the following table:

<u>No. Of Tests*</u>	<u>Modification Factor For Standard Deviation</u>
less than 15	Use table in 7.6.3
15	1.16
20	1.08
25	1.03
30 or more	1.00

* Interpolate for intermediate numbers of tests.

7.6.3 When a concrete production facility does not have field strength test records for calculation of standard deviation the required average strength f_{cr} shall be determined as follows:

If the specified compressive strength f'_c is less than 3000 psi,

$$f_{cr} = f'_c + 1000.$$

If the specified compressive strength f'_c is 3000 to 5000 psi,

$$f_{cr} = f'_c + 1200.$$

7.7 Color. All concrete structures exposed to view shall be colored with color admixture except those indicated on the drawings. The admixture shall be batched in a manner that will ensure that the admixture is completely and thoroughly mixed throughout the concrete. Quantities of admixture added to concrete shall be carefully controlled to avoid variations in color between adjacent placements as well as maintain a consistent coloring throughout the project area.

8. PRODUCTION EQUIPMENT.

8.1 Capacity. The batching and mixing equipment shall have a capacity of at least 100 cubic yards per hour.

8.2 Batching Plant shall conform to the requirements of the Concrete Plant Standards of CPMB and as specified; however, rating plates attached to batch plant equipment are not required.

8.2.1 Equipment. The batching controls shall be semi-automatic or automatic. The semi-automatic batching system shall be provided with interlocks such that the discharge device cannot be actuated until the indicated material is within the applicable tolerance. The semi-automatic or automatic batching system shall be equipped with an accurate recorder or recorders which meet the requirement of the Concrete Plant Standards of CPMB. Separate bins or compartments shall be provided

for each size group of aggregate and cement and pozzolan. Aggregates shall be weighed either in separate weigh batchers with individual scales or cumulatively in one weigh batcher on one scale. Aggregate shall not be weighed in the same batcher with cement, or pozzolan. If both cement and pozzolan are used they may be batched cumulatively provided Portland cement is batched first. If measured by weight, water shall not be weighed cumulatively with another ingredient. Water batcher filling and discharging valves shall be so interlocked that the discharge valve cannot be opened before the filling valve is fully closed. An accurate mechanical device for measuring and dispensing each admixture shall be provided. Each dispenser shall be interlocked with the batching and discharging operation of the water so that each admixture is separately batched and discharged automatically in a manner to obtain uniform distribution throughout the batch in the specified mixing period. Where use of truck mixers make this requirement impracticable, the admixture dispensers shall be interlocked with the sand batcher. Admixtures will not be combined prior to introduction in water or sand. The plant shall be arranged so as to facilitate the inspection of all operations at all times. Suitable facilities shall be provided for obtaining representative samples of aggregates from each bin or compartment.

8.2.2 Scales. The weighing equipment shall conform to the applicable requirements of NBS Handbook 44, except that the accuracy shall be plus or minus 0.2 percent of scale capacity. The Contractor shall provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring devices. The tests shall be made at the frequency required in paragraph: SCALES and in the presence of a Government inspector.

8.2.3 Batching Tolerances.

8.2.3.1 Weighing Tolerances. Whichever of the following tolerances is greater shall apply, based on required scale reading.

<u>Material</u>	<u>Percent of Required Weight</u>	<u>Percent of Scale Capacity</u>
Cementitious Materials	± 1	± 0.3
Aggregate	± 2	± 0.3
Water	± 1	± 0.3
Admixture	± 3	± 0.3

8.2.3.2 Volumetric Tolerances. For volumetric batching equipment the following tolerances shall apply to the required volume of material being batched:

Water: Plus or minus 1 percent.

Admixtures: Plus or minus 3 percent.

8.2.4 Moisture Control. The plant shall be capable of ready adjustment to compensate for the varying moisture contents of the aggregates, and to change the weights of the materials being batched. An electric moisture meter complying with the provisions of CRD-C 143 shall be provided for measuring of moisture in the fine aggregate. The sensing element shall be arranged so that measurement is made near the batcher charging gate of the sand bin or in the sand batcher.

8.3 Mixers.

8.3.1 General. The mixers shall not be charged in excess of the capacity recommended by the manufacturer. The mixers shall be operated at the drum or mixing blade speed designated by the manufacturer. The mixers shall be maintained in satisfactory operating condition, and the mixer drums shall be kept free of hardened concrete. Should any mixer at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired.

8.3.2 Concrete Plant Mixers shall be tilting, non-tilting, horizontal shaft or vertical-shaft type and shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixing time and uniformity shall conform to all the paragraphs in ASTM C 94 applicable to central-mixed concrete.

8.3.3 Truck Mixers. Truck mixers, the mixing of concrete therein, and concrete uniformity, shall conform to the requirements of ASTM C 94. A truck mixer may be used either for complete mixing (transit-mixed) or to finish the partial mixing done in a stationary mixer (shrink-mixed). Each truck shall be equipped with two counters from which it will be possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed.

9. CONVEYING EQUIPMENT.

9.1 General. Concrete shall be conveyed from mixer to forms as rapidly as practicable and within the time interval in paragraph: *five* TIME INTERVAL BETWEEN MIXING AND PLACING by methods which will prevent segregation or loss of ingredients. Any concrete transferred from one conveying device to another shall be passed through a hopper which is conical in shape and shall not be dropped vertically more than ~~eight~~ feet, except where suitable equipment is provided to prevent segregation and where specifically authorized. Telephonic or other satisfactory means of rapid communication between the mixing plant and the forms in which concrete is being placed shall be provided and available for use by Government inspectors.

9.2 Buckets. The interior hopper slope shall be not less than 50 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least 5 times the nominal maximum size aggregate and the area of the gate opening shall be not less than two-square feet. The maximum dimension of the gate opening shall not be greater than twice the minimum dimension. The bucket gates shall be essentially grout tight when closed and may be manually, pneumatically or hydraulically operated except for buckets larger than 2 cubic yards shall not be manually operated. The design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

9.3 Transfer Hoppers. Concrete may be charged into non-agitating hoppers for transfer to other conveying devices. Transfer hoppers shall be capable of receiving concrete directly from delivery vehicles, and have conical-shaped discharge features. The machine shall be equipped with a hydraulically-operated gate and with a means of external vibration to effect complete and facile discharge. Concrete shall not be held in non-agitating transfer hoppers more than 30 minutes.

9.4 Trucks. Truck mixers operating at agitating speed or truck agitators used for transporting plant-mixed concrete shall conform to the requirements of ASTM C 94. Non-agitating equipment may be used for transporting plant mixed concrete over a smooth road when hauling time is less than 15 minutes. Bodies of non-agitating equipment shall be smooth, watertight, metal containers equipped with gates that will permit the discharge of the concrete.

9.5 Chutes. When concrete can be placed directly from a truck mixer, agitator or non-agitating equipment, the chutes attached to this equipment may be used. A discharge deflector shall be used when required by the Contracting Officer. Separate chutes and other similar equipment will not be permitted for conveying concrete except when specifically approved.

9.6 Belt Conveyors. Belt conveyors may be used when approved. Such conveyors shall be designed and operated to assure uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means for preventing segregation of the concrete at the transfer points and the point of placing. Belt conveyors shall meet the additional requirements as follows: The idler spacing shall not exceed 36 inches. If concrete is to be placed through installed horizontal or sloping reinforcing bars the conveyor will discharge concrete into a pipe or elephant trunk which is long enough to extend through the reinforcing bars. In no case will concrete be discharged to free fall through the reinforcing bars.

9.7 Pump Placement. Concrete may be conveyed by positive displacement pump when approved. Invert and side slope concrete will not be pumped. The pumping equipment shall be piston or squeeze pressure type. The pipeline shall be rigid steel pipe or heavy duty flexible hose. The inside diameter of the pipe shall be at least three times the nominal maximum size coarse aggregate in the concrete mixture to be pumped but not less than 4 inches. The maximum size coarse aggregate will not be reduced to accommodate the pumps. The distance to be pumped shall not exceed limits recommended by the pump manufacturer. The concrete shall be supplied to the concrete pump continuously. When pumping is completed, concrete remaining in the pipeline shall be ejected without contamination of concrete in place. After each operation, equipment shall be thoroughly cleaned, and flushing water shall be wasted outside of the forms.

10. PREPARATION FOR PLACING.

10.1 Embedded Items. Before placing concrete, care shall be taken to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings, or required. Embedded items shall be free of oil and other foreign matter such as loose coatings or rust, paint and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Voids in sleeves, inserts and anchor slots shall be filled temporarily with readily removable materials to prevent the entry of concrete into voids.

10.2 Concrete on Earth Foundations. Earth surfaces upon which concrete is to be placed shall be clean, damp, and free from frost, ice, and standing or running water. Prior to placing concrete, the earth foundation shall have been satisfactorily compacted in accordance with the requirements of the SECTION: FILLS AND SUBGRADE PREPARATION. Additionally, the foundation shall be inspected by the Contractor prior to concrete placement in order to certify that it is ready to receive concrete. The results of each inspection shall be submitted in writing.

10.3 Concrete on Rock Foundations. Rock surfaces upon which concrete is to be placed shall be clean, free from oil, standing or running water, ice, mud, drummy rock, coatings, debris and loose, semi-detached or unsound fragments. Faults or seams shall be cleaned to a satisfactory depth and to firm rock on the sides. Immediately before concrete is placed, all rock surfaces shall be cleaned thoroughly by the use of air-water jets, sandblasting or other approved methods. All rock surfaces shall be kept continuously wet for at least 24 hours immediately prior to placing concrete thereon. All approximately horizontal surfaces shall be covered, immediately before the concrete is placed, with a layer of mortar approximately similar to that in the concrete mixture.

10.4 Construction Joint Treatment.

10.4.1 General. Concrete surfaces to which other concrete is to be bonded shall be prepared for receiving the next lift or adjacent concrete by cleaning with either air-water cutting, sandblasting, high pressure water jet, or other approved method.

10.4.2 Cleaning.

10.4.2.1 Air-Water Cutting. Air-water cutting of a construction joint shall be performed at the proper time and only on horizontal construction joints. The surface shall be cut with an air-water jet to remove all laitance and to expose clean, sound fine aggregate, but not so as to undercut the edges of the larger particles of aggregate. The air pressure used in the jet shall be 100 psi/or minus 10 psi and the water pressure shall be just sufficient to bring the water into effective influence of the air pressure. After cutting, the surface shall be washed and rinsed as long as there is any trace of cloudiness of the wash water. The surface shall again be washed just prior to placing the succeeding lift. Where necessary to remove accumulated laitance, coatings, stains, debris, and other foreign material, sandblasting will be required as the last operation before placing the next lift.

10.4.2.2 High-Pressure Water Jet. A stream of water under a pressure of not less than 3000 psi may be used for cleaning. Its use shall be delayed until the concrete is sufficiently hard so that only the surface skin or mortar is removed and there is no undercutting of coarse aggregate particles where the cleaning occurs more than two days prior to placing the next lift or where work in the area subsequent to the cleaning causes dirt or debris to be deposited on the surface, the surface shall be cleaned again as the last operation prior to placing the next lift. If the water jet is incapable of a satisfactory cleaning, the surface shall be cleaned by sandblasting.

10.4.2.3 Sandblasting. When employed in the preparation of construction joints, sandblasting shall be performed as the final operation completed before placing the following lift. The operation shall be continued until all accumulated laitance, coatings, stains, debris, and other foreign materials are removed. The surface of the concrete shall then be washed thoroughly to remove all loose materials. The surface shall again be washed just prior to placing the succeeding lift.

10.4.2.4 Waste Disposal. The method used in disposing of waste water employed in cutting, washing and rinsing of concrete surfaces shall be such that the waste water does not stain, discolor, or affect exposed surfaces of the structures, or

damage the environment of the project area. Method of disposal shall be subject to approval.

11. PLACING. ⁵

11.1 General. Concrete placement will not be permitted when, in the opinion of the Contracting Officer, weather conditions prevent proper placement and consolidation. Concrete shall be deposited as close as possible to its final position in the forms, and in so depositing there shall be no vertical drop greater than 6 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it may be effectively consolidated in horizontal layers 1-1/2 feet or less in thickness with a minimum of lateral movement. The amount deposited in each location shall be that which can be readily and thoroughly consolidated. The surfaces of construction joints shall be kept continuously wet for the first twelve hours during the twenty-four hour period prior to placing concrete. Free water shall be removed prior to placement of concrete. Sufficient placing capacity shall be provided so that concrete placement can be kept plastic and free of cold joints while concrete is being placed.

11.2 Time Interval Between Mixing and Placing. Concrete shall be placed within thirty minutes after discharge into non-agitating equipment. When concrete is truck mixed or when a truck mixer or agitator is used for transporting concrete mixed by a concrete plant mixer, the concrete shall be delivered to the site of the work and discharge shall be completed within 1-1/2 hours after introduction of the cement to the aggregates. When the length of haul makes it impossible to deliver truck mixed concrete within these time limits, batching of cement and a portion of the mixing water shall be delayed until the truck mixer is at or near the construction site. Not more than 80 percent of the water and all other materials except cement shall be batched at the distant batch plant and transported to the cement batcher without mixing.

11.3 Cold-Weather Placing. Concrete shall not be placed without a procedure approved in accordance with paragraph: COLD WEATHER REQUIREMENTS when the concrete is likely to be subjected to freezing temperatures before the expiration of the curing period. The ambient temperature of the space adjacent to the concrete placement and surfaces to receive concrete shall be above 32 degrees F. The placing temperature of the concrete having a minimum dimension less than 12 inches shall be between 60 degrees F and 75 degrees F. The placing temperature of the concrete having a minimum dimension greater than 12 inches shall be between 50 degrees and 75 degrees F. Heating of the mixing water or aggregates will be required to regulate the concrete placing temperatures. Materials entering the mixer shall be free from ice, snow or frozen lumps. Salt, chemicals or other materials shall not be mixed with the concrete to prevent freezing, except that a chemical accelerator may be used.

SUBMITTALS

11.4 Hot-Weather Placing. Concrete shall be properly placed and finished with approved procedures in accordance with paragraph: ~~5-3.8~~ The concrete placing temperature shall not exceed 85 degrees F. Cooling of the mixing water and/or aggregates will be required to obtain an adequate placing temperature. An approved retarder may be used to facilitate placing and finishing. Steel forms and reinforcement shall be cooled prior to concrete placement when steel temperatures are greater than 120 degrees F. Conveying and placing equipment shall be cooled if necessary to maintain proper concrete placing temperature.

11.5 Consolidation. Immediately after placing, each layer of concrete shall be consolidated by internal vibrating equipment. Vibrators will not be used to transport concrete within the forms. Hand spading may be required if necessary with internal vibrating along formed surfaces permanently exposed to view. Form or surface vibrators shall not be used. Consolidation will proceed independently of all other placing operations. Vibrators for consolidation will not be attached to Bidwell Type or any other screening or leveling equipment selected by the Contractor. Vibrators of the proper size, frequency and amplitude shall be used for the type of work being performed in conformance with the following requirements:

<u>Application</u>	<u>Head Diameter (inches)</u>	<u>Frequency VPM</u>	<u>Amplitude (inches)</u>
Thin walls, beams, etc.	1-1/4 - 2-1/2	9000 - 13500	0.02 - 0.04
General construction	2 - 3-1/2	8000 - 12000	0.025 - 0.05

The frequency and amplitude shall be within the range indicated in the table above as determined in accordance with paragraph: VIBRATORS. The vibrator shall be inserted vertically at uniform spacing over the entire area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding layer if such exists. It shall be held stationary until the concrete is consolidated and then withdrawn slowly. Spare vibrators and a standby power source shall be available at all times during concrete placement. Spare vibrators and a standby power source shall be available at all times during concrete placement.

12. FINISHING.

12.1 Unformed Surfaces.

12.1.1 General. The ambient temperature of spaces adjacent to surfaces being finished shall not be less than 50 degrees F. In hot weather when the rate of evaporation of surface moisture, as determined by use of Figure 2.1.5 of ACI 305, may reasonably be expected to exceed 0.2 pounds per square feet per hour, provision for windbreaks, shading, fog spraying, or wet covering with a light colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as finishing operations will allow.

12.1.2 General. The ambient temperature of spaces adjacent to surfaces being finished shall be not less than 50 degrees F. All unformed surfaces that are not to be covered by additional concrete or backfill shall have a float finish, unless a steel trowel finish is specified, and shall be true to the elevation shown on the drawings. Surfaces to receive additional concrete or backfill shall be brought to elevation shown on the drawings and left true and regular. Exterior surfaces shall be sloped for drainage unless otherwise shown on the drawing or as directed. Joints shall be carefully made with a jointing or edging tool. The finished surfaces shall be protected from stains or abrasions.

12.1.3 Float Finish. A float finish shall be applied to channel invert, ~~and side slopes.~~ Surfaces shall be screeded and darbied or bull-floated to bring the surface to the required finish level with no coarse aggregate visible. No cement or mortar shall be added to the surface during the finishing operation. The

concrete, while still green but sufficiently hardened to bear a man's weight without deep imprint, shall be floated to a true and even plane. Floating may be performed by use of suitable hand floats or power driven equipment. Hand floats shall be made of magnesium or aluminum. Tolerance for a floated finish shall be true plane within 5/16-inch in ten feet as determined by a 10-foot straight edge placed anywhere on the slab in any direction.

12.1.4 Trowel Finish. A steel trowel finish shall be applied to the following surfaces: spillways, tops of channel walls, and as indicated on the drawings. Concrete surfaces shall be finished with a float finish and after surface moisture has disappeared, the surface shall be steel-troweled to a smooth, even, dense finish free from blemishes including trowel marks. Tolerance shall be true planes within 5/16-inch in ten feet as determined by a 10-foot straightedge placed anywhere on the slab in any direction.

12.1.5 Broom Finish shall be applied to the surface indicated on the drawings. The concrete surface shall be finished with a float finish and trowel finish. The troweled surface shall be broomed with a fiber-bristle brush in a direction transverse to that of the main traffic. *of all bridges and to the surface*

12.2. Formed Surfaces. After form removal, all fins and loose materials shall be removed. All voids, and honeycombs exceeding 1/2 inch in diameter and all tie rod holes permanently exposed to view shall be reamed or chipped and filled with dry pack mortar. Defective areas larger than 36 square inches in any surface, permanently exposed or not shall be delineated in a rectangular shape by a saw cut a minimum depth of one-inch and repaired with concrete replacement. The cement used in the mortar or concrete for all surfaces permanently exposed to view shall be a blend of portland cement, white cement, and coloring agent properly proportioned so that the final color when cured will be the same as adjacent concrete. Temperature of the concrete, ambient air, replacement concrete or mortar during remedial work including curing shall be above 50 degrees F. The prepared area shall be dampened, brush-coated with a neat cement grout or with an approved epoxy resin, and filled with mortar or concrete. The mortar shall consist of 1 part cement to 2-1/2 parts fine aggregate. The quantity of mixing water shall be the minimum necessary to obtain a uniform mixture and permit placing. Mortar shall be thoroughly compacted in place and struck off to adjacent concrete. Replacement concrete shall be drier than the usual mixture and thoroughly tamped into place and finished. Forms shall be used if required. Metal tools shall not be used to finish permanently exposed surfaces. The patched areas shall be cured for 7 days.

12.2.1 General. Surfaces, unless other type of finish is specified, shall be left with the texture imparted by the forms except defective surfaces shall be repaired as described above. Unless painting of surfaces is required, uniform color shall be maintained by use of only one mixture without changes in materials or proportions for any structure or portion of structure which is exposed to view or on which a special finish is required. The form panels used to produce the finish shall be orderly in arrangement, with joints between panels planned in approved relation to openings, building corners and other architectural features. Forms shall not be reused if there is any evidence of surface wear or defects which would impair the quality of the surface.

12.2.2 Textured Finish. This type of finish shall be applied where specified to conform to details shown on the drawings by use of approved textured form liners. Liner panels shall be secured in the forms by cementing or stapling, but

not by methods which will permit impressions or nail heads, screw heads, washers or the like to be imparted to the surface of the concrete. Edges of textured panels shall be sealed to each other to prevent grout leakage. The sealant used shall be non-staining to the surface.

13. CURING AND PROTECTION.

13.1 General. All concrete shall be cured by an approved method for a period of 7 days. Immediately after placement, concrete shall be protected from premature drying, extremes in temperatures, rapid temperature change, and mechanical injury. All materials and equipment needed for adequate curing and protection shall be available and at the placement site prior to start of concrete placement. Concrete shall be protected from the damaging effects of rain for 12 hours, flowing water for 14 days (7 days with type III cement). Concrete shall be shielded from direct rays of the sun for 3 days. No vehicular traffic shall be allowed on invert or footing concrete until a period of 28 days have passed or until the concrete has reached the specified design strength. The strength of the slabs shall be determined by a pair of cylinder breaks performed by the Contractor at the desired age. No fire or excessive heat shall be permitted near or in direct contact with concrete at any time. Concrete will be cured in accordance with the following requirements.

Curing Requirements

<u>Structural Element</u>	<u>Method</u>
Invert and Footings	Moist Cure or Sheet Cure
Side Slopes	Moist Cure or Sheet Cure
Vertical Walls and Other Elements	Any method described below

13.2 Moist Curing. Concrete moist-cured shall be maintained continuously (not periodically) wet for the entire curing period. If water or curing materials stain or discolor concrete surfaces which are to be permanently exposed, they shall be cleaned as required in paragraph: APPEARANCE. When wooden form sheathing is left in place during curing, the sheathing shall be kept wet at all times. Horizontal surfaces shall be cured by ponding, by covering with a minimum uniform thickness of 2 inches continuously saturated sand, or by covering with saturated non-staining burlap or cotton mats. Horizontal construction joints may be allowed to dry for twelve hours immediately prior to placing of the following lift.

13.3 Membrane Curing. Concrete may be cured with an approved curing compound in lieu of moist curing except that membrane curing will not be permitted on any surface to which sack rubbed finish is to be applied, or any surface containing protruding steel reinforcement, or on abrasive aggregate finish.

13.3.1 ^{WHITE} A Pigmented Type Curing Compound conforming to CRD-C 300 may be used on surfaces which will not be exposed to view when the project is completed, or on surfaces that are to be painted.

13.3.2 The Curing Compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. The surfaces

shall be thoroughly moistened with water and the curing compound applied as soon as free water disappears. The curing compound shall be applied to unformed surfaces as soon as free water has disappeared. The curing compound shall be in a 2-coat continuous operation, having the applications at right angles to each other, and applied by approved motorized power-spraying equipment and at a uniform coverage of not more than 400 square feet per gallon for each coat. Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage herein specified. All concrete surfaces on which the curing compound has been applied shall be adequately protected for the duration of the entire curing period from pedestrian and vehicular traffic and from any other cause which will disrupt the continuity of the curing membrane.

13.3.3 - See following page

13.4 Impervious-Sheet Curing. The following concrete surfaces may be cured using impervious sheets: channel invert or side slopes. All surfaces shall be thoroughly wetted and be completely covered with waterproof paper, polyethylene film or with polyethylene-coated burlap having the burlap thoroughly water-saturated before placing. Covering shall be laid with light colored side up. Covering shall be lapped not less than 12 inches and securely weighted down or shall be lapped not less than 4 inches and taped to form a continuous cover with completely closed joints. The sheet shall be weighted to prevent displacement so that it remains in contact with the concrete during the specified length of curing. Coverings shall be folded down over exposed edges of slabs and secured by approved means. Sheets shall be immediately repaired or replaced if tears or holes appears during the curing period.

13.5 Cold Weather. When the daily outdoor low temperature is less than 32 degrees F, the temperature of the concrete shall be maintained above 40 degrees F for at least the first three days and above 40 degrees F for the remainder of the required curing period. In addition, during the period of protection removal, the air temperature adjacent to the concrete surfaces shall be controlled so that concrete near the surface will not be subjected to a temperature differential of more than 25 degrees F as determined by observation of ambient and concrete temperatures. Curing compounds shall not be used on concrete surfaces which are maintained at curing temperature by use of free steam.

14. SETTING OF BASE PLATES AND BEARING PLATES.

14.1 General. After being plumbed and properly positioned, column base plates, shall be provided with full bearing with damp-pack bedding mortar except where non-shrink grout is approved or required. The space between the top of concrete or masonry bearing surface and the bottom of the plate shall be approximately 1/24 of the width of the plate, but not less than 1/2 inch for plates less than 12 inches wide. Concrete surfaces shall be rough, clean, free of oil, grease, and laitance, and shall be damp. Metal surfaces shall be clean and free of oil, grease, and rust.

14.2 Damp-pack bedding mortar shall consist of 1 part Type I portland cement and 2-1/2 parts of fine aggregate conforming to ASTM C 33, proportioned by weight, and not more than 4-1/2 gallons of water per bag of cement. The space between the top of the concrete or masonry bearing surface and the bottom of the plate shall be packed with the bedding mortar by tamping or ramming with a bar or rod until the voids are completely filled. Mortar shall be colored to match adjacent concretes.

INSERT PARAGRAPH 13.3.3

13.3.3 A TINTED CURING COMPOUND CONFORMING TO THE REQUIREMENTS OF PARAGRAPH: MATERIAL MAY BE USED ON ALL SURFACES EXPOSED TO VIEW, EXCEPT THOSE TO WHICH A MOIST OR SHEET CURE MUST BE APPLIED.

14.3 Non-shrink grout shall conform to the requirement of paragraphs: NON-SHRINK GROUT. For clearance of two inches or more, the mix shall include by weight 1-1/2 parts of sound, clean uncrushed gravel conforming to size No. 8, table 2 ASTM C 33 in combination with fine aggregate conforming to ASTM C 33, to one part portland cement unless otherwise recommended by the material manufacturer. Water content shall be the minimum that will provide a flowable mixture and completely fill the space to be grouted without segregation, bleeding, or reduction of strength. Non-shrink grout exposed to view shall be colored to match adjacent concrete.

14.3.1 Mixing and placing shall be in conformance with the material manufacturer's instructions and as specified therein. Ingredients shall be thoroughly dry-mixed before adding water. After adding water, the batch shall be mixed for 3 minutes. Batches shall be of size to allow continuous placement of freshly mixed grout. Grout not used within 30 minutes after mixing shall be discarded. The space between the top of the concrete or masonry bearing surface and the plate shall be filled solid with the grout. Forms shall be of wood or other equally suitable material for retaining the grout and shall be removed after the grout has set. The placed grout shall be worked to eliminate voids; however, overworking and breakdown of the initial set shall be avoided. Grout shall not be retempered or subjected to vibration from any source. Where clearances are unusually small, placement shall be under pressure with a grout pump. Temperature of the grout, and of surfaces receiving the grout, shall be maintained at 65 degrees to 85 degrees F. until after setting.

14.3.2 Treatment of Exposed Surfaces. Those types containing metallic aggregate shall have, after the grout has set, the exposed surfaces cut back one-inch and immediately covered with a parge coat of mortar proportioned by weight one part portland cement, two parts sand, and sufficient water to make the mixture placeable. The parge coat shall have a smooth, dense finish. The exposed surface of other types of non-shrink grout shall have a smooth, dense finish.

14.3.3 Curing. Grout and parge coats shall be cured in conformance with paragraph: CURING AND PROTECTION.

15. CONTRACTOR QUALITY CONTROL.

15.1 General. The Contractor shall perform the inspection and tests Described in paragraph 15.2, and based upon the results of these inspections and tests he shall take the action required in paragraph 15.3 and submit reports as required in paragraphs 15.3 and 15.4. The laboratory performing the tests shall conform to ASTM E 329. The individuals who sample and test concrete or the constituents of concrete as required in this specification shall have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of concrete Field Testing Technicians, Grade I.

15.2 Inspection Details and Frequency of Testing.

15.2.1 Fine Aggregate.

15.2.1.1 Grading. At least once during each shift in which concrete is being delivered, there shall be one sieve analysis and fineness modulus determination in accordance with ASTM C 136 and CRD-C 104, respectively, for the fine aggregate or for each fine aggregate, if it is batched in more than one size or classification.

The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits.

15.2.1.2 Moisture Content. There shall be when in the opinion of the Contracting Officer the electric moisture meter is not operating satisfactorily at least four tests for moisture content in accordance with either ASTM C 70, C 566, or CRD-C 112 during each 8-hour period of mixing plant operation. The times for the tests shall be selected randomly within the 8-hour period. An additional test shall be made whenever the slump is shown to be out of control or excessive variation in workability is reported by the placing foreman. When the electric moisture meter is operating satisfactorily, at least two direct measurements of moisture content shall be made per week to check the calibration of the meter.

15.2.2 Coarse Aggregate.

15.2.2.1 Grading. At least once during each shift concrete is being delivered, there shall be a sieve analysis in accordance with ASTM C 136 for each size group of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor is responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken shall show the results of the 5 most recent tests including the current test. The Contractor may adopt limits for control coarser than the specification limits for samples taken other than at the batch plant bins to allow for degradation during handling.

15.2.2.2 Moisture Content. A test for moisture content of each size of coarse aggregate in accordance with ASTM C 566 or CRD-C 112 shall be made at least once a shift. When two consecutive readings for smallest size coarse aggregate differ by more than 1.0 percent, frequency of testing shall be increased to that specified for fine aggregate in paragraph: GRADING. These results shall be used to adjust the added water in the control of the batch plant.

15.2.3 Deleterious Substances. When in the opinion of the Contracting Officer, a problem exists in connection with deleterious substances in fine or coarse aggregates, tests shall be made in accordance with ASTM C 33. Testing frequency shall be not less than one per week.

15.2.4 Scales.

15.2.4.1 Weighing Accuracy. The accuracy of the scales shall be checked by test weights at least once a month for conformance with the applicable requirement of paragraph: SCALES. Such tests shall also be made whenever there are variations in properties of the fresh concrete which could result from batching errors.

15.2.4.2 Batching and Recording Accuracy. Once a week the accuracy of each batching and recording device shall be checked during a weighing operation by noting and recording the required weight, recorded weight and the actual weight batched. The contractor shall provide the necessary calibration devices and confirm that the admixture dispensers described in paragraph: EQUIPMENT are operating properly.

15.2.5 Batch-Plant Control. When the concrete plant is operating the measurement of all constituent materials including cement, pozzolan, each size of aggregate, water and admixtures shall be continuously controlled. The aggregate weights and

amount of added water to compensate for free moisture in the aggregates shall be adjusted as necessary. The amount of air-entraining admixture shall be adjusted to control air content within specified limits. A report shall be prepared indicating type and source of cement used, type and source of pozzolan used, amount and source of admixtures used, aggregate source, the required aggregate and water weights per cubic yard, amount of water as free moisture in each size of aggregate, and the batched aggregate and water weights per cubic yard for each class of concrete batched during plant operation.

15.2.6 Concrete.

15.2.6.1 Air Content. At least two tests for air content shall be made on randomly selected batches of each class of concrete during each 8-hour period of concrete production. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Tests shall be made in accordance with ASTM C 231. The average of each set of two tests shall be plotted on a control chart on which the average is set at the percentage specified by the Contractor on his mix design submittal and the upper and lower control limits shall be $\pm 1\frac{1}{2}$ percent of the specified air content respectively. The range shall be plotted on a control chart on which the upper control limit is 2.0 percent.

15.2.6.2 Slump. At least two slump tests shall be made on randomly selected batches of each mixture of concrete during each day's concrete production in accordance with ASTM C 143. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. The average of each set of two tests shall be plotted on a control chart. The range shall be plotted on a control chart on which the upper control limit is 3.0 inches.

15.2.6.3 Batch Tickets. The manufacturer of the concrete shall furnish to the Contracting Officer's Representative with each batch of concrete, before unloading at the site, a delivery ticket prepared in accordance with the requirements of ASTM C-94.

15.2.7 Preparation for Placing. Foundation or construction joints, forms and embedded items shall be inspected in sufficient time prior to each concrete placement by the Contractor in order to certify to the Contracting Officer it is ready to receive concrete. The results of each inspection shall be reported in writing no less than 2 hours prior to placement of by 4:00 PM for placements prior to 9:00 AM the following day.

15.2.8 Placing. The placing foreman shall supervise all placing operations, shall determine that the correct quality of concrete or grout is placed in each location as directed by the Contracting Officer and shall be responsible for measuring and recording concrete temperatures, ambient temperature, weather conditions, time of placement, yardage placed, and method of placement.

15.2.9 Vibrators. The frequency and amplitude of each vibrator shall be determined in accordance with CRD-C 521 prior to initial use and at least once a month when concrete is being placed. Additional tests shall be made when a vibrator does not appear to be adequately consolidating the concrete. The frequency shall be determined while the vibrator is operating in concrete holding the tachometer against the upper end of the vibrator while almost submerged and

just before the vibrator is withdrawn from the concrete. The amplitude shall be determined with the head vibrating in air. Two measurements shall be taken, one near the tip and another near the upper end of the vibrator head, and these results averaged. The make, model, type and size of the vibrator and frequency and amplitude results shall be reported in writing.

15.2.10 Curing.

15.2.10.1 Moist Curing. At least once every 8 hours an inspection shall be made of all areas subject to moist curing. The surface moisture condition shall be noted and recorded.

15.2.10.2 Curing Compound. No curing compound shall be applied until it has been verified that the compound is properly mixed and ready for spraying. At the end of each operation the quantity of compound used and the area of concrete surface covered shall be reported and the rate of coverage in square feet per gallon shall be computed. The report shall state whether coverage is uniform.

15.2.10.3 Impervious Sheet Curing. At least once each shift an inspection shall be made of all areas being cured using impervious sheets. The condition of the covering and the tightness of the laps and tapes shall be noted and recorded.

15.2.11 Protection. At least once each shift an inspection shall be made of all areas subject to cold weather protection. Deficiencies shall be noted. During removal of protection, measurement of concrete and ambient temperature shall be made at least hourly.

15.2.12 Mixer Uniformity.

15.2.12.1 Concrete Plant Mixer. At the start of concrete placing, and at least once every six months when concrete is being placed, uniformity of concrete shall be determined. The tests shall be performed in accordance with ASTM C 94. Whenever adjustments in mixer or increased mixing times are necessary because of failure of any mixer to comply, the mixer shall be retested after adjustment. Results of tests shall be reported in writing.

15.2.12.2 Truck Mixers. At the start of concrete placing and at least once every three months when concrete is being placed, uniformity of concrete shall be determined in accordance with ASTM C 94. The truck mixers shall be selected randomly for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of blades may be regarded as satisfactory. Results of tests shall be reported in writing.

15.3 Action Required.

15.3.1 Fine Aggregate.

15.3.1.1 Grading. When the amount passing any sieve is outside the specification limits, the fine aggregate shall immediately be resampled and retested. If there is another failure on any sieve, the fact shall immediately be reported to the Contracting Officer, and immediate steps shall be taken to rectify the situation.

15.3.1.2 Moisture. Whenever the moisture content of the fine aggregate changes by 0.5 percent or more, the scale settings for the fine aggregate batcher and

water batcher shall be adjusted directly or by means of a moisture compensation device.

15.3.2 Coarse Aggregate.

15.3.2.1 Grading. When the amount passing any sieve is outside the specification limits, the coarse aggregate shall immediately be resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the Contracting Officer. When two consecutive averages of 5 test are outside of specification limits, that fact shall be reported to the Contracting Officer and immediate steps shall be taken to correct the grading.

15.3.3 Deleterious Substances. When the results for a deleterious substance is outside the specification limit, the aggregate shall be resampled and retested for the deleterious substance that failed. If the second sample fails, that fact shall be reported to the Contracting Officer. When material finer than No. 200 sieve for coarse aggregate exceeds the specification limit, immediate steps, such as washing or other corrective actions, shall be initiated.

15.3.4 Scales. Whenever either the weighing accuracy or batching accuracy is found not to comply with specification requirements, the plant shall not be operated until necessary adjustments or repairs have been made. Discrepancies in recording accuracies shall be corrected immediately.

15.3.5 Concrete.

15.3.5.1 Air Content. Whenever points on the control chart approach the upper or lower control limits an adjustment should be made in the amount of air-entraining admixture batched. If a single test result is outside the specification limit such adjustment is mandatory. As soon as practical after each adjustment another test shall be made to verify the correctness of the adjustment. Whenever a point fails above the upper control limit for range, the dispenser shall be calibrated to insure that it is operating correctly and with good reproducibility. Whenever two consecutive points either for average or range are outside the control limits, the Contracting Officer shall be notified. Whenever the air content departs from the specified range, the concrete shall not be delivered to the forms.

15.3.5.2 Slump. Whenever points on the control chart approach the upper or lower control limits an adjustment should be made in the batch weights of water and fine aggregate. The adjustments are to be made so that the total free water does not exceed that amount specified in the approved mixture proportions based on the free water available with the fine aggregate and that amount of water batched. If the adjustments to the batch weights or water and fine aggregate do not satisfactorily produce the required slump the mixture shall be re-proportioned to meet the specified criteria and re-submitted to the contracting officer for approval. When a single slump is outside the control limits such adjustment is mandatory. As soon as practical after each adjustment another test shall be made to verify the correctness of the adjustment. Whenever the slump exceeds the upper limit stipulated in paragraph 7.4 the concrete shall not be delivered to the forms. Whenever two consecutive slump tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range above the upper control limit, the slump shall be considered to be out of control and the additional testing for aggregate moisture content required in paragraph 15.2 shall be undertaken.

15.3.5.3 Test Panel. The Contractor shall place a test panel for each colored concrete specified with a minimum dimension of 6 feet by 6 feet by 6 inches thick. The test panel shall be placed in the presence of the Contracting Officer, and the mix design shall conform in all respects to the mix proposed for use in the project. The Contractor shall also overlay on an area of the test panel not less than 12 inches square a dry-pack mortar sample using the same mix intended for use in setting of base plates for concrete fence posts. The concrete and mortar shall be finished, protected, and cured adjacent to the site of proposed construction using methods proposed for use by the Contractor on the features of the project which shall receive colored concrete. Only one half of the panel area will be cured with curing compound. The remaining portion will not be cured. The test panel shall not be protected from the effects of the sun while curing. Color comparisons as a basis for acceptance of color shall not be made in less than 14 days after placement of concrete for the test panel. Wetting of the concrete shall not be permitted within a period of 7 days prior to making color comparisons. No concrete shall be scheduled for placement within 30 days of construction of the test panel, and no concrete shall be placed prior to demonstrated compliance with the color requirements of these specifications. When, in the opinion of the Contracting Officer, the test panel do not conform to color requirements herein, the Contractor shall continue place additional test panel at no additional cost to the Government until a final mix design has been developed that produces concrete conforming to color requirements herein. Approval of test panel color and mix design shall not relieve the Contractor from the requirements of these specifications. The Contractor shall not remove the test panel until concrete work is complete. At completion of concrete work, the test panel shall be considered to be scrap materials and disposed of in accordance with SECTION: GENERAL REQUIREMENTS. Additionally, test panels will be constructed to document the quality of the color of the tinted curing compound. The test panel will be constructed of any of the proposed colored concrete mixes to be supplied by the Contractor. The curing compound will be applied to the panels in conformance with the paragraph: CURING AND PROTECTION. After a period of 3 days, the color of the exposed concrete surfaces will be evaluated to assure that the color of the curing compound as applied to the concrete conforms to the requirements of the paragraph: COLOR.

15.3.6 Placing. The placing foreman shall not permit placing to begin until he has verified that an adequate number of acceptable vibrators in working order and with competent operators are available. Placing shall not be continued if any pile is inadequately consolidated. If any batch of concrete fails to meet the temperature requirements, immediate steps shall be taken to improve temperature controls.

15.3.7 Curing.

15.3.7.1 Moist Curing. When a daily inspection report lists an area of inadequate curing, the required curing period for that area shall be extended by one day.

15.3.7.2 Curing Compound. When the coverage rate of curing compound is less than that specified or when the coverage is not uniform, the entire surface shall be sprayed again.

15.3.7.3 Impervious Sheet Curing. When a daily inspection report lists any tears, holes or laps of joints that are not completely closed, the tears and holes

shall promptly be repaired or the sheets replaced, the joints closed, and the required curing period for those areas shall be extended by one day.

15.3.8 Protection. When any concrete temperature during the period of protection or protection removal fails to comply with the specifications, that fact shall be reported to the Contracting Officer and immediate steps should be taken to correct the situation.

15.3.9 Mixer Uniformity. When a mixer fails to meet mixer uniformity requirements, either the mixing time shall be increased or adjustments shall be made to the mixer until compliance is achieved.

15.4 Reports. All results of tests conducted at the project site shall be reported as required. Each report shall include the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold weather protection, reports of pertinent temperatures shall be made daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all Contractor quality control records.

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SECTION 3F

SHOTCRETE

Index

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|------------------------------|------------------------------|
| 1. Reference Standards | 7. Preparation of Surfaces |
| 2. Quality Assurance | 8. Placement of Shotcrete |
| 3. Evaluation and Acceptance | 9. Repair of Surface Defects |
| 4. Submittals | 10. Finishing |
| 5. Materials | 11. Curing and Protection |
| 6. Production of Shotcrete | 12. Construction Joints |

1. REFERENCE STANDARDS.

1.1 American Society for Testing and Materials (ASTM) with Corresponding U.S. Army Corps of Engineers Handbook for Cement and Concrete (CRD) Standard Indicated Where Available.

C 33-86 (CRD-C 133)	Concrete Aggregates
C 42-84a (CRD-C 27)	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
C 94-86b (CRD-C 31)	Ready-Mixed Concrete
C 150-85a (CRD-C 201)	Portland Cement
C 171-69 (R 1986) (CRD-C 310)	Sheet Materials for Curing Concrete
C 260-86 (CRD-C 13)	Air-Entraining Admixtures for Concrete
C 266-86 (CRD-C 223)	Time of Setting
C 494-86 (CRD-C 87)	Chemical Admixtures for Concrete
C 595-86 (CRD-C 203)	Blended Hydraulic Cements
C 618-85 (CRD-C 255)	Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
C 685-86 (CRD-C 98)	Volumetric Batching and Continuous Mixing

1.2 U.S. Army Corps of Engineers Handbook for Cement and Concrete (CRD).

CRD-C 400-63	Water for Use in Mixing or Curing Concrete
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CRD-C 300-77	Membrane-Forming Compounds for Curing Concrete
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1.3 See following page

INSERT PARAGRAPH 1.3

1.3 FEDERAL SPECIFICATIONS (FED. SPEC.).

SS-W-110C

WATER-REPELLANT, COLORLESS, SILICONE
RESIN BASE

2. **QUALITY ASSURANCE.** The Government will test shotcrete to determine compliance with this specification. The Contractor shall provide facilities and labor as may be necessary for obtaining representative test samples. Shotcrete will be sampled and tested by the method given in paragraph: **TEST REPORTS.**

2.1 **Test Panel.** One test panel will be made with minimum dimensions of 18 X 18 X 3 inches, gunned in the same positions as the work represented, for every 50 cubic yards of shotcrete placed, but at least one panel per shift. Panels shall be gunned during the course of the work by the Contractor's regular nozzleman. Panels shall be field cured in the same manner as in the job. Three 3 inch diameter cores will be drilled at least 40 hours prior to testing from each panel and tested in accordance with ASTM C 42.

3. **EVALUATION AND ACCEPTANCE.** The average compressive strength of three cores taken from the test panel, representing a shift or 50 cubic yards of shotcrete, tested at 28 days of age shall equal or exceed the required compressive strength specified in paragraph: **SHOTCRETE QUALITY**, with no individual core less than 90 percent of the required compressive strength. When the length of a core is less than twice the diameter, the correction factors given in ASTM C 42 will be applied to obtain the compressive strength of individual cores. Final acceptance of the shotcrete will be based on results obtained from cores.

4. **SUBMITTALS.**

4.1 **Test Reports.**

4.1.1 **Cement and Pozzolan Materials** will be accepted on the basis of a manufacturer's certificate of compliance.

4.1.2 **Aggregates** will be accepted on the basis of test reports that show the material meeting the requirements of this specification.

4.2 **Manufacturers Literature.** Literature from suppliers which demonstrates compliance with applicable specifications for curing materials, shall be supplied.

4.3 **Mixture proportions and test data** from prior experience *and so forth* if available may be submitted for approval. If test data from prior experience are not available or accepted, specimens shall be made and tested from three or more different mixture proportions in accordance with paragraph 6.4.2. The recommended mixture proportions, sources of materials, and all test results shall be submitted for acceptance. Mixture proportions shall be selected on the basis of compressive strength tests of specimens continuously moist cured until testing at 28 days. For mixture acceptance purposes, average core compressive strength shall be at least equal to 1.2 times the required compressive strength specified in paragraph: **SHOTCRETE QUALITY.**

4.4 **Preconstruction Testing.**

4.4.1 **General Requirement.** Test specimens shall be made by each application crew using the equipment, materials, mixture proportions and procedures proposed for the job.

4.4.2 Test Panel. A test panel at least 30 X 30 inches shall be made for each mixture being considered, and for each shooting position to be encountered in the job. The same reinforcement as in the structure shall be provided. The test panels shall be fabricated to the same thickness as the structure, but not less than 3 inches. At least five 3-inch diameter cores from each panel shall be taken for testing as per ASTM C 42.

4.4.3 *See following page*

~~4.5 Operator Qualifications. The names and qualifications of the nozzlemen shall be submitted for approval. Any additional nozzlemen added to the job throughout the project shall be similarly submitted for approval.~~

4.5 *See following page*

5. MATERIALS.

5.1 Cement shall conform to the requirements of the SECTION: CONCRETE.

5.2 Aggregates shall conform to ASTM C 33, with the combined gradation as shown below.

<u>Sieve Size</u>	<u>Percent by Weight Passing Individual Sieves</u>
19.0 mm (3/4 inch)	--
12.5 mm (1/2 inch)	--
9.5 mm (3/8 inch)	100
4.75 mm (No. 4)	95-100
2.36 mm (No. 8)	80-100
1.18 mm (No. 16)	50-85
600. um (No. 30)	25-60
300. um (No. 50)	10-30
150. um (No. 100)	2-10

5.3 Water. Fresh, clean and potable mixing water or nonpotable water which meets the requirements of CRD-C 400 shall be used.

5.4 Curing Materials.

5.4.1 Impervious sheet materials ASTM C 171, type optional except polyethylene film, if used, shall be white opaque.

5.4.2 Membrane - forming curing compound ASTM C 309, Type 1-D, ~~or Type 2.~~

5.5 Shotcrete Quality. The shotcrete shall be produced by either dry-mix or wet-mix process. The required compressive strength shall be 3,500 pounds per square inch at 28 days.

★ 5.6 SEALANT. SEALANT SHALL CONFORM TO THE REQUIREMENTS OF FED. SPEC. SS-W-110C.

INSERT PARAGRAPH 4.4.3

4.4.3 TEST SPECIMENS FOR ARTIFICIAL ROCK. AT LEAST THREE TEST SPECIMENS SHALL BE CONSTRUCTED AT A LOCATION DETERMINED BY THE CONTRACTING OFFICER FOR THE ARTIFICIAL ROCK. THE SPECIMENS SHALL BE FABRICATED IN ACCORDANCE WITH THE DETAILS SHOWN ON THE PLANS AND SPECIFIED HEREIN. THE SPECIMENS SHALL BE ROUGHLY CUBICAL AND SHALL BE A MINIMUM SIZE OF 30 INCHES BY 30 INCHES AND SHALL INCLUDE THE INTERGRAL COLOR AND PAINTING AS SPECIFIED HEREINAFTER. THE SPECIMENS WILL BE APPROVED BY THE CONTRACTING OFFICER PRIOR TO CONSTRUCTION OF ANY OF THE REQUIRED ARTIFICIAL ROCK. THE APPROVED SPECIMENS SHALL BE PROTECTED BY THE CONTRACTOR FOR THE ENTIRE CONSTRUCTION PERIOD AND SHALL BE USED AS A STANDARD FOR JUDGING THE QUALITY OF THE ARTIFICIAL STONE. AT THE COMPLETION OF THE CONTRACT THE SPECIMENS SHALL BE DISPOSED OF BY THE CONTRACTOR.

INSERT PARAGRAPH 4.5

4.5 OPERATOR QUALIFICATIONS. THE NAMES AND QUALIFICATIONS OF THE NOZZLEMEN AND ROCK CARVERS SHALL BE SUBMITTED FOR APPROVAL. ANY ADDITIONAL NOZZLEMEN ADDED TO THE JOB THROUGHOUT THE PROJECT SHALL BE SIMILARLY SUBMITTED FOR APPROVAL. THE ROCK CARVERS SHALL HAVE A MINIMUM OF 3 YEARS EXPERIENCE IN CONSTRUCTION OF ARTIFICIAL ROCK FEATURES AND SHALL SUPPLY WRITTEN CERTIFICATION OF EXPERIENCE.

6. PRODUCTION OF SHOTCRETE.

6.1 Dry Mix Process.

6.1.1 Batching and Mixing. Aggregate and cement may be batched by weight or by volume. If volumetric batching is used, a minimum of one weight batching check shall be made every 4 hours for control purposes to insure that the specified mixture design is being achieved. Weighing equipment shall be capable of batching with the accuracy specified in ASTM C 94. Volumetric equipment shall be capable of batching with the accuracy specified in ASTM C 685. The mixing equipment shall be capable of thoroughly mixing the materials in sufficient quantity to maintain placing continuity and be capable of discharging all mixed material without any carry over from one batch to the next.

6.1.2 Delivery Equipment. The equipment shall be capable of discharging the aggregate-cement mixture into the delivery hose and delivering a continuous smooth stream of uniformly mixed material to the discharge nozzle. The discharge nozzle shall be equipped with a manually operated water injection system (water ring) for directing an even distribution of water through the aggregate-cement mixture. The water valve shall be capable of ready adjustment to vary the quantity of water, and shall be convenient to the nozzleman. The water pressure at the discharge nozzle shall be sufficiently greater than the operating air pressure to assure that the water is intimately mixed with the other materials. If the line water pressure is inadequate a water pump shall be introduced into the line. The water pressure shall be uniformly steady (nonpulsating). The delivery equipment shall be thoroughly cleaned at the end of each shift. Equipment parts, especially the nozzle liner and water ring, shall be regularly inspected and replaced as required.

6.2 Wet Mix Process.

6.2.1 Batching and mixing shall be accomplished in accordance with the applicable provisions of ASTM C 94. If volumetric batching and mixing are used, the materials shall be batched and mixed in accordance with the applicable provisions of ASTM C 685. The mixing equipment shall be capable of thoroughly mixing the specified materials in sufficient quantity to maintain continuous placing. Ready-mix shotcrete complying with ASTM C 94 may be used.

6.2.2 Delivery Equipment. The equipment shall be capable of delivering the premixed materials accurately, uniformly, and continuously through the delivery hose. Recommendations of the equipment manufacturer shall be followed on the type and size of nozzle to be used, and on cleaning, inspection, and maintenance of the equipment.

6.3 Air Supply. Contractor shall provide a supply of clean, dry air adequate for maintaining sufficient nozzle velocity for all parts of the work and, if required, for simultaneous operation of a suitable blow pipe for clearing away rebound.

7. PREPARATION OF SURFACES.

7.1 Earth. Earth shall be compacted and trimmed to line and graded before placing shotcrete. Surfaces to receive shotcrete shall be dampened.

7.2 Existing Concrete. All unsound and loose materials shall be removed by sandblasting, grinding, or high-pressure water jets before applying shotcrete. Any area to be repaired shall be chipped off or scarified to remove offsets which would cause an abrupt change in thickness without suitable reinforcement. Edges shall be tapered to leave no square shoulders at the perimeter of a cavity. The surface shall be dampened but without visible free water.

7.3 Shotcrete. When a layer of shotcrete is to be covered by a succeeding layer at a later time, it shall first be allowed to develop its initial set. Then all laitance, loose material, and rebound shall be removed by brooming or scraping. Laitance which has been allowed to take final set shall be removed by sandblasting and the surface thoroughly cleaned.

8. PLACEMENT OF SHOTCRETE.

8.1 General. Shotcrete shall be placed using suitable delivery equipment and procedures. The temperature of surfaces to receive shotcrete shall not be less than 35 degrees Fahrenheit.

8.2 Placement Techniques.

8.2.1 Placement Control. Thickness, method of support, air pressure, and water content of shotcrete shall be controlled to preclude sagging or sloughing off. Shotcreting shall be discontinued or suitable means shall be provided to screen the nozzle stream if wind or air currents cause separation of the nozzle stream during placement.

8.2.2 Corners. Horizontal and vertical corners and any area where rebound cannot escape or be blown free shall be filled first.

8.3 Placement Around Reinforcement. The nozzle shall be held at such distance and angle to place material behind reinforcement before any material is allowed to accumulate on its face. In the dry-mix process, additional water may be added to the mix when encasing reinforcement to facilitate a smooth flow of material behind the bars. Shotcrete shall not be placed through more than one layer of reinforcing steel rods or mesh in one application unless demonstrated by preconstruction tests that steel is properly encased.

8.4 Line and Thickness Control. Adequate ground wires or other accepted means shall be used to establish the thickness, surface planes, and finish lines of the shotcrete. The surfaces shall be within a tolerance of $\pm 3/8$ inch as determined by a 10 feet long straightedge placed on the surfaces. ★ THE THICKNESS OF SHOTCRETE FOR ARTIFICIAL STONE MAY VARY FROM 3 TO 5 INCHES.

8.5 Placement Precautions. The following precautions shall be taken during placement.

- a. Do not place shotcrete if drying or stiffening of the mix takes place at any time prior to delivery to the nozzle.
- b. Do not use rebound or previously expended material in the shotcrete mix.
- c. The area to which shotcrete is to be applied shall be clean and free of rebound or overspray.

9. REPAIR OF SURFACE DEFECTS.

9.1 Surface Defects. Surface defects shall be repaired as soon as possible, after initial placement of the shotcrete. All shotcrete which lacks uniformity, which exhibits segregation, honeycombing, or lamination, or which contains any dry patches, slugs, voids, or sand pockets shall be removed in accordance with paragraph: EXISTING CONCRETE, and replaced with fresh shotcrete.

9.2 Core Holes. Core holes shall not be repaired with shotcrete. Instead, they shall be filled solid with patching mortar, after being cleaned and thoroughly dampened.

10. FINISHING.

10.1 Arizona Canal Lining. The Arizona Canal Lining shall receive a finished surface which shall be equivalent, in evenness, smoothness, and freedom from rock pockets and surface voids, to that obtained by effective use of a long-handled burlap trowel. The desired finish technique will be selected by the Contractor and approved by the Contracting Officer's Representative.

10.2 Natural Gun Finish. Except where noted above, the undisturbed final layer of shotcrete as applied from the nozzle without hand finishing shall be provided.

11. CURING AND PROTECTION.

11.1 Initial Curing. Immediately after finishing, shotcrete shall be kept continuously moist for at least 24 hours. One of the following materials or methods shall be used:

- a. Ponding or continuous sprinkling.
- b. Absorptive mat or fabric, sand, or other covering kept continuously wet.
- c. Curing compounds. The application rate of 100 square feet per gallon will be used for all shotcrete. Curing compounds shall not be used on any surfaces against which additional shotcrete or other cementitious finishing materials are to be bonded unless positive measures, such as sandblasting, are taken to completely remove curing compounds prior to the application of such additional materials.

11.2 Final Curing. Additional curing shall be provided immediately following the initial curing and before the shotcrete has dried. One of the following materials or methods shall be used:

- a. Continue the method used in initial curing.
- b. Application of impervious sheet material conforming to ASTM C 171.

11.3 Duration of Curing. Curing shall be continued for the first 7 days after shotcreting or until the required strength is obtained. During the curing period, shotcrete shall be maintained above 55 degrees Fahrenheit and in a moist condition as specified above.

12. CONSTRUCTION JOINTS. Unless otherwise specified, construction joints shall be tapered to a shallow edge form, about one inch thick. If nontapered joints are specified, special care shall be taken to avoid or remove trapped rebound at the joint. The entire joint shall be thoroughly cleaned and wetted prior to the application of additional shotcrete. * CONSTRUCTION JOINTS IN THE ARTIFICIAL STONE SHALL BE CONSTRUCTED TO SIMULATE NATURAL FISSURES, FRACTURES OR CREVICES.

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★ 13. ARTIFICIAL ROCK.

13.1 FINISH. A ROUGH COAT SHALL BE APPLIED 2-1/2 INCHES TO 3 INCHES THICK, THOROUGHLY EMBEDDED INTO THE REINFORCING MESH. A FINISH COAT 1/2 INCH TO 2 INCHES THICK INCLUDING AN INTEGRAL COLOR SHALL BE APPLIED TO SIMULATE NATURAL WEATHERED GRANITE BOULDERS. WHILE THE FINISH COAT IS STILL PLASTIC NATURAL APPEARING FISSURES, FRACTURES, AND CREVICES SHALL BE CARVED INTO EACH ROCK TO APPROXIMATE NATURAL GRANITE BOULDERS AS CLOSELY AS POSSIBLE.

13.2 CURING. IMMEDIATELY AFTER FINISHING, ARTIFICIAL ROCK SHALL BE CURED FOR A PERIOD OF 24 HOURS WITH IMPERVIOUS SHEETS. PRIOR TO APPLICATION OF SEALANT, THE ROCK SHALL BE PAINTED AND ALLOWED TO CURE FOR AN ADDITIONAL 24 HOURS.

13.3 COLOR. THE FINISH COAT OF THE SHOTCRETE FOR THE ARTIFICIAL ROCK SHALL BE INTEGRALLY COLORED TO SIMULATE THE COLORS FOUND IN NATURAL GRANITE. ADDITIONALLY THE ROCKS SHALL BE PAINTED WITH THREE COATS OF DILUTED LATEX PAINT CONFORMING TO THE REQUIREMENTS OF THE SECTION: PAINTING. GENERAL. EACH COAT SHALL BE A DIFFERENT COLOR AND SHALL BE VARIOUS SHADES OF LIGHT GRAYS AND TANS SELECTED BY THE CONTRACTOR AND APPROVED BY THE CONTRACTING OFFICER. THE COLORS WILL BE SELECTED TO APPROXIMATE NATURAL WEATHERED GRANITE. THE FINISHED SURFACE SHALL GIVE THE ROCK A MOTTLED APPEARANCE. AFTER THE FINAL COAT OF PAINT HAS ADEQUATELY DRIED, ONE COAT OF SEALANT SHALL BE APPLIED IN ACCORDANCE WITH THE MANUFACTURERS RECOMMENDATIONS.

SECTION 4A

REINFORCED MASONRY

Index

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|-------------------------------------|--------------------------------------|
| 1. Applicable Publications | 7. Materials |
| 2. Qualifications of Testing Agency | 8. Mortar Mixes |
| 3. Sample Panels | 9. Grout Mixtures |
| 4. Submittals | 10. Preparation of Concrete Surfaces |
| 5. Delivery, Storage, and Handling | 11. Protection |
| 6. Environmental Conditions | 12. Installation |

1. APPLICABLE PUBLICATIONS. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1 U. S. Army Corps of Engineers Publication.

CRD-C 619-85

Grout Fluidifier

1.2 American Concrete Institute (ACI) Standard.

SP-66

ACI Detailing Manual - 1980

1.3 American Society for Testing and Materials (ASTM) Publications.

A 82-85

Steel Wire, Plain, for Concrete Reinforcement

A 116-81

Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric

A 615-86

Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

C 5-79
(R 1984)

Quicklime for Structural Purposes

C 33-86

Concrete Aggregates

C 39-86

Compressive Strength of Cylindrical Concrete Specimens

C 90-85

Hollow Load-Bearing Concrete Masonry Units

C 91-87

Masonry Cement

C 94-86b

Ready-Mixed Concrete

C 140-75
(R 1980)

Sampling and Testing Concrete Masonry Units

C 144-84	Aggregate for Masonry Mortar
C 150-85a	Portland Cement
C 207-79 (R 1984)	Hydrated Lime for Masonry Purposes
C 270-86b	Mortar for Unit Masonry
C 404-85	Aggregates for Masonry Grout
C 426-70 (R 1982)	Drying Shrinkage of Concrete Block
C 641-82	Staining Materials in Lightweight Concrete Aggregates
C 780-80 (R 1985)	Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
C 952-86	Bond Strength of Mortar to Masonry Units
D 1667-81 (R 1986)	Flexible Cellular Materials--Vinyl Chloride Polymers and Copolymers (Closed-Cell Vinyl)
D 2240-86	Rubber Property--Durometer Hardness
E 447-84	Compressive Strength of Masonry Prisms

2. **QUALIFICATIONS OF TESTING AGENCY.** The Contractor shall retain at his expense a testing laboratory to perform the laboratory and field testing and sampling specified herein. The laboratory shall have all facilities required to perform the specified sampling and testing. Personnel employed in the testing shall have had previous experience in sampling and testing the materials involved. Information regarding testing laboratories and qualifications of testing personnel shall be submitted to the Contracting Officer for approval.

3. **SAMPLE PANELS.** After material samples are approved, and prior to starting masonry work, construct sample panels of each type and color of masonry. Sample panels shall not be built in or as part of the structure but shall be located where directed. Panels shall be not less than 6 feet long by 4 feet high, except that panels may be 4 feet long by 2 feet high. Panels shall be of typical wall thickness for the masonry represented. Panels shall show color range, texture, bond, mortar joints including tooling, anchors, joint reinforcement, wall ties, reinforcing bars, grouting, and cleaning of masonry. The approved sample panels after cleaning shall be used as a standard of workmanship for the type of masonry represented. Protect sample panels from the weather and construction operations until the masonry work controlled by the sample panels has been completed and approved. Remove sample panels after completion of work controlled by the panel. Erection of masonry will not be permitted until sample panels have been approved.

4. SUBMITTALS.

4.1 Samples. The following samples shall be submitted for approval before work is started.

- a. Anchors and Ties - Two of each type proposed for use.
- b. Concrete Masonry Units - Shapes, sizes, and kinds in sufficient numbers to show full range of color and texture.
- c. Joint Reinforcement - One piece of each type of reinforcement, including corner and wall intersection pieces, showing at least two cross joints.
- d. Aggregates - One sample shall be taken at the source from each stockpile for each type aggregate specified herein. Each sample shall be collected by taking three incremental samples at random from the source material to make a composite sample of not less than 10 pounds.

4.2 Certificates of Conformance or Compliance. Before delivery of the following materials, notarized certificates attesting that materials meet the requirements specified shall be submitted in accordance with the SPECIAL CLAUSES.

- a. Concrete Masonry Units
- b. Joint Reinforcement
- c. Lime
- d. Reinforcing Bars

4.3 Certified Laboratory Test Reports. In addition to the submittal of certificates specified herein, certified copies of the reports of all tests listed below and required in referenced publications for the following materials shall be submitted. The testing shall have been performed by an approved independent laboratory acceptable to the Contracting Officer within 6 months of submittal of reports for approval. Test reports on a previously tested material shall be accompanied by notarized certificates from the manufacturer certifying that the previously tested material is of the same type, quality, manufacturer, and make as that proposed for this project.

a. Concrete Masonry Units - linear dry shrinkage, compressive strength and absorption of each type of unit and popout and staining properties of lightweight aggregates used in the units.

b. Cement - Certified mill test reports of each mill lot.

4.4 Shop Drawings. The following shop drawings shall be submitted for approval prior to delivery of the materials to the jobsite.

4.4.1 Reinforcing Bars. Shop drawings for reinforcing bars shall include plans, elevations, and details showing treatment of reinforcing at turns and offsets; intersections of similar and dissimilar materials; tops, bottoms, and ends of walls; and wall openings. Shop drawings shall also show details of positioning devices used to hold the vertical reinforcing bars in the proper position within the cells.

5. DELIVERY, STORAGE, AND HANDLING. Handle, store, and protect masonry units in a manner to avoid chipping, breakage, or contact with the soil or contaminating materials and exposure to the elements. Concrete masonry units delivered to the job site shall have a moisture content specified in ASTM C 90. Keep anchors, ties, and joint reinforcement free of rust. Steel reinforcing bars shall be free of loose scale and rust. Deliver cement and lime in unbroken bags, barrels, or other approved containers, plainly marked and labeled with the manufacturers' names and brands. Store cementitious materials in dry, weathertight sheds or enclosures or under watertight tarpaulins. Store and handle cement in a manner which will prevent the inclusion of foreign materials and damage by water or dampness.

6. ENVIRONMENTAL CONDITIONS.

6.1 Hot Weather Installation. Masonry erected when the ambient air temperature is more than 99 degrees F. in the shade and the relative humidity is less than 50 percent shall be protected from direct exposure to wind and sun for 48 hours after installation.

6.2 Cold Weather Installation. Materials to be used and built upon shall be free from ice and snow, and shall not be in a frozen condition. Do not lay masonry during temperatures below minus 10 degrees F. unless authorized in writing. Before erecting masonry during temperatures below 40 degrees F., submit for approval a written statement giving the methods proposed to heat the masonry materials and to protect the masonry from freezing. The air temperature on both sides of the masonry shall be maintained above 40 degrees F. for at least 72 hours, but time may be reduced to 48 hours if high-early-strength cement is used instead of portland cement or masonry cement in the mortar. Keep masonry units completely covered and free from frost, ice, and snow at all times and maintain them at a minimum temperature of 32 degrees F. when laid. Maintain temperature of mortar and grout between 40 degrees F. and 120 degrees F. by heating mixing water and/or sand. Temperature of mixing water or of water and sand introduced to cement shall not exceed 160 degrees F.

7. MATERIALS.

7.1 General. The source of materials which will affect the appearance of the finished work shall not be changed after the work has started. Wire gages specified herein are American Steel Wire Gages. Materials shall conform to the respective specifications and other requirements specified below.

7.2 Admixtures. The high-lift grout admixture shall conform to CRD-C 619 and in addition shall produce an expansive action in the plastic grout sufficient to offset initial water loss shrinkage and promote bonding of the grout to all interior faces of the masonry units. Other admixtures may be used in mortar or grout provided that the admixture does not affect bond or compressive strength of mortar or grout designed without the use of the admixture. Anti-freeze compounds shall not be used. The admixtures shall not contain calcium chloride salts or any other chemical that will adversely affect metals or the coatings of metals embedded in the mortar or grout.

7.3 Aggregate for Mortar. ASTM C 144, except that not less than 3 percent nor more than 15 percent shall pass the No. 100 sieve. Aggregate used in mortar for

joints 1/4 inch or less shall have 100 percent passing the No. 8 sieve with 10 percent being retained on the No. 16 sieve.

7.4 Aggregate for Grout.

7.4.1 Fine Aggregate. ASTM C 404 or C 144.

7.4.2 Coarse Aggregate. ASTM C 404, size No. 8 or ASTM C 33, 3/4 inch maximum size as indicated in Grading Table for coarse aggregates.

7.4.3 Lightweight Aggregate. ASTM C 331 except gradation shall conform to ASTM C 33 or C 404 as indicated in Grading Table.

7.5 Anchors, Ties, and Centering Devices.

7.5.1 Wire Devices. Factory fabricated from steel wire conforming to ASTM A 82. Wire devices in walls shall be formed from wire that has been zinc coated in accordance with ASTM A 116, Class 1.

7.5.1.1 Centering clips shall be formed from not lighter than 9 gage wire. Clips shall be of a design that will prevent displacement of the reinforcing bars during the course of construction.

7.5.1.2 Wire anchors for use with embedded slots or wire inserts shall be formed from not lighter than 9 gage wire looped and closed.

7.6. Portland Cement. ASTM C 150, Type II, including the requirements for low alkali content.

7.7 Concrete Masonry Units. Superlite Founders Finish, color to be Sedona Blend for restroom and walls as indicated on the drawings.

7.7.1 Aggregates. ASTM C 33 or C 331 except as follows.

7.7.1.1 Grading of aggregates as stipulated in ASTM C 33 and testing of lightweight aggregates for drying shrinkage as stipulated in ASTM C 331 will not be required.

7.7.1.2 Lightweight aggregates and blends of lightweight and heavier aggregates in proportions used in producing the units shall comply with the following requirements when tested for stain-producing iron compounds in accordance with ASTM C 641. By visual classification method, the iron stain deposited on the filter paper shall not exceed the "light stain" classification; by chemical analysis method and reported as ferric oxide, the iron stain deposited on the filter paper from 200-gram sample shall not exceed 1.2 milligrams of ferric oxide.

7.7.2 The linear drying shrinkage of concrete masonry units shall not exceed 0.045 percent when tested in accordance with ASTM C 426. Maximum moisture content percentage of the total absorption will be in accordance with ASTM C 90.

7.7.3 Kinds and Shapes. In addition to the requirements specified above, concrete masonry units of the various kinds shall conform to the specifications referenced below. Units shall include closer, jamb, header, lintel, and bond beam

units and special shapes and sizes to complete the work as indicated. All units used in exposed masonry surfaces in any one building shall have a uniform fine to medium texture and a uniform color as indicated above.

7.7.3.1 Hollow Concrete Masonry Units. ASTM C 90, Type I, grade N-I.

7.8 Horizontal Joint Reinforcement. Fabricated from steel wire using welded connections. Tack welding will not be permitted. The reinforcement shall conform to the following requirements.

7.9 Steel Wire. ASTM A 82. Wire sizes for the various types of joint reinforcement shown on the drawings shall not be less than those listed below.

Type	Minimum Wire Size Longitudinal Wire	Minimum Wire Size Crosswires
Standard Duty	9 gage	9 gage

7.9.1 Finish. Joint reinforcement for walls shall be formed from wire that has been zinc coated in accordance with ASTM A 116, Class 1.

7.9.2 Lengths. Joint reinforcement for straight runs shall be furnished in flat sections not less than 10 feet long. Factory-formed pieces shall be provided at corners and intersections of walls and partitions.

7.9.3 Design. Design of joint reinforcement shall be as specified below for the various types of wall construction. The outermost longitudinal wires shall be spaced 2 inches plus or minus 1/8-inch less than the nominal thickness of the wall in which it is placed.

7.9.4 Single Wythe Hollow or Filled Cell Unit Construction. Ladder design having two or more smooth or deformed longitudinal wires. Joint reinforcement shall be of one design throughout all single wythe walls. The distance between contacts of crosswires with each longitudinal wire shall not exceed 6 inches for smooth longitudinal wires and 16 inches for deformed longitudinal wires.

7.10 Lime Paste. Lime paste shall be made with pulverized quicklime or hydrated lime. Hydrated lime processed by the steam method shall be allowed to soak not less than 24 hours. Quicklime and other hydrated lime shall be allowed to soak not less than 72 hours. In lieu of hydrated-lime paste for use in mortar, the hydrated lime may be added in the dry form.

7.10.1 Hydrated Lime. ASTM C 207, Type S.

7.10.2 Pulverized Quicklime. ASTM C 5, except 100 percent shall pass the No. 20 sieve and 90 percent shall pass the No. 50 sieve.

7.11 Reinforcing Bars. ASTM A 615, Grade 60.

7.12 Water. Water used in mortar and grout shall be taken from a supply distributed for domestic purposes and at the time of mixing shall be clean and free of acids, alkalies, or other organic materials.

7.13 Flashings shall be as indicated on the drawing.

8. MORTAR MIXES.

8.1 Proportions. Mortar shall be Type S in accordance with the property specifications of ASTM C 270 as modified below. Materials shall be portland or masonry cement, hydrated lime or lime paste, aggregate, mortar coloring and water as specified herein. Mortar used for concrete masonry construction shall match the color of the masonry units. The mortar shall have a flow, after suction, of 70 percent or more when tested for water retention in accordance with ASTM C 91, except mortar shall be mixed to an initial flow of 125 to 135 percent.

8.2 Color. Mortar Coloring, not to exceed 3 percent of the weight of cement for carbon black and 10 percent of the weight of cement for all other pigments, shall be added to the mortar used for exposed masonry surfaces to produce a uniform color matching concrete masonry unit. The color pigment should be ground into the cement at the cement mill or shall be furnished in accurately pre-measured and packaged units that can be added without measuring to a measured amount of cement.

9. GROUT MIXTURES.

9.1 Proportions. Grouts shall be mixed in laboratory established proportions to attain a compressive strength at 28 days of not less than 2,000 psi when tested in accordance with ASTM C 91 for fine aggregate and ASTM C 39 for grout containing coarse aggregate. Grout shall be used subject to the limitations of Table I.

9.1.1 Fine Grout. Fine grout shall consist of portland cement, lime paste or hydrated lime, and fine aggregate mixed with sufficient water to obtain a pouring consistency without segregation of the constituents. Slump shall be between 9 and 11 inches.

9.1.2 Low-Lift Grout. Low-lift grout shall consist of portland cement, lime paste or hydrated lime, fine aggregate and coarse aggregate mixed with sufficient water to obtain a pouring consistency without segregation of the constituents. Slump shall be between 9 and 11 inches. Maximum size of coarse aggregate for grout shall be in accordance with Table I.

10. PREPARATION OF CONCRETE SURFACES. Clean laitance, dust, dirt, oil, organic matter or other foreign materials from concrete surface upon which reinforced masonry is to be placed. Use sand blasting, if necessary, to remove laitance from pores and to expose the aggregate.

11. PROTECTION. Facing materials shall be protected against staining. Top of walls shall be covered with nonstaining waterproof covering or membrane when work is not in process. Covering shall extend a minimum of 2 feet down on each side of the wall and be held securely in place. Before starting or resuming, top surface of masonry in place shall be cleaned of loose mortar and foreign material.

12. INSTALLATION.

12.1 Laying Masonry Units. Adjust each unit to its final position while mortar is still soft and plastic. Remove and relay in fresh mortar, any unit that is disturbed after mortar has stiffened. Keep chases, raked-out joints, and spaces to be grouted free from mortar and other debris. Units used in exposed masonry surfaces shall be free from chipped edges or other imperfections detracting from the appearance of the finished work.

12.1.1 Tolerances. Lay masonry plumb, true to line, with courses level. Bond pattern shall be kept plumb throughout. Lay masonry within the following tolerances.

12.1.1.1 Variation from the plumb in the lines and surfaces of columns, walls and arrises.

- a. In adjacent masonry units - 1/8 inch.
- b. In 10 feet - 1/4 inch.
- c. In any story or 20 feet maximum - 3/8 inch.
- d. In 40 feet or more - 1/2 inch.

12.1.1.2 Variations from the plumb for external corners, expansion joints, and other conspicuous lines.

- a. In any story or 20 feet maximum - 1/4 inch.

12.1.1.2 Variations from the level or grades indicated on the drawings for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines.

- a. In any bay or 20 feet maximum - 1/4 inch.

12.1.1.4 Variations of the linear building lines from established position in plan and related portion of columns, walls, and partitions.

- a. In any bay or 20 feet maximum - 1/2 inch.
- b. In 40 feet or more - 3/4 inch.

12.1.2 Cutting and Fitting. Wherever possible, use full units of the proper size in lieu of cut units. Cutting and fitting, including that required to accommodate the work of others, shall be done by masonry mechanics using power masonry saws. Concrete masonry units shall be wet cut. Wet cut units, before being placed in the work, shall be dried to the same surface-dry appearance as uncut units being laid in the wall. Cut edges shall be clean, true and sharp. Make openings carefully so that wall plates, cover plates or escutcheons required by the installation will completely conceal the openings and will have bottoms parallel with the masonry bed joints. Cut webs of hollow masonry units to the minimum required for proper installation. Provide reinforced masonry lintels above openings over 12 inches wide for pipes, ducts, and cable trays unless steel sleeves are used.

12.1.3 Embedded Items. Fill spaces around metal door frames and other built-in items with mortar. Openings around flush-mount electrical outlet boxes in wet locations, including the flush joint above the box, shall be pointed with mortar. Anchors, ties, wall plugs, accessories, flashings, pipe sleeves and other items required to be built-in shall be built-in as the masonry work progresses. Embed anchors, ties and joint reinforcement fully in the mortar. Fill cells receiving anchor bolts and cells of the first course below bearing plates with grout.

12.1.4 Unfinished Work. Step back unfinished work for joining with new work. Tothing may be resorted to only when specifically approved. Remove loose mortar and thoroughly clean the exposed joints before laying new work.

12.1.5 Wetting Masonry Units. Do not wet concrete masonry units. Do not lay units having a film of water or frost on the surface.

12.1.6 Jointing. Tool joints when the mortar is thumbprint hard. Tool horizontal joints first. Brush joints to remove all loose and excess mortar. Mortar joints shall be finished as follows.

12.1.6.1 Flush Joints. Joints in concealed masonry surfaces and joints above electrical outlet boxes in wet areas shall be flush cut. Make flush cut joints by cutting off the mortar flush with the face of the wall. Joints in unparged masonry walls below grade shall be pointed tight.

12.1.6.2 Tooled Joints. Joints in exposed exterior and interior masonry surfaces shall be tooled slightly concave. Tool joints with a jointer slightly larger than the joint width so that complete contact is made along the edges of the unit. Perform tooling so that the mortar is compressed and the joint surface is sealed. Use a jointer of sufficient length to obtain a straight and true mortar joint.

12.1.7 Joint Widths. Joint widths shall be approximately 3/8-inch wide.

12.1.8 Forms and Shores. Where required, construct forms to the shapes, lines, and dimensions of the members indicated. Construct forms sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout. Do not remove supporting forms or shores until the supported masonry has acquired sufficient strength to support safely its weight and any construction loads to which it may be subjected. In no case shall supporting forms or shores be removed in less than 10 days. At least 16 hours shall have elapsed after grouting masonry columns or walls before applying uniform loads and an additional 48 hours shall have elapsed before applying concentrated loads.

12.2 Reinforced Hollow Unit Masonry. Reinforced hollow unit masonry shall consist of hollow concrete masonry units reinforced vertically and horizontally with steel bars located within cells or kerfs in the units and with all cells filled solidly with grout. Lay hollow masonry units so as to preserve the vertical continuity of cells filled with grout. The minimum clear horizontal dimensions of vertical cores shall be 2 inches by 3 inches. Units shall be masonry bonded at wall corners. Intersections shall be anchored by reinforcing bars or stirrups as indicated.

12.2.1 Bond Pattern. Except where stacked bond is indicated, lay hollow masonry units in running bond.

12.2.3 Mortar Joints. Fill bed joints with mortar for the full thickness of the face shell. Where all cells are to be grouted, spread cross webs with mortar at grout barriers only. Provide grout barriers not more than 25 feet apart as required to limit the horizontal flow of grout for each grout pour. Butter head joints for the full thickness of the face shell and shove the units into place. Avoid fins of mortar that protrude into cells to be grouted.

12.2.3 Joint Reinforcement: Place joint reinforcement so that longitudinal wires are fully embedded in the face shell mortar bed for their entire length. Provide a minimum mortar cover over longitudinal wires of 5/8-inch on the weather side of walls and 1/2-inch at all other locations. Lap reinforcement at least 6 inches for deformed longitudinal wires and at least 12 inches for smooth longitudinal wires. Install factory-fabricated sections at corners and wall intersections.

12.3 Placing Reinforcing Steel. Prior to placing grout, clean all reinforcement of loose, flaky rust, scale, grease, mortar, grout, or other coating which might destroy or reduce its bond with the grout. Unless otherwise indicated, the details of reinforcement shall conform to ACI SP-66. Do not bend or straighten reinforcing in a manner injurious to the steel. Do not use bars with kinks or bends not shown on the drawings. Placement of reinforcement shall be inspected and approved prior to placing grout. Vertical bars shall be spliced only where indicated.

12.3.1 Positioning Bars. Position vertical bars accurately at the centerline of the wall. Maintain a minimum clearance between the bars and masonry units of 1/2 inch and between parallel bars of one diameter of the reinforcement. Hold vertical reinforcing in place using metal supports, centering clips, spacers, ties, or caging-devices located near the ends of each bar and at intermediate intervals of not more than 160 diameters of the reinforcement.

12.3.2 Splices. Locate splices only where shown on the drawings. Stagger splices in adjacent bars. Lap bars a minimum of 40 diameters of the reinforcement or 2 feet whichever is greater. Welded or mechanical connections shall develop at least 125 percent of the strength of the reinforcement.

12.4 Placing Grout. Place grout using a hand bucket, concrete hopper, or grout pump. Place grout so as to completely fill the grout spaces without segregation of the aggregates. Where grouting is discontinued for more than 1 hour, stop the grout 1-1/2 inches below the top of a course to form a key at pour joints. The height of grout pours and type of grout used shall be limited by the dimensions of grout spaces as indicated in Table III.

12.4.1 Grout Holes. Provide grouting holes in slabs, spandrel beams, and other in-place overhead construction. Locate holes over vertical reinforcing bars. Provide additional openings spaced not more than 16 inches on centers where grouting of all hollow unit masonry is indicated. Openings shall not be less than 4 inches in diameter or 3 by 4 inches in horizontal dimensions. Upon completion of grouting operations, plug grouting holes and finish to match surrounding surfaces.

12.4.2 Grouting Equipment.

12.4.2.1 Grout Pumps. Pumping through aluminum tubes will not be permitted. Operate pumps to produce a continuous stream of grout without air pockets. Upon completion of each day's pumping, eject grout from pipeline without contamination or segregation of the grout. Remove waste materials and debris from the equipment. Dispose of waste materials, debris, and all flushing water outside the masonry.

12.4.2.2 Vibrators. Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the grout. Maintain at least one spare vibrator, or sufficient parts for repairing vibrators, at the site at all

times. Apply vibrators at uniformly spaced points not further apart than the visible effectiveness of the machine. Limit duration of vibration to time necessary to produce satisfactory consolidation without causing segregation.

12.4 Low-Lift Method. Place grout as masonry is erected at a rate that will not cause displacement of the masonry due to hydrostatic pressure of the grout. If mortar has been allowed to set prior to grouting, remove all fins protruding more than 1/2-inch into the grout space. Place grout in final position within 2-1/2 hours after mixing when air temperature is 80 degrees F or higher and 3-1/2 hours after mixing when the air temperature is less than 80 degrees F. Rod or puddle grout during placement using a one inch by 2 inch wood stick or a mechanical vibrator to insure complete filling of the grout space. Do not insert the vibrators into lower pours that are in a semi-solidified state.

12.4.4 Blowouts. Brace walls against wind and other forces during construction. Allow sufficient time between lifts to preclude displacement of solid masonry units or cracking of face shells of hollow masonry units. If blowouts, misalignment, or cracking of face-shells should occur during construction, tear down and re-build the wall at no additional cost to the Government.

12.5 Pointing and Cleaning. After mortar joints have attained their initial set but prior to hardening, completely remove mortar and grout daubs or splashings from exposed masonry surfaces. Before completion of the work, rake out all defects in joints in exposed masonry surfaces, fill with mortar and tool to match existing joints. Immediately after grout work is completed remove scum and stains which have percolated through the masonry using a high pressure stream of water. Do not use metal tools or metal brushes for cleaning.

12.5.1 Concrete Masonry Units. Dry brush exposed concrete masonry unit surfaces at the end of work each day and after any required pointing. Use stiff-fiber bristled brushes only.

12.6 Field Tests.

12.6.1 Moisture Content. Sampling and testing of concrete masonry units for moisture content shall be performed by the Contractor. Upon delivery of units to the project site and periodically thereafter, samples shall be selected at random from stockpiles and tested in accordance with ASTM C 140. If the moisture content requirements in ASTM C 90 are not met additional protection for stockpiles will be provided immediately. If the moisture content is over 5 percent the maximum, the units will be rejected for use until they are made to conform to the moisture content requirements.

TABLE I

POUR HEIGHT AND TYPE OF GROUT FOR VARIOUS

GROUT SPACE DIMENSIONS

<u>Minimum Horizontal Dimensions of Core (inches)</u>	<u>Grout Type (See paragraph Grout)</u>	<u>Coarse Aggregate</u>	<u>Maximum Height of Grout Pour (inches)</u>
2 by 3	Fine	None	8
2 by 4	Fine	None	16
2-1/2 by 4	Fine or low lift	ASTM C 404, Size 8	48

* * * * *

SECTION 5A

MISCELLANEOUS METALS

Index

- | | |
|----------------------------|-----------------|
| 1. Applicable Publications | 4. Fabrication |
| 2. General | 5. Installation |
| 3. Materials | |

1. APPLICABLE PUBLICATIONS. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1 American National Standards Institute (ANSI) Standard.

A 14.3-1984 American National Standard Safety Requirements for Fixed Ladders

B 16.3-1977 Malleable Iron Threaded Fittings

1.2 American Society for Testing and Materials (ASTM) Standards.

A 36-84a Structural Steel

A 120-84 Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses

A 123-84 Zinc (Hot-Galvanized) Coatings on Shapes, Plates, Bars, and Strip

A 126-84 Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

A 320-85a Alloy Steel Bolting Materials for Low-Temperature Service

A 500-84 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

A 513-84a Electrical-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing

B 32-87 Solder Metal

1.3 American Welding Society (AWSI).

D1.1-86 Structural Welding Code - Steel

1.4 Federal Specifications (Fed. Spec.).

FF-S-325 (Int Am-3)	Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)
RR-C-271C	Chains and Attachments, Welded and Weldless
TT-E-489G	Enamel, Alkyd, Gloss (for Exterior and Interior Surfaces)
QQ-B-750 (& Am-2)	Bronze, Phosphor; Bar, Plate, Rod Sheet Strip, Flat Wire, and Structural and Special Shaped Sections
QQ-S-763E	Steel Bars, Wire, Shapes, and Forgings, Corrosion Resisting
VV-G-632A	Grease, Industrial, General Purpose

1.5 Military Specifications (Mil. Spec.).

MIL-F-3541A	Fittings, Lubrication
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1.6 National Association of Architectural Metal Manufacturers (NAAMM) Manual.

Metal Bar Grating Manual (Oct 1979; Suppl No. 1, Apr 1980)

2. GENERAL.

2.1 Shop Drawings. Complete shop drawings for fabrication of fence panels, fence posts, pipe gates, and outlet gates shall be submitted for approval in accordance with the requirements of the SPECIAL CLAUSES.

2.2 Welding shall conform to the provisions of AWS D1.1. Welders who have not been certified within 2 years of the date of commencement of work under this contract will not be allowed to perform the work.

2.3 Bolt holes shall be reamed or drilled normal to the member and shall be truly cylindrical throughout. Cutting bolt holes with a torch will not be permitted without the prior written approval of the Contracting Officer.

3. MATERIALS.

3.1 General. Materials indicated on the drawings or required in the work and not covered elsewhere by detailed requirements shall conform to the requirements of this section. In all cases where materials are not specifically covered in these specifications, the Contractor shall furnish approved highest grade commercial materials or products.

3.2 Steel pipe shall be zinc-coated (galvanized) steel pipe conforming to the requirements of ASTM A 120, Standard Weight, Schedule 40.

3.3 Steel Shapes and Plates.

3.3.1 Steel bars and plates shall conform to ASTM A 36. Galvanized coating, where required, shall conform to ASTM A 123.

3.3.2 Steel tubing shall conform to ASTM A 500, Grade A for posts, and ASTM A 513 for picket rails.

3.4 Concrete, mortar and grout shall conform to the requirements of SECTION: CONCRETE.

3.5 Formwork shall conform to SECTION: FORMWORK FOR CONCRETE.

3.6 Chain shall be galvanized and shall conform to the requirements of Fed. Spec. RR-C-271, Type 1, Grade C, Class 4. The chain shall be attached with a galvanized connecting link and shall accommodate a 5/16-inch diameter padlock shackle.

3.7 Bolts and anchor bolts shall conform to Fed. Spec. 00-S-763, Class 304, Condition A, or the applicable requirements of ASTM A 320, Grade B8. Nuts shall be galvanized.

3.8 Expansion bolts shall conform to Fed. Spec. FF-S-325.

3.9 Grease fittings shall conform to Mil. Spec. MIL-F-3541.

3.10 Signs. Reflective material on picket fence gate, pipe gate and pipe barrier reflectors and unauthorized vehicles prohibited signs on pipe gates shall conform to the State Specifications of the Department of Transportation, Highway Division of the State of Arizona. Unauthorized vehicles prohibited signs on pipe gates shall be constructed as indicated on the drawings. Letters are to be black reflective material, standard 2 inch. Sign background shall be silver white. The reflectors and signs shall be constructed of heavy galvanized bonderized steel sheets having a minimum thickness of 16 gauge. Sign markings shall be baked enamel.

3.11 Pipe caps shall conform to ANSI B 16.3.

3.12 Bronze shall conform to Fed. Spec. 00-B-750, hard temper of either composition.

3.13 Cast Iron for Flap Gates shall conform to ASTM A126, Class B.

4. FABRICATION.

4.1 Picket Fence Panels. Pickets shall be steel tubing with caps welded at the top of the pickets. Fence panels shall be fabricated in the shop. Pickets, rails, and brackets shall be finished to provide smooth, straight edges free of burrs. All surfaces of the fence panels and brackets shall be cleaned in the shop to remove all rust, scale, dirt, and other foreign matter. "Tight" mill scale that cannot be lifted by applying a sharp knife to any edge will be permitted. The cleaning shall be accomplished by scraping, wire brushing, and wiping or other approved methods. The cleaning and painting operations shall be carried out in such a manner that the time between cleaning and the application of paint will not exceed 24 hours. Pickets, rails, and brackets shall be shop painted with 1 coat

of zinc chromate primer and 2 coats of flat black exterior oil paint conforming to Fed. Spec. TT-E-489, Class A. Any damage of the picket fence panels during transportation and/or installation will be cause for reiection of the fence panels. Any chipping of original color during transportation and/or installation shall be repainted with original color.

4.2 Concrete Fence Posts. Steel base plates for posts need not be galvanized. Any cracking of the fence posts during installation of fence panel brackets will be cause for rejection of the post, and the damaged post shall be replaced at no additional cost to the Government (the Contractor will not be permitted to repair damaged posts).

4.3 Pipe Gate. Pipe gates shall be fabricated with steel pipe and shall be fabricated in the shop. Care shall be taken to deform pipe without "breaking" the steel. Any pipe deformations that demonstrate visible cracking or weakening may be cause for rejection the pipe gate or shall be repaired at no additional cost to the Government. All metal gate components (except grease fittings) shall be galvanized. Welded, cut, damaged, and deformed areas of galvanizing metal shall be neatly coated with Grade 50B solder conforming to ASTM B 32. A minimum of two bolts, each not less than 1/4-inch in diameter, shall be used to fasten panels and signs to the pipe gates.

4.4 Gratings and Frames. Steel grating shall be manufactured in accordance with the NAAMM Bar Grating Manual for bar-type gratings. Edges shall be banded with bars 1/4 inch less in height than bearing bars for grating sizes above 3/4 inch. Banding bars shall be flush with the top of bearing bars. Frames shall be of welded steel construction finished to match the grating. Gratings and frames shall be galvanized after fabrication.

4.5 Ladders. Ladders shall be steel fixed-rail conforming to ANSI A 14.3. Ladders and accessories shall be galvanized. Rungs shall be solid-section rods, fitted into punch holes in rails, welded and ground smooth. All splices and connections shall have a smooth transition with original members without projections that are sharp or more extensive that required for joint strength. Rails shall be fitted with rackets at the spacing indicated for anchorage to structure.

4.6 Side Drain Flap Gates. Flap Gates shall be required for the side drains indicated and shall have a clear opening of the same diameter as the side drain pipe. Flap gates shall be designed and constructed to prevent backflow, withstand a minimum seating head of 10 feet and shall be free flowing for unseating heads. Seat and cover shall be cast iron. Links shall be galvanized steel with commercial grade bronze bushings at pivot points. The flap gates shall be installed in accordance with the installation instructions recommended by the manufacturer.

5. INSTALLATION.

5.1 General. Fence posts, both concrete and steel, and pipe gate posts shall be installed plumb. Fence posts shall be installed to provide a straight and even alignment. Fence panels shall be installed level and in a straight alinement from one side of the post to the other. All bolts and nuts shall be tight. Expansion anchors shall be snug and shall not permit movement when tested by hand. Surfaces of galvanized metals that are abraded, cut, or welded during installation shall be neatly covered with grade 50B solder conforming to ASTM B 32.

5.2 Excavation for concrete-embedded items shall be of the dimensions indicated on the drawings. Holes shall be cleared of loose materials prior to placement of concrete.

5.3 After fence panels are fastened to the posts, the heads of anchoring bolts and any painted areas that are damaged during installation shall be painted with paint conforming to the requirements for shop painting above. Paint shall be applied with a brush (spray methods shall not be used). Any such paint that gets on other than the surfaces specified to be painted shall be removed by the Contractor at no additional cost to the Government.

5.4 The Contractor shall use non-shrink grout conforming to the requirements of SECTION: CONCRETE to fill the voids under and above the base plates for fence posts.

5.5 The Contractor shall grease pipe gates thoroughly with grease conforming to Fed. Spec. VV-G-632 immediately after installation of gate leaves. The gates shall be installed in such a fashion that they work freely. The Contractor shall examine the operation of all pipe gates not sooner than 30 days after installation for ease of operation. Any gates that cannot be operated by one person will be repaired (including any required structural modifications) by the Contractor at no additional cost to the Government, and requirements for repair shall conform to the requirement for installation above.

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SECTION 9A

PAINTING, GENERAL

Index

- | | |
|-------------------------------------|--|
| 1. Applicable Publications | 11. Mixing and Thinning |
| 2. Definition | 12. Application |
| 3. Packing, Labeling and Storage | 13. Miscellaneous |
| 4. Submittals | 14. Surfaces to be Painted |
| 5. Colors and Tints | 15. Surfaces Not Requiring Painting |
| 6. Quality Assurance Provisions | 16. Surfaces for Which Painting
Is Prohibited |
| 7. Environmental Conditions | 17. Cleaning |
| 8. Materials | 18. Painting Schedule |
| 9. Hazardous Materials Restrictions | |
| 10. Surface Preparation | |

1. APPLICABLE PUBLICATIONS. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1 Federal Specifications (Fed. Spec.).

TT-E-489G	Enamel, Alkyd, Gloss (for Exterior and Interior Surfaces)
TT-E-505a & Am-3	Enamel, Odorless, Alkyd, Interior, High Gloss, White and Light Tints
TT-E-506K	Enamel, Alkyd, Gloss, Tints and White (for Interior Use)
TT-E-543a & Am-1	Enamel, Interior, Undercoat, Tints, and White
TT-E-545B & Am-1	Enamel, Odorless, Alkyd, Interior-Undercoat, Flat, Tints and White
TT-P-645A	Primer, Paint, Zinc-Chromate, Alkyd Type

1.2 Federal Standard (Fed. Std.).

No. 595a & Change Notices 1, 2, 3, 4, 5, 6, 7, 8, & 9	Colors
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1.3 American Society for Testing and Materials (ASTM) Publication.

B-117-85	Salt Spray (Fog) Testing
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2. DEFINITION. The term "paint" as used herein, includes emulsions, enamels, paints, stains, varnishes, sealers, cement-emulsion filler, and other coatings, whether used as prime, intermediate, or finish coats.

3. **PACKING, LABELING, AND STORAGE.** Paints shall be in sealed containers that legibly show the designated name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions, including any warnings and special precautions, and name of manufacturer. Pigmented paints shall be furnished in containers not larger than 5 gallons. Paint shall be stored on the project site or segregated at the source of supply sufficiently in advance of need to allow 30 days for testing. Emulsion paints shall be stored to prevent freezing.

4. **SUBMITTALS.**

4.1 **Certificates of Compliance.** The Contractor shall furnish a certificate of compliance in accordance with the **SPECIAL CLAUSES** attesting that all paints proposed for use contain not more than 0.06 percent lead as defined in paragraph: **HAZARDOUS MATERIALS RESTRICTIONS.**

4.2 **Manufacturer's Instructions.** Detailed mixing, thinning, and application instructions, minimum and maximum application temperature, and curing time and drying time between coats shall be furnished for anti-graffiti coatings. For the anti-graffiti coatings, the instructions shall also include surface preparation requirements and the number and types of coats required for each surface.

4.3 **Samples.** Upon notification by the Contractor that the material is at the site or source of supply, one-quart sample of each batch, except for small quantities approved as proprietary brands, shall be taken by random selection from the sealed containers by the Contractor in the presence of a representative of the Contracting Officer. The contents of the sampled containers shall be thoroughly mixed to render the sample representative. Samples shall be identified by designated name, specification number, batch number, project contract number, intended use, and quantity involved.

4.4 **Small Quantity Substitution.** The Contractor shall submit for approval the names of the proprietary brands of materials that are proposed to be substituted for the specified materials when the required quantity of a particular color is 25 gallons or less.

4.5 **Test Reports.** The Contractor shall furnish either one of the following reports for batches in excess of 25 gallons.

a. A test report showing that the batch meets all specification requirements.

b. A test report showing that a previous batch of the same formulation as the batch to be used met all specification requirements, and a report of test results for properties of weight per gallon, viscosity, fineness of grind, drying time, color, and gloss.

5. **COLORS AND TINTS.** Colors and tints shall conform to Fed. Std. 595 and shall be as selected by Contracting Officer. The color of the undercoats shall vary slightly from the color of the next coat.

6. **QUALITY ASSURANCE PROVISIONS.** Materials will be approved based on test reports furnished, except where samples are tested, approval will be based on tests of samples. If materials are approved based on test reports furnished, samples will be retained by the Government for testing, should the materials

appear defective during or after application. In addition to any other remedies under the contract, the actual costs of retesting materials found to be defective will be deducted from payments due the Contractor.

7. ENVIRONMENTAL CONDITIONS. Unless otherwise recommended by the paint manufacturer, the ambient temperature shall be between 45 and 95 degrees F. when applying coatings other than water-thinned, epoxy, and anti-graffiti coatings. Water-thinned coatings will only be applied when ambient temperature is between 50 and 90 degrees F. Epoxy and anti-graffiti coatings will only be applied within the minimum and maximum temperature recommended by the coating manufacturer. Paints, except water-thinned types, shall be applied only to surfaces that are completely free of surface moisture as determined by sight or touch. In no case shall paint be applied to surfaces upon which there is visible frost or ice.

8. MATERIALS.

8.1 General. Materials shall conform to the requirements of the specifications listed herein and in the PAINTING SCHEDULE except when the required quantity of material of a particular color is 25 gallons or less, an approved proprietary brand of materials equal in intended usage and color to that specified may be used.

8.2 Exterior Oil Paint. Exterior oil paint shall conform to Fed. Spec. TT-E-489.

8.3 Ferrous-Metal Primer. Ferrous-metal primer shall conform to Fed. Spec. TT-P-645.

8.4 Polyester Powder Coating. Coating shall conform to ASTM B-117. Three mile finish.

9. HAZARDOUS MATERIALS RESTRICTIONS.

9.1 Lead. Paint shall contain not more than 0.06 percent lead by weight (calculated as lead metal) in the total nonvolatile content of the paint.

10. SURFACE PREPARATION.

10.1 General. Items not to be painted which are in contact with or adjacent to painted surfaces shall be removed or protected prior to surface preparation and painting operations. Exposed ferrous metals including nails on or in contact with surfaces to be painted with water-thinned paints shall be spot-primed with zinc dust, zinc dust-zinc oxide, zinc yellow-iron oxide, or zinc chromate primer. Surfaces to be painted shall be clean before applying paint or surface treatments. Oil and grease shall be removed with clean cloths and cleaning solvents prior to mechanical cleaning. Cleaning solvents shall be of low toxicity with a flashpoint in excess of 100 degrees F. Cleaning shall be programmed so that dust and other contaminants will not fall on wet, newly painted surfaces.

10.2 Ferrous Surfaces. Ferrous surfaces that have not been shop-coated shall be solvent-cleaned. Surfaces that contain loose rust, loose mill scale, and other foreign substances shall be mechanically cleaned by power wire brushing or sandblasting. Minor amounts of residual rust, that cannot be removed except by thorough blast-cleaning, and tight mill scale that cannot be removed by applying a sharp knife to any edge, will be allowed to remain. After cleaning, one coat of ferrous-metal primer shall be applied to all ferrous surfaces to receive paint.

The semitransparent film applied to some pipes and tubing at the mill is not to be considered as a shop coat, but shall be overcoated with the specified ferrous metal primer prior to application of finish coats. Shop coated ferrous surfaces shall be protected from corrosion by treating and touching up corroded areas immediately upon detection.

10.3 Galvanized and Non-Ferrous Surfaces. Galvanized and other non-ferrous surfaces to be painted shall be solvent-cleaned and treated with vinyl-type wash coat.

11. MIXING AND THINNING.

11.1 General. Packaged paint may be thinned immediately prior to application where necessary to suit conditions of surface, temperature, weather, and method of application with not more than one pint of suitable thinner per gallon. The use of thinner shall not relieve the Contractor from obtaining complete hiding. Paints of different manufacturers shall not be mixed.

12. APPLICATION.

12.1 General. Paint may be applied by brush, roller or spray except as hereinafter specified. At time of application, paint shall show no signs of deterioration. Uniform suspension of pigments shall be maintained during application. Paint shall be applied so finished surfaces shall be free from runs, drops, ridges, waves, laps, brush marks, and variations in color, texture, and finish. Hiding shall be complete. Each coat shall be applied as a film of uniform thickness. Rollers for applying paints and enamels shall be of a type designed for the coating to be applied and the surface to be coated. Special attention shall be given to insure that all surfaces including edges, corners, crevices, welds, and rivets received a film thickness equivalent to that of adjacent painted surfaces. Adequate ventilation shall be provided during paint application. Respirators shall be worn by all persons engaged in spray painting. Adjacent areas shall be protected by the use of drop cloths or other approved precautionary measures shall be taken. Paints shall be applied only to surfaces that are completely free of surface moisture as determined by sight or touch. In no case shall paint be applied to surfaces upon which there is visible frost or snow. Floor sealer coat shall be given additional touchup coats necessary to eliminate dull spots. Excess sealer shall be wiped off after each application.

12.2 Coating Progress. Sufficient time shall elapse between successive coats to permit proper drying. This period shall be modified as necessary to suit adverse weather conditions. Oil base paints shall be considered dry for recoating when the paint feels firm, does not deform or feel sticky under moderate pressure of the thumb, and the application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

12.3 Metal Surfaces. (Sign letters only.) First coats other than vinyl-type wash coats shall be applied by brush. The three-coat paint systems specified for exterior and interior ferrous surfaces shall be applied so that the dry film thickness of the three-coat systems at any point shall be not less than 4.0 mils with the primer having a minimum dry film thickness of 1.5 mils. The dry film thickness of the four-coat system at any point shall be not less than 4.5 mils with the primer having a minimum dry film thickness of 1.2 mils.

12.4 Finish. All metal components, after fabrication, shall be freed of weld spawls, excess weld and burrs. Parts shall be washed and rinsed with acid etch detergent and lacquer thinner solvent.

12.5 Exterior Color. An exterior colored finish shall be applied to all metal and aluminum components. All components shall be washed and rinsed with solvent to make ready for finish. Color finish shall be electrostatically applied polyester dry powder, oven cured at temperatures in excess of 400 degrees F. and conform to ASTM-B-117. NOTE: Urethane, lacquer and enamel paints are not acceptable.

13. MISCELLANEOUS.

13.1 Lettering. Lettering shall be provided as indicated on the drawings, and shall be black enamel, finished with a protective coating of spar varnish. Samples shall be approved before application.

14. SURFACES TO BE PAINTED. Surfaces listed in the PAINTING SCHEDULE, other than those listed in paragraphs: SURFACES NOT REQUIRING PAINTING and SURFACES FOR WHICH PAINTING IS PROHIBITED, will receive the surface preparation, paints, and number of coats prescribed in the schedule.

15. SURFACES NOT REQUIRING PAINTING. The following listed items will not require painting: Masonry walls. Shop painted items specified hereinafter.

16. SURFACES FOR WHICH PAINTING IS PROHIBITED. The following listed items shall not be painted: plumbing fixtures, light fixtures.

17. CLEANING. Cloths, cotton waste and other debris that might constitute a fire hazard shall be placed in closed metal containers and removed at the end of each day. Upon completion of the work, staging, scaffolding, and containers shall be removed from the site or destroyed in an approved manner. Paint and other deposits upon adjacent surfaces shall be removed and the entire job left clean and acceptable.

18. PAINTING SCHEDULE. The PAINTING SCHEDULE prescribes the surfaces to be painted, required surface preparation, and the number and types of coats of paint.

18.1 Shop-Painted Items. Surfaces of items finish-painted by the manufacturer, or specified to be finish-painted under other sections of the specifications, are exempted from the requirements for surface preparation and painting. Shop-primed items shall receive surface preparation and finish painting as required by this section.

PAINTING SCHEDULE

<u>Surface</u>	<u>Surface Preparation</u>	<u>1st Coat</u>	<u>2nd Coat</u>	<u>3rd Coat</u>
Interior exposed ferrous surfaces, unless otherwise specified, and interior underside of steel roof decking where exposed.	As previously specified.	TT-P-645	TT-E-489	TT-E-489
Ferrous surfaces of mechanical and electrical equipment that has been factory primed.	Solvent Clean as specified.	TT-E-489, Class A	TT-E-489, Class A	None
Interior concrete floors.	As previously specified.	Concrete floor sealer	Concrete floor sealer	
Electrical conduit runs metallic tubing, uninsulated pipes, pipe hangers, in areas having painted adjacent surfaces.	As previously specified.	TT-E-543 or TT-E-545 (a)	TT-E-506 or TT-E-505 (a)	None (a)

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SECTION 9B

STATION MARKING

Index

- | | |
|----------------------------|--|
| 1. Applicable Publications | 3. Station Marking |
| 2. Materials | 4. Tabulation of Station Marking Locations |

1. APPLICABLE PUBLICATIONS. The Federal Specification (Fed. Spec.) listed below forms a part of this specification to the extent referenced. The publication is referred to in the text by the basic designation only.

TT-P-115F

Paint, Traffic, Highway, White and Yellow

2. MATERIALS.

2.1 Paint.

2.1.1 Exterior Paint on Concrete shall conform to Fed. Spec. TT-P-115, except the color shall be non-fading black.

3. STATION MARKING.

3.1 Preparation of Surfaces. Concrete surfaces shall be thoroughly cleaned of all curing compound, efflorescence, dirt, oil or deleterious material by approved methods. The surface preparation shall be accomplished in such manner that paint will satisfactorily adhere to the surface.

3.2 Application. Painting shall be done in a neat and workmanship manner and may be applied by brush, spray, roller or any combination of these methods. Painting of numbers and letters shall be accomplished with stencils and brush and spray application. Color for letters and numbers shall be black. All markings on concrete shall be in uniform capital block letters and numbers, 6 inches high, 3 inches wide, and 3/4-inch wide of line. Markings on concrete walls shall be horizontal with the bottom of the marking 5 feet above the bottom (invert at walls) of the wall.

4. TABULATION OF STATION MARKING LOCATIONS.

Arizona Canal Diversion Channel

<u>Wall</u>	<u>Station</u>	<u>Test of Marking</u>
Left	550+00	55
Left	560+00	56
Left	570+00	57
Left	580+00	58
Left	590+00	59
Left	600+00	60
Left	610+00	61
Left	620+00	62
Left	630+00	63
Left	640+00	64
Left	650+00	65
Left	660+00	66
Left	670+00	67
Left	680+00	68
Left	690+00	69
Left	700+00	70
Left	710+00	71
Left	720+00	72
Left	730+00	73
Left	740+00	74
Left	750+00	75
Left	760+00	76
Left	770+00	77

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SECTION 11A

MISCELLANEOUS ITEMS OF WORK

Index

- | | |
|---|---|
| 1. Applicable Publications | 8. Playground Equipment |
| 2. Shop Drawings | 9. Playground Equipment List |
| 3. Drinking Fountains and Water Faucets | 10. Ramadas |
| 4. Trash Receptacles | 11. Signage |
| 5. Picnic Tables and Benches | 12. Bike Racks |
| 6. Softball Backstop | 13. Play Area Sand |
| 7. Cooking Grille | |

1. APPLICABLE PUBLICATIONS. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1 American Society for Testing and Materials (ASTM) Publications.

- | | |
|-----------|--|
| A 513-84a | Electric Resistance - Welded Carbon and Alloy Steel Mechanical Tubing |
| B 117-85 | Salt Spray (Fog) Testing |
| B 179-84 | Aluminum Alloys in Ingot Form for Sand Castings, Permanent Mold Castings, and Die Castings |
| B 26-86 | Aluminum-Alloy Sand Castings |
| B 108-85a | Aluminum-Alloy Permanent Mold Castings |

~~1.2 American Wood Preservers Bureau (AWPB).~~

- | | |
|--------------------|---|
| LP 2-80 | Softwood Lumber, Timber and Plywood Pressure Treated with Water-Borne Preservatives for Above Ground |
|--------------------|---|

~~1.3 Redwood Inspection Service (RIS).~~

~~Standard Specifications for Grades of California Redwood Lumber.~~

~~2. SHOP DRAWINGS. Shop drawings, along with catalog cuts, templates, and erection and installation details, as appropriate, for all miscellaneous items of work shall be submitted for approval in accordance with the "General Requirements." Submittals shall be complete in detail; shall indicate type, style, and dimensions; and shall show construction details, anchorage, and installation.~~

3. DRINKING FOUNTAINS AND WATER FAUCETS.

3.1 General. Drinking fountain assembly shall include the complete installation and provision of the following:

Drinking Fountain and Pedestal
Dry Well

3.2 Drinking Fountain and Pedestal. Drinking fountain and pedestal shall be manufactured by HAWS or approved equal. They shall be finished, sized, and installed as shown on drawings. Fountain shall contain integral satin chrome-plated anti-squirt bubbler mounted on a stainless steel receptor. Unit shall be equipped with pushbutton valve with automatic stream regulator and secured with vandal-resistant screws. Units shall be plumbed and mounted as per manufacturer's instructions.

~~3.3 Water faucets shall be installed as shown on the drawing.~~

~~3.4 Dry Well, Gravel and Piping. Dry well shall be gravel sump unit of size and installation shown on the drawings, and gravel shall be as required by SECTION: MISCELLANEOUS AGGREGATES. Piping shall conform to the applicable requirements of the SECTION: IRRIGATION SYSTEM.~~

4. TRASH RECEPTACLES.

4.1 Installation. Trash receptacles shall be installed as shown on the drawings complete with concrete base. Trash receptacles shall be 32 gallon exposed aggregate of the size and finish as indicated on the drawings and shall be manufactured by Form Products or an approved equal. The receptacle shall be constructed of reinforced concrete. Color shall be brown, and weigh 800 pounds.

~~5. PICNIC TABLES AND BENCHES.~~

~~5.1 Installation. Picnic tables and benches shall be installed as shown on the drawings complete with concrete base for tables and benches outside the ramadas.~~

~~5.2 Picnic tables and benches shall be as manufactured by DuMor, Inc., or equal. Concrete for the base shall conform to the requirements of SECTION: CONCRETE FOR BUILDING CONSTRUCTION. The standard rectangular picnic table is 71 inches long and the handicapped table is 99 inches long. The standard square table is 4 foot square. (Dimensions do not include seats). Wood is 4" x 6" select heart redwood for tables. The benches are 96 inches long. Wood is 4" x 4" clear heart redwood for benches.~~

6. SOFTBALL BACKSTOP.

6.1 Installation of the Softball Backstop shall be installed in the location shown on the drawings in accordance with manufacturers requirements and as detailed on the drawings.

7. BASKETBALL COURT - SEE Following Page

~~7. COOKING GRILLS.~~

~~7.1 Installation. Grills shall be installed as shown on the drawings and in accordance with the manufacturers requirements.~~

SECTION 11A:

DELETE 7. REPLACE WITH:

7. BASKETBALL COURT

7.1 The Basketball Court shall be installed in the location shown on the drawings in accordance with manufacturers requirements and as detailed on the drawings.

7.2 Grills shall be constructed of 3/16 inch plate steel with a baked on enamel finish color, black, supported on a 4 inch O.D. steel pipe of the same finish. Barbecues shall be as manufactured by DuMor #24-00 dual grill and #60-222 single grill or an approved equal.

8. ~~PLAYGROUND EQUIPMENT.~~

8.1 Installation. The play equipment shall be installed in the location shown on the drawings and in accordance with the manufacturers requirements.

8.2 The play equipment "A", "B", and "C" as indicated on the drawings shall be manufactured by Playworld or an approved equal and shall be constructed as follows.

8.2.1 Support Posts, Cross Rails, Swing Top Rails, Horizontal Ladder Rails, and Hand Treck Rail. These components shall be fabricated of 5" O.D. 11 gauge, A60 galvanealed exterior and interior steel tubing. Yield strength shall be 40,000 psi with a tensile strength of 45,000 psi. Tubing shall comply with ASTM A 513.

8.2.2 Decks. Available in the choice of:

- a. Square vinyl coated metal
- b. Triangular vinyl coated metal
- c. Rectangular with pine planks
- d. Rectangular with redwood planks

a. and b. Square and triangular expanded metal decks shall be a welded construction of expanded steel in a 1-1/2" x 2-1/2" angle iron frame. Entire weldment shall be coated with plastisol vinyl and oven cured to insure durability.

c. Pine deck planks shall be made from 4" x 6" nominal southern yellow pine kiln dried prior to being vacuum-pressure treated with Osmose K-33 in strict accordance with LP 2.

d. Redwood deck planks shall be made from 4" x 6" nominal heart (free of heart center) redwood that has a natural resistance to warping, checking, splitting, decay, and insect infestation. All redwood shall be supplied by mills that subscribe to the sustained yield concept put forth by the "Redwood Inspection Service."

8.2.3 Rails and Tie Rods. Deck support tie rods shall be fabricated of 1-5/16" outside diameter Schedule 40 (.109) galvanized inside and out steel tubing with a powder coated tan color finish. Other tie rods, ladder rungs, hand rungs, chinning/turning bar, activity barrier, pipe wall barrier, slide barrier, swinging bridge handrail, wood arch climber side rails and spiral climber mounting post shall be 1-5/16" outside diameter Schedule 20 (.085) galvanized inside and out steel tubing. Slide support legs and spiral climber assembly shall be 1-5/8" outside diameter Schedule 20 galvanized steel tubing. Sliding pole and rail slide shall be 1-7/8" outside diameter Schedule 20 galvanized steel tubing. Parallel bars, steel arch climber side rails, 'C' or 'S' horizontal rails and center leg supports along with the smaller model horizontal ladder rails shall be

constructed of 2-3/8" outside diameter Schedule 40 galvanized steel tubing. All 1-5/8", 1-7/8", and 2-3/8" outside diameter steel tubing shall be galvanized on both interior and exterior surfaces. All steel tubing shall comply with ASTM A 90 and ASTM B 1117. In addition, the 1-5/16" outside diameter tubing shall be cross hatched for improved traction and gripping ability.

8.2.4 Attachment Fittings. Pipe clamps, tee clamps, swing hangers, and deck hangers shall be cast of high-tensile strength 40-E alloy aluminum. They shall comply with ASTM B 179, ASTM B 26, and ASTM B 108. Pipe end caps and retainers shall also be cast from aluminum alloy. NOTE: All clamps shall be hinged on one side to facilitate installation. Swing hangers shall be fitted with oil impregnated bronze bearing.

8.2.5 Stainless Steel Slides. Stainless steel slide bedways are available in widths of 18" or 36" and shall be formed from one piece 16 gauge 304-2B stainless steel with continuous 1" O.D. stainless tubing welded to side channels for support. All 18" wide models shall have 1" O.D. stainless steel tubing hand rails welded to side channels at entry area.

8.2.6 Spiral Slides. (3, 5, and 6 segment) spiral slides shall be manufactured from Dupont's sclair polyethylene resin with impregnated color pigment which is impervious to ultraviolet rays and will not fade or change color. Slide shall be reinforced with a solid support web structure, leaving no sharp corners or exposed metal edges. Center support post shall be 3-1/2" O.D. galvanized steel pipe. Transition step platform (5 and 6 segment models only) shall be fabricated of 14 gauge steel tread plate and 1-5/16" O.D. Schedule 20 galvanized steel tubing. Handrails and sit down bar shall also be fabricated of 1-5/16" O.D. steel tubing with 1-5/8" O.D. Schedule 40 fittings.

8.2.7 Roller Slides. Side rails shall consist of 3-1/2" O.D. Schedule 20 galvanized steel tubing with a welded on 1/4" x 2" continuous flat steel bolting plate. Rollers shall be 1-7/8" O.D. Schedule 20 galvanized steel tubing with plastic bearings on each end. Roller shafts shall be 1/2" diameter zinc plated steel rod. Rollers and side rails shall have a powder coated finish.

8.2.8 Structural Plastic Parts. Wall panels, tube slides, crawl tubes, tunnel climber and plastic slide chutes shall be high density cross linked polyethylene which is imperivous to ultraviolet rays and will not fade or change color. They shall have tensile strength of 2,600 psi at 2 inch minutes. Bubble section of wall panel shall be formed of clear lexan plastic.

8.2.9 Track Glide. Hand grip design shall be cast tenzallooy aluminum. Track glide top rail assembly shall be fabricated of 3-1/2" O.D. 13 gauge galvanized pipe and welded on 10 gauge formed steel plate. Trolley and trolley eye shall be zinc plated steel with plastic rollers.

8.2.10 Chain. All chain (with the exception of chain for swinging bridge) shall be available in a choice of 4/0 galvanized finish or 5/0 plastisol vinyl coated to a thickness of 80 to 100 MILS. Swinging bridge chains shall be 5/16" galvanized finish.

8.2.11 Belt and Tot Swining Seats. Seats shall be made of pliable molded rubber enclosing spring steel core rendering them slash proof. All fittings are hot dipped galvanized.

8.2.12 Enclosed Metal Steps. Step section and step mounting platform shall be formed of 14 gauge galvanized steel tread plate. Step side channels shall be fabricated of 14 gauge galvanized steel and handrails shall be constructed of 1-5/16" O.D. Schedule 20 galvanized steel tubing.

8.2.13 Mounting Brackets. Brackets for stainless steel slides, wood arch bridge, chain net climbers and roller slides shall be fabricated of formed steel and hot dipped galvanized finish.

8.2.14 Finish. All metal components, after fabrication, shall be freed of weld spawls, excess weld and burrs. Parts shall be washed and rinsed with Oakite 33 and then with Berkley #909 solvent.

8.2.15 Exterior Color. An exterior colored finish shall be applied to all metal and aluminum components. All components shall be washed and rinsed with Oakite 33 and Berkley #909 to make ready for finish. Color finish shall be electrostatically applied polyester dry powder, oven cured at temperatures in excess of 400°F and conform to ASTM B 117. NOTE: Urethane, lacquer and enamel paints are not acceptable.

8.2.16 Hardware. All connecting hardware such as bolts, nuts, set screws, etc., shall be zinc plated steel. NOTE: Capped locknuts which cover the ends of bolt shafts shall be supplied. Tamper proof bolts shall be supplied for all clamp assemblies.

8.2.17 Installation Instructions. Explicit installation instructions shall be provided, which will include detailed scale top view and footing drawings plus written instructions to assure proper installation of the "Playmakers" structure.

9. PLAYGROUND EQUIPMENT LIST.

9.1 Playmaker #500-1278 All Steel Playstructure Playset "C" on Plans, with following exceptions. Replace tube slide and steel slide with #500-48WSL Plastic wave slide with runout, remove 2 unit swing and replace with tire swing #500-01TSW, replace redwood decks with expanded metal decks #500-00DK, replace redwood swing bridge with expanded metal planks #1-500-00BRG.

9.2 Play design #CR-800 free standing polyethylene spiral slide.

9.3 Playworld System #0266, 6 unit heavy duty swing with 3-1/2 O.D. top rail and tripod legs, 12' high.

9.4 Burke #C-299 Giraffe Climber.

9.5 Playworld Systems #0388 Super Dome.

9.6 Playmaker #1-500-978 Playstructure Playset "A" on plans replace redwood deck with expanded metal decks, remove balance beams, replace tube slide with #500-48WSL plastic wave slide with runout, replace 2 wood walls with 2 #500-03BBL poly panel with bubble.

9.7 Playworld #0264, heavy duty swing with 4 seats, 10' high, 3-1/2 O.K. top rail with tripod legs.

- 9.8 Playworld #0602 Critter Bounce with Aluminum Turtle, Duck, and Chipmunk.
- 9.9 Playworld #0389 Arch Climber, Powder Coated Paint, 4' high.
- 9.10 Playworld #0390 Arch Climber, Powder Coated Paint, 6' high.
- 9.11 Playdesign #238-540 Parallel Bars with Balance Platform.
- 9.12 Playdesign #238-520 Freestanding crawl tube.
- 9.13 Playdesign #PD-015 Playdome 4' high.
- 9.14 Playdesign #PG-650 Playglobe.
- 9.15 Mexico Forge #1400 Tumble Gym.
- 9.16 Challenger All Steel Playstructure #1-350-248, Playset "B" on plans, replace belt seats with full back #BJ-1030 toddler seat, replace steel slide with #350-48WSL plastic wave slide with runout, all coated chain. Replace fireman's pole with #350-48EMS enclosed metal steps with 48" deck.
- 9.17 Playworld #051D Pony, Aluminum Spring Animal With "C" Spring.
- 9.18 Playworld #0512 Turtle, Aluminum Spring Animal With "C" Spring.
- 9.19 Playworld #0526, Panda, Aluminum Spring Animal With "C" Spring.
- 9.20 Play Designs #PCE-04 Play Coach.
- 9.21 PCA #382-401 wheelchair swing with platform and pullchain.
- 9.22 Patterson-Williams #2943-A Tot Twosome swing.
- 9.23 Guarantee. Guarantee all materials and workmanship excluding vandalism and abnormal use for a period of one year after complete installation and final approval by the Contracting Officer.
10. RAMADAS.
- 10.1 Ramadas shall be as manufactured by Huzzard or an approved equal, all steel scenic shelters, 24 x 24. Concrete footings and slab shall conform to the requirements of SECTION: CONCRETE FOR BUILDING CONSTRUCTION.
- 10.2 Guarantee. Guarantee all materials and workmanship excluding vandalism and abnormal use for a period of one year after complete installation and final approval by the Contracting Officer.
11. SIGNAGE.
- 11.1 Metal signs. All signs shall be installed as shown on the drawings. Concrete shall conform to the requirements of SECTION: CONCRETE FOR BUILDING CONSTRUCTION. Metal shall conform to the requirements of SECTION: MISCELLANEOUS METALS. Paint shall conform to the requirements of SECTION: PAINTING, GENERAL.

12. BIKE RACKS.

12.1 Bike racks shall be installed as located and detailed on the plans.

13. PLAY AREA SAND.

13.1 Play area sand shall be a clean, washed concrete sand, installed after the play equipment is installed, to a depth of 8 inches as indicated in the drawings.

* * * * *

SECTION 16A

ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

Index

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|--------------------------------------|----------------------------------|
| 1. Applicable Publications | 8. Duct Lines |
| 2. General Requirements | 9. Transformer Stations |
| 3. Submittals | 10. Lighting |
| 4. Materials and Components | 11. Concrete Pullboxes/Handholes |
| 5. General Installation Requirements | 12. Grounding |
| 6. Cables, General Requirements | 13. Tests |
| 7. Low-Voltage Cables | 14. Painting and Finishing |

1. APPLICABLE PUBLICATIONS. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1 Military Specification (Mil. Spec.).

DoD-P-21035A

Paint, High Zinc Dust Content,
Galvanizing Repair (Metric)

1.2 Federal Specifications (Fed. Spec.).

W-F-1814A/GEN
& Suppl 1

Fuses, Cartridge, High-Interrupting
Capacity

W-S-610C
& Am-1

Splice Conductor

FF-P-101

Radlocks

1.3 American Association of State Highway and Transportation Officials (AASHTO) Publications.

Standard Specifications for Highway Bridges (1983, 13th Ed.;
Interim Specifications - Bridges 1984)

LTS-1

Structural Supports for Highway
Signs, Luminaires, and Traffic
Signals (1975, 1st Ed.; with
Revisions contained in HB-12
Interim Specs 1978 & 1979)

1.4 American National Standards Institute, Inc. (ANSI) Standards.

C2-1984

National Electrical Safety Code

C12.1-1982

Code for Electricity Metering

C12.4-1984

Mechanical Demand Registers

C12.10-1978

Watt-hour Meters

C37.31-1962	Indoor Apparatus Insulator Electrical and Mechanical Characteristics
C78.380-1984	Method for the Designation of High-Intensity Discharge Lamps
C80.1-1983	Rigid Steel Conduit - Zinc Coated
C82.4-1985	Ballasts for High-Intensity- Discharge and Low-Pressure Sodium Lamps (Multiple Supply Type)
C119.1-1974	Sealed Insulated Underground Connector Systems Rated 600 Volts
C136.2-1985	Voltage Classification of Luminaires Used in Roadway Lighting Equipment
C136.3-1984	Luminaire Attachments Used in Roadway Lighting Equipment
C136.6-1984	Interchangeability of Metal Heads and Reflector Assemblies Used in Roadway Lighting Equipment
C136.9-1984	Mechanical Interchangeability of Socket Support Assemblies for Use in Metal Heads Used in Roadway Lighting Equipment
C136.10-1979	Physical and Electrical Interchangeability of Photocontrol Devices, Plugs, and Mating Receptacles Used in Roadway Lighting Equipment
C136.11-1979	Multiple Sockets Used in Roadway Lighting Equipment
C136.14-1980	Enclosed Side-Mounted Luminaires for Horizontal-Burning High-Intensity Discharge Lamps Used in Roadway Lighting Equipment
C136.15-1980	Field Identification of High- Intensity Discharge and Low- Pressure Sodium Lamps in Luminaires Used in Roadway Lighting Equipment
Z35.1-1972	Accident Prevention Signs

1.5 American Society for Testing and Materials (ASTM) Publications.

A 123-84	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 153-82	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
B 8-81	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
B 117-85	Salt Spray (Fog) Testing
D 1654-79a (R 1984)	Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

1.6 Factory Mutual System (FM) Publication.

Approval Guide (Equipment, Materials, Services for Conservation of Property) 1986 with Quarterly Supplements

1.7 Illumination Engineering Society (IES) Publication.

RP-8-1983 Roadway Lighting

1.8 Institute of Electrical and Electronics Engineers (IEEE) Standard.

No. 142-1982 Recommended Practice for Grounding of Industrial and Commercial Power Systems

1.9 National Electrical Manufacturers Association (NEMA) Standards.

AB 1-1975 (R 1981) Incl Rev 1 thru 3	Molded Case Circuit Breakers
FB 1-1983 (R 1984)	Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
PB 1-1984	Panelboards
PB 2-1984	Deadfront Distribution Switchboards
SG 3-1981	Low-Voltage Power Circuit Breakers
SG 5-1981	Power Switchgear Assemblies
TC 6-1983	PVC and ABS Plastic Utilities Duct for Underground Installation

1.10 National Fire Protection Association (NFPA) Standard.

70-1987
& Errata
& Int Am 70-87-2

National Electrical Code

1.11 Underwriters Laboratories Inc. (UL) Publications.

Electrical Construction Materials Directory (May 1986 with Quarterly Supplements)

UL 6	Rigid Metal Conduit (Oct 23, 1981, 9th Ed.; Rev Oct 10, 1983; Errata Aug 29, 1986)
UL 198E	Class R Fuses (Apr 22, 1982, 3rd Ed.; Rev thru Feb 19, 1985)
UL 467	Grounding and Bonding Equipment (Nov 22, 1984, 6th Ed.; Rev thru Apr 30, 1985)
UL 486A	Wire Connectors and Soldering Lugs for Use with Copper Conductors (Nov 24, 1980, 7th Ed.; Rev thru Feb 19, 1987)
UL 486B	Wire Connectors for Use with Aluminum Conductors (Apr 13, 1982, 2nd Ed.; Rev thru Feb 18, 1986)
UL 489	Molded-Case Circuit Breakers and Circuit-Breaker Enclosures (Oct 15, 1980, 6th Ed.; Rev thru Jan 2, 1986)
UL 514	Outlet Boxes and Fittings (May 14, 1979, 6th Ed.; Rev thru Jun 1, 1982)
UL 854	Service-Entrance Cables (Feb 9, 1987, 7th Ed.; Rev thru Feb 10, 1987)
UL 1242	Intermediate Metal Conduit (Oct 10, 1983, 1st Ed.; Rev Apr 10, 1986)

2. GENERAL REQUIREMENTS. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2.1 Code Compliance. The installation shall comply with the requirements and recommendations of NFPA No. 70 and ANSI C2.

2.2 Standard Product. Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

2.3 Nameplates. Each major component of equipment shall have as a minimum the manufacturer's name, address, and catalog or style number on a nameplate securely attached to the item of equipment. Nameplates for individual items of electrical equipment shall be as specified in referenced publications and shall be provided on each item of equipment.

2.4 Prevention of Corrosion.

2.4.1 Metallic materials shall be protected against corrosion as specified. Aluminum shall not be used in contact with earth or concrete. Where aluminum conductors are connected to dissimilar metal, fittings conforming to UL 486B shall be used.

2.4.2 Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 123 and A 153.

2.4.3 Luminaires fabricated from ferrous metals, unless hot-dip galvanized or of porcelain enamel finish, shall be factory finished with a weather-resistant finish in accordance with paragraph PAINTING AND FINISHING, except exposure shall be 200 hours. Finish color shall be the manufacturer's standard, unless otherwise indicated.

2.5 Unusual Service Conditions. Items furnished under this section shall be specifically suitable for the following unusual service conditions.

2.5.1 Altitude. 1500'.

2.5.2 Ambient Temperature. 90°F.

2.5.3 Wind Velocity. 70 mph.

2.6 Verification of Dimensions. The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

3. SUBMITTALS.

3.1 Proof of Compliance. Where materials or equipment are specified to conform to the standards or publications, and requirements of AASHTO, ANSI, ASTM, AEIC, FM, IEEE, IES, NEMA, NFPA, or UL, or to conform to a Fed. Spec., the Contractor shall submit proof that the items furnished under this section of the specifications conform to the specified requirements. The label of, or listing in the Electrical Construction Materials Directory of UL or listing in the Approval Guide of FM or the manufacturer's certification or published catalog specification data statement that the items comply with applicable specifications, standards, or publications and with the manufacturer's standards will be acceptable evidence of such compliance.

3.2 Shop Drawings. After receiving complete material lists and before installation of any of these items, the Contractor shall submit complete shop drawings and such other descriptive data as the Contracting Officer may require to demonstrate compliance with the contract documents as required by the CONTRACT CLAUSES and the SPECIAL CLAUSES. Shop drawings shall be submitted for the following items and such other items as the Contracting Officer may direct.

- a. Service Entrance Section.
- b. Secondary panel boards.
- c. Parking Lot/Area lighting luminaires, mounting brackets, poles, and pole bases.
- d. Handholes.
- e. Cable.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures, including changes in related portions of the project and the reasons therefore, shall be submitted with the shop drawings. Approved departures shall be made at no additional cost to the Government.

3.3 List of Equipment and Materials. A complete itemized listing of equipment and materials proposed for incorporation into the work shall be submitted. Each such itemization shall include an item number, the quantity of items proposed, the name of the manufacturer of each such item.

3.4 Instruction Manuals. Six copies of instruction manuals shall be furnished within 7 calendar days following the completion of factory tests and shall include assembly, installation, operation and maintenance instructions, spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked and all documents previously submitted and approved. Manuals shall also include data outlining step-by-step procedures for system startup and operation, and a troubleshooting guide which lists possible operational problems and corrective action to be taken. A brief description of all equipment and their basic operating features shall also be included. Documents shall be bound in a suitable binder adequately marked or identified on the spine and front cover. A table of contents page shall be included and marked with pertinent contract information contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets shall be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers. Three additional copies of the instruction manuals shall be submitted within 30 calendar days following the approval of the manuals.

3.5 Manufacturer's Certifications.

3.5.1 Certificates of Compliance. Certificates shall be prepared by the manufacturers when the manufacturer's published data or drawings do not indicate conformance with other requirements of these specifications.

3.5.2 Certified Factory Test Reports. Certified factory test reports shall be submitted when manufacturers perform routine factory tests normally performed by the manufacturer, including tests required by standards listed in paragraph: APPLICABLE PUBLICATIONS. Additional certification is required to verify each transformer has passed a production line impulse test consisting of one reduced-wave and one full-wave lightning impulse test on each fully-insulated high-voltage terminal.

3.6 Contractor's Data. The Contractor shall submit the following types of data to supplement the manufacturer's data and drawings and Contractor's drawings.

3.6.1 Certifications. Certifications shall be submitted when specified or required, including Certified Factory and Field Test Reports, and Certificates of Compliance submitted in lieu of other proofs of compliance with these contract provisions.

3.6.2 Certified Field Test Reports. Field tests shall be made and test reports shall be written and certified by the Contractor to the Contracting Officer. Field tests shall include cable, operational, and resistance-to-ground tests.

~~3.6.3 Protective Coordination Study. The Contractor shall prepare and submit a protective coordination study within 30 calendar days following the approval of circuit protective devices, including circuit breakers, fuses, overloads, and protective relays. The study shall include calculations and composite time-current characteristic coordination curves to demonstrate proper coordination of protective devices to be installed to protect equipment and conductors against fault currents and sustained overload conditions for conductors and equipment installed under this contract. The study shall further indicate proper coordination with existing protective devices associated with the supply of power to equipment provided under this contract. Additionally, the study shall include the proper settings of adjustable circuit breakers and protective relays and any timers associated with the protection of equipment and conductors required by this contract. The Contractor shall test and calibrate all protective devices in accordance with the manufacturers' specification prior to making the proper device setting and before the initial energization of the conductors and equipment. Field settings of adjustable protective devices shall be shown on electrical drawings that show the proper wiring of the protective devices and the rating and wiring on nonadjustable protective devices.~~

3.7 Contractor's Drawings. The Contractor shall submit drawings as required to supplement contract drawings, manufacturer's data and drawings, and Contractor's data to demonstrate compliance with applicable contract requirements. Drawings shall be dimensioned or scaled to show the relative arrangement and mounting details of the equipment or equipment assemblies.

4. MATERIALS AND COMPONENTS. Materials and equipment shall conform to the following requirements.

4.1 Cables. Cables shall be of annealed copper, except that 1350 alloy aluminum conductors may be used as an equivalent for copper conductors of No. 6 AWG and larger. Intermixing of copper and aluminum conductors in these sizes is not permitted, except at connections to conductors not provided under this contract. Design is based on copper conductors and aluminum conductors shall have an ampacity not less than that of the indicated copper conductors. Cables shall be single-conductor type, unless otherwise indicated.

4.1.1 Low-Voltage Cables. Low-voltage cables shall conform to UL 854 for Type USE service entrance cable and shall utilize either cross-linked, thermosetting-polyethylene or ethylene-propylene-rubber insulation.

4.1.2 Grounding Cables. Grounding cables shall be bare, except where installed in conduit with associated phase conductors. Insulated cable shall be of the same material, green color-coded, and shall be insulated to match associated phase conductors, except that cable need be rated no more than 600 volt. Bare cables shall be ASTM B 8 soft-drawn unless otherwise indicated; aluminum is not acceptable.

4.2 Cable Connectors.

4.2.1 Connectors for Low-Voltage Cables. Fed. Spec. W-S-610; UL 486A for copper conductors and UL 486B for aluminum conductors; and ANSI C119.1 for sealed insulated connectors.

4.3 Concrete. Concrete shall be 2500 psi at 28 days.

4.4 Conduit and Fittings, Steel.

4.4.1 Conduit, Intermediate Metal. UL 1242.

4.4.2 Conduit, Rigid. ANSI C80.1 and UL 6.

4.4.3 Conduit Outlets and Fittings. NEMA FB 1, and UL 514.

4.5 Duct and Conduit Calking Compound. Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 35 degrees F., shall not slump at a temperature of 300 degrees F., and shall not harden materially when exposed to the air. Compounds shall readily calk or adhere to clean surfaces of asbestos-cement, fiber, or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials.

4.6 Duct and Fittings, Nonmetallic Type for Installation Underground. Wall thicknesses and fittings shall be suitable for the application. Ducts shall be single, round-bore type. Ducts shall be of the same material when used for applications requiring the same type of wall thickness.

4.6.1 Plastic. NEMA TC 6. Conduit fittings shall conform to the applicable NEMA standards, except that where NEMA standards for conduit fittings do not exist for the type of plastic installed, fittings shall be as recommended by the conduit manufacturer.

4.7 Grounding and Bonding. Equipment, UL 467. Wire, ASTM B 8, softdrawn copper. All connections below grade shall be fusion welded. Connections above grade shall be fusion welded or connectors in accordance with UL 467.

4.8 Lamps and Ballasts, High-Intensity-Discharge Type. Lamps shall be suitable for the burning position utilized. Ballasts shall conform to ANSI C82.4; shall be coordinated to the lamp the ballast supplies; shall be rated for the voltage indicated; and shall have a power factor of not less than 90 percent, a crest factor of 2.0 or less, and a voltage range of not less than plus or minus 10 percent. Ballasts shall be suitable for operating at 5 degrees F. and above.

4.8.1 High-Pressure Sodium Lamps. ANSI C78.380, installed where indicated.

4.9 Luminaire Components, Parking Lot/Area Lighting.

4.9.1 Luminaires. Attachments, ANSI C136.3. Classification, ANSI C136.2. Field identification marking, ANSI C136.15. Interchangeability, ANSI C136.6 for metal heads and reflectors, and ANSI C136.9 for sockets. Luminaires, side-mounted, ANSI C136.14. Sockets, ANSI C136.11.

4.9.2 Photo-Control Devices. ANSI C136.10.

4.10 Nameplates. Nameplates shall be made of corrosion-resistant metal with not less than 1/4-inch tall raised or engraved characters. The nameplate shall be mounted on the front of the enclosure.

4.11 Padlocks. Padlocks shall conform to Fed. Spec. FF-P-101, size 3-1/2 minimum.

4.12 Poles.

4.12.1 Metal. Poles shall be steel or aluminum.

4.13 Protective Apparatus and Metering Devices.

4.13.1 Circuit Breakers, Low-Voltage. Power, NEMA SG 3; molded-case, NEMA AB 1 and UL 489.

4.13.2 Fuses, Low-Voltage, Current-Limiting Types. Fed. Spec. W-F-1814, Class L or UL 198E, Class R.

4.13.3 *SEE Following Page*

~~4.13.3 Watthour Meters. ANSI C12.1 and C12.10, except numbered terminal wiring sequence and case size may be the manufacturer's standard. Watthour meters shall be of the drawout switchboard type having a 15-minute, cumulative form, demand register meeting ANSI C12.4 and provided with not less than two and one-half stators. Watthour demand meters shall have factory-installed electronic pulse initiators meeting the requirements of ANSI C12.1. Pulse initiators shall be solid-state devices incorporating light-emitting diodes, phototransistors, and power transistors, except that mercury-wetted output contacts are acceptable. Initiators shall be totally contained within watthour demand meter enclosures, shall be capable of operating up to speeds of 500 pulses per minute with no false pulses, and shall require no field adjustments. Initiators shall be calibrated for a pulse rate output of one pulse per 1/4 disc revolution of the associated meter and shall be compatible with the indicated equipment.~~

4.13.4 Panelboards. NEMA PB 1.

4.13.4.1 All panelboards shall be equipped padlock attachments.

INSERT PARAGRAPH 4.13.3

4.13.3 WATTHOUR METERS. ALL METERS WILL BE FURNISHED AND INSTALLED BY THE UTILITY COMPANY. THE CONTRACTOR SHALL PROVIDE METER SOCKETS TO MEET UTILITY COMPANY REQUIREMENTS.

4.13.5 Switchboard, Dead-Front Distribution Type. NEMA PB 2.

~~4.13.6 Switchgear, Metal-Enclosed Low-Voltage Power Circuit Breaker Type. NEMA SC 5.~~

4.13.7 Control Cabinets NEMA 3R construction and equipped with padlock attachments.

4.14 Warning Signs, High-Voltage. ANSI Z35.1, porcelain enameled steel or approved equal.

5. GENERAL INSTALLATION REQUIREMENTS. Steel conduits installed underground shall be installed and protected from corrosion in conformance with the requirements of SECTION: ELECTRICAL WORK, INTERIOR. Except as covered herein, excavation, trenching, and backfilling shall conform to the requirements of SECTION: EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Concrete work shall conform to the requirements of SECTION: CONCRETE.

6. CABLES, GENERAL REQUIREMENTS. The type of installation, sizes, and number of cables shall be as indicated. Conductors larger than No. 8 AWG shall be stranded. Each circuit shall be identified by means of fiber, laminated plastic, or nonferrous-metal tags, or approved equal, each handhole, each junction box, and at each terminal. Loads shall be divided as evenly as practicable on the various phases of the system. Manufacturer's written recommendations shall be furnished for each type of splice, and for fireproofing application methods, and shall be approved before any work is done. Compounds and tapes shall be electrical grade suitable for the cable insulation provided and shall use design materials and techniques recommended by the manufacturer. Maximum length of cable pull and cable pulling tensions shall not exceed the cable manufacturer's recommendations.

6.1 Duct Line Installation. Cables shall be installed in duct lines. Cable splices in low-voltage cables shall be made in handholes only. Neutral and ground conductors shall be installed in the same duct with their associated phase conductors.

6.2 Connection to Buildings. Cables shall be extended into the various buildings as indicated, and shall be properly connected to the first applicable termination point in each building. Interfacing with building interior conduit systems shall be at conduit stubouts terminating 5 feet outside of a building and 2 feet below finished grade as specified and provided under SECTION: ELECTRICAL WORK, INTERIOR. After installation of cables, conduits shall be sealed with caulking compound to prevent entrance of moisture or gases into buildings.

7. LOW-VOLTAGE CABLES. Cable shall be rated 600 volts. Other parts of cable systems such as splices and terminations shall be rated at not less than 600 Volts. Splices in wires No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, Type I, Class 1, Grade B, Style G, or Type II, Class 1 of Fed. Spec. W-S-610 and conforming to the applicable requirements of UL 486A. Splices in wires No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, Type II, Class 2 of Fed. Spec. W-S-610, conforming to the applicable requirements of UL 486A and UL 486B. They shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket. All splices below grade or in wet locations shall be

sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

8. DUCT LINES. Duct lines shall be nonencased direct-burial, thick-wall type. Communication lines run elsewhere may be direct-burial, thick-wall type.

8.1 Requirements. Numbers and sizes of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 4 inches per 100 feet. Depending on the contour of the finished grade, the high-point may be at a terminal, a handhole, or between handholes. Manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 18 inches for ducts of less than 3-inch diameter, and 36 inches for ducts 3 inches or greater in diameter. Both curved and straight sections may be used to form long sweep bends as required, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells whenever duct lines terminate in manholes or handholes. Duct line markers shall be provided as indicated at the ends of long duct line stubouts or for other ducts whose locations are indeterminate because of duct curvature or terminations at completely below-grade structures. In lieu of markers, a 5-mil brightly colored plastic tape not less than 3 inches in width and suitably inscribed at not more than 10 feet on centers with a continuous metallic backing and a corrosion resistant 1-mil metallic foil core to permit easy location of the duct line, shall be placed approximately 12 inches below finished grade levels of such lines.

8.2 Treatment. Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. After a duct line is completed, a standard flexible mandrel shall be used for cleaning followed by a brush with stiff bristles. Mandrels shall be at least 12 inches long and have diameters 1/4 inch less than the inside diameter of the duct being cleaned. Pneumatic rodding may be used to draw in lead wires. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

~~8.3 Concrete Encasement. Each single duct shall be completely encased in concrete with a minimum of 3 inches of concrete around each duct, except that only 2 inches of concrete are required between adjacent electric power or adjacent communication ducts and 4 inches of concrete shall be provided between adjacent electric power and communication ducts. Duct line encasements shall be monolithic construction. Where a connection is made to a previously poured encasement, the new encasement shall be well bonded or doweled to the existing encasement. Separators or spacing blocks shall be made of steel, concrete, plastic, or a combination of these materials placed not further apart than 4 feet on centers. Ducts shall be securely anchored to prevent movement during the placement of concrete and joints shall be staggered at least 6 inches vertically.~~

8.4 Nonencased Direct-Burial. Top of duct lines shall be not less than 24 inches below finished grade. Ducts shall be installed with a minimum of 3 inches of ~~earth~~ *sand or stone free earth* around each duct, except that between adjacent electric power and

sand or stone-free

communication ducts, 12 inches of earth is required. Bottoms of trenches shall be graded toward handholes and shall be smooth and free of stones, soft spots, and sharp objects. Where bottoms of trenches comprise materials other than sand or stone-free earth, 3-inch layers of sand or stone-free earth shall be laid first and compacted to approximate densities of surrounding firm soil before installing ducts in direct-contact tiered fashion. Joints in adjacent tiers of duct shall be vertically staggered at least 6 inches. The first 4-inch layer of backfill cover shall be sand or stone-free earth compacted as previously specified. Duct banks may be held in alignment with earth. However, high-tiered banks shall use a wooden frame or equivalent form to hold ducts in alignment prior to backfilling. Selected earth at duct banks shall be thoroughly tamped in 4- to 6-inch layers.

8.5 Installation of Couplings. Joints in each type of duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected and as approved. In the absence of specific recommendations, various types of duct joint couplings shall be made watertight as specified.

8.5.1 Plastic Duct. Duct joints shall be made by brushing a plastic solvent cement on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick one-quarter-turn twist to set the joint tightly.

8.6 Ground Rods. In each handhole, at a convenient point close to the wall, ~~a one-inch by 10-foot galvanized steel ground rod having a zinc coating in accordance with Class B-1 materials in Table I of ASTM A 153 or a 3/4-inch by 8-foot copper-clad steel ground rod shall be driven into the earth.~~ When precast concrete handholes are used, the top of the ground rod may be below the floor and a No. ~~20~~ AWG tinned ground conductor brought into the handhole through a watertight sleeve in the handhole wall. This ground rod shall be utilized to ground fixture poles as indicated.

8

will be provided by the utility. P. 1-

9. TRANSFORMER STATIONS. Transformer stations ~~shall be of the outdoor type having the ratings and arrangements indicated.~~

9.1 Installation. Low Voltage Transformers shall be mounted on concrete pads. Units shall be carefully installed so as not to scratch finishes. After installation, finished surfaces shall be inspected and scratches touched up with a finish furnished by the manufacturer especially for this purpose.

9.1.1 Concrete Pads. Concrete pads shall be constructed as indicated. Tops of concrete pads shall be level and shall project 4 inches above finished paving or grade and sloped to drain. Conduits for primary, secondary, and grounding conductors shall be set in place prior to pouring of concrete pads.

9.1.2 ~~Padlocks~~ Padlocks shall be provided, all electrical panels, ~~and for each fence gate.~~

FOR

10. LIGHTING.

10.1 Parking Lot/Area Lighting Luminaires. Luminaires shall be of the enclosed type each consisting of a cast aluminum housing, a finished aluminum reflector for corrosion protection, an enclosing glass refractor or globe providing the indicated IES RP-8 type light distributions, and a slip-fitter capable of adapting

to 1-1/4 inch through 2-inch mounting brackets. Luminaire heads shall have standard dimensions suitable for interchangeable, standard optical assemblies. Heads shall be internally wired and rated 600 volts. Where indicated, luminaires shall be equipped with weatherproof plug-in or twist-lock receptacles to receive photo-control elements. Lamps shall be of the sizes and types indicated and provided with appropriate ballasts.

10.2 Vandal-Resistant Construction. Where indicated, luminaires shall be provided with vandal-resistant construction. Exposed diffusers, reflectors, or refractors shall be of a polycarbonate resin, except that other material may be used if protected by a polycarbonate resin shield or cast metal guard. Luminaires mounted 15 feet and less above grade shall have exposed screws of the tamper-resistant type.

10.3 Photo-Control. Where indicated, luminaires shall be individually controlled by a photo-control element mounted on the luminaire. Each photo-control element shall have an adjustable operating range of approximately 0.5 to 5.0 footcandles and shall be mounted in a replaceable, weatherproof, plug-in or twist-lock assembly.

10.4 Time-Control. Where indicated, luminaires shall be group controlled by astronomic, electrically wound time switches having 20-minute carry-over features and automatic adjustment provisions to allow for seasonal changes of sunset and sunrise. Adjustable settings shall allow turning on either 20 or 40 minutes before or after sunset, in addition to sunset, and adjustable off positions shall allow turning off from 8.30 p.m. to 2.30 a.m., in addition to sunrise. Three-position key-operated control switches marked ON, OFF, and AUTOMATIC shall be provided for override of time-control systems. Time switches may directly control opening and closing of lighting circuits if switches provided have an adequate rating. Where switches do not have such a rating, contactors of adequate rating and of the required number of poles shall be provided. Time-control equipment assemblies shall be mounted integrally in an enclosure suitable for outdoor operation.

10.5 Poles. Lighting poles shall be a nominal 20 and 30 feet in length of aluminum, steel, as indicated. Poles shall be suitable for use with underground supply conductors. Poles shall be designed for a wind velocity of 100 mph at the base of the pole, for a wind gust factor of 1.3, and for the height and drag factors recommended by AASHTO LTS-1. The effective projected area of luminaires and other pole-mounted devices shall be taken into account in pole design. Poles shall have grounding provisions. Bases shall be of the anchor-bolt-mounted type. The type of pole shaft material provided shall not be mixed on any project.

10.5.1 Aluminum Poles. Aluminum poles and aluminum brackets shall have a uniform satin finish and shall not be painted.

10.5.2 Steel Poles. Steel poles and steel brackets shall be hot-dip galvanized in accordance with ASTM A 123 and shall not be painted.

10.5.3 Pole Setting. Poles shall be mounted on cast-in-place foundations. Conduit ells shall be provided for cable entrances into pole interiors.

10.5.3.1 Cast-In-Place Foundations. Concrete foundations, sized as indicated, shall have anchor bolts accurately set in foundations using templates supplied by the pole manufacturer. After the concrete has cured, pole anchor bases shall be set on foundations and leveled by shimming between anchor bases and foundations or by setting anchor bases on leveling nuts and grouting. Poles shall be set plumb. Anchor bolts shall be the manufacturers' standard, and not less than necessary to meet the pole wind loading specified herein and other design requirements.

11. CONCRETE PULLBOXES/HANDHOLES. Concrete ~~pullboxes and~~ handholes shall consist of precast reinforced concrete boxes, extensions, bases, and covers. Concrete reinforcing shall be that which is regularly used in the standard products of the manufacturer. Pullbox tops shall be flush with sidewalks or curbs or placed 1/2-inch above surrounding grades when remote from curbed roadways or sidewalks. Covers shall be marked Low-Voltage and provided with ~~two lifting eyes and~~ two hold-down bolts. Each box shall have a suitable opening for a ground rod. Conduit, cable, ground rod entrances, and unused openings shall be sealed with mortar. In paved areas, frames and covers for handhole entrances in vehicular traffic areas shall be rated for H20 wheel loads in accordance with AASHTO Standard Specifications for Highway Bridges, and top of covers shall be flush with the finished surface of the paving.

12. GROUNDING. Neutral conductors, ~~cable shields, metallic cable sheaths and armor,~~ metallic conduits, cable terminations, junction boxes, poles, ~~surge arresters, fencing enclosing~~ electrical equipment, and other noncurrent-carrying metallic parts of equipment shall be grounded.

12.1 General Requirements. A resistance of not greater than 25 ohms shall be provided, unless otherwise specified. Ground resistances shall be measured in normally dry conditions not less than 48 hours after rainfall. Resistances of systems requiring separate ground rods, rather than a counterpoise, shall be measured separately before bonding below grade. The combined ground resistance of separate systems bonded together below grade may be used to meet the specified ground resistance, but the minimum number of rods indicated must still be provided.

12.1.1 Ground Rods. Ground rods shall be copper-clad steel, and shall be not less than 3/4 inch in diameter by 8 feet in length. Unless otherwise indicated, ground rods shall be driven into the ground until tops of rods are approximately one foot below finished grade. Where the specified ground resistance cannot be met with the indicated number of ground rods, additional ground rods, longer ground rods, or deep-driven sectional rods shall be installed and connected until the specified resistance is obtained, except that not more than three additional 8-foot ground rods shall be required at any one installation. Ground rods shall be spaced as evenly as possible at least 6 feet apart and connected 2 feet below grade.

12.1.2 Connections. Connections above grade shall be made with bolted solderless connectors and those below grade shall be made by a fusion-welding process. In lieu of a fusion-welding process, a compression ground grid connector of a type which uses a hydraulic compression tool to provide the correct circumferential pressure may be used. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication

that a connector has been adequately compressed on the ground wire. Where ground wires are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for this purpose shall be utilized.

12.2 Neutral Grounding. Neutral conductors shall be grounded where indicated. Ground wires shall be not less than No. 1/0 AWG, except that where the rated phase current exceeds 400 amperes, the size of neutral ground wires shall be increased to not less than one-half the size of the cross-sectional area of the individual phase conductors. Neutral ground wires shall be protected by conduit where such wires run exposed above grade in nonfence-enclosed areas or are run through concrete construction. Where concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit so as to provide an opening for the ground wire and the opening shall be sealed with a suitable compound after installation of the ground wire. Bends greater than 45 degrees in ground wire connections to the ground rods or counterpoises are not permitted.

12.3 Equipment Grounding. Equipment frames of metal-enclosed equipment, metal splice boxes, chain-link fencing, and other noncurrent-carrying metal items, shall be grounded unless otherwise indicated. Connections to earth shall be made in the same manner as required for neutral grounding. Equipment or devices operating at less than 750 volts may be connected to secondary neutral grounds.

12.4 Lighting Pole Grounding. Bases of lighting poles shall be connected to an adjacent ground rod by means of a No. 8 AWG wire. A ground connection from poles back to neutral ground points shall also be provided utilizing either metal raceways or ground wires.

12.5 Handhole, ~~or Concrete Pullbox~~ Grounding. Ground rods installed in electrical-distribution-system handholes, ~~or concrete pullboxes~~ shall be properly connected to the ~~cable shielding, metallic sheath, and armor at each cable joint or splice by means of No. 4 AWG or equivalent braided tinned copper wire. Connections to metallic cable sheaths shall be by means of tinned terminals soldered to ground wires and to cable sheaths.~~ Care shall be taken in soldering not to damage metallic cable sheaths or shields. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 2 inches above and 6 inches below concrete penetrations. ~~Ground wires shall be neatly and firmly attached to manhole or handhole walls and the amount of exposed bare wire shall be held to a minimum.~~ *CONTINUOUS ground conductor throughout electrical distribution system using the same size conductor as indicated.*

13. TESTS.

13.1 Operating Test. After the installation is completed, the Contractor shall conduct an operating test for approval. Equipment shall be demonstrated to operate in accordance with the requirements herein. Tests shall be performed in the presence of the Contracting Officer. The Contractor shall furnish instruments and personnel required for the test and the Government will furnish the necessary electric power.

13.2 Ground-Resistance Measurements. Ground-resistance measurements of each ground rod shall be taken and certified by the Contractor to the Contracting Officer. No part of the electrical distribution system shall be energized prior to the resistance testing of that system's ground rods and grounding system and submission of test results to the Contracting Officer. Test reports shall

indicate the location of the ground rod and grounding system and the resistance and the soil conditions at the time the test was performed. When the building water service is used as a ground or part of the grounding system, ground-resistance measurements shall also be made of this connection. Ground-resistance measurements shall be made in normally dry weather, not less than 48 hours after rainfall, and with the ground under test isolated from other grounds. The resistance to ground shall be measured using the fall-of-potential method described in IEEE No. 142.

14. PAINTING AND FINISHING.

14.1 Factory Coating. Equipment and component items, including but not limited to transformer stations and ferrous metal luminaires not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 125 hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The scribed test mark and test evaluation shall be in accordance with ASTM D 1654 with a rating of not less than 7 in accordance with Table 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to Mil. Spec. DoD-P-21035.

14.2 Field Painting. Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory, shall be as specified in SECTION: PAINTING, GENERAL.

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SECTION 9B

STATION MARKING

1. APPLICABLE PUBLICATIONS. The Federal Specification (Fed. Spec.) listed below forms a part of this specification to the extent referenced. The publication is referred to in the text by the basic designation only.

TT-P-115F

Paint, Traffic, Highway, White and Yellow

2. MATERIALS.

2.1 Paint.

2.1.1 Exterior Paint on Concrete shall conform to Fed. Spec. TT-P-115, except the color shall be non-fading black.

3. STATION MARKING.

3.1 Preparation of Surfaces. Concrete surfaces shall be thoroughly cleaned of all curing compound, efflorescence, dirt, oil or other deleterious material by approved methods. The surface preparation shall be accomplished in such manner that paint will satisfactorily adhere to the surface.

3.2 Application. Painting shall be done in a neat and workmanship manner and may be applied by brush, spray, roller or any combination of these methods. Painting of numbers and letters shall be accomplished with stencils and brush and spray application. Color for letters and numbers shall be black. All markings on concrete shall be in uniform capital block letters and numbers, 6 inches high, 3 inches wide, and 3/4-inch wide of line. Markings on concrete walls shall be horizontal with the bottom of the marking 5 feet above the bottom (invert at walls) of the wall.

4. TABULATION OF STATION MARKING LOCATIONS.

Arizona Canal Diversion Channel

<u>Wall</u>	<u>Station</u>	<u>Text of Marking</u>
Left	550+00	55
Left	560+00	56
Left	570+00	57
Left	580+00	58

Cave Creek Channel

<u>Wali</u>	<u>Station</u>	<u>Text of Marking</u>
Left & Right	10+00	1
Left & Right	20+00	2
Left & Right	30+00	3
Left & Right	40+00	4
Left & Right	50+00	5
Left & Right	60+00	6
Left & Right	70+00	7
Left & Right	80+00	8
Left & Right	90+00	9
Left & Right	100+00	10
Left & Right	110+00	11
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