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ARIZONA DEPARTMENT OF TRANSPORTATION  
ADVERTISEMENT FOR BIDS

BID OPENING: FRIDAY, DECEMBER 11, 1987 AT 11:00 A.M.

PROJECT AND LOCATION:

RAM 600-1-507 **NORTHEAST OUTER LOOP** (SR 117) (PHOENIX URBAN AREA)  
(PRICE ROAD DRAINAGE TUNNEL)

ROUTE NO.	DISTRICT	ITEM NO.	FUND CODE
SR 117	1	444	83701

A999.502

# ARIZONA DEPARTMENT OF TRANSPORTATION

## ADVERTISEMENT FOR BIDS

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The location and description of the proposed work and the representative items and approximate quantities are as follows:

The proposed work is in the City of Tempe on the Outer Loop Highway (SR 117) beginning 0.3 miles east of Price Road and 0.1 miles south of SR 360 and extending north west to Price Road and then north adjacent to Price Road to a point 0.3 miles north of University Drive for a total distance of approximately 2.9 miles. The work consists of constructing approximately 15,470' of an 18' inside diameter drainage tunnel, two drop structures, a pump station with pumping system, a permanent access shaft and related incidental work.

Mobilization	L. Sum	1
Drop Structures	Each	2
Pump Station	L. Sum	1
Tunnel Access Shaft	L. Sum	1
Tunnel (18' I.D.)	L. Ft.	15,472
Chemical Grouting	Gals.	133,000
Consolidation Grouting	L. Ft.	12,500
Engineer's Office	L. Sum	1

The number of working days specified for the completion of the work is 422.

Project plans, specifications, Engineering Report for the Price Road Drainage Tunnel, and proposal pamphlets may be obtained from Contracts and Specifications Services (602) 255-8251. The cost is \$55.00. No refund will be made for plans and specifications returned.

The "Engineering Report for the Price Road Tunnel", which includes the CRS Sirrine Site Conditions and Engineering Reports and the Dames and Moore Groundwater Report, is available as a separate document at a cost of \$30.00. Plans and Specifications may be purchased without the Engineering Report at a cost of \$25.00.

No contracting firm will be issued a proposal pamphlet unless it is prequalified for this project.

No proposal will be accepted from any contractor who is not a duly licensed contractor in accordance with Arizona Revised Statutes 32-1101 through 32-1170.03.

The Arizona Department of Transportation hereby notifies all bidders that, pursuant to this advertisement for bids, Disadvantaged Business Enterprises and Woman-Owned Business Enterprises will be afforded full opportunity to submit bids in response to this solicitation and will not be discriminated against on the grounds of race, color, or national origin in consideration for an award.

On November 9 through November 11, 1987, a subsurface viewing program allowing bidders to inspect subsurface conditions in three existing borings plus drilling observations of two additional borings will be conducted by the Department. Inspection of existing borings will be made on November 9, 10 and 11, while observation of additional borings will be made on November 9 and November 10, 1987.

On November 10, 1987, a pre-bid conference will be held at 1:30 p.m. in the Department Headquarters Auditorium, Rooms 163-165, at 206 South 17th Avenue in Phoenix.

A proposal guaranty in the form of either a certified or a cashier's check made payable to the State Treasurer of Arizona for not less than five percent of the amount of the bid or in the form of a surety (bid) bond for five percent of the amount of the bid shall accompany the proposal.

Surety (bid) bonds will be accepted only on the form provided by the Department and only from corporate sureties authorized to do business in Arizona.

Proposal pamphlets shall be returned only in the envelopes provided by the Department to:

Contracts and Specifications Services, Room 121-F  
Highways Division  
Arizona Department of Transportation  
1651 West Jackson Street  
Phoenix, Arizona 85007-3276

Sealed bids will be received until the hour indicated and then publicly opened and read. No bids will be received after the time specified.

Management Consultant	Larry Olsen	(602) 244-9096
	Bill Boyd	(602) 244-9096
Construction Supervisor	Ron Romley	(602) 255-7478

DALLIS B. SAXTON, Engineer  
Contracts and Specifications Services

SPECIAL PROVISIONS  
ARIZONA DEPARTMENT OF TRANSPORTATION  
ARIZONA PROJECT RAM 600-1-507  
NORTHEAST OUTER LOOP (SR117)(PHOENIX URBAN AREA)  
PRICE ROAD DRAINAGE TUNNEL  
DRAINAGE TUNNEL, OUTLET AND DROP STRUCTURE

PROFESSIONAL ENGINEER SEALS:

This book of specifications and related contract documents represents the efforts of the following firm:

HOWARD NEEDLES TAMMEN & BERGENDOFF

A principal of the firm has affixed his seal below which attests that those portions of these specifications which relate to the drawings numbers appearing after his seal were prepared under his direction.



Drawing Number  
(Sheet No.)

2 through 60

SPECIAL PROVISIONS  
 ARIZONA PROJECT RAM-600-1-507  
 STATE ROUTE 117  
 NORTHEAST OUTER LOOP HIGHWAY (SR117)(PHOENIX URBAN AREA)  
 PRICE ROAD DRAINAGE TUNNEL  
 DRAINAGE TUNNEL, PUMP STATION, ACCESS SHAFT AND DROP STRUCTURES

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BIDDING SCHEDULE

DCCO  
10/09/87

RAM 600-1-507

SPECIAL PROVISIONS

ARIZONA PROJECT RAM 600-1-507

NORTHEAST OUTER LOOP HIGHWAY (SR117)(PHOENIX URBAN AREA)

PRICE ROAD DRAINAGE TUNNEL

DRAINAGE TUNNEL, PUMP STATION, ACCESS SHAFT AND DROP STRUCTURES

PROPOSED WORK:

The proposed work is in the City of Tempe on the Outer Loop Highway (SR 117) beginning 0.33 miles east of Price Road and 0.073 miles south of SR 360 and extending north west to Price Road and then north adjacent to Price Road to a point 0.28 miles north of University Drive for a total distance of approximately 2.98 miles. The work consists of constructing approximately 15,470' of an 18' inside diameter drainage tunnel, two drop structures, a pump station with pumping system, a permanent access shaft and related incidental work.

(SPC87ST, DC, 08/17/87)

SPECIFICATIONS:

The work embraced herein shall be performed in accordance with the requirements of the following separate documents:

Arizona Department of Transportation, Highways Division, Standard Specifications for Road and Bridge Construction, Edition of 1982,

Arizona Department of Transportation, Highways Division, Supplemental Specifications to Standard Specifications for Road and Bridge Construction, October 1985,

Arizona Department of Transportation, Highways Division, Standard Drawings, listed in the project plans and defined hereinafter,

Arizona Department of Transportation, Highways Division, Urban Highway Details, 1987,

Arizona Department of Transportation, Traffic Control Manual for Highway Construction and Maintenance, August, 1981,

Manual on Uniform Traffic Control Devices for Streets and Highways, 1978, and Amendments, and

The Proposal Pamphlet which includes the following documents:

These Special Provisions,

Standard Federal Equal Employment Opportunity Construction Contract Specifications (Executive Order 11246), July 1, 1978, Revised November 3, 1980 and Revised April 15, 1981,

Notice of Requirement for Affirmative Action to Ensure Equal Employment Opportunity (Executive Order 11246), July 1, 1978, Revised November 3, 1980 and Revised April 15, 1981,

Executive Order 75-5, April 28, 1975, Revised November 25, 1980,

Compliance Reports, Non-Federal Aid Projects, July 1, 1975, Revised May 20, 1981,

Railway - Highway Insurance Protection Required of Contractors, July 11, 1967, Revised August 4, 1980, Revised June 15, 1981, Revised March 22, 1982,

The Engineering Report, which includes the Site Conditions Report and the Results of Groundwater Investigation Report, both for the Price Road Drainage Tunnel, are bound together as a separate document hereby incorporated as a part of these Special Provisions.

Proposal,

Bidding Schedule,

Surety (Bid) Bond, 12-1303,

Certification With Regard to the Performance of Previous Contracts or Subcontracts, Subject to the Equal Opportunity Clause of Executive Order No. 75-5 and the Filing of Required Reports, Non-Federal Aid Projects, July 1, 1975,

Certification With Respect to the Receipt of Addendums,  
and

Affidavit by contractor certifying that there was no collusion in bidding for contract,

**BID SUBMISSION:**

In the submission of a bid, the contractor shall completely execute the following documents:

Proposal,

Bidding Schedule,

Surety (Bid) Bond, 12-1303,

Certification With Regard to the Performance of Previous Contracts or Subcontractors, Subject to the Equal Opportunity Clause of Executive Order No. 75-5 and the Filing of Required Reports, Non-Federal Aid Projects, July 1, 1975,

Certification With Respect to the Receipt of Addendums,  
and

Affidavit by contractor certifying that there was no collusion in bidding for contract.

PROPOSAL GUARANTY:

Each bidder is advised to satisfy himself as to the character and the amount of the proposal guaranty required in the Advertisement for Bids.

CONTRACT DOCUMENTS:

The bidder to whom an award is made will be required to execute a Performance Bond and a Payment Bond, each in 100 percent of the amount of his bid, an Insurance Certificate and the Contract Agreement.

A copy of these documents is not included in the Proposal Pamphlet which is furnished to prospective bidders; however, each bidder shall satisfy himself as to the requirements of each document.

The documents, approved by the Department of Transportation, Highways Division, are identified as follows:

- Statutory Performance Bond, 12-1301, December, 1975
- Statutory Payment Bond, 12-1302, December, 1975
- Contract Agreement, 12-0912, January, 1986
- Certificate of Insurance, 12-0100, June, 1985

A copy of each document may be obtained by making a request to Contracts and Specifications Services.

COPIES OF PROJECT DOCUMENTS:

Distribution of a limited number of plans and Special Provisions will be made to the successful low bidder, at no charge, following confirmation of bid prices and DBE submittal, if applicable. The distribution will be made on the following basis:

<u>CONTRACT SIZE</u> <u>(DOLLARS)</u>	<u>FULL</u> <u>SIZE</u> <u>PLANS</u>	<u>1/2 SIZE</u> <u>PLANS</u>	<u>BOUND</u> <u>BID</u> <u>BOOKS</u>	<u>UNBOUND</u> <u>BID</u> <u>BOOKS</u>
\$0 - \$10,000,000	2	25	5	25
Over \$10,000,000	5	50	5	50

These plans and Special Provisions will be set aside and designated for use by the low bidder along with an equal number held in reserve for the responsible District Office. In the event that excess documents remain following bid opening, the additional documents will be evenly split between the low bidder and the A.D.O.T. District Office.

Any additional plans or Special Provisions that the low bidder may require beyond the above distribution will be available at the invoice cost of printing by ordering thru the Engineer.

**MATERIAL AND SITE INFORMATION:**

Projects requiring materials, excavation, or site investigation may have additional information available concerning the material investigations of the project site and adjacent projects. This information, when available and applicable, may be examined in the Office of the Management Consultant, De Leuw, Cather & Co., at 426 N. 44th Street, Suite 252, Phoenix, Arizona 85008. This information will not be attached to the contract documents. Copies of available information may be purchased by prospective bidders.

Information on possible material sources may be reviewed at the office of the Assistant State Engineer, Materials Section, 206 S. 17th Avenue, Phoenix, Arizona 85007.

**ADDITIONAL INFORMATION:**

The following information is available for examination at the office of the Management Consultant, De Leuw, Cather & Co., at 426 N. 44th Street, Suite 252, Phoenix, Arizona 85008. This information will not be attached to the Contract Documents. Copies may be purchased by prospective bidders.

A) Site Conditions Report for the North Tunnel, East Tunnel and West Tunnel from Station 9+00 to Station 58+14, Phoenix-Casa Grande Highway Inner Loop Drain Tunnels, Arizona Department of Transportation, March 1986.

B) Site Conditions Report for the West Tunnel from Station 58+14 to Station 146+20, Phoenix-Casa Grande Highway Inner Loop Drain Tunnels, Arizona Department of Transportation, April 1986.

C) Report on East Tunnel Instrumentation Sites 12, 13 and 14, Phoenix-Casa Grande Highway Inner Loop Drain Tunnels, Arizona Department of Transportation, March 1986.

D) Engineering Report for the West Tunnel from Station 9+00 to Station 58+14, Phoenix-Casa Grande Highway Inner Loop Drain Tunnels, Arizona Department of Transportation, April 1986.

E) Engineering Report for the West Tunnel from Station 58+14 to Station 146+20, Phoenix-Casa Grande Highway Inner Loop Drain Tunnels, Arizona Department of Transportation, May 1986.

F) Report on North Tunnel Instrumentation through December 1985, Phoenix-Casa Grande Highway Inner Loop Drain Tunnels, Arizona Department of Transportation, April 1986.

G) Report on East Tunnel Instrumentation, Sites 1 through 11, through December 1985, Phoenix-Casa Grande Highway Inner Loop Drain Tunnels, Arizona Department of Transportation, June 1986.

H) Report on West Tunnel Instrumentation Sites 1 through 14, Phoenix-Casa Grande Highway Inner Loop Drain Tunnels, Arizona Department of Transportation, October 1986.

I) Grouting Program for the 66 Inch Sewer Line at Watkins Street and Central Avenue, April 1986.

J) "Report, Geohydrological and Tunneling Evaluation, Storm Water Disposal for the Inner Loop Freeway, Interstate 10, Phoenix, Arizona" by Dames and Moore, dated February 28, 1983, for Howard Needles Tammen and Bergendoff.

K) "Preliminary Geotechnical Investigation Report, Inner Loop Freeway, Interstate 10, Offsite Drainage Study, Phoenix, Arizona" by Sergent, Hauskins & Beckwith, dated March 7, 1983, for Howard Needles Tammen & Bergendoff.

L) "Subsurface Information, Project I-10-3 (187), I-10-3 (188), I-10-3 (189), Location: North Tunnel, East Tunnel, West Tunnel," for work authorized by the Arizona Department of Transportation Contract and Specification Services, undated.

M) "Phoenix Storm Drain Tunnels, Construction Problems Evaluation" by Ronald E. Heuer, Geotechnical Consultant, dated November 5, 1985, for the Arizona Department of Transportation, which contains "Phoenix-Casa Grande Storm Drain Tunnels" by Robert E. Heuer, dated April 1984, prepared for Fru-Con Construction Company.

N) "Geotechnical Investigation Report, Historical Data, West Papago Tunnel," by Sergent, Hauskins & Beckwith, dated February 26, 1986, for CRS Serrine, Inc.

O) "An Investigation of the Load Carrying Capacity of Drilled Cast-In-Place Concrete Piles Bearing on Coarse Granular Soils and Cemented Alluvial Fan Deposits," Research Project - Arizona HPR-1-10 (122), Drilled Cast-in-Place Concrete piles, by Sergent, Hauskins & Beckwith, dated May 1973, for Arizona Department of Transportation.

P) "Final Construction Report for the North Tunnel."

Q) "Final Construction Report for the East Tunnel."

R) "Final Construction Report for the West Tunnel."

S) "Final Report on North Tunnel, East Tunnel and West Tunnel Instrumentation."

(NOGOAL, 6, 04/24/87)

DISADVANTAGED BUSINESS ENTERPRISES:

POLICY:

It is the policy of the Arizona Department of Transportation (Department) that Socially and Economically Disadvantaged Business Enterprises (DBE's) shall have maximum opportunity to participate as contractors, subcontractors, suppliers, or vendors in the performance of contracts.

(MAG2, DC, 4/21/86)

MARICOPA ASSOCIATION OF GOVERNMENTS SPECIFICATIONS AND STANDARDS:

The project plans and these special provisions reference certain standard specifications and standard details promulgated by the Maricopa Association of Governments, commonly known as MAG.

When MAG standard specifications and standard details are specified for certain items of work, the description, materials, construction requirements, method of measurement, and basis of payment for those items shall conform to the requirements of the special MAG Standards in Parts 200 through and including 700, except as may be superseded or supplemented by these special provisions. Part 100 and the fifteen pages of forms in the MAG Standard Specifications are not applicable.

MAG Standards are available from:

Maricopa Association of Governments  
1820 West Washington Street  
Phoenix, Arizona 85007

Standards are also available from:

Engineering Records  
Arizona Department of Transportation  
1655 West Jackson, Room 112-F  
Phoenix, Arizona 85007 (602) 255-7498

If obtained from the Arizona Department of Transportation, the cost of each standard, which includes the cost of postage, is as follows:

- (1) Uniform Standard Specifications for Public Works Construction, 1979 \$17.25
- (2) Uniform Standard Details for Public Works Construction, 1979 \$14.25

**GENERAL REQUIREMENTS:**

Access to designated city streets for hauling construction materials and excavated material will be provided, however, the contractor shall obtain a permit from the City of Tempe. The permit may place restrictions on streets to be used and time of day hauling is permitted.

Prior to construction, the Engineer and the City of Tempe will document the conditions of city streets which might be affected by tunnel construction. Damage to streets, curbs and sidewalks which occur during construction will be assumed caused by the tunnel work and shall be repaired by the contractor. In the event such damage is so extensive that complete resurfacing is required, in the opinion of the Engineer, then the contractor shall make such replacement to the extent necessary to provide a street equivalent in quality to that as initially constructed.

Any City of Tempe land monuments disturbed by the contractor's construction activities shall be relocated at contractor's expense in a manner acceptable to the City. Concrete used as a foundation for the monument shall be Class B. Brass caps will be furnished to the contractor by the city. Cast-in-place monuments shall be cast in drilled holes without the use of forms. Brass caps shall be placed in survey monuments before the concrete has acquired initial set, and shall be firmly embedded in the concrete. The concrete block shall be so located that the reference point will fall within a one inch circle in the center of the brass cap. The top of survey monument covers shall be set flush with the pavement surface. No measurement or payment will be made for the replacement of City monuments.

It will be the responsibility of the contractor to construct the access roads to the work area in accordance with the project plans and to maintain these roads in a manner acceptable to the City of Tempe, the Salt River Project, and the Engineer. The access road from the south shall be left in a condition equal to or better than its condition prior to beginning the project. The contractor shall furnish and place aggregate base on the access road and work area on the north end of the project in accordance with the details shown on the project plans. No measurement or direct payment will be made for this work.

ADDITIONS AND REVISIONS TO THE STANDARD AND SUPPLEMENTAL SPECIFICATIONS

(ERATA100, 6, 12/30/86)

SUPPLEMENTAL SPECIFICATIONS ERRATA:

The following changes shall be made to cover errors in the text of the Supplemental Specifications:

Page 15: The first sentence of the fifth paragraph under Subsection 105.06 shall read:

Compensation for idle time of labor will be determined in accordance with the provisions of Subsection 109.04 (B)(1) - Labor, . . .

The sixth paragraph under Subsection 105.06 shall read:

Compensation for idle time of equipment will be determined in accordance with the provisions of Subsection 109.04(B)(3) - Equipment, . . .

Page 47: The last sentence of the first paragraph under Subsection 203-5.03 (B) (1) shall read:

Tests for pH and resistivity shall be in accordance with the requirements of Arizona Test Method 236.

Page 73: The first sentence of the first paragraph following Table 305-2 shall read:

\*Material represented by cores deficient by more than 0.75 inches in thickness and/or represented by lots attaining seven day compressive strengths with the mean value . . .

Page 146: The last sentence of the last paragraph under Subsection 604-3.05 shall read:

The weight of the coating . . .

Page 159: The first paragraph under Subsection 701-3.06 shall read:

Pavement marking obliteration shall be accomplished by the contractor as indicated on the plans or as directed by the Engineer.

- Page 161: The first line following the fourth paragraph shall read:  
701-5.02 Maintenance and Protection of Traffic: is  
modified to add:
- Page 323: The third sentence of the fifth paragraph under Subsection  
925-5 shall read:  
Should such extra work require the contractor to pay  
mobilization or travel costs for the party or parties, . .
- Page 343: The second sentence of the first paragraph under  
Subsection 1013 (D) shall read:  
The certification shall be supported by Certificates of  
Compliance . . .

(CNSLT101, 6, 10/21/85)

SECTION 101 - DEFINITIONS AND TERMS:

101.18 ENGINEER: of the Standard Specifications is modified to add:

It is the intent of the Department to utilize a consultant engineering firm as its agent to administer this contract.

Except as may be otherwise specified in the agreement between the consultant engineering firm and the Department, the "... assistant or other representative duly authorized by the State Engineer to act for him who is responsible for engineering supervision of the construction", as defined under Subsection 101.18 of the Standard Specifications, shall also mean the duly authorized consultant engineering firm.

101.26 MAJOR ITEMS: of the Standard Specifications is modified to add:

Item number 9300071 Chemical Grouting, is subject to substantial quantity variation and will not be considered a major item. Payment will be made at the contract price for the quantity actually used.

(PLANS101, 6, 04/07/87)

101.31 PLANS: of the Supplemental Specifications is revised to read:

The standard drawings approved by the Arizona Department of Transportation are bound together in four separate sets:

The construction ("C") standard drawings are bound together with a light blue cover dated 1986.

The structure (bridge) standard drawings are bound together with a yellow cover dated 1987.

The signing and marking standard drawings are bound together with a gray cover dated 1986.

The traffic signals and lighting standard drawings are bound together with a light blue cover dated 1985.

All standard drawings approved by the Arizona Department of Transportation contained in the four bound sets plus subsequent revisions and additions are listed on the project plans along with the latest (current) revision dates.

DCCO  
10/09/87

RAM 600-1-507  
DIVISION I

Prospective bidders, contractors, subcontractors, material suppliers, and others are hereby advised to see that they have copies of and are familiar with the standard drawings appropriate to their particular operations.

Standard Drawings are available from:

Records Administration Section  
Engineering Records  
Arizona Department of Transportation  
1655 West Jackson, Room 112F  
Phoenix, Arizona 85007 (602) 255-7498

The cost of each set of Standard Drawings is \$4.50. Single copies of each drawing are also available at \$0.15 each. The above costs include postage. The minimum mail order is \$1.00.

SECTION 102 - BIDDING REQUIREMENTS AND CONDITIONS:

102.02        PREQUALIFICATION OF BIDDERS:        in the Standard Specifications is modified to add:

Prequalification of bidders is required and will be specific for this project. Application for prequalification may be made only by means of the forms prepared for this project. Qualified bidder list will be available after August 27, 1987.

(NOCLU102, 6, 08/12/86)

102.09        NONCOLLUSION AFFIDAVIT: of the Standard Specifications is revised to read:

Each bidder shall file a sworn statement executed by, or on behalf of the person, firm, association, or corporation submitting the bid, certifying that such person, firm, association, or corporation has not, either directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken any action, in restraint of free competitive bidding in connection with the submitted bid. This sworn statement shall be in the form of an affidavit executed and sworn to by the bidder before a person who is authorized by the laws of the State to administer oaths. The required form for the affidavit is included in the proposal pamphlet.

Failure to submit the sworn statement as part of the bid proposal package will make the bid nonresponsive and not eligible for award consideration.

102.11        DELIVER OF PROPOSAL: of the Standard Specifications is modified to add:

No bid will be accepted from any contractor who is not a duly licensed contractor in accordance with Arizona Revised Statutes 32-1101 through 32-1170.03.

SECTION 104 - SCOPE OF WORK:

104.04 MAINTENANCE OF TRAFFIC: in the Standard Specifications is modified to add:

With the exception of designated work areas at the portals and drop shafts, streets above or adjacent to the tunnels shall be kept open at all times. Damage to streets due to subsidence or by other reason of work performed under this contract, shall be immediately repaired to the extent required elsewhere in these Specifications. Repairs shall be performed in a manner which will be the least disruptive to traffic. Streets used for hauling material, both excavated and other material, shall be cleaned of debris dropped during the construction process on a daily basis.

104.07 COST REDUCTION INCENTIVE: in the Standard Specifications is modified to add:

An alternative finished size tunnel to that shown on the project plans may be proposed by the contractor in accordance with the provisions of Subsection 104.07. The tunnel size shall be no smaller than 18 foot inside diameter and no larger than 21 foot inside diameter. The price bid by the contractor shall provide for the construction of the tunnel at the size shown on the project plans.

Consideration will be given to an alternative tunnel size after award of the contract, however, acceptance will be at the sole discretion of the Engineer. Cost of re-engineering and review of tunnel section, access shaft, inlet connections, and all other appurtenant structures which will require modification shall be in accordance with provisions of Subsection 104.07.

SECTION 105 - CONTROL OF WORK:

105.01 AUTHORITY OF THE ENGINEER: in the Supplemental Specification is modified to add:

Notwithstanding the limitations on the Engineer's authority contained herein, the provisions under DRILLING AND GROUTING, AND GEOTECHNICAL INSTRUMENTATION, assign additional authority and responsibility to the Engineer. The authority of the Engineer shall be interpreted to include the additional authority specified herein.

(RESUB105, DC, 06/16/87)

105.02 PLANS AND WORKING DRAWINGS: paragraph five of the Supplemental Specifications is modified to add:

An equal amount of time will be required to review any resubmittal that was originally rejected because of errors and omissions. The contractor assumes all responsibility and costs associated with delays to his operation due to inaccurate or incomplete submittals.

105.07 COOPERATION BETWEEN CONTRACTORS: of the Standard Specifications is modified to add:

Project RAM 600-1-505 (University, Broadway, Southern Pacific RROP and Southern Avenue Bridges) and Project RAM 600-1-506 (First Street to Southern Avenue - Grade, Drain and Pave) will be progressing coincidentally with this work. Certain restrictions have been placed on these contractors when the tunnel face is advancing beneath their project limits. The Engineer shall be notified in writing one week in advance of the heading reaching the limits of either project and a point within 400 feet of the University, Broadway, Southern Pacific R.R.O.P., and Southern Avenue bridges.

105.08 CONSTRUCTION STAKES, LINES AND GRADES: in the Supplemental Specifications is revised to read:

The Engineer will set construction stakes establishing the centerline of tunnels and a benchmark at the ends establishing elevation. These reference points will be on the ground surface and it shall be the contractor's responsibility to transfer them to the working surfaces of the tunnel. In addition, the contractor shall establish surface settlement monitoring points based upon the benchmarks set by the Engineer, in accordance with details elsewhere specified.

105.19 PRECONSTRUCTION INSPECTION AND SURVEY: is hereby added to the Standard Specifications:

The contractor shall document street, highway and canal conditions and elevations by photographs and surveys. Limited surveys of utilities, selected buildings and structures that may be damaged shall also be made. The contractor shall document existing conditions in accordance with the requirements specified below. The contractor may not avoid responsibility for damages by pleading inadequate documentation.

In general, documentation by the contractor shall consist of visually inspecting and recording, by notes and photographs, existing cracks or other structural damage to streets, highways, canals and other existing structures. The inspection shall be conducted by a qualified technician under the direct supervision of an Arizona Registered Professional Engineer having experience in this type of survey. The records so obtained shall be retained in the contractor's file for at least three years after completion of the contract. A copy shall be furnished to the Engineer. In the event those specialists conducting the survey deem it advisable to inspect the interior of any given premises and permission is refused, the record shall so reflect, recording the date and time of the request as well as the name of the person making the refusal and a letter containing this information shall be sent to the owner of the property by certified mail with a copy furnished to the Engineer. In the event of damage claims, a report on the preconstruction conditions shall be prepared by the contractor for the particular structures as requested by the Engineer from those notes and photographs.

The contractor shall establish vertical and horizontal survey control points on all structures and improvements located in the vicinity of the work prior to beginning work and at approved intervals shall periodically check the points for movements. Upon request, the contractor shall furnish the Engineer with copies of the survey notes for each survey and a copy of the layout of the survey control points.

Records in triplicate of all observations shall be prepared by the contractor. Two copies of each document and photograph shall be provided to the Engineer.

The above records and photographs are intended for use as evidence in ascertaining the extent of any damage which may occur as a result of the contractor's operations and are for the protection of the adjacent property owners, the contractor and the Department. The records will provide a means of determining whether, and to what extent, damage may have occurred as a result of the contractor's operation.

(MATSO106, DC, 06/16/87)

SECTION 106 - CONTROL OF MATERIALS

106.03 LOCAL MATERIAL SOURCES: the first paragraph of the Supplemental Specifications is revised to read:

The use of material sources situated in the 100-year flood plain of any stream or watercourse, and located within 1.0 mile upstream and 2.0 miles downstream of any highway structure or surfaced roadway crossing, shall be limited as follows:

- (A) Existing commercial sources, as defined in the last paragraph of Subsection 1001-2 - Definitions, shall not be utilized as a source of borrow.
- (B) No new source or existing non-commercial source will be approved for any materials except as specified in the following subparagraph C.
- (C) Borrow material may be obtained from flood plain management or flood-control construction projects which, at the time of advertisement for bids for the Department project, are under construction or have been designed, approved and programmed for construction under the sponsorship of the appropriate agencies having flood plain management and/or flood-control jurisdiction over the area in which the proposed source is located. The contractor shall furnish the Engineer with written approval from the appropriate flood plain management and/or flood control agencies and shall meet all other requirements specified for contractor-furnished sources.

(MATL106, 6, 02/18/87)

- (D) Material sources located on Native American Indian Reservations will be considered for use based on an individual analysis. The analysis shall include a review of applicable land use plans, flood plain management plans, environmental plans, applicable laws and regulations pertaining to Indian Reservations, and an engineering analysis of the effects on any highway facility or structure. The contractor shall obtain from the Native American Tribal Council all permits, licenses, and approvals and present to the Department for review. The Department will review each request on a case by case basis.

(SAFPL107, DC, 07/18/86)

SECTION 107 - LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

107.08 PUBLIC CONVENIENCE AND SAFETY: of the Standard Specifications is modified to add:

The contractor shall submit a safety plan to the Engineer detailing the procedures the contractor will implement to satisfy OSHA and State Occupational Safety Guidelines related to the worker and public safety in the construction of structures, excavations, confined air space and other worksites as requested by the Engineer. The Contractor shall also submit an evacuation plan to the City of Tempe Fire Department in accordance with the submittals requirements of the Tunnel and Shaft Construction Section of these Special Provisions.

(PUCOR107, DC, 5/22/86)

107.08 Public Convenience and Safety of the Standard Specifications is modified to add:

The contractor shall be prepared at the preconstruction conference to discuss traffic control and safety plans that are based upon his schedule of the prosecution of the work.

The traffic control and safety plan (hereinafter "plan") of the contractor shall be predicated on the requirements of the appropriate contract documents, or portions thereof, which pertain to traffic control. These documents include, but are not necessarily limited to, the Manual on Uniform Traffic Control Devices, the Traffic Control Manual for Highway Construction and Maintenance (Arizona Department of Transportation), the project plans, Standard Drawings, the Standard Specifications, and these special provisions.

Unless otherwise provided for hereinafter, all traffic shall be regulated in accordance with the provisions of the Manual on Uniform Traffic Control Devices, and the Traffic Control Manual for Highway Construction and Maintenance (Arizona Department of Transportation), revised August, 1981. Where the Traffic Control Manual and the Manual on Uniform Traffic Control Devices conflict, the higher standard shall prevail.

At the time of the preconstruction conference, the contractor shall designate an employee who is well qualified and experienced in construction traffic control and safety to be responsible for the implementing, monitoring, and altering, as necessary, of the plan. This employee shall be available at all times. At this same time, the Engineer will designate a Department employee as the Department's representative who will be responsible to

see that the plan and any alteration thereto, is implemented and monitored to the end that traffic is carried through the work in an effective manner and that the public and workmen are protected from hazards and accidents.

In the course of construction it may be found that it is necessary to alter the plan. Such alteration shall be in accordance with the criteria set forth in the referenced manuals.

The contractor's plan shall incorporate the Department's plan, as specified in the contract documents, and shall be expanded to include all construction phases which may not be covered.

107.09 RAILWAY-HIGHWAY PROVISIONS: in the Standard Specifications are modified to add:

RELATIONS WITH RAILROAD COMPANY:

GENERAL REQUIREMENTS:

The term "Railroad" shall be understood to mean THE SOUTHERN PACIFIC TRANSPORTATION COMPANY.

The contractor shall cooperate with the Railroad where his work is under th Railroad's right-of-way in order to expedite the work and avoid interference with the operation of the Railroad's equipment.

It is expected that the Railroad will cooperate with the contractor to the end that the work may be handled in an efficient manner, but the contractor shall have no claim for damages or extra compensation in the event his work is held up by the work of the Railroad forces.

No work shall be commenced under the Railroad's right-of-way until:

(a) After April 1, 1988 the letter agreement in the form contained hereinafter, and made a part hereof, shall have been executed and delivered to the State for forwarding to Railroad along with the insurance policy or policies as required herein for Railroad,

(b) Receipt of approval from Railroad of the letter agreement, policy or policies of insurance of certified copies,

(c) The certified copies of insurance, as required herein for State, shall have been delivered to State.

The approximate ratio of the estimated cost of the work within 50 feet of the Railroad's tracks to the total estimated contract work is 1 to 430.

**RAILROAD PROTECTIVE INSURANCE:**

In addition to any other form of insurance or bonds required under terms of the contract and specifications, the contractor shall carry insurance of the kinds and in the amount specified in Railway Highway Insurance Required of contractors (July 1967). The insurance shall not contain any clause or endorsement that will exclude liability for contamination or pollution, and such insurance shall be carried until all work required under the terms of the contract to be performed within or adjacent to the Railroad's right-of-way shall have been completed and the Railroad's property left in an acceptable condition, as determined by the Engineer.

The contractor shall deliver the original and one certified copy of the policy or policies furnished under C below and two certified copies of each of the policies furnished under A and B below to:

Arizona Department of Transportation  
Highways Division

Utility and Railroad Engineering Services  
205 South 17th Avenue, Room 248  
Phoenix, Arizona 85007

The certification of copies of insurance policies furnished under A and B below shall include a guarantee that the policies will not be amended, altered, modified, or cancelled without at least 30 days prior notice sent by registered mail to the Engineer and to the Railroad.

No direct payment will be made to the contractor for the cost of the insurance described herein, or any extension thereof, full compensation being considered as included in the prices for the contract items.

**(A) CONTRACTOR'S PUBLIC LIABILITY AND PROPERTY DAMAGE LIABILITY INSURANCE:**

The contractor shall, with respect to operations he performs within or adjacent to the Railroad's right-of-way, carry regular Contractor's Public Liability and Property Damage Liability Insurance containing no clause or endorsement that will exclude liability for contamination or pollution and providing for coverage of the same limits as specified under C below.

If any work within or adjacent to the Railroad's right-of-way is subcontracted, the contractor, in addition to carrying the above insurance shall provide the above insurance on behalf of the subcontractors to cover their operations.

(B) CONTRACTOR'S PROTECTIVE PUBLIC LIABILITY AND PROPERTY DAMAGE LIABILITY INSURANCE:

The contractor shall, with respect to the operations performed for him by subcontractors with or adjacent to the Railroad's right-of-way, carry regular Contractor's Protective Public Liability and Property Damage Liability Insurance containing no clause or endorsement that will exclude liability for contamination or pollution and providing for coverage of the same limits as specified under C below.

(C) RAILROAD'S PUBLIC LIABILITY AND PROPERTY DAMAGE LIABILITY INSURANCE:

The contractor shall, with respect to the operations performed by him or by his subcontractors within or adjacent to the Railroad's right-of-way, have issued and furnish in favor of the Railroad a policy, or policies, of insurance in the Railroad Protective Liability Form attached thereto and made a part hereof with coverage of the limits specified therein. The policy or policies shall contain no clause or endorsement that shall exclude liability for contamination or pollution.

PROTECTION OF RAILROAD FACILITIES:

The contractor shall comply with the rules and regulations of the Railroad or the instructions of the Engineer in relation to the proper manner of protecting the tracks and property of the Railroad and the traffic moving on such tracks, as well as the wires, signals, and other property of the Railroad, its tenants or licensees, at and in the vicinity of the work during the period of construction.

The contractor shall perform his work in such a manner and at such times as shall not endanger or interfere with the safe operation of the tracks and property of the Railroad and the traffic moving on such tracks, as well as wires, signals, and other property of the Railroad, its tenants or licensees, at or in the vicinity of the work.

The Railroad will provide personnel or protective devices to protect its facilities and movements of trains or engines as it deems necessary. In general, the Railroad will provide such personnel or protective devices:

- (A) When any part of any equipment is standing or being operated, or any construction activity is in progress, within the limits of 10 feet measured horizontally from the centerline of any track on which trains may be operated, regardless of elevation above or below the track.
- (B) For any excavation below the elevation of the track, regardless of distance from the track, if the track or other Railroad facilities are in danger of settlement or movement.
- (C) During any of the contractor's operations, including but not limited to clearing, grubbing, grading or blasting, in proximity to the Railroad's facilities, which may endanger the Railroad's facilities or operations.

Railroad will require one of its inspectors within the tunnel when the contractor is working under Railroad's right-of-way at a cost of approximately \$300 per day to be paid to Railroad by the contractor.

If the final billing from the Railroad has not been received at the time the final payment is made to the contractor, the Department will withhold from this final payment an amount estimated to be sufficient to cover the final billing from the Railroad. In the event that an insufficient amount has been withheld when the final billing has been received, the contractor shall reimburse the Department in the required amount.

No direct payment will be made to the contractor for the cost of personnel, protective devices or private crossings furnished by the Railroad because of the contractor's activities, such costs being considered as included in the prices of contract items.

(DISPO107, DC, 06/16/87)

107.12 PROTECTION AND RESTORATION: of the Standard Specification is modified to add:

Disposal of surplus material shall be the responsibility of the contractor. However, the contractor shall, with each and every disposal site he arranges for other than commercial waste sites, provide the Engineer with a copy of the written approval of the property owner indicating that the property owner is fully aware of what the material consists. The contractor shall also provide a letter to the Engineer from the City or County, whichever has jurisdiction, giving site approval for materials disposal at each site to be used. Approval letter shall be received and approved by the Engineer prior to the disposal of any materials at any site.

The contractor shall conform to the requirements of 107.23 of the Supplemental Specifications - Environmental Analysis, for any disposal site utilized for this project, except for the following:

For all sites proposed for disposal that are not in floodplains and will be used for less than 50,000 cubic yards of surplus material, the Engineer will make appropriate on-ground surveys prior to disposal activity and will either approve or disapprove the use of the site. Approval of the site by the Engineer does not relieve the contractor of furnishing the required written approvals and permits as specified herein.

(NOPOL107, DC, 06/16/87)

107.14 PREVENTION OF AIR AND NOISE POLLUTION: of the Standard Specifications is modified to add:

Noise levels resulting from the contractor's construction activities shall not exceed 86 dBA Leq at any right-of-way line abutting a residential area between the hours of 10:00 PM and 5:00 AM. The Engineer will measure noise levels.

Driving of piles will be allowed between the hours of 5:00 A.M. and 10:00 P.M. unless local ordinances require otherwise.

(INS107, 6, 09/09/86)

107.17 INSURANCE: of the Supplemental Specifications is revised to read:

Prior to the execution of the contract, the contractor shall file with the Department a certificate or certificates of insurance executed by an insurance company doing business in the State of Arizona and acceptable to the Department. The certificate of insurance shall be on the form provided by the Department and shall state that with respect to the contract awarded the contractor, the contractor carries insurance in accordance with the requirements of this Subsection.

Without limiting any liabilities or any other obligations of the contractor, the contractor shall provide and maintain, and cause its subcontractors to provide and maintain, the minimum insurance coverage listed below until all obligations under this contract are satisfied:

- (1) General Liability insurance with a minimum combined single limit of \$1,000,000.00 each occurrence applicable to all premises and operations. The

policy shall include coverage for bodily injury, broad form property damage (including completed operations), personal injury (including coverage for contractual and employee acts), blanket contractual, independent contractors, products and completed operations. Further, the policy shall include coverage for the hazards commonly referred to as XCU (explosion, collapse and underground). The products and completed operations coverage shall extend for one year past acceptance, cancellation or termination of the work. The policy shall contain a severability of interests provision.

- (2) Comprehensive Automobile Liability insurance with a combined single limit for bodily injury and property damage of not less than \$1,000,000.00 each occurrence with respect to contractor's owned, hired, or non-owned vehicles, assigned to or used in performance of the work.
- (3) Workers' Compensation insurance to cover obligations imposed by Federal and State statutes having jurisdiction of its employees engaged in the performance of the work, and Employers' Liability insurance with a minimum limit of \$100,000.00. Evidence of qualified self-insured status will suffice for this section.

The policies required by 1 and 2 above shall be endorsed to include the Department, its agents, officials, employees and the State of Arizona as additional insureds and shall stipulate that the insurance afforded the contractor shall be primary insurance and that any insurance carried by the Department, its agents, officials, employees or the State of Arizona shall be excess and not contributory insurance to that provided by the contractor as provided by A.R.S. 41-621C.

All insurance policies or certificates shall include a requirement providing for 30 days prior written notice to the Department of any cancellation or reduction of coverage. The contractor shall cease operations on the occurrence of any such cancellation or reduction and shall not resume operations until the required insurance is in force and new certificates of insurance have been filed with the Department.

The certificate(s) of insurance shall be issued to the Department by the contractor's insurer as evidence that policies providing the required coverages, conditions and limits are in full force and effect. Certificates of insurance should be addressed as follows:

Arizona Department of Transportation  
Contracts and Specifications Services  
1651 West Jackson Street, Room 121F  
Phoenix, Arizona 85007

Failure on the part of the contractor to produce or maintain required insurance shall constitute a material breach of contract upon which the Department may immediately terminate the contract or, at its discretion, produce or renew such insurance and pay any and all premiums in connection therewith, and all monies so paid by the Department shall be repaid by the contractor to the Department upon demand, or the Department may offset the cost of the premiums against any monies due to the contractor from the State.

Costs for coverage maintained by the contractor in excess of those required shall not be charged to the Department without prior approval of the Department.

The Department reserves the right to request and receive certified copies of any or all of the above policies and/or endorsements.

The contractor and its insurers providing the required coverages shall waive all rights of recovery against the Department and its agents, officials and employees.

107.18 CONTRACTOR'S RESPONSIBILITY FOR WORK: of the Standard Specifications is modified to add:

(A) Buildings and Structures. All damages to buildings and structures adjacent to the tunnel resulting from tunnel construction shall be repaired by the contractor. Any precautionary measures to be taken will be the contractor's responsibility. The contractor shall conduct a preconstruction survey and shall continuously monitor buildings and structures for settlement and tilt during the time tunneling operations are within a distance which could influence the buildings. Details of the preconstruction survey and monitoring are given elsewhere in these special provisions.

(B) Streets. All damage to streets, highways and canals occurring as a result of subsidence shall be repaired by the contractor. See Subsection 107.25.

(UTIL107, 6, 02/02/87)

107.19 CONTRACTOR'S RESPONSIBILITY FOR UTILITY PROPERTY AND SERVICES: of the Standard Specifications is modified to add:

The contractor's attention is directed to the requirements of A.R.S. 40-360.21 through .29 requiring all parties excavating in public streets, alleys or utility easements to first secure the location of all underground facilities in the vicinity of the excavation.

At least 48 hours prior to commencing excavation, the contractor shall call Blue Stake Center, between the hours of 7:00 A.M. and 4:30 P.M., Monday through Friday for information relative to the location of buried utilities in the following project locations:

Maricopa County 263-1100

The following agencies and utilities may be involved in work in the area of the project, and the contractor shall contract the name and telephone number indicated to coordinate any of his activities that may be in conflict:

<u>Utility or Agency</u>	<u>Name</u>	<u>Number</u>
Salt River Project (Electrical Distr)	Dave DeBenon	(602) 236-2090
Arizona Public Service	Al Field	(602) 271-6951
Southwest Gas	Elton H. Buell	(602) 484-5297
El Paso Natural Gas	Harold Stratman	(602) 438-1675
Mountain Bell	Curtis S. Sayer	(602) 831-4777
Dimension Cable TV	Blair Turner	(602) 866-0072 Ext. 243
SRVWUA (Operational Support Group)	Bob Maurer	(602) 236-2962
Air Products (8" Nitrogen Line)	Gill Garcia	(602) 899-7700
City of Tempe	Howard Hargis	(602) 731-8250

The type and location of all known underground and other utilities within the project area are shown on the plans. Such information is not guaranteed to be accurate or all inclusive. The Contractor is responsible for making his own determinations as to the type and location of underground and other utilities as may be necessary to avoid damage thereto.

In the event any utility services are interrupted as a result of subsidence in areas of dewatering or tunneling, the contractor shall promptly notify the utility owner or other proper

authority and shall cooperate in the restoration of services in accordance with the requirements of Subsection 107.25.

(RCRDS107, 6, 09/05/86)

107.24 CONTRACTOR AND SUBCONTRACTOR RECORDS: is hereby added to the Supplemental Specifications:

The contractor, subcontractors, and all material suppliers shall keep and maintain all books, papers, records, files, accounts, reports, bid documents with backup data, and all other material relating to the contract and project for five years following completion and acceptance of the work.

All of the above material shall be made available to the Department for auditing, inspection and copying and shall be produced upon request, at the Department offices located at 206 South 17th Avenue, Rm. 172A.

The contractor shall insert the above requirement in each subcontract, purchase order and lease agreement and shall also include in all subcontracts a clause requiring subcontractors to include the above requirement in any lower-tier subcontract, purchase order or lease agreement.

107.25 CONTRACTOR'S RESPONSIBILITY FOR DAMAGED PROPERTY: is hereby added to the Standard Specifications:

(A) STREETS, HIGHWAY AND CANAL:

Subsidence due to dewatering or tunneling operations beneath city streets and subsequent damage to the highway, canal, streets, curbs and sidewalks is anticipated and will be assumed to have been caused by the tunnel work. It shall be the responsibility of the contractor to repair such damage in accordance with the requirements of the Engineer and of the City of Tempe for any subsidence resulting from his operations. All repairs shall be performed in a manner which will be the least disruptive to traffic. The type and extent of repair will be determined by the Engineer. Tunneling operations shall cease if repairs for settlement are not completed within the time frame specified by the Engineer.

(B) BUILDINGS AND STRUCTURES:

All damage to buildings and structures adjacent to or above the tunnel resulting from tunnel construction shall be repaired by the contractor. Any precautionary measures to be taken shall be the contractor's responsibility. The contractor shall conduct a preconstruction survey and shall continuously monitor buildings and

structures for settlement and tilt during the time tunneling operations are within a distance which could influence the buildings and structures. Details of the required preconstruction survey are given herein under Subsection 105.19. Details of settlement monitoring are given herein under Geotechnical Instrumentation.

(C) UTILITIES:

It shall be the responsibility of the contractor to maintain in place all public and private utilities affected by the work performed under this contract and to repair all damages to such utilities. See Subsection 107.19 for precautions and other requirements.

(D) GENERAL:

Any subsidence along the tunnel alignment that in the Engineer's judgement requires backfilling shall be backfilled in accordance with methods and materials approved by the Engineer.

(E) PAYMENT:

No measurement or payment will be made for work required under (A), (B), (C) or (D).

(SUBC108, 6, 08/18/87)

SECTION 108 - PROSECUTION AND PROGRESS:

108.01 SUBLETTING OF CONTRACT: of the Standard Specifications is modified to add:

Contractors shall not sublet to subcontractors who are not duly licensed contractors in accordance with Arizona Revised Statutes 32-1101 through 32-1170.03.

Further information regarding licensing may be obtained by contacting:

Registrar of Contractors  
1818 West Adams Street  
Phoenix, AZ 85007  
Phone: (602) 255-1502

(SPIT108, 6, 10/21/85)

108.01 SUBLETTING OF CONTRACT: of the Standard Specifications is modified to add:

The following items are hereby designated as Specialty  
Items:

5060500, 5060510, 7010001, and 9300071

(CPS108, DC, 08/06/87)

108.03 PRECONSTRUCTION CONFERENCE: of the Standard Specifications is modified to add:

The contractor shall be responsible for planning, scheduling and reporting the progress of the work as to ensure timely completion of the work called for in the contract.

The contractor shall submit a schedule in two (2) parts incorporating the Sequence of Construction as shown on the plans or in these Special Provisions in accordance with the following:

Part I shall be a preliminary schedule and shall be submitted at the Preconstruction Conference for Engineer's acceptance. It shall be a schematic (arrow) diagram or precedence diagram, showing the work stages and operations for all activities required by the contract. The diagram shall be in sufficient detail to allow day-to-day monitoring of the contractor's operations. Along

with the preliminary schedule, the contractor shall include his calendar for the contract period which shall show work days, calendar days and dates.

Part II shall be submitted for the Engineer's acceptance within fifteen (15) calendar days after Part I has been approved by the Engineer, and this schedule shall include a complete critical path schedule to cover the contractor's anticipated time schedule. The schedule shall include a detailed network diagram acceptable to the Engineer with the following features:

- (A) It shall be time-scaled in calendar days. All activities shall be plotted on their early start and finish dates. Activities shall not exceed 30 calendar days in length of time when detailed in each critical path schedule.
- (B) It shall show the order and interdependence of activities and the sequence of work as reflected in the schedule report specified in (G) below. The critical activities shall be prominently distinguished.
- (C) It shall include, in addition to all construction activities, such tasks as mobilization, demobilization, submittal and approval of samples of materials and shop drawings, procurement of significant materials and equipment, and fabrication of special items, as well as installation and testing; and interfacing with other projects.
- (D) The activities shall be sufficiently detailed so that a reviewer can follow the sequence. For example, the activities shall show forming, reinforcing, and placement of concrete on the calendar days they are scheduled to be performed.
- (E) The diagram shall show for each activity the preceding and following event numbers and the description and duration of the activity in calendar days.
- (F) The activities shall be organized and described so as to conform to the contract bid items.
- (G) The diagram shall be accompanied by a Schedule report of the network with a tabulation of the following data for each activity:

- (1) Preceding and following event numbers
- (2) Activity description
- (3) Activity duration
- (4) Earliest start date
- (5) Earliest finish date
- (6) Latest start date
- (7) Latest finish date
- (8) Total float times
- (9) Responsibility for activity - e.g., contractor, subcontractor, supplier, etc.
- (10) Resource summary for each activity listing personnel, equipment and anticipated revenue.

The contractor shall make updated schedules and reports under the following circumstances or as requested:

(A) The contractor shall submit a monthly report of actual construction progress by the tenth working day of each calendar month by updating his schedule report to reflect all preceding work on the project. If in the opinion of the Engineer, the detailed network diagram requires revision in whole or in part, he shall so direct the contractor and the contractor shall submit such revision within ten (10) calendar days.

(B) The monthly report also shall show the activities or portion of activities completed during the one (1) month reporting period and the portion completed on the project to date; showing actual start and finish dates plus future activities for the next two (2) months.

(C) The monthly report shall state the percentage of revenue actually earned as of the report date.

(D) The monthly report shall be accompanied by a narrative description of job progress, problem areas, current and anticipated delaying factors and their anticipated effect, and any corrective actions proposed or taken. This report shall identify departures from earlier schedules or changes in logical sequence or logic ties.

(E) The monthly report shall include a summary of all activities scheduled to begin in next 60 days that have negative float, those activities whose float has changed and those activities with less than 30 day float. The activities shall be sequenced by the total float from least to greatest float.

(F) Float time is not for the exclusive use or benefit of either the Department or the contractor. Extension of time for performance may be granted to the extent that equitable time adjustment for the activity affected exceeds the total float or where otherwise justified, impact on the contract completion can be shown.

(G) Each schedule and report submitted, as above required, shall be furnished in seven (7) originals for Part I, Preliminary Schedule, Part II, Detail Network Diagram, and required revision of Part II Detail Network Diagram; three (3) originals shall be furnished for the monthly report, plus three (3) copies of the narrative.

If the Contractor elects to use an automated system, the software shall be Primavera or equal.

No measurement or direct payment will be made for contractor costs relating to preparation and submission of schedules and reports and revisions thereto.

Acceptance of the contractor's schedules by the Engineer is not to be construed as relieving the contractor of his obligation to complete the contract work within the contract time, or as granting, rejecting, or in any other way acting on the contractor's requests for adjustments to the date for completing contract work, or claims for additional compensation. Such requests shall be processed in strict compliance with other relevant provisions of the contract.

Failure of the contractor to comply with the requirements of this special provision, will be grounds for the Engineer to withhold an additional 10 percent of the monthly progress payments until the contractor is in compliance. Additional money withheld will be paid upon compliance to the contractor in the next scheduled monthly estimate. If the monthly report is not received by the tenth working day of each month, but prior to the 25th of the month, 5 percent will be withheld until the following estimate. When the late report is submitted, the money withheld will be released on the next estimate.

(FORCE109, 6, 02/20/87)

SECTION 109 - MEASUREMENT AND PAYMENT

109.04 (B)(1) - LABOR: of the Standard Specifications is modified to add:

(E) A percentage of the actual amount of wages, determined by the Department to be necessary to cover the contractor's costs incurred for Public Liability and Property Damage Insurance and Umbrella coverage insurance.

109.04 (B)(3) - EQUIPMENT: of the Standard Specifications is revised to read:

Equipment which the Engineer considers necessary for the performance of work will be eligible for payment at the established rates only during the hours that it is operated except as otherwise allowed elsewhere in these specifications. Equipment hours will be recorded to the nearest one-half hour. The equipment rental rates established herein include allowance for overhead and profit except where otherwise specified. For the use of equipment approved by the Engineer, the contractor will be paid the rental rates, as modified herein, set forth in the Rental Rate Blue Book for Construction Equipment which is published by the Equipment Guide-Book Company, a division of Nielson-Dataquest, 1290 Ridder Park Drive, San Jose, California 95131, Phone (800) 227-8444. All rate determinations will be based on the Blue Book rental rate chapter revisions that are applicable at the time the equipment is being used.

(A) RENTAL RATES (WITHOUT OPERATORS):

The rental rate for each item of equipment will be the sum of the base machine rate, attachment rate and operating rate(s). All rates will be rounded to the nearest five cents.

The base rate for the machine and attachments represents the major cost of equipment ownership, such as depreciation, interest, taxes, insurance, storage and major repairs.

The hourly operating rate represents the major costs of equipment operation, such as fuel and oil, lubrication, field repairs, tires, expendable parts and supplies.

For all equipment utilized on Force Account Work, the hourly rate for each piece of equipment and attachments will be paid at the Blue Book monthly rate for the make and model multiplied by the

appropriate rate adjustment factor, divided by one hundred and seventy-six, plus the hourly operating costs. Rate adjustment factors will be furnished in the special provisions.

The rate adjustment factor assigned to any attachment will be the yearly factor as determined for the base equipment.

The contractor will furnish to the Engineer, serial numbers and year of manufacture for all pieces of equipment used on force account work.

When multiple attachments are included with the rental equipment, only the attachment having the higher rental rate will be eligible for payment, provided the attachment has been approved by the Engineer as being necessary to the force account work.

The Blue Book regional adjustment factors will not apply in determining the rental rates.

Rental charges will not be allowed for small tools that show a daily rate less than five dollars or for unlisted equipment that has a value of less than four hundred dollars.

The above provisions apply to approved equipment of modern design and in good working condition. The equipment shall be handled and used to provide normal output or production. Equipment that is not in good working condition or is not of proper size for efficient performance of the work may be rejected by the Engineer. Equipment ordered for force account work will be paid for until such time as the Engineer directs that the use of such equipment be discontinued or until completion of the work.

For any equipment not listed in the Blue Book, rental rates shall be agreed to in writing prior to the use of such equipment on force account work or paid for by invoices in the case of outside rented equipment.

(B) STAND-BY TIME:

Equipment that is in operational condition and is standing by with the Engineer's approval for participation in force account work will be paid for at fifty percent of the appropriate hourly rate as determined by the provisions set forth in Subsection 109.04 (B) (3) (a) less operating costs. Payment for such "stand-by" will be limited to not more than eight hours in a twenty-four hour day or forty hours in a normal work week.

No compensation will be allowed for equipment that is inoperable due to breakdown.

No payment will be allowed for equipment that is not operating because the work has been suspended in accordance with the specifications or because the work has been suspended by the contractor for his own reasons.

(C) OUTSIDE RENTED EQUIPMENT:

In cases where a piece of equipment to be used is rented or leased by the contractor from a third party exclusively for force account work, the actual invoiced amount will be paid when such rates are reasonably in line with established rental rates for the equipment in question and approved by the Engineer. A ten percent markup will be allowed for overhead and profit for all rented equipment paid for by invoices. To this amount, the hourly operating cost will be added.

In no case will equipment be considered for rental which exceeds the hourly rate for the first eight hours and the daily rate divided by eight for all additional hours as compared with similar equipment listed in the Blue Book.

(D) OWNER-OPERATED EQUIPMENT:

Payment for rental of equipment owned and operated by persons other than the prime contractors or subcontractors will be based on the actual paid invoice. An amount equal to ten percent of the total rental of the equipment, including the owner-operator, will be added for overhead, profit and all other costs incidental to furnishing and operating the equipment. The Engineer shall approve the rental rates prior to commencement of the work.

(E) MOVING OF EQUIPMENT:

Rental time will also be allowed for the time required to move needed equipment to the location of the force account work and to return it to its original location. Loading and transportation costs will be allowed in lieu of moving times when equipment is moved by means other than its own power. Moving time back to the original location or loading and transportation costs will not be allowed if the equipment is used at the site of the force account work on contract items or related work.

For use of equipment moved on the work exclusively for force account work, the actual cost of transferring the equipment to the site of the work and returning it to the original location will be allowed as specified herein as an additional item of expense.

The original location of the equipment to be hauled to the site of the work shall be agreed to by the Engineer in advance.

Where the move of the equipment is made by common carrier, the allowance will be the invoiced amount paid for the freight plus fifteen percent. If the contractor hauls the equipment with his own forces, rental will be allowed for the hauling unit plus the driver's wages and the cost of loading and unloading the equipment.

The maximum rental period for the day that the equipment is moved on the work and the day that the use of the equipment is discontinued shall be the actual time that the equipment is in operation on force account work. When the contract includes line items of force account work, no payment will be allowed for loading, unloading and transportation costs of such equipment since the contractor is deemed to know what the work consists of and the type of equipment that is required to adequately perform the work.

RATE ADJUSTMENT FACTOR TABLE

Year of Manufacture	Factor
1986 and later	.907
1985	.903
1984	.896
1983	.892
1982	.885
1981	.865
1980	.835
1979	.816
1978	.787
1977 or earlier	.770

109.06 PARTIAL PAYMENTS: in the Standard Specifications is modified to add:

Partial payment without the execution of a supplemental agreement will be made in accordance with the third paragraph for the following items:

- Item 5030185 - Drop Structure (A)
- Item 5030186 - Drop Structure (B)
- Item 5060100 - Pump Station
- Item 9300007 - Tunnel Access Shaft

(SBKFL203, 6, 02/02/87)

SECTION 203 - EARTHWORK:

203-5.01 DESCRIPTION: the second paragraph of the Supplemental Specifications is revised to read:

Structure backfill shall consist of furnishing, placing and compacting backfill material around structures to the lines designated on the plans, specified in the special provisions, directed by the Engineer and as specified herein.

203-5.03 (B) (2) USE OF SLURRY: of the Supplemental Specifications is revised to read:

As an alternate to the material requirements of Structure Backfill, the Engineer may allow material conforming to the following requirements to be used in a slurry mixture in situations where the slurry will be confined by free-draining soils:

Sieve Size	Percent Passing
1 1/2 inch	100
1 inch	90-100
No. 8	35- 80
No. 200	0- 8

The plasticity index shall not exceed 8 when tested in accordance with the requirements of AASHTO T 90.

DCCO  
10/09/87

RAM 600-1-507  
DIVISION II

(SRV206, 6, 10/21/85)

SECTION 206 - FURNISH WATER SUPPLY:

206-1 - DESCRIPTION: of the Standard Specifications is modified to  
add:

Water may be obtained from canals under the jurisdiction of the Salt River Valley Water Users' Association and pumped into mobile tank trucks. The water shall be used within the boundaries of the Salt River Project.

If the contractor expects to obtain water from any one of the canals, he shall enter into an agreement with the Association by executing the Permit for Operation of Mobile Tank Trucks. No water shall be obtained from canals until the contractor has furnished the Engineer with a completely executed copy of the permit.

DCCO  
10/09/87

RAM 600-1-507  
DIVISION II

(DUPAL207, DC, 08/21/87)

SECTION 207 - DUST PALLIATIVE

207-5 BASIS OF PAYMENT: of the Standard Specifications is modified to add:

No measurement or payment will be made for water used to control dust along haul routes off the Project site unless approved by the Engineer. This shall in no way relieve the Contractor of his legal responsibility to mitigate the damage to the public and property adjacent to his routes or activities.

In addition, no payment shall be made for water required to water loads to eliminate dust on or off the Project site, such cost being considered as included in the unit price for the material being hauled.

(BEDNG501, 6, 12/26/85)

SECTION 501 - PIPE:

501-3.02 (A) BEDDING MATERIAL: of the Supplemental Specifications is revised to read:

Bedding material shall conform to the following gradation:

Sieve Size	Percent Passing
1 1/2 inch	100
1 inch	90- 100
No. 8	35- 80
No. 200	0- 8

Bedding material shall have a value of resistivity not less than 2000 ohm-cm or the value shown on the project plans, whichever is less. When resistivity is not shown on the plans, the bedding material shall have a value of resistivity not less than that of the existing in-place material or 2000 ohm-cm, whichever is less. Bedding material shall have a pH value between 5.0 and 9.0, inclusive, for all installations except where galvanized pipe is used. Bedding material for galvanized pipe shall have a pH value between 6.0 and 9.0, inclusive. Tests for pH and resistivity shall be in accordance with the requirements of Arizona Test Method 236.

The plasticity index shall not exceed 8 when tested in accordance with the requirements of AASHTO T 90.

ITEM 5030185 - DROP STRUCTURE (A):

1.00 DESCRIPTION:

The work under this item consists of furnishing all materials and constructing the drop structure in accordance with the details shown on the project plans the requirements of Section 601 and these special provisions. This item is all inclusive of work specified between tunnel Station 7+96 through Station 10+00.

2.00 MATERIALS:

Concrete shall be Class S ( $f'c = 4,000$ ) conforming to the requirements of Section 1006. Reinforcing steel shall conform to the requirements of Section 1003.

Structural steel shall conform to the requirements of Section 604.

The PVC and synthetic rubber waterstop shall conform to the requirements of Subsections 1011-1 and 1011-2.

The retractable ladder, with cage, shall be aluminum or other approved light weight, non corrosive material. Other ladders shall be galvanized steel, aluminum or other approved material. All ladders shall meet OSHA and applicable Federal Safety Standards.

3.00 CONSTRUCTION REQUIREMENTS:

The access well shall be covered by a removable grating and provision shall be made to lock it in place. All grating shall be designed in accordance with the requirements shown on the project plans. Designs and shop drawings shall be submitted to the Engineer for approval.

Steel grating to cover the open area of the drop structure shall be bolted to the frame with half-inch (1/2") diameter stainless steel hex socket button head cap bolts.

The ladder retraction device shall consist of a pulley and cable system with a positive locking device, operable by one person and shall be acceptable to the engineer. The contractor shall submit shop drawings for the ladders, cage and retraction device in accordance with the subsection 105.02.

The temporary access at the upstream end of the tunnel shall not be removed prior to the completion of the transition structure. The contractor shall submit a detailed removal plan including temporary sheeting and shoring to the Engineer for approval prior to removal.

4.00 METHOD OF MEASUREMENT:

Measurement of this work will be made as a unit for the Drop Structure complete in place.

5.00 BASIS OF PAYMENT:

Payment for this work will be made at the contract price each for ITEM 5030185 - DROP STRUCTURE (A), which price shall be full compensation for the item complete, including excavating, backfilling, grout, concrete work, steel reinforcement, connection to tunnel, grating and frame, access ladders, site grading, etc. all as described and specified herein and on the project plans.

ITEM 5030186 - DROP STRUCTURE (B):

1.00 DESCRIPTION:

The work under this item consists of furnishing all materials and constructing the storm drop shaft structure at the location and in accordance with the details shown on the project plans; the requirements of Section 601 and these special provisions.

2.00 MATERIALS:

Concrete shall be Class S ( $f'c = 4,000$ ) conforming to the requirements of Section 1006.

Reinforcing steel shall conform to the requirements of Section 1003.

Grout shall conform to the requirements of Subsection 913-2.04.

Other materials shall conform to the requirements shown on the project plans. All gratings and exposed metal shall be galvanized.

Gratings shall be provided with a locking device to prevent unauthorized access into the drop structure. The locking device shall be as approved by the Engineer.

Ladders shall be galvanized steel, aluminum or other approved non corrosive material and shall meet OSHA and applicable Federal Safety Standards.

4.00 METHOD OF MEASUREMENT:

Measurement of this work will be made as a unit for the drop shaft structure complete in place including the inflow structure.

5.00 BASIS OF PAYMENT:

Payment for this work will be made at the contract price each for ITEM 5030186 which price shall be full compensation for the item complete, including excavating, backfilling, grout, concrete work, steel reinforcement, steel lined connection to tunnel, inflow structure with plug, grating and frame, ladders, landing platform, anchoring, manhole steps, hand railing, site grading, all as described and specified herein and on the project plans.

Reinforced concrete pipe will be paid for under ITEM 5011105.

ITEM 5050013 - MANHOLE (C-18.10) (MODIFIED):

The work under this item consists of furnishing all materials and constructing a manhole adjacent to the 30" outlet pipe from the pump station in accordance with the details shown on the project plans, the requirements of Section 505 and these special provisions.

The 24" pipe connections to the outlet pipe shall conform to the requirements of Section 501.

Measurements and payment for this work will be in accordance with Section 505, except that the contract price shall include the cost of the round grate and the 24" pipe connection.

The liquid level sensor and related equipment will be paid for under Item 5060500.

ITEM 5060100 - PUMP STATION:

1.00 DESCRIPTION

The work under this item consists of furnishing all materials and constructing a pump station and catch basin at the location shown and in accordance with the details shown on the project plans and the requirements of Section 601 and these special provisions.

2.00 MATERIALS:

2.01 CONCRETE AND REINFORCING STEEL:

Concrete shall be Class S, (f'c = 4,000 psi) conforming to the requirements of Section 1006, and reinforcing steel shall conform to the requirements of Section 1003.

2.02 PIPE AND FITTINGS:

All pipe shall be ductile iron of the Class specified on the project plans, cement mortar lined all in accordance with MAG Standard Specifications 750. Fittings shall be cast iron or ductile iron, of the Class specified on the project plans cement mortar lined, in accordance with MAG Specification 750.

All joints on pump discharge piping, from the pump connection to the catch basin shall be flanged. Flanges, nuts and bolts and rubber gaskets shall conform with AWWA Standard C-110 for fittings and AWWA Standard C-151 for pipe. Compatibility of flanges between pipe, fittings, and other points of connection shall be the responsibility of the contractor.

2.03 SLUICE GATE:

Sluice gate shall be 24" x 24" rectangular opening with rising stem, Type E wall thimble, floor stand operator and attachment fixtures, all in accordance with the requirements of AWWA C501-80 - "AWWA Standard for Sluice Gates", and the supplemental provisions as described below.

The closure shall be of the conventional type, installed on Type "E" wall thimble of not less than 36" length.

Design heads for the sluice gate shall be 10 feet of water, for both seating and unseating conditions.

The extension stem shall be of the rising-stem type, with galvanized steel stem cover and position indicator furnished on the floor stand operator. Lifting mechanism shall be a crank-operated, rising stem, double gear type, designed to permit slide operation with an effort of not more than 40 pounds on the crank. The crank shall be removable and fitted with a corrosion resistant rotator handle. Maximum crank radius shall be 15 inches.

2.04 ANCHOR BOLTS, FASTENERS AND CONNECTIONS:

Regardless of location, all anchor bolts, fasteners, connections, straps and other items used to support pipe, fittings and gates shall be of the sizes indicated on the plans or as recommended by the manufacturer and shall be made of galvanized steel or as recommended by the manufacturer.

2.05 TRASH GUARDS:

Trash guards shall be fabricated of carbon steel, ASTM A36 shapes as shown on the project plans. Each trash guard shall be fabricated to the dimensions shown on the project plans by welding all components into a single unit, ready for installation.

After each trash guard has been fabricated, the entire assembly shall be thoroughly cleaned of all grease, oil, dirt, rust and scale, and hot-dipped galvanized.

2.06 MANHOLE FRAME AND COVER:

Manhole frame and cover shall conform to the requirements of Standard C-18.10 except as modified on the project plans. The frame and cover shall be provided with a locking device to prevent unauthorized access into the pump station. The locking device shall be as approved by the Engineer.

3.00 CONSTRUCTION REQUIREMENTS:

3.01 FINISHES:

All concrete shall receive Class I finish as described in Subsection 601-3.05, except that all concrete which is exposed to view at the Pump Station site shall receive a Class II finish to a point one foot below finished grade of the backfill material.

All anchor bolts, fasteners, openings, etc., shall be accurately set in place in the forms prior to the start of concrete placement. Locations of each item shall be coordinated by the contractor to match the requirement of the equipment involved.

3.02 INSTALLATION OF PIPING AND VALVES INSIDE STRUCTURE:

Piping requirements inside the pump station structure shall be carefully coordinated with the pumping equipment and the structure placement so that proper fit and alignment of each item is obtained.

Piping shall follow the alignment shown on the project plans. Pipe risers shall be vertical and plumb and horizontal sections shall be set level without the use of pipe joint deflections. Defective installations shall be removed and replaced by the contractor at no additional cost to the Department.

Cutting and fitting of pipe shall be accomplished in a manner that will not disturb the cement mortar lining. Damage to linings shall be repaired in accordance with pipe manufacturer's suggested methods or the affected pipe or fittings shall be replaced at no additional cost to the Department.

Supports, clamps and braces for pipe and fittings shall be as shown on the project plans. Anchor bolts, fasteners and expansion anchors shall be of the same size noted on the project plans and shall be made of galvanized steel or as recommended by the manufacturer.

Exterior surfaces of pipe, fittings and supports shall be cleaned of all dirt, grease and other foreign material and shall be given a seal coating of Inertol Tar Stop, or approved equal, to prevent bleeding of the tar coating. Surfaces shall then be given a two-coat application of coal tar epoxy for a total minimum dry film thickness of 16 mils.

3.03 SLUICE GATE INSTALLATION:

The sluice gate shall be installed on the wall thimble at the lower opening of the pump station. Gate and frame shall be installed plumb and vertical with all gaps and other openings between thimble frame and concrete completely sealed with non-hardening butyl caulking or equivalent.

The extension shaft on the operator shall be installed in a true vertical position and shall be firmly supported at intervals with stem supports as furnished by the gate supplier. Supports shall be adjusted to allow the gate to be operated from above the pump station without binding.

All surfaces of the gate, frame, extension stem and supports, except for machined bearing surfaces shall be given a factory applied two-coat application of coal-tar epoxy, for a total minimum dry film thickness of 16 mils. After installation, all painted surfaces shall be touched up in the field to repair any coating damage which occurred during construction.

3.04 TESTING:

(A) PIPING AND FITTINGS:

All piping and fittings shall be subjected to a hydrostatic test to check for leaks. Minimum test pressure on all portions of the pipe shall be 50 psi for a duration of at least 2 hours. The contractor shall provide all equipment necessary for the test.

Tests shall be made in accordance with applicable portions of AWWA Standard C-600, latest edition, except as modified herein. Tests shall be conducted on each pump discharge line, between the points of connection to the pumps and the point of discharge into the catch basin.

To pass the leakage test, no visible leakage in each test section shall be noted.

(B) SLUICE GATE TESTING:

The sluice gate shall be subjected to shop tests for seat clearance and performance, in accordance with AWWA C501-80, Section 4.2. Written certification that these tests were performed shall be furnished with the sluice gate at the time of delivery.

Sluice gate manufacturer shall also certify that the gate meets or exceeds the requirements of AWWA C501-80.

After installation, the manufacturer shall provide a representative to inspect the completed gate assembly, and shall certify that the installation meets the recommended installation and adjustment requirements of the manufacturer for proper operation of the finished gate assembly. Any adjustments or repairs required by the representative shall be accomplished by the contractor at no additional cost to the Department.

3.05 PUMP ACCESS FRAME AND COVER:

The pump access frame and cover shall be a duplex aluminum access frame and cover, rated at 150 lb/sq. ft., complete with provisions to attach the upper guide bracket from the pumping equipment and hooks to support the pump lifting cable and electrical cable.

An access frame shall be cast into the top slab directly above the pumps and in strict accordance with dimensions supplied by the pump manufacturer. Doors shall be of skid proof design and shall be provided with stainless steel hinges and fasteners. The doors

shall open to 90 degrees and shall lock automatically in that position with a stainless steel positive locking arm and release handle. Doors shall be furnished with stainless steel lifting handle and locking bar.

Size of the pump access frame and cover shall be as shown on the project plans and in accordance with the requirements of the pumping equipment as stated by the pump manufacturer.

3.06           INSTALLATION:

The access frame shall be cast into the pump station top slab. All aluminum surfaces in contact with concrete shall be given one coat of zinc chromate primer in accordance with Federal Specifications TT-P-645 and shall be allowed to dry hard (air dry 24 hours) before assembly.

3.07           GRATING AND LADDER:

All grating and ladder anchors and fasteners shall be of galvanized steel construction and shall be of the sizes shown on the project plans.

Ladder shall conform to OSHA requirements for Type 1A (300 lb.) fixed ladder.

Grating shall be furnished in the sizes shown on the project plans and shall be constructed of straight, parallel bearing bars with 0.065 inch thick webs and 0.25 inch wide grooved top and bottom flanges. Bearing bars shall be placed edgewise at a spacing of 1-3/16 inches on center and joined by straight cross bars at a spacing of 4 inches on center. Cross bars shall be secured to bearing bars by swaging process to prevent turning, twisting or loosening. The ends of the grating shall be banded.

Grating shall rest on metal angle rebates or as shown on the project plans depending on location. Grating shall be securely fastened to its supports by galvanized steel clips or clamps spaced not more than 18 inches apart.

3.08           INSTALLATION OF GRATING AND LADDER:

The installation of ladders and grating shall conform to the details shown on the project plans.

3.09           INSTALLATION (TRASH GUARDS):

After fabrication and coating, each trash guard shall be installed in the proper location using fasteners as shown on the project plans.

5.00 BASIS OF PAYMENT:

Payment for this work will be made at the contract lump sum price for ITEM 5060100 - PUMP STATION which price shall be full compensation for the item complete including structural excavation, structure, backfill, concrete, reinforcing steel, catch basin, gratings, manhole frame and cover, ladder, hatch cover and inlet pipe from tunnel as described and specified herein and on the project plans.

Pumps, electric motors and related equipment and pump station electrical system and related equipment will be paid for under Items 5060510 and 5060500 respectively.

ITEM 5060500 - PUMP STATION ELECTRICAL SYSTEM:

1.00 DESCRIPTION:

The work consists of furnishing all materials and installing a complete and functioning electrical and control system for the pump station as shown on the project plans and as described herein.

The work shall also include excavating and backfilling trenches for the incoming primary service from the transformer pad to the Service Entrance Station (SES), all in accordance with the details shown on the project plans and with the requirements of the utility company. The contractor shall contact the utility company prior to the start of construction to determine specific requirements.

1.01 REGULATIONS AND CODES:

Electrical work, including connection to electrical equipment integral with mechanical equipment, shall be performed in accordance with the latest published regulations of the National Electrical Code (NEC), State and local codes, and according to the latest Institute of Electrical and Electronic Engineers (IEEE), American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), Insulated Power Cable Engineers Association (IPECA), National Electrical Manufacturers Association Occupational Safety and Health Act (OSHA). When applicable, the material used in the performance of the electrical work shall be approved by the Underwriters' Laboratories, Inc. (UL) for Class I, Division I, Group D locations.

1.02 COORDINATION OF THE ELECTRICAL SYSTEM:

The contractor shall verify all actual equipment and motor full load and locked-rotor current ratings. The necessary minimum equipment, wire, and conduit sizes as shown on the project plans shall

be coordinated with the actual current rating of equipment furnished. The branch circuit conductor size and overcurrent protection device shall have capacity of not less than 125 percent of the actual full-load current rating. The size of the branch circuit conductors shall be such that the voltage drop from the overcurrent protection devices up to the equipment shall not be greater than 2 percent when the equipment is running at full-load and rated voltage.

The motor running overcurrent protection devices shall be rated or selected to trip at no more than 125 percent of the motor full-load current rating for motors marked to have a temperature rise not over 40 degrees C or motors marked with a service factor not less than 1.15 and at no more than 115 percent for all other types of motors. The motor controller size shall be coordinated to the current rating and horsepower size of the installed motor.

The motor-branch-circuit overcurrent protection device shall trip open in 30 seconds or less on locked-rotor current of the motor. This device shall also protect the motor-branch-circuit conductors and the motor control apparatus against overcurrent due to short-circuits or grounds. The motor control circuits shall have overcurrent protection of the type indicated on the project plans.

### 3.00 CONSTRUCTION REQUIREMENTS:

Minimum sizes of equipment or electric devices are shown, but it is not intended to show every offset and fitting, or every structural or mechanical difficulty that will be encountered during the installation of the electrical system.

All work shown on the project plans is approximately to scale, but actual dimensions and detailed drawings shall be followed as closely as field conditions permit. Field verification of scale dimensions of project plans is directed since actual locations, distances or levels will be governed by field conditions.

The contractor shall lay out and install electrical conduits as necessary prior to placing slabs and walls. He shall furnish and install all sleeves and openings through slabs and walls required for passage of all cables. Sleeves shall be galvanized rigid steel, rigidly supported, and suitably packed or sealed to prevent ingress of wet concrete.

The contractor shall furnish and install all inserts and hangers required to support conduits and other electrical equipment. If the inserts, hangers, or sleeves are improperly placed or installed, the contractor shall do all necessary work at his own expense to rectify the errors.

All electrical equipment shall be capable of operating successfully at full-rated load, without failure, at high ambient air temperatures that occur within equipment exposed to direct sunlight.

The contractor shall submit eight copies of shop drawings, data and details to the Engineer on all controls, fixtures, wiring, electrical equipment or conduit for approval prior to use of any components in the work.

Where it becomes necessary to cut into work already in place for the purpose of making electrical installations, core drills shall be used for making circular holes. Other demolition methods for cutting or removing shall be approved by the engineer prior to starting the work. The contractor shall repair all damage caused thereby to the satisfaction of the Engineer.

Wherever dissimilar metals, except conduit and conduit fittings, come in contact, the Contractor shall isolate these metals as required with neoprene washers, 9 mil polyethylene tape or gaskets. Where fastening conduit, stainless steel fasteners and stainless steel bolts shall be used.

### 3.01 CIRCUIT IDENTIFICATION:

The 3 phase wires shall be identified at the switchgear, panelboards and motor control centers as Phases A, B, and C. Phase A shall be red, Phase B shall be black and Phase C shall be blue, The neutral shall be white.

In addition to color coding all conductors, each conductor shall be identified in each pull box, manhole, panelboard or termination with vinyl markers. Letters on the markers shall be 1/4 inch high.

### 3.02 CONDUIT:

All conduit shall be as indicated on the project plans. All wiring shall be in conduit except as otherwise shown. Conduit size shall not be less than the National Electrical Code (NEC) size required for the conductors therein and shall not be smaller than 3/4 inch. No underground conduit shall be less than one inch.

Conduit runs are schematic only and shall be modified to suit field conditions with the approval of the Engineer.

Conduit shall run continuously between outlets and shall be provided with junction boxes where connections are made, except in special pull boxes indicated on the project plans. Couplings, connectors and fittings shall be approved types designed and manufactured for the purpose and shall provide a firm mechanical assembly and electrical conductivity throughout.

Conduit runs shall be straight and true; elbows, offsets and bends shall be uniform and symmetrical. Changes in direction shall be made with lone radius bends or with fittings of the conduit type. Conduit type fittings shall be Crouse-Hinds, Appleton or equal, with wedge nut covers.

Conduit runs shall not interfere with the proper and safe operation of equipment and shall not block or interfere with ingress or egress, including equipment removal hatches.

Exposed conduits shall be securely fastened with clamps or straps. All exposed conduit shall be run on the walls and ceiling only except as otherwise shown, and shall be parallel to the planes of the walls or ceiling. No diagonal runs will be permitted. Flexible conduit shall be used only for short lengths required to facilitate connections between rigid conduit and motors or control equipment. The maximum length of flexible conduit shall be 5 feet. Where flexible conduit is used, it shall be weatherproof and watertight as manufactured by American Brass Company "Sealite", General Electric Plastic Coated Flexible Conduit, or equal. All conduits located outdoors or in wet locations shall be watertight.

Conduit runs on water-bearing walls shall be supported one inch away from the wall on an approved channel. No conduit shall be run in water-bearing walls, unless specifically designated otherwise.

All conduit shall be thoroughly reamed after the threads have been cut to remove burrs. All joints shall be made with approved sealing compound and shall be watertight. Bushings or conduit fittings shall be used at all conduit terminations. The total of all bends in any run between pull boxes or junction boxes shall not exceed 360 degrees. Pull boxes shall be installed at points approved by the Engineer. Conduits brought into pull boxes, conduits, and other openings shall be capped until used to prevent the entrance of moisture.

Joints shall be made up watertight. Hangers and fastening shall be secure and of a type appropriate in design and dimensions for the particular application.

Conduit runs shall be cleaned and internally sized (obstruction tested) to the satisfaction of the Engineer prior to pulling in conductors.

Expansion fittings shall be installed across all expansion joints and at other locations where necessary to compensate for thermal expansion and contraction. Expansion fittings shall be OZ Type AX with jumper for exposed location and Type OX structural expansion joints, as recommended by conduit manufacturers.

Shop drawings shall be submitted as requested by the Engineer for approval, showing routing, conduit size and number and size of wires in each conduit before installation of conduit.

Conduit and couplings shall be hot-dipped galvanized with zinc coated threads and outer coating of zinc bichromate as manufactured by Jones & Laughlin Steel Corporation, Allied Tube & Conduit Corporation, or equal. Steel conduit where installed in earth or on grade below slab shall be wrapped with dielectric tape, half lapped.

#### CONDUCTORS:

All wiring shall be as indicated on the project plans. Wires shall be new and shall be soft drawn copper with not less than 97 percent conductivity. The wire and cable shall have size, grade of insulation, voltage and manufacturer's name permanently marked on the outer covering at not more than 2 foot intervals. All wires shall conform to the latest Standards of the ASTM and IPECA and shall be tested for their full length by these Standards. Insulation thickness shall be not less than that specified by the NEC.

Wire sizes shall be American Wire Gauge (AWG) sizes with Class B stranded construction. No. 12 and No. 10 AWG may be solid conductor.

No. 2 AWG and smaller shall be factory color coded with a separate color for each phase and neutral, which shall be used consistently throughout the system. Large cables shall be coded by the use of colored tape.

As far as practicable, all circuits shall be continuous from origin to termination without splices in intermediate pull boxes. Sufficient slack shall be left at the termination to make proper connections. In no case shall a splice be pulled into the conduit.

Individual conductor cables for circuit of 480 volts or less shall be insulated for not less than 600 volts and shall have Type USE insulation. Where wire size is not indicated, they shall be of the size required by the NEC, except that no wire shall be less than No. 12 AWG unless otherwise noted. Wire and cable shall be as manufactured by American Insulated Wire Corporation, Anaconda Wire and Cable Company, or equal. Control circuit conductors may be sized to meet equipment ratings as approved by the Engineer.

Multi-Conductor control cables shall have conductors with EPR Insulation, one uninsulated ground wire, and an overall NBR-PVC Jacket. The cable shall conform to the following: U.L. VW-1, IEEE-383, U.L. Approved Type TC, 600 V Rating, 90°C Dry and 75°C

Wet. The cables shall be U.L. listed, OSHA Acceptable, recognized for use in Class I, Division I hazardous locations and specifically approved for direct burial, submersible wet or dry locations, and shall also be sunlight resistant.

3.03 PULLING LUBRICANT:

All cables shall be properly coated with pulling compound recommended by the cable manufacturer before being pulled into conduits so as to prevent mechanical damage to the cables during installation.

Other lubricants to be substituted shall be accompanied by a statement from the cable manufacturer as to its acceptable use with the cable being installed.

3.04 GROUNDING:

The grounding systems shall be per NEC Article 250 and FUSER.

All equipment, pump cases or devices shall be grounded. These systems shall be installed at each structure where switchgear, motor control centers, switchboards or panelboards are installed.

Where ground conductors are not sized, the NEC shall govern.

All connections of ground cable shall be thermoweld connections. Maximum allowable ground resistance shall be 5 ohms, measured in dry season. The ground electrode system shall be measured with a direct reading megger earth tester. The measurement shall be done in the presence of the Engineer and records shall be taken.

All pump casegrounds shall be run as a separate conductor in the conduit to the motor control center or system ground. All wireways or enclosures shall be properly bounded and grounded and ground conductors shall be run for all circuits.

3.05 OUTLET; SWITCH, PULL AND JUNCTION BOXES:

Device boxes and junction boxes shall be heavy-duty cast watertight and shall be compatible with the location and conduit system being used, rigid steel or rigid copper free aluminum and shall be as manufactured by Crouse-Hinds, Appleton or equal, with wedge nut covers and/or stainless steel cover screws with cover gasket.

Fasteners used with wiring devices shall be aluminum or stainless steel and all screws, nuts or bolts shall be stainless steel.

3.06 RECEPTACLES:

Duplex receptacles shall be 2-pole, 3-wire grounded, 120 volts, industrial grade, ground fault circuit interrupting, rated at 20 amperes and shall be as manufactured by Hubbell, General Electric or equal. Special receptacles or covers shall be as shown on the project plans.

Enclosures shall be weatherproof with yellow "fiberglass" lift cover plates. All buttons, gauges and controls shall be located within the weatherproof enclosure.

3.07 PANELBOARDS:

Dead-front panelboards, including lighting distribution and control panels, shall be furnished and installed as indicated on the project plans. All bus bars shall be aluminum. Mounting and type enclosures shall be as indicated on the project plans. The minimum interrupting capacity of any device shall be 10,000 amperes.

MOTOR CONTROL CENTERS:

The Motor Control Centers (MCC's) shall conform to NEMA Standard "A-C General Purpose Motor Control Centers" Part ICS 2-322, U.L. Standard No. 845, and to the NEC.

The MCC's shall be constructed of vertical sections nominally 90 inches high, 20 inches wide, and 20 inches deep. Each section shall have a horizontal wire trough located at both top and bottom, and shall be connected by a vertical wire trough. Each unit shall have an individual front door for access. Construction details shall be as indicated on the MCC data sheet.

The starters shall be 3-pole, 480-volt, full voltage, magnetic combination type, with trip indicating motor circuit protectors. Connection to the bus shall be by stab-type contacts. Quantities shall be as shown on the drawings. Internal connections and accessories shall be as shown on the motor starter wiring diagrams.

Circuit breakers shall be 3-pole, heavy duty, 600 V, quick-make, quick-break, with an AIC of 22,000 amperes symmetrical. Quantities shall be as shown on the drawings.

Accessories to be included in the MCC are:

1. 5 KVA 480V: 240/120V Transformer 1.6% Z.

2. 6 Pole 240/120V Panelboard 30A secondary overcurrent protection including appropriate breakers as shown on the plans.
3. Meter socket.
4. Provisions for current transformer.

MCC CONSTRUCTION DATA:

WIRING	SYSTEM	ENCLOSURE
Class 2	480 Volt	_____ NEMA 1 Gasketed
Type C	3 Phase	_____ <u>X</u> NEMA 3 Weather Resistant
	3 Wire	_____ Junction Box Required

BUS RATING	BUS BRACING	BUS MATERIAL
Mains, Amps <u>600</u>	22,000 Amps (SYM) <u>x</u>	Copper _____
Vertical, Amps <u>300</u>	42,000 Amps (SYM) _____	Aluminum _____
Neutral, Amps <u>None</u>		Either _____ <u>x</u>
Bare Ground, Amps <u>300</u>		

CONTROL VOLTAGE

Voltage Level <u>120</u>	Source:
Secondary Fuses:	Starter Control Transformer _____ <u>x</u>
One <u>x</u>	MCC Control Transformer _____ <u>x</u>
Two _____	External Control Source _____

EXTERNAL CONNECTIONS

Incoming Line Feeders:	Entrance:
Cable <u>x</u>	Incoming Line: Top _____, Bottom _____ <u>x</u>
Bus Duct _____	Load Feeders: Top _____, Bottom _____ <u>x</u>
	CONTROL CABLES: Top _____, Bottom _____ <u>x</u>

All internal wire and cable shall be insulated for 600 volts.

The motor control centers shall be General Electric Style 8000 Seimans-ITE MARQ21 or approved equal.

See project plans for MCC Control Diagram.

Protective devices shall be such that they can be replaced without disturbing adjacent units. Wire connections shall be suitable for wire sizes indicated. Branch circuits shall be numbered as indicated on the project plans and a complete typed circuit schedule shall be furnished under a transparent cover and affixed to the panel. Phase busing shall be full height without reduction. Full

size neutral bars shall be included and shall have suitable lug for each outgoing circuit requiring a neutral connection. Spaces for future protective devices provided in lighting panels shall be bused for the maximum device that can be fitted into them.

Panelboards shall be furnished with a primer, rust-resistant phosphate undercoat and two coats of oven-baked enamel with finish color to be approved by the Engineer. They shall have sufficient size to provide a minimum of 4 inches of gutter space on all sides. Doors shall be such that they:

(A) In making switching devices accessible, shall not uncover any live parts.

(B) Are hinged and have latches that require no tool to operate.

(C) Can be locked and two keys shall be furnished.

3.08 LIGHTING:

Fixtures shall include lamps or mounting hardware to provide complete operating units.

Lamps shall be as manufactured by General Electric Company, Westinghouse, Sylvania or equal.

Catalog data including applicable coefficients of utilization tables, isolux chart of illumination on a horizontal plane, beam efficiency, horizontal and vertical beam spread, and beam lumens shall be submitted to the Engineer for approval for all fixtures before fixtures are ordered. Substitutions will be permitted only by specific approval of the Engineer.

Fixtures shall be as designated in the fixtures schedule or as detailed on the project plans.

3.09 PUMP FAILURE SYSTEM:

The pump failure system shall consist of:

Pump Motor Overload Trip.

Moisture detection device in the motor enclosure.

Motor winding temperature sensor.

When the pump failure system is activated, it shall turn off the pump, and the red flashing warning light shall be activated.

3.10 PUMP CONTROL:

Pump controls shall consist of manually activated on/off pushbuttons, with a low or high level shutoff switch which shall be activated by liquid level sensors mounted in the pump station and the manhole.

The liquid level sensor system for each pump shall consist of:

1. A control unit which contains a main circuit breaker, 120V:24V Control Transformer, required contacts, terminal blocks, connections, and related items in a NEMA 4 Enclosure.
2. An extension cable that shall be run from the control unit to the junction box located in the appropriate location.
3. The junction box to be installed at the manhole location shall be a NEMA 4 cast aluminum box.
4. The liquid level sensors shall be of the non-floating, displacement type. Sensors shall be capable of withstanding up to 110 feet of water pressure and shall be furnished with sufficient cable to complete the installation without splices in the cable.
5. The cable shall be provided with intermediate guides or supports supplied by the manufacturer as required.

The sensor shall be wired to turn off either or both tunnel pumps when a low or high water condition is experienced in the pump station or the manhole. All liquid level regulator control units and sensors shall be intrinsically safe and be placed inside of a NEMA 4 lockable enclosure.

3.11 TEST:

The electrical work shall be free from improper grounds and from short circuits. The corrections of the wiring shall be verified first by visual comparison of the conductor connections with connection diagrams. Individual circuit continuity checks shall next be made by using electrical circuit testers. Last, the corrections of the wiring shall be verified by the actual electrical operation of the electrical and mechanical devices. Any deviation from the wiring shown on the project plans or approved drawings shall be corrected and indicated on the project plans.

3.12 RECORD DRAWING:

Prior to completion of the contract, the contractor shall furnish the Engineer with a set of electrical plans marked with any changes, deviations or additions to any part of the electrical work.

4.00 METHOD OF MEASUREMENT:

The pump station electrical system will be measured as a unit for a complete and functional electrical system.

5.00 BASIS OF PAYMENT:

Payment for this work as described herein will be made at the contract price each for ITEM 5060500, which price shall be full compensation for the item complete as described and specified herein and on the project plans.

ITEM 5060510 - PUMPS, ELECTRIC MOTORS AND RELATED EQUIPMENT:

1.00 DESCRIPTION:

The work under this item consists of furnishing all materials and installing pumps, electric motors and related equipment necessary to construct a complete and functioning pumping system in accordance with the details shown on the project plans and these special provisions.

2.00 MATERIALS:

SUBMERSIBLE PUMPS AND MOTORS:

(A) GENERAL:

Furnish and install two submersible non-clog pumps and motors, as specified herein, complete with discharge connection elbow, guide bars and guide bar brackets. Each unit shall be fitted with a stainless steel lifting cable and sufficient power cable, seal chamber probe cable and thermal lead cables to permit raising and lowering the pumps.

(B) PUMPS AND MOTOR DESIGN:

The pumps shall be capable of handling raw, unscreened stormwater. The discharge connection elbow shall be 12" size and shall be permanently installed in the pump station along with the 12" discharge piping. The pumps shall be automatically connected to the discharge connection elbow when lowered into place and shall be

easily removed for inspection or service without the need for personnel to enter the pump station. Sealing of the pumping unit to the discharge connection elbow shall be accomplished by a simple linear downward motion of the pump. A sliding guide bracket shall be an integral part of the pump unit. The entire weight of the pump unit shall be guided by no less than two guide bars and pressed tightly against the discharge connection. The pump, with its appurtenances and cables, shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 110 feet.

Guide bars shall be of the size recommended by the pump manufacturer and as approved by the Engineer. The guide bars shall not support any portion of the weight of the pump when it is in operating position. Guide bar brackets, seal chamber probe cable, level sensor cable and power cable holders shall be furnished and installed.

Each pump shall be capable of delivering water at the following operating points, within the stated tolerances:

4,200 gallons per minute (gpm) at a total dynamic head (TDH) of 58 feet.

Pumps shall be able to operate against a maximum TDH of 86 feet and a minimum TDH of 29 feet.

All points as stated above shall fall within the selected pump's operating curve, and shall not overload the pump motor at any point on the curve, as specified hereinafter.

The pumps and motors shall be designed for NEMA Class I, Division I, Group D service. Each pump motor shall be a squirrel-cage, induction, shell type design, housed in an air-filled, watertight chamber. Motor insulation shall be Class F. The motor shall be designed for continuous duty with a minimum service factor of 1.15 at 40°C. Motor and pump shall be designed to permit no less than 10 starts per hour without exceeding insulation class or affecting the service life of the unit.

Each unit shall be provided with an adequately designed heat dispersion.

Each motor shall be rated for not more than 100 horsepower, and shall be connected for operation on a 460 volt, 3 phase, 60 hertz 3 wire service.

Each motor shall be fitted with a minimum 125 feet of unspliced cable. Multi-Conductor cables shall have conductors with EPR Insulation, one uninsulated ground wire, and an overall NBR-PVC Jacket. The cable shall conform to the following: U.L. VW-1 Type TC, IEEE-383, 600V Rating, 90°C Dry and 75°C Wet. The cables shall be

U.L. listed, OSHA Acceptable, recognized for use in Class I, Division I, Group D hazardous locations and specifically approved for direct burial, submersible wet or dry locations, and shall also be sunlight resistant. All conductors shall be copper.

(C) PUMP/MOTOR CONSTRUCTION

Major pump components shall be of gray cast iron, Class 30, with smooth surfaces devoid of blow holes and other irregularities. Where watertight sealing is required, O-rings made of nitrile rubber shall be used. All exposed nuts and bolts shall be of AISI type 304 stainless steel or brass construction. All surfaces, coming into contact with storm water, other than stainless steel or brass shall be protected by an approved raw sewage resistant coating.

All mating surfaces where watertight sealing is required shall be machined and fitted with nitrile rubber O-rings. Fittings shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This shall result in controlled compression limit.

The junction chamber, containing the terminal board, shall be sealed from the motor by elastomer compression seal (O-ring). Connection between the cable conductors and stator leads shall be made with threaded compressed type binding post permanently affixed to a terminal board.

Thermal sensors shall be used to monitor stator temperatures. The stator shall be equipped with three thermal switches embedded in the end coils of the stator winding (one switch in each stator phase). These shall be used in conjunction with and supplemental to external motor overload protection and wired to the control panel.

The installed thermal sensor cable shall be suitable for submersible pump application with P122-Mine Safety Health Act approval. This shall be indicated by a code or legend permanently embossed on the cable. Cable sizing shall comply with NEC Specifications. Cables shall be of sufficient length to connect to the terminal boxes as shown on the plans.

The pump shaft shall be of AISI type 304 stainless steel.

Each pump shall be provided with a tandem mechanical rotating shaft seal system. The lower seal unit, between the pump and oil chamber, shall contain one stationary and one positively driven rotating tungsten carbide ring. The upper seal unit, between the pump and motor housing, shall contain one stationary tungsten carbide or chrome ring and one positively driven rotating carbon ring. The seals

shall require neither maintenance nor adjustment, but shall be easily inspected and replaced. An electrode probe shall be provided to indicate water in unit.

The pump shaft shall rotate on two totally sealed lubricated bearings.

The impeller shall be dynamically balanced, non-clogging design capable of handling solids, fibrous materials, silt, sand, mud and other matter found in normal storm water applications. The impeller shall be capable of passing a minimum 3 inch solid sphere.

The volute shall be of single piece design and shall have smooth fluid passages large enough at all points to pass any size solids which can pass through the impeller.

A wear ring system shall be installed to provide efficient sealing between the volute and impeller.

Each pump/motor assembly shall be fitted with 95 feet of 3/8 inch AISI type 304 stainless steel lifting cable (7 x 19), with all fasteners and attachments made of AISI type 304 stainless steel.

(D) PUMP TEST:

The pump manufacturer shall perform the following inspections and tests on each pump before shipment from factory:

(1) Impeller, motor rating and electrical connections shall first be checked for compliance with the specifications.

(2) Motor and Cable Insulation Test for moisture content or insulation defects shall be made.

(3) Prior to submergence, the pump shall be run dry to establish correct rotation and mechanical integrity.

(4) The pump shall be run for 30 minutes submerged, a minimum of 110 feet under water.

(5) After Operational Test (4), the Insulation Test (2) shall be performed again.

(6) One pump shall be performance tested per Hydraulic Institute Standards.

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A certified report stating the foregoing steps have been done shall be supplied for each pump prior to shipment.

The pumps shall be the standard manufactured items of the manufacturer who shall have similar type pumps installed and operating in the United States for a period of not less than 5 years.

(E) PUMP WARRANTY:

The pump manufacturer shall warrant the units being supplied to the Department against defects in workmanship and material for a period of five years or 10,000 hours under normal use, operation and service. The warranty shall cover parts and labor and shall be in printed form and apply to all units.

(F) DOCUMENTATION

The pump manufacturer shall supply a minimum of five sets of its standard Submittal Drawings, Operating and Maintenance Instruction Manuals and Parts Lists.

Standard submittals shall consist of:

- 1) Pump Outline Drawing,
- 2) Control Data,
- 3) Access Frame,
- 4) Typical Installation Guides,
- 5) Technical Manuals,
- 6) Parts List.

5.00 BASIS OF PAYMENT:

Payment for this work will be made at the contract lump sum price for ITEM 5060510, which price shall be full compensation for the item complete, including pumps, electric motors, and related equipment, as described and specified herein and on the project plans.

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(PAINT610, DC, 07/27/87)

SECTION 610 - PAINTING: of the Supplemental Specifications is revised to read:

610-1 DESCRIPTION:

The work under this section shall consist of furnishing paint and other materials and painting metal structures or other surfaces where shown on the plans in accordance with the requirements of these specifications. The work shall include preparation of the surfaces to be painted, the protection and drying of the paint coatings and the protection of pedestrian, vehicular or other traffic near or under the work from paint spatter and disfigurement.

610-2 MATERIALS:

Paint shall conform to the requirements of Section 1002, unless otherwise specified.

610-3 CONSTRUCTION REQUIREMENTS:

610-3.01 WEATHER CONDITIONS:

Paint shall be applied only on thoroughly dry surfaces and only when the atmospheric temperature is at or above 40 degrees F. at the site of the work. Paint shall not be applied when the air is misty or when weather conditions exist which might damage the work. If fresh paint is damaged by the elements, it shall be replaced or repaired by the contractor at his expense.

The contractor may provide suitable enclosures to permit painting during inclement weather. Provisions shall be made by the contractor to artificially control atmospheric conditions inside the enclosures within limits suitable for painting throughout the painting operation.

610-3.02 SURFACE CLEANING:

(A) GENERAL:

All surfaces of structural steel or other metals, except galvanized surfaces, shall be cleaned prior to painting.

All surfaces of new structural steel or other metals which are to be painted shall be blast cleaned to a near-white finish in accordance with SSPC-SP10 unless otherwise specified or approved in writing by the Engineer.

When repainting existing steel structures, the method of cleaning will be specified in the special provisions. Areas not designated for repainting which are damaged as a result of the contractor's operations shall be repaired by the contractor, at his expense, and as approved by the Engineer.

(B) BLAST CLEANING:

Abrasives used for blast cleaning shall be clean dry sand, mineral grit, steel shot, or steel grit and shall have a gradation such that the abrasive will produce a uniform profile of 1 to 2 mils, as measured with Testex Replica Tape. The use of other abrasives will not be permitted unless approved in writing by the Engineer.

All dirt, rust, old paint, mill scale and other foreign material shall be removed from steel or other metal surfaces with an approved blast cleaning apparatus.

All abrasive and paint residue shall be removed from steel surfaces with a good commercial grade vacuum cleaner equipped with a brush type cleaning tool, or by double blowing. If the double blowing method is used, the top surfaces of all structural steel, including top and bottom flanges, longitudinal stiffeners, splice plates, hangers, etc. shall be vacuumed after the double blowing operations are completed.

When blast cleaning is being performed near machinery, all journals, bearings, motors and moving parts shall be sealed against entry of abrasive dust.

Blast cleaned surfaces shall be primed or treated the same day blast cleaning is done, unless otherwise authorized by the Engineer. If cleaned surfaces rust or are contaminated with foreign material before painting is accomplished, they shall be recleaned by the contractor at his expense.

(C) STEAM CLEANING:

All dirt, grease, loose chalky paint or other foreign material which has accumulated on previously painted surfaces shall be removed with a steam cleaning apparatus prior to all other phases of cleaning. It is not intended that sound paint be removed by this process. After steam cleaning, any paint which has become loose, curled, lifted or loses its bond to the preceding coat or coats shall be removed to sound paint or metal surface by the contractor at his expense.

A detergent shall be added to the feed water of the steam generator or applied to the surface to be cleaned. The detergent shall be of such composition and shall be added in such quantity that the specified cleaning is accomplished.

Any residue, detergent or other foreign material which may accumulate on cleaned surfaces shall be removed by flushing with fresh water.

Steam cleaning shall not be performed more than two weeks prior to starting painting operations or other phases of cleaning.

Subsequent painting shall not be performed until the cleaned surfaces are thoroughly dry and in no case in less than 24 hours after cleaning.

(D) HAND CLEANING:

Manual or powered wire brushes, hand scraping tools, power grinders or sandpaper shall be used to remove all dirt, loose rust, mill scale, or paint which is not firmly bonded to the surfaces.

610-3.03 APPLICATION:

The contractor shall notify the Engineer, in writing, at least one week prior to beginning cleaning and painting operations including shop painting.

Painting shall be accomplished in a neat and workmanlike manner. Paint shall be applied with hand brushes, by spray, or roller or by a combination thereof.

Each application of paint shall be smoothly and uniformly spread so that no excess paint will collect at any point. Any skips, holidays, thin areas or other deficiencies shall be corrected before the succeeding paint application. The surface of the paint being covered shall be free of moisture, dust, grease or any other deleterious materials which would prevent the bond of the succeeding applications.

When paint brushes are used, they shall have a sufficient body and length of bristle to spread the paint in a uniform film.

Surfaces which are inaccessible shall be painted with daubers or by other means approved by the Engineer.

When rollers are used, they shall be of a type which will not leave a stippled texture in the paint film.

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When sprayers are used, a water trap, approved by the Engineer, shall be furnished and installed at each spray pot.

Prior to application, paint shall be mixed with mechanical mixers for a sufficient length of time to thoroughly mix the pigment and the vehicle together and it shall be kept thoroughly agitated during its application.

The handling and the application of paints shall be done in accordance with all applicable occupational, safety and health standards, rules and regulations.

610-3.04 PROTECTION AGAINST DAMAGE:

The contractor shall provide protective devices as necessary to prevent damage to the work and to other property or persons from all cleaning and painting operations.

Paint or paint stains which result in an unsightly appearance on surfaces not designated to be painted shall be removed or obliterated as approved by the Engineer.

All painted surfaces that are marred or damaged as a result of the contractor's operations shall be repaired with materials and to a condition equal to that of the paint coating specified herein.

Upon completion of all painting operations and of any other work that would cause dust, grease or other foreign materials to be deposited upon the painted surfaces, the painted surfaces shall be thoroughly cleaned.

610-3.05 PAINTING STRUCTURAL STEEL:

(A) PAINT COATS:

(1) GENERAL:

All surfaces of new structural steel and other metals shall be painted with one shop coat (prime coat) and two field coats (first field coat and finish coat), unless otherwise specified.

The contractor shall provide evidence satisfactory to the Engineer that the paint systems selected are compatible.

The dry film thickness of the paint will be measured in place with a calibrated magnetic film thickness gauge.

If the minimum dry film thickness is exceeded, it shall be limited to that which will result in uniform drying throughout the paint film.

(2) PRIME COAT:

The prime coat shall be Paint No. 1 conforming to the requirements of Subsection 1002-3 and when applied the dry film thickness of the paint shall be not less than 2.5 mils.

(3) FIRST FIELD COAT:

The first field coat shall be Paint No. 2 conforming to the requirements of Subsection 1002-3. When applied, the dry film thickness shall be not less than 1.5 mils.

(4) FINISH COAT:

The finish coat shall be Paint No. 3 conforming to the requirements of Subsection 1002-3. When applied, the dry film thickness shall be not less than 1.0 mil.

(B) SHOP PAINTING:

After structural steel has been fabricated, blast cleaned and accepted by the Engineer, all surfaces, except metal surfaces which are to be embedded in concrete, shall be painted with a prime coat.

Structural steel which is to be welded shall not be painted before welding is complete. If it is to be welded only in the fabricating shop and subsequently erected by bolting, it shall receive one prime coat after the shop welding is completed. Areas of structural steel to be field welded shall be masked and the remainder of the steel shall be given one prime coat.

As soon as practicable after being accepted by the Engineer and prior to removal from the shop, machine-finished surfaces shall be prime coated with a rust inhibitor which can easily be removed.

Erection marks for field identification of steel members and weight marks shall be painted upon surface areas previously painted with the shop coat.

Surfaces of milled or finished iron and steel castings shall be given one shop coat of paint.

(C) FIELD PAINTING:

After erection of steel structures has been completed, including all riveting, welding, bolting and any straightening of bent metal, all adhering rust, scale, dirt, grease and other foreign material shall be removed as specified under Subsection 610-3.02. All areas where the prime coat is damaged or deteriorated shall be thoroughly cleaned and spot painted with the same type of paint used for the shop coat and to the specified dry film thickness.

When the spot painting coat is thoroughly dry, the first field coat and the finish coat shall be applied. In no case shall a succeeding coat be applied until the previous coat has dried throughout the full thickness of the paint film.

All small cracks and cavities which have not become sealed in a watertight manner by the first field coat shall be filled before the finish coat is applied.

At the option of the contractor, the two field coats may be applied in the shop. When finished coats are applied in the shop, the contractor shall repaint all damaged or deteriorated areas in the field as directed by the Engineer.

610-3.06 PAINTING DAMAGED GALVANIZED COATING:

Areas of galvanized coating damaged due to welding after fabrication or due to handling, shall be roughened by sanding or acid and the roughened areas shall be painted with at least one full coat of Paint Number 4 - Zinc, conforming to the requirements of Subsection 1002-3.

610-3.07 PAINTING OF MISCELLANEOUS STEEL ITEMS:

All miscellaneous steel items that are not elements of bridges, cantilever sign supports, or bridge truss sign structures, may be hand cleaned and have the required field paint coats applied in the shop.

610-4 (BLANK)

610-5 BASIS OF PAYMENT:

No measurement or direct payment will be made for painting as described and specified herein and on the plans, the cost being considered as included in the prices paid for the various contract items of work involving painting.

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DIVISION VII

(PDMPT701, 6, 08/24/87)

SECTION 701 - MAINTENANCE AND PROTECTION OF TRAFFIC: of the Standard and Supplemental Specifications is revised to read:

701-1 DESCRIPTION:

The work under this section shall consist of providing flagging services and pilot trucks, and furnishing, installing, maintaining, moving and removing barricades, warning signs, lights, signals, cones, and other traffic control devices, to provide safe and efficient passage through and/or around the work and to protect workmen in or adjacent to the work zone. The work shall be done in accordance with the requirements of the Arizona Department of Transportation's Traffic Control Manual for Highway Construction and Maintenance, hereinafter the "Traffic Control Manual," and the design details included in the project plans where applicable.

The requirements of the Traffic Control Manual shall be considered as the minimum standards for the protection of workmen and the traveling public.

When a traffic control plan is included in the project plans, this plan shall govern unless an alternate plan acceptable to the Engineer is submitted by the contractor. If no traffic control plan is provided or if the contractor desires to deviate from the provisions for maintaining traffic as described in this section, he shall submit to the Engineer for approval a proposed sequence of operations and a compatible method of maintaining traffic. The proposal shall be submitted early enough to allow at least two weeks for review and approval.

The traffic control and safety plan of the contractor, along with his work schedule and actual operations, shall be such that no condition that is considered to be unsafe shall exist within 30 feet of the edge of the traveled way unless the motorist and workmen are adequately protected and, as a result of effective planning and efficient scheduling of the work, the duration, degree, length, amount, size, etc., of any potentially unsafe condition is minimized.

701-2 MATERIALS (Equipment, Workmen, Devices and Facilities):

701-2.01 GENERAL:

Except as specified herein, all equipment, procedures used by workmen, devices and facilities shall conform to the requirements of the Traffic Control Manual.

701-2.02 FLASHING ARROW PANELS:

Flashing arrow panels shall conform to the requirements of Section 6E-9 of the Traffic Control Manual with the following additions:

Each arrow panel shall have its own independent power source. The power source shall be capable of supplying adequate continuous power for the sign operation over extended periods of time. Fuel capacity shall be such as to provide for at least 12 hours of continuous operation without refueling.

701-2.03 TEMPORARY CONCRETE BARRIER:

Temporary concrete barrier shall conform to the requirements of Subsections 910-2 and 910-3 for precast sections.

701-2.04 TEMPORARY IMPACT ATTENUATION DEVICES:

Temporary impact attenuation devices shall conform to the requirements of Subsections 702-2 and 702-3 for the type of device shown on the project plans or as approved by the Engineer.

701-2.05 TEMPORARY PAVEMENT MARKINGS:

(A) RAISED PAVEMENT MARKERS:

(1) RAISED PAVEMENT MARKERS (Permanent) (Used as Temporary):

Raised pavement markers shall conform to the requirements of Subsections 706-2 and 706-3.

Adhesive for temporary pavement markers shall be an approved bituminous adhesive.

(2) TEMPORARY RAISED PAVEMENT MARKERS:

Temporary raised pavement markers shall be of the following type:

- BW-One directional - White - Reflectorized
- BY-One directional - Yellow - Reflectorized
- CW-Two directional - White - Reflectorized
- CY-Two directional - Yellow - Reflectorized

Markers shall consist of an acrylic plastic shell containing one or two hermetically sealed prismatic air cell reflective lenses as required to reflect incidental light from a single direction or from opposite directions. The markers shall be in

the shape of a shallow round-cornered square with a spherical dome for enhancing the daytime signal.

The dimensions of the plastic shell shall be 4"x4"x.75", with a Reflecting Lens Face Slope of 45 degrees and the area of each reflecting surface shall be .38 square inches. The outer surface of the shell shall be smooth except for purposes of identification and grating. The shell shall be molded of methyl methacrylate conforming to Federal Specification L-P-380C, Type 1, Class 3.

Horizontal entrance angle shall mean the angle in the horizontal plane between the direction of incident light and the normal to the leading edge of the marker. Observation angle shall mean the angle at the reflector between observer's line of sight and the direction of the light incident on the reflector. Specific Intensity (SI) shall mean the candlepower of the returned light at the chosen observation and entrance angles for each foot of illumination at the reflector on a plane perpendicular to the incident light. The shape, finish and color of the marker shall be designed to provide a diffused specular daytime signal. The specific intensity of each white reflecting surface at 0.2 degrees observation angle shall be not less than the following when the incident light is parallel to the base of the marker:

Horizontal Entrance Angle	S.I.
0 degrees	1.0
20 degrees	0.4

For yellow reflectors the specific intensity shall be 60 percent of the value for white. For red reflectors, the specific intensity shall be 25 percent of the value for white.

A random lot of markers will be tested. The markers to be tested shall be located with the center of the reflecting face at a distance of 5 feet from a uniformly bright light source having an effective diameter of 0.2 inches. The photocell width shall be 0.05 inches. It shall be shielded to eliminate stray light. The distance from light source center to the photocell center shall be 0.21 inches. If a test distance of other than 5 feet is used, the source and receiver dimensions and the distance between source and receiver shall be modified in the same proportion as the test distance. Failure of more than 4 percent of the reflecting faces shall be cause for rejection of the lot.

Markers shall support a load of 10,000 lbs. as applied in the following manner:

A random sample of three markers shall be selected for test purposes. A marker shall be centered between the

flat parallel platens of a compression testing machine. A flat piece of 65 durometer rubber 6"x6"x.375" shall be centered on top of the marker. The load shall be slowly applied through the rubber to the top of the marker. Failure shall constitute either cracking or significant deformation of the marker at any load less than 10,000 lbs.

Certificates of compliance conforming to the requirements of Subsection 106.05 of the Specifications shall be submitted.

Temporary raised pavement markers shall be installed utilizing an approved raised pavement marker bituminous adhesive.

(B) PAVEMENT MARKING PAINT:

Paint for temporary striping shall be white or yellow and shall conform to the requirements of Subsection 708-2.

Glass beads for use with pavement marking paint shall conform to the requirements of Subsection 708-2.

(C) PREFORMED PAVEMENT MARKINGS:

Prefomed pavement markings for temporary applications shall meet the requirements of Subsection 705-2 for Type II - removable and Type III - nonremovable.

701-2.06 SIGN POSTS:

Sign Posts may be wood, steel or aluminum, at the option of the contractor and shall be approved by the Engineer prior to installation. Wood posts shall be Southern Pine, Douglas Fir or other soft wood. Wood posts need not be treated.

Angle braces will not be allowed.

701-2.07 DELINEATORS:

Delineators (Std. Dwg. 4-M-4.01) shall be as shown on the plans and shall conform to the requirements of Subsection 703-2.

701-2.08 CHIP SEAL PAVEMENT MARKER:

Type Y markers shall have a yellow body and cover with yellow reflective tape on both sides.

Type W markers shall have a white body and cover with white reflective tape on both sides.

The temporary pavement marker body and cover shall be manufactured from a polyurethane material conforming to the following requirements:

	<u>Requirement</u>	<u>ASTM Test Method</u>
Specific Gravity (Min.)	1.19	D- 792
Hardness (Min.)	80A	D-2240
Tensile Strength (Min. PSI)	4600	D- 412
Ultimate Elongation (Min. %)	330	D- 412
Modulus @ 300% PSI	1000	D- 412
Stiffness @		
-20 deg. F. (Min. PSI)	17000	D-1053
70 deg. F. (Min. PSI)	900	D-1053
Compression Set		
22 hrs. @ 70 deg. C	65	D- 395
Taber Abrasion		
CS17 wheel		
Wt. loss mg/1000 cycles	3	-----

Temporary pavement markers and covers shall be manufactured in accordance with the details shown on the project plans. A pavement marker sample shall be submitted to the Engineer for approval, prior to placement of markers.

Reflective tape shall be metalized polycarbonate microprism retroreflective material with acrylic backing or equal. The tape shall have a minimum reflectance equal to or greater than 1800 candle power per foot-candle per square foot at 1/10 degree observation and 0 degree entrance angles.

Pressure sensitive adhesive tape shall be butyl rubber pad.

Covers shall be attached to the vertical part of the marker so that they will not come off under traffic, but so that they can be easily removed manually.

701-3 CONSTRUCTION REQUIREMENTS:

701-3.01 GENERAL:

The contractor shall provide for the adequate protection of all vehicular and pedestrian traffic and workmen, through any portion of the work where construction operations interfere with, obstruct, or create a hazard to the normal movement of traffic.

The name of the contractor's employee who is responsible for implementing, monitoring, and altering, as necessary, the traffic control plan shall be made known to the local law enforcement agency or jurisdiction. Furthermore, the name of the Department employee who will be responsible to see that the traffic control plan, and any alteration thereto, is implemented and monitored such that the traffic is carried through the work in an effective manner and that the motorists, pedestrians, and workmen are protected from potential hazards and accidents shall also be made known to the local law enforcement agency of jurisdiction. The contractor's designee shall also be available at anytime to respond to calls involving damage to barricades, lights, signs and other devices resulting from vandalism, traffic accident or other causes.

If at any time the Engineer determines that proper provisions for safe traffic control are not being provided or maintained, he may order suspension of the work until the proper level of traffic control is achieved. In cases of serious or willful disregard for safety of the public or his employees by the contractor, the Engineer may proceed forthwith to place the traffic control measures in proper condition and deduct the cost thereof from monies due or becoming due the contractor.

All contractor's personnel, equipment, machinery, tools and supplies shall be kept clear of active traffic lanes, except as necessary for the prosecution of the work. The contractor shall promptly remove any material or debris that is spilled or tracked onto the traveled roadway as a result of the prosecution of the work. Materials, vehicles and parked equipment shall be kept as far from the traveled way as practical. The contractor shall not park equipment or store materials within 30 feet of the edge of a traveled way. Equipment may be parked and materials may be stored in the right-of-way only at locations approved by the Engineer, and may require protection.

Any devices provided under this section which are lost, stolen, destroyed or are deemed unacceptable by the Engineer, while their use is required on the project, shall be replaced by the contractor and, except as hereinafter specified for temporary impact attenuators, at no additional cost to the Department.

701-3.02 MAINTENANCE AND PROTECTION OF TRAFFIC:

All traffic control devices necessary for the first stage of construction shall be properly placed and in operation before any construction is allowed to start. When work of a progressive nature is involved, such as resurfacing a road under traffic, the necessary devices shall be moved concurrently with the advancing operation.

All traffic control devices shall be kept clean, free from dirt, mud, and roadway grime. Scratches, rips and tears in reflective sheeting shall be promptly corrected by the contractor, as approved by the Engineer.

When the contract requires the placement of temporary pavement markings by the contractor, he shall apply them as directed in conjunction with changes in the traffic pattern. Placement of new pavement markings and removal of old lines and markers shall be done immediately when the need for each arises. Roadway marking shall be completed and ready for traffic within 24 hours unless otherwise specified by the Engineer. The area from which a marking is removed shall be reasonably close to the same color and texture as the adjoining pavement. Pavement markings shall be removed from the pavement to the fullest extent possible by any method that does not materially damage the surface or texture of the usable pavement. Sandblasting, using air or water is an acceptable method for removing pavement markings, however, other methods may be approved by the Engineer. The method used shall meet all state and local air, water pollution and safety codes and/or policies. Overpainting of markings with paint or asphalt will not be permitted. No scars which may misdirect traffic shall be left on the pavement at any time.

Types of barricade supports or devices not specifically described in Traffic Control Manual, but which would cause a hazard to traffic if used by the contractor, will not be permitted in the work. The methods used by a contractor to control traffic for lane changes or other diversion when details regarding same are not included in the contract, shall produce a safe condition for travel to the maximum extent possible at all times.

An off-duty law enforcement officer shall not work more than 12 consecutive hours unless an emergency situation exists which, in the opinion of the Engineer, requires that the officer remain in the capacity of a flagger.

In the event an off-duty officer fails to report to the project site as scheduled, the Engineer may approve a written plan from the contractor to proceed with the work without the officer.

701-3.03      TEMPORARY CONCRETE BARRIERS:

Barriers shall be installed in accordance with the details and at the locations shown on the project plans or where directed by the Engineer. The barrier shall meet the quality standards of Section 910. Sections of temporary barrier shall be fastened together as shown on the plans to form a continuous chain. After placement, each unit shall be moved longitudinally to remove slack in the joints between the units. Where shown on the project plans or directed by

the Engineer, the ends of the barrier run shall be flared back or fitted with an impact attenuation device. Attenuation devices shall be installed in accordance with the requirements of Subsection 701-3.04.

Barrier Markers shall be installed as shown on the plans, or standard drawings.

Any unit which has been excessively damaged, as determined by the Engineer, shall not be used. Any unit damaged during or after installation shall be replaced with an undamaged unit, at no additional cost to the Department.

701-3.04 TEMPORARY IMPACT ATTENUATION DEVICES:

Energy absorbing terminals conforming to the requirements of Subsection 702-2.02 shall be installed at the locations and in accordance with the details shown on the project plans and the manufacturer's instructions.

Devices that are damaged by the traveling public shall be repaired by the contractor utilizing a replacement parts package, which shall be on the job site whenever this system is in use. The replacement parts package supplied by the contractor shall be the one recommended by the manufacturer of the attenuation device.

Sand barrel crash cushions conforming to the requirements of Subsection 702-2.03 shall be placed in accordance with the details shown on the project plans and filled with the designated weight of sand (fine aggregate) having a dry weight of 90 to 100 pounds per cubic foot and a moisture content not greater than five percent, by weight.

Crash cushions damaged by the traveling public shall be removed and disposed of by the contractor. New devices shall be furnished and installed by the contractor. The contractor shall have available, on the job site, a sufficient number of spare crash cushions to completely replace a minimum of two (2) installations.

Upon completion of the work for which temporary impact attenuation devices are required, all devices and replacement parts packages shall be carefully removed and stockpiled by the contractor within the limits of the project at a location specified by the Engineer. Upon approval of the Engineer, undamaged attenuation devices may be used for permanent installation in accordance with the requirements of Subsections 702-2 and 702-3.

701-3.05 TEMPORARY PAVEMENT MARKINGS (Application and Removal):

(A) GENERAL:

Application and removal of temporary pavement markings shall conform to the requirements of Subsection 708-3, the Traffic Control Manual and these specifications as applicable. Placement of new and removal of old markings shall be done immediately when the need for each arises, in conjunction with changes in the traffic pattern.

On overlay projects, pavement marking for temporary center line striping shall be four inch wide by one foot length strips of either temporary pavement marking tape or paint placed at 40 foot intervals. Temporary marking shall be placed on each subsequent pavement course.

(B) RAISED PAVEMENT MARKERS:

The adhesive shall be applied uniformly to the cleaned pavement surface and the pavement marker shall be placed in the correct position on the adhesive area with the application of pressure as specified by the manufacturer.

(C) PREFORMED PAVEMENT MARKINGS:

Preformed pavement markings for temporary applications shall be Type II (Temporary-Removable) and Type III (Temporary-Nonremovable) and shall conform to the requirements of Subsection 705-3.

Type II Preformed Pavement Markings shall be used where removal of markings is required by the Traffic Control Plan or as specified in Subsection 705-3.

Type III Preformed Pavement Markings shall be used where removal of markings is not required due to obliteration, abandonment or overlayings the pavement surface. Temporary pavement marking paint may also be used where removal of markings is not required unless otherwise shown on the project plans or in the special provisions.

701-3.06 OBLITERATION OF EXISTING PAVEMENT MARKINGS:

Pavement marking obliteration shall be accomplished by the contractor as indicated on the plans or as directed by the Engineer.

Pavement markings shall be removed to the fullest extent possible from the pavement by any method that does not materially damage the surface or texture of the usable pavement. Sandblasting,

using air or water, is an acceptable method for removing pavement markings, however, other methods may be approved by the Engineer. Overpainting of markings with paint or asphalt will not be permitted.

Sand or other material deposited on the pavement as a result of removing pavement markings shall be removed as the work progresses. Accumulations of sand or other material, which might interfere with drainage or might constitute adverse safety conditions to traffic, will not be permitted.

Where blast cleaning is used for the removal of pavement markings or for removal of objectional material, the residue including dust shall be removed immediately after contact between the sand and the surface being treated. Such removal shall be by a vacuum attachment operating concurrently with the blast cleaning operation, or by other methods approved by the Engineer. Blasting shall not be used within 12 feet of a lane occupied by public traffic.

Any damage to the pavement caused by pavement marking removal shall be repaired by methods acceptable to the Engineer. When asphalt slurry is used to repair damage to the pavement caused by pavement marking removal or the obliteration of the marks remaining after the markings have been removed, the asphalt slurry shall be placed parallel to the new direction of travel and shall be not less than two feet in width.

701-3.07 TRUCK MOUNTED ATTENUATOR:

Trucks and truck mounted attenuators shall be furnished by the contractor at the locations shown on the project plans and/or as directed by the Engineer.

Trucks shall be highway maintenance service trucks with shoulder type restraint system weighing between 10,000 and 24,000 lbs. These trucks shall be equipped with truck-mounted impact attenuators. The attenuators shall consists of three basic components.

A back-up support structure for attaching the back-up to the truck.

A back-up.

A crushable cartridge containing an energy absorbing material.

The dimensions of the attenuator shall be approximately 7 ft. long, 2 ft. high and 8 ft. wide and the total weight of the attenuator shall be approximately 1,000 pounds.

Attenuators shall have rear-mounted black and high intensity yellow chevron stripes and a standard trailer lighting system, including brake lights, turn signals, and ICC bar lights and two yellow rotating beacons mounted on opposite rear corners of the truck approximately four and one half feet from ground level. When in position, roadway clearance shall be between 10 and 12 inches. The attenuator shall be designed to provide for quick and simple connection to the truck.

When impacted head-on at 45 mph, the truck-mounted attenuator shall perform as follows:

For vehicles weighing up to 4,500 lbs. the average over-all longitudinal deceleration shall be less than 9 g's; the 2 ft. flail space velocity shall be less than 40 ft./sec; the roll-ahead distance of the truck, with wheels locked and parking brake set, on clean, dry pavement, shall be less than 15 feet.

For vehicles weighing 1,800 lbs., the average over-all longitudinal deceleration shall be less than 12 g's; the 2 ft. flail space velocity shall be less than 40 ft./sec; the roll-ahead distance of the truck, with wheels locked and parking brake set, on clean, dry pavement, shall be less than 10 feet.

It shall be the contractor's responsibility to keep the attenuator bright and clean for maximum visibility.

701-3.08 CHANGEABLE MESSAGE BOARD:

Changeable message boards, when required on a project, will be furnished by the Department and maintained by the contractor. The board consists of a portable, trailer mounted, lamp matrix, changeable message sign. The contractor shall transport the board to, from, and within the work site as directed by the Engineer.

The contractor shall provide routine maintenance of the changeable message sign. Such maintenance shall include, but not be limited to, furnishing and installing oil, fuel, filters, and light bulbs and keeping the sign clean and in good operating conditions. The engine oil and oil filter shall be changed after each 50 hours of running time.

The contractor shall furnish a vehicle and driver to tow the message sign to and from the project site and to move the sign within the project site as directed by the Engineer.

The contractor shall provide safe storage for the sign when it is not being used during construction.

Upon completion of the work, the sign shall be cleaned and returned to the Department in good working condition.

The contractor will not be responsible for any damage to the sign which may occur as a result of incidents beyond the control of the contractor while the sign is in use during construction operations.

701-3.09 CHIP SEAL PAVEMENT MARKER:

Temporary pavement markers and covers shall be located and placed on the asphaltic concrete prior to any work being started on the chip seal coat, all in a manner as approved by the Engineer.

Immediately after application of the chip seal coat to the roadway pavement, the plastic covers shall be removed, exposing the reflective tape surfaces.

Temporary Pavement Markers that are damaged by the contractor shall be replaced by the contractor at his own expense.

701-4 REIMBURSEMENT:

701-4.01 GENERAL:

The Department will reimburse the contractor for the work of maintaining and protecting traffic on the basis of the predetermined reimbursement rates hereinafter specified under Subsection 701-4.02 for the various elements of work.

Except as hereinafter specified for Temporary Concrete Barrier and Temporary Impact Attenuation Devices, no additional reimbursement will be made to the contractor for any elements of work other than those listed under Subsection 701-4.02, unless approved in writing by the Engineer prior to use, as may be required for acceptably maintaining and protecting traffic. The cost for elements of work required for traffic control and not listed under Subsection 701-4.02 will be negotiated with the Engineer prior to approval.

Elements of work specified under this subsection which are lost, stolen, destroyed, or are deemed unacceptable by the Engineer, while in use on a project shall be replaced by the contractor and, except as hereinafter specified for temporary impact attenuation devices, at no additional cost to the Department.

701-4.02 PREDETERMINED REIMBURSEMENT RATES:

(A) GENERAL:

Item 7010001 - MAINTENANCE AND PROTECTION OF TRAFFIC is included in the Bidding Schedule for the purpose of establishing an account from which the contractor will be reimbursed for the work of maintaining and protecting traffic on the basis of the predetermined reimbursement rates hereinafter specified under Subsections 701-4.02(B) and 701-4.02(C) for the various elements of work.

The methods of measurement and basis of payments will be as specified under Subsections 701-5 and 701-6.

(B) ELEMENTS OF WORK (Complete-in-Place):

The elements of work listed under this subsection will be measured for payment upon the satisfactory completion of the initial installation or obliteration. Except as hereinafter specified under Basis of Payment, no subsequent measurements will be made.

<u>Element of Work</u>	<u>Unit</u>	<u>Rate (\$)</u>
Preformed Pavement Marking (Type II)	L. Ft.	1.60
Preformed Pavement Marking (Type III)	L. Ft.	1.30
Temporary Pavement Marking (Painted Line)	L. Ft.	0.12
Obliterate Pavement Marking	L. Ft.	0.50
Delineator (Std. Dwg. 4-M-4.01)	Each	25.00
Raised Pavement Marker (Temporary)	Each	4.00
Raised Pavement Marker (Permanent) (Used as Temporary)	Each	4.50
Chip Seal Pavement Marker	Each	2.00

(C) ELEMENTS OF WORK (In Use):

The elements of work listed under this subsection will be measured from the point at which the element is put into active use on the project and accepted by the Engineer until such times that the Engineer determines that the element is no longer required.

<u>Element of Work</u>	<u>Unit</u>	<u>Rate (\$)</u>
Temporary Concrete Barrier (In Use)	L. Ft./Day	0.04
Impact Attenuation Device (Sand Barrel) (In Use)	Ea./Day	0.05

<u>Element of Work</u>	<u>Unit</u>	<u>Rate (\$)</u>
Impact Attenuation Device (Energy Absorbing Terminal) (In Use)	Ea./Day	1.00
Impact Attenuation Device (Truck Mounted)	Hour	27.00
Flashing Arrow Panel	Hour	5.00
Pilot Truck	Hour	11.90
Relocation Service, Truck	Hour	13.50
Flagger	Hour	18.78
Flagger (Uniformed Police Officer)	Hour	21.42
Official Police Vehicle	Mile	0.20
Operator (Pilot Truck, Relocation Service, Truck Mounted Attenuation Device)	Hour	22.70
Relocation Service, Barricade Setter	Hour	10.49
Maintain Changeable Message Board	Hour	1.45
Vertical Panels	Ea./Day	0.45
Barricade (Type II)	Ea./Day	0.45
Barricade (Type III)	Ea./Day	0.85
Flashing Warning Light (Type A)	Ea./Day	0.25
Flashing Warning Light (Type B)	Ea./Day	2.00
Steady-Burning Warning Light, (Type C)	Ea./Day	0.85
High Intensity Reflective Sheeting, Small Sign (Less than 10 Sq. Ft.)	Ea./Day	1.00
High Intensity Reflective Sheeting, Medium Sign (10 Sq. Ft. to 16 Sq. Ft.)	Ea./Day	1.25
High Intensity Reflective Sheeting, Large Sign (More than 16 Sq. Ft.)	Ea./Day	1.50
Standard Intensity Reflective Sheeting, Small Sign (Less than 10 Sq. Ft.)	Ea./Day	0.50
Standard Intensity Reflective Sheeting, Medium Sign (10 Sq. Ft. to 16 Sq. Ft.)	Ea./Day	0.75
Standard Intensity Reflective Sheeting, Large Sign (More than 16 Sq. Ft.)	Ea./Day	1.00
Sign Stand (Large, 9 Sq. Ft. or Larger)	Ea./Day	0.90
Sign Stand (Small, Less than 9 Sq. Ft.)	Ea./Day	0.60
Traffic Cones, 28 inch	Ea./Day	0.71
Drum (18" x 36")	Ea./Day	1.20

701-4.03 RELOCATION SERVICES:

Following the initial installation of the elements of work described in Subsection 701-4.02, the Engineer may direct the

contractor to move any element of work from one location and re-erect it at another location. Except as hereinafter specified for Temporary Concrete Barrier (New Installation), measurement for reimbursement of the work associated with such relocations will be made as specified for the Relocation Service elements of work.

When work of a progressive nature is involved, such as resurfacing a road under traffic, or closing a lane or lanes for work to be accomplished during a shift, no measurement for reimbursement will be made for relocating the necessary traffic control equipment, workmen, devices, facilities, signs (except semi-permanent signs on embedded posts), etc., that are moved concurrently with the advancing operation, or at the end of a shift.

701-4.04 REIMBURSEMENT EXCEPTIONS:

(A) DEFICIENT ELEMENTS OF WORK:

Any deficiencies in the traffic control plan, devices equipment, services, or other elements of work listed under Subsection 701-4.02 will be brought to the attention of the contractor by the Engineer and all deficiencies shall be corrected before the close of that work day or work shift.

Reimbursement will not be withheld from the contractor for those elements of work that are restored to full usefulness prior to the close of the work day or work shift in which notice of the defect is given.

No reimbursement will be made to the contractor for those deficient elements of work listed under Subsection 701-4.02(C) that are not restored to full usefulness prior to the close of the work day or work shift in which notice of the defect is given. Measurement for reimbursement will not resume until the beginning of the work day or work shift following that work day or work shift in which those elements are restored to usefulness.

(B) SUBSTANTIAL DEFICIENCIES:

For each work day or work shift during which there are, as determined by the Engineer, substantial deficiencies in the contractor's traffic control plan, devices, and/or services, no reimbursement will be made to the contractor for any element of work listed under Subsection 701-4.02(C).

Measurement for reimbursement will not resume for any element of work until the beginning of the work day or work shift following that work day or work shift in which all corrective measures have been performed by the contractor and approved by the Engineer.

In cases of serious or willful disregard for the safety of the public or his employees by the contractor, the Engineer may proceed forthwith to place the traffic control measures in proper condition and deduct the cost thereof from monies due or becoming due the contractor.

(C) NONDILIGENT PROSECUTION OF WORK:

In the event that the Engineer determines that the contractor's construction operations are not resulting in the diligent prosecution of the work under contract, no reimbursement will be made to the contractor for the elements of work listed under Subsection 701-4.02 until such time as the Engineer determines that the contractor is devoting appropriate efforts toward completion of the work. Payment will be suspended effective with the end of the work day or work shift in which written notice is issued to the contractor by the Engineer notifying the contractor of his failure to prosecute the work. Payment will resume with the beginning of the work day or work shift following that work day or work shift in which the Engineer determines that satisfactory efforts are being made by the contractor toward completion of the work. In any case, the contractor shall continue to be responsible for maintaining all barriers, attenuators, signs, lights and other traffic control devices in proper functioning condition at all times.

(D) NON-WORKING PERIODS:

Measurement for reimbursement of the elements of work listed under Subsection 701-4.02(C) will begin on the day they are installed in place for traffic control and direction. When the elements are not needed for traffic control, they shall be removed or covered and will not be measured. During non-working periods such as holidays, Sunday, etc., the elements in place and in satisfactory condition will be measured for reimbursement on the day following such downtime. During these non-working periods the contractor shall conduct a minimum of one check per day to see that the elements are in place and in satisfactory condition.

No reimbursement will be made to the contractor for the elements of work listed under Subsection 701-4.02(C) for non-working periods resulting from a suspension of work that, in the opinion of the Engineer, is due to the fault of the contractor. In any case, the contractor shall continue to be responsible for maintaining all barriers, attenuators, signs, lights and other traffic control devices in proper functioning condition at all times.

(E) LIMITATION OF MEASUREMENT:

Elements of work listed under 701-4.02(C) that are measured on a unit per day basis will be measured for reimbursement once and only once for each full work day or work shift. Measurement will be based on the maximum number of units of the specific element of work that are in simultaneous use during any given period regardless of the length of time that the elements are in use and regardless of the number of times the elements are relocated.

(F) EXPIRATION OF CONTRACT TIME:

No reimbursement will be made to the contractor for the elements of work listed under Subsection 701-4.02(C) when they are required in association with construction work being performed after the expiration of the contract time and all approved extensions.

In any case, the contractor shall continue to be responsible for maintaining all barriers, attenuators, signs, lights and other traffic control devices in proper functioning condition at all times.

701-5 METHOD OF MEASUREMENT:

Maintenance and Protection of Traffic will be measured by the approved elements of work that are both (1) utilized by the contractor during the course of approved construction operations and (2) included as an item in the bidding schedule or listed as an element of work under Subsection 701-4. Measurement will be made as follows:

Temporary Concrete Barrier will be measured by the linear foot along the center line of the uppermost surface.

Temporary Impact Attenuation Devices (Sand Barrel and Energy Absorbing Terminal) will be measured by the unit for each complete device.

Truck mounted attenuators will be measured by the hour for each hour that a truck mounted attenuator is used to protect the work site.

Flashing Arrow Panels will be measured by the hour for each hour that each panel is in place and operating.

Pilot Trucks and Relocation Service Trucks will be measured by the hour for each approved hour of operation.

Flagging Services will be measured by the hour for each hour that a civilian flagger is provided and for each hour that a uniformed, off-duty law enforcement officer is employed directly by the contractor as a flagger, when authorized in advance by the Engineer. Overtime hours will be converted into straight time hours for measurement. In the event an off-duty officer reports to the project site and the work shift is cancelled within the first two hours, the contractor will be reimbursed for two hours at the appropriate rate. Flaggers used for the contractor's convenience, such as ingress and egress of construction equipment along the project traveled way, will not be measured for payment.

Use of Official Police Vehicles will be measured by the mile of operation within the project limits and to and from the project site as approved by the Engineer.

Operator (Pilot Truck, Relocation Service Truck, and Truck Mounted Attenuation Device) will be measured by the hour for each hour that the operator operates the vehicle. Overtime hours will be converted to straight time hours for measurement.

Relocation Service Barricade Setters will be measured by the hour for each man hour of the approved relocation operation. Overtime hours will be converted to straight time hours for measurement.

Preformed Pavement Markings, Type II and Type III, will be measured in accordance with the requirements of Subsection 705-4.

Temporary Pavement Marking, Painted Line, will be measured in accordance with the requirements of Subsection 708-4.

Obliterate Pavement Marking will be measured by the linear foot of existing marking obliterated, regardless of width or type of material.

Maintenance of the Changeable Message Board will be measured by the hour for each hour that the board is utilized to maintain and control traffic.

Delineators (Std. Dwg. 4-M-4.01) and pavement markers will be measured as a unit for each delineator and marker furnished and subsequently utilized at the project site. No measurement will be made for delineators and markers that are furnished to replace damaged units as specified under Subsection 701-4.01.

Vertical Panels, Barricades, Warning Lights, Signs, Sign Stands, Traffic Cones, and Drums will be measured as a unit for each device furnished and subsequently utilized at the project site.

701-6 BASIS OF PAYMENT:

The contractor will be compensated for accepted quantities of Maintenance and Protection of Traffic at the predetermined reimbursement rates and in accordance with the procedures of Subsection 701-4 of these Special Provisions.

701-6.01 ELEMENTS OF WORK (Bid Items):

(A) TEMPORARY CONCRETE BARRIER (New Installation):

Temporary concrete barrier, measured as provided above, will be paid for at the contract unit price, which price shall be full compensation for the work, complete, as specified herein and as shown on the plans, including, but not limited to, furnishing, placing, dismantling, and removal. The price bid shall also include any required connection devices and barrier markers. Should it be necessary to dismantle, pick up and relocate the entire barrier installation or portion thereof during construction, the removed and relocated barrier will be considered a new installation and measured for payment at the contract unit price. No additional payment will be made for the realigning or adjusting of barrier installations, for lateral movement of 12 feet or less.

The Engineer will be the sole judge as to whether barriers are to be dismantled, picked up and relocated and paid for as a new installation or are to be adjusted or realigned and paid for as specified for Temporary Concrete Barrier (In Use).

Fifty percent of the unit price bid will be paid upon satisfactory installation. The remaining 50 percent will be paid upon removal.

(B) TEMPORARY IMPACT ATTENUATION DEVICES (Sand Barrel and Energy Absorbing Terminal):

Temporary Impact Attenuation Devices (Sand Barrel and Energy Absorbing Terminal), measured as provided above, will be paid for at the contract unit price, which price shall be full compensation for the work complete-in-place, as specified herein and as shown on the plans, including but not limited to furnishing the devices with replacement parts, and installing, dismantling, realigning and adjusting, removing and stockpiling the devices.

Should it be necessary to dismantle, pick up and relocate attenuation device installations during construction, the work of removing and relocating the devices will be measured for reimbursement as herein specified for Relocation Services.

The Engineer will be the sole judge as to whether devices are to be dismantled, picked up and relocated or are to be adjusted or realigned.

Fifty percent of the unit price bid will be paid upon satisfactory installation. The remaining 50 percent will be paid upon final removal.

Measurement and payment for furnishing materials, equipment and labor and repairing attenuation devices that are damaged by the traveling public will be made in accordance with the requirements of Subsection 109.04.

No measurement or direct payment will be made for furnishing replacement parts and repairing devices damaged by other than the traveling public.

701-6.02 ELEMENTS OF WORK (Complete-In-Place):

(A) PREFORMED PAVEMENT MARKINGS:

The accepted quantities of preformed pavement markings, measured as provided above, will be paid for at the predetermined reimbursement rate for the type specified, which rate shall be full compensation for the work, complete in place, including necessary pavement cleaning, removal of type II temporary markings, and maintaining Type II and Type III temporary markings in construction work zones. Installation for accepted quantities shall be considered satisfactory when the markings are installed within one inch (1") of the true alignment.

Additional reimbursement will be made for replacement of temporary markings when the contractor is required by the Engineer to install marking materials on distressed pavements or during adverse weather conditions and subsequent failure occurs. Distressed pavement conditions are defined as alligator cracking, bleeding, or spalling of bituminous pavements and spalling of PCC pavements. Adverse weather conditions are defined as any occurrence where application is required at pavement temperatures less than 60 degrees F. or when precipitation occurs within 24 hours before or after application. The Department will pay for the replacement, where failures occur, at the reimbursement rate for the initial occurrence.

In the event a second failure occurs when markings have been reapplied on distressed pavements or under weather conditions described above, the Engineer shall determine if conditions require primer, alternate methods of marking or reapplication of preformed markings. Preformed markings will be paid for at the reimbursement rate. Primers or other methods of markings deemed necessary by the Engineer will be paid for in accordance with the provisions of Subsection 109.04 - Extra and Force Account Work.

(B) TEMPORARY PAVEMENT MARKING (Painted Line):

The accepted quantities of Temporary Pavement Marking (Painted Line), measured as provided above, will be paid for at the predetermined reimbursement rate per linear foot, which rate shall be full compensation for the work, complete in place, as specified herein.

(C) Obliterate Pavement Marking:

Obliterate Pavement Marking, measured as provided above, will be paid for at the predetermined reimbursement rate per linear foot which rate shall be full compensation for the work, complete, including furnishing all labor and equipment required and restoring the pavement surface to a condition deemed suitable by the Engineer.

(D) DELINEATORS (Std. Dwg. 4-M-4.01) AND PAVEMENT MARKERS:

The accepted quantities of delineators, and pavement markers, measured as provided above, will be paid for at the predetermined reimbursement rate each, which rate shall be full compensation for the work, complete in-place, as specified herein and as shown on the plans. If it is necessary to remove and relocate delineators, measurement for reimbursement of the work associated with such relocations will be made as specified for the Relocation Service element of work.

701-6.03 ELEMENTS OF WORK (In Use):

(A) TEMPORARY CONCRETE BARRIER (In Use):

The accepted linear foot quantities of temporary concrete barrier, measured as provided above on a daily basis, will be paid for at the predetermined reimbursement rate, which rate shall be full compensation for the use of the barrier installation(s) and for the work of furnishing all material, equipment and labor and maintaining, realigning and adjusting the barrier installation(s) as

specified herein and as shown on the plans. No reimbursement will be made for barrier not in service, such as, barrier in stockpiled configuration awaiting phase construction change.

There will be no reimbursement for each day that the Engineer determines the barrier traffic reflectors are not in good reflective condition, or for each day that the Engineer determines the barrier is out of alignment.

(B) TEMPORARY ATTENUATION DEVICE (Sand Barrel and Energy Absorbing Terminal) (In Use):

The accepted unit quantities of temporary attenuation devices, measured as provided above on a daily basis, will be paid for at the predetermined reimbursement rate, which rate shall be full compensation for the use of the devices and for the work of realigning and adjusting the devices as specified herein and as shown on the plans.

There will be no measurement and payment for temporary impact attenuation in a stockpiles configuration.

(C) TRUCK MOUNTED ATTENUATORS:

The accepted quantities of truck mounted attenuators, measured as provided above, will be paid for at the predetermined reimbursement rate per hour of work site protection, which rate shall be full compensation for the work, complete, including, but not limited to, furnishing all materials, equipment and labor (exclusive of the operator) and maintaining and repairing the truck and truck mounted attenuator as specified herein and on the project plans. It shall be the contractor's responsibility to replace any damaged or destroyed parts of the attenuator at no additional expense to the Department.

(D) FLASHING ARROW PANELS:

The accepted quantity of flashing arrow panels, measured as provided above, will be paid for at the predetermined reimbursement rate, which rate shall be full compensation for the work, complete, including, but not limited to, operation, maintenance and movement on the job site.

(E) PILOT TRUCKS AND RELOCATION SERVICE TRUCKS:

The accepted quantities of pilot and relocation service trucks, measured as provided above, will be paid for at the predetermined hourly reimbursement rate, which rate shall be full compensation for the work, complete, including, but not limited to, furnishing and maintaining the vehicle.

(F) FLAGGING SERVICES:

The accepted quantities of flagging services, measured as provided above, will be paid for at the predetermined hourly rate, which rate shall be full compensation for the work, complete, including, but not limited to, all overhead costs and fringe benefits. No additional compensation will be made to the contractor if the rate he is required to pay exceeds the predetermined reimbursement rate.

(G) OFFICIAL POLICE VEHICLE:

The accepted quantities of official police vehicles, measured as provided above, will be paid for at the predetermined reimbursement rate per mile, complete, including, but not be limited to, furnishing and maintaining the vehicle.

(H) OPERATORS (Pilot Truck, Relocation Service, and Truck Mounted Attenuation Device):

The accepted quantities of operators, measured as provided above, will be paid for at the predetermined reimbursement rate per hour, which rate shall be full compensation for the work, complete, including, but not be limited to, all overhead costs and fringe benefits. No additional payment will be made to the contractor if the rate he is required to pay exceeds the predetermined reimbursement rate.

(I) RELOCATION SERVICE, BARRICADE SETTER:

The accepted quantities of relocation service barricade setters, measured as provided above, will be reimbursed at the predetermined reimbursement rate per hour, which rate shall be full compensation for the work, complete, including, but not limited to, all overhead costs and fringe benefits. No additional payment will be made to the contractor if the rate he is required to pay exceeds the predetermined reimbursement rate.

(J) MAINTAIN CHANGEABLE MESSAGE BOARD:

The accepted quantities of maintaining changeable message boards, measured as provided above, will be paid for at the predetermined reimbursement rate per hour, which rate shall be full compensation for the work, complete, including, but not limited to, furnishing, moving, and maintaining the board as specified herein.

(K) VERTICAL PANELS, BARRICADES, WARNING LIGHTS, SIGNS,  
SIGN STANDS, TRAFFIC CONES, AND DRUMS:

The accepted unit quantities of vertical panels, barricades, warning lights, signs, sign stands, traffic cones, and drums, measured as provided above on a daily basis, will be paid for at the predetermined reimbursement rate, which rate shall be full compensation for the work, complete, including, but not limited to, furnishing all materials, labor and equipment necessary for the initial installation, maintenance, and removal of each device furnished.

Relocation of vertical panels, barricades, warning light, signs, sign stands, traffic cones, and drums will be made as specified for the Relocation Service elements of work, with the following exception.

When work of a progressive nature is involved, such as resurfacing a road or closing a lane or lanes for work to be accomplished during a shift, no measurement for reimbursement will be made for the relocation of the elements of work moved concurrently with the advancing operation, or at the end of a shift.

The work of removing and reinstalling signs on embedded posts will be reimbursed at the relocation service rates regardless of the type of work or operation.

The predetermined reimbursement rate for signs includes the cost of flags and ballasting.

The predetermined reimbursement rate for barricades and vertical panels includes the cost of ballasting.

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SECTION 901 - MOBILIZATION:

901.5 BASIS OF PAYMENT: in the Standard Specifications is modified to add:

Except for a new tunnel shield or boring machine being manufactured, payment will be made after the equipment/facilities have arrived on the jobsite, on the basis of satisfactory evidence of cost plus the reasonable costs of the contractor's work for mobilization. Payment for the new tunnel shield or boring machine being manufactured for use on this specific project will be made only to the extent of progress payments that the contractor has made to the manufacturers, but limited to a maximum of 50 percent of the cost of the equipment. The contractor shall submit proper documentation showing total cost of the new tunnel shield or boring machine to receive any progress payments for the new tunnel shield or boring machine. Payment for the remaining 50 percent of the cost of the new tunnel shield or boring machine will be made when the equipment has arrived on the job site and substantial evidence of total cost has been forwarded. If the contractor's bid amount for mobilization exceeds 15% of the total contract, payment for the amount greater than 15% will not be made until the final pay estimate.

ITEM 9240010 - FORCE ACCOUNT WORK (ADWR Pumping Fees):

The contractor will be required to pay to the Arizona Department of Water Resources the amount of \$1.00 per acre foot for all ground water removed after one year from the date the removal permit is issued.

The contractor shall maintain water withdrawal records in accordance with the requirements specified herein under CONTROL OF WATER. Upon submission to the Engineer of acceptable evidence of the amount paid to the ADWR, the contractor will be reimbursed in accordance with the requirements of Subsection 109.04 (B) Force Account Work.

The cost for original permits issued to the contractor shall be at the contractor's expense.

ITEM 9260004 - ENGINEERS FIELD OFFICE:

1.00 DESCRIPTION:

The work under this item consists of furnishing, erecting and maintaining two Engineers Field Offices within the limits of the project in accordance with the requirements of these special provisions.

1.01 GENERAL:

The offices shall be approved weatherproof buildings or mobile trailers of the type specified herein. The structures shall have a minimum ceiling height of seven feet and shall be provided with windows and doors equipped with adequate locking devices. Each window shall have a minimum area of eight square feet, shall be screened and of a type that will open and close to provide adequate ventilation.

All equipment and furnishings provided by the contractor shall be new or in nearly new condition.

Each office facility shall be equipped with the following as a minimum:

A. Lighting. Electric light, non-glare type luminaires to provide a minimum illumination level of 100 ft.-candles at desk height.

B. Heating and Cooling. Adequate equipment to maintain an ambient air temperature of  $70^{\circ} F \pm 5^{\circ}$ .

C. Calculator. Electronic, printing, calculating machine with operating instruction and an adequate supply of printing paper. Such calculating machine shall have the following functions as built-in features: Sin x, Cos x, Tan x, log x, Ln x, the inverse functions of the preceding functions, y to a power, the square root of x, the square of x, the reciprocal of x, and pi. The trigonometric functions shall accept as input angular measurements expressed in degrees, radians, and grads and the machine shall have the ability to convert one type of angular measurement to another. The machine shall also have the capability of Polar-Rectangular conversions. The supply of printing paper for all specified calculators shall be replenished by the contractor as required by the Engineer.

D. Telephone. Three separate phone lines for the exclusive use of Department and consultant personnel: two for the Resident Engineers office facility and one for the facility to be located at the tunnel inlet.

E. Potable Water.

F. Adding Machine. Tape type registering to at least ten digits.

G. First Aid Kit. The contractor shall keep the kit properly stocked with appropriate first aid supplies at all times.

H. Toilet. A separately enclosed room, properly ventilated and complying with applicable sanitary codes, provided with a lavatory with running water, and flush-type toilet.

I. Water Cooler, electric-refrigerated.

J. Signs. The contractor shall furnish and install necessary signs to identify the Engineer's Office.

K. Fire Extinguisher. 2-Non-toxic, dry chemical, fire extinguishers meeting Underwriters' Laboratories, Inc., approval for Class A, Class B, and Class C fires with a minimum rating of 2A:10B:10C.

L. Fire-Resistant Cabinet. Fire-resistant, legal size file cabinet with lock and two keys, meeting the requirements for "Filing Devices, Insulated (36E9)" Class D Label, of the Underwriters' Laboratories, Inc. Specifications. The number of drawers shall be as specified under Subsection 1.02-Specific Requirements.

M. Thermometer. A minimum - maximum thermometer.

N. Pencil Sharpener.

All facilities and furnished equipment at the office shall be maintained in good working condition by the contractor.

1.02 SPECIFIC REQUIREMENTS:

In addition to the general requirements, the Resident Engineer's office shall have a minimum of 1500 square feet. Unless otherwise approved by the Engineer, the facility shall be partitioned to provide the following: four offices with a minimum of 120 square feet each; two general work areas with a minimum of 200 square feet each; one conference room of at least 170 square feet; one shower/change room of at least 170 square feet.

Each room shall have at least two windows and a door to allow the room to be isolated from adjoining areas. The shower/change room shall be properly ventilated and comply with all applicable sanitary codes. It shall be equipped with lavatory, toilet, two showers and four vandalproof lockers. The lockers shall have a minimum of seven cubic feet of storage.

In addition to the furnishings specified in Section 1.01, the Resident Engineer's office shall contain the following:

- 4 - Suitable office desks with drawers and locks and chairs.
- 8 - Office chairs.
- 2 - Fire-resistant cabinets, 4-drawer, as specified in "M" above.
- 3 - Drafting -type tables, each three feet by six feet, supported by wall brackets and legs or standard free standing.
- 3 - Draftsman's stools.
- 1 - Office table three feet by 12 feet (conference type).
- 1 - Vertical filing plan rack for four sets of 22" x 36" plans.
- 4 - Extension telephones.
- 4 - Bookcases with 4 shelves.
- 2 - Bookcases with 2 shelves.
- 1 - Storage cabinet 72" x 36" x 18" with locks.
- 1 - Tack board 24" x 38".
- 1 - Typewriter standard electric with pica type and 16 inch carriage.
- 1 - Photocopying Machine. Desk top, heavy duty, electric, dry process photocopying machine capable of using bond paper for sizes up to and including 11" x 17" and an adequate supply of copy paper. The supply of copy paper shall be replenished by the contractor as required by the Engineer.

In addition to the Resident Engineer's Office an office facility of at least 450 square feet shall be furnished. This facility shall be partitioned to provide two offices with a minimum of 120 square feet each and a general work area with a minimum of 140 square feet.

The Engineer will designate the location of the offices. The offices shall remain on the project site for up to 30 calendar days following completion and acceptance of the work by the Department. The offices shall be fully equipped and shall be acceptable to the Engineer prior to commencement of any construction activity.

The contractor shall be responsible for maintaining the offices and all facilities and equipment therein in good working condition. Utility costs shall be the responsibility of the contractor as well as any fees for permits, sanitary, water, electrical or gas hookups, installation charges, etc. The cost of long distance telephone calls made by the Engineer will be paid for by the Engineer.

Upon completion of the work and following removal of the offices and any appurtenant structures, utilities, surfacing, etc., the affected areas shall be either restored to their former condition or improved as may be specified on the project plans.

4.00 METHOD OF MEASUREMENT:

5.00 BASIS OF PAYMENT:

The method of measurement and the basis of payment will be in accordance with the requirements of Section 926.

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ITEM 9300007 - TUNNEL ACCESS SHAFT:

1.00 DESCRIPTION:

The work under this item consists of furnishing all materials and constructing the permanent access shaft with cover and the square (outside) tunnel section including the concrete bulkhead between approximate stations 164+71.70 and 165+23.70 in accordance with the details shown on the project plans; the requirements of the specifications for Section 601 and these special provisions.

2.00 MATERIALS:

Concrete shall be Class S (f'c=4,000 psi) conforming to the requirements of the Specifications for Section 1006. Reinforcing steel shall conform to the requirements of the Specifications for Section 1003.

5.00 BASIS OF PAYMENT:

Payment for this work will be made at the contract lump sum price for ITEM 9300007 - TUNNEL ACCESS SHAFT, which price shall be full compensation for this item complete, including excavating, backfilling, removable cover and concrete bulkhead, as described and specified herein and on the project plans.

The 24" ductile iron pipe and trashguard will be considered as included in the contract price for ITEM 5060500 - PUMP STATION.

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TUNNEL AND SHAFT CONSTRUCTION:

1.00 DESCRIPTION:

1.01 GENERAL:

The work under Item 9300018 - Tunnel (18') consists of all work necessary for tunnel excavation and all related work, including but not limited to: temporary access for construction, furnishing and installing tunnel initial support, lighting and ventilation, control of water, contact grouting and final concrete lining.

Shafts, ramps, and temporary cuts shall be excavated and supported by methods determined by the contractor to be capable and suitable for coping with subsurface conditions and compatible with his chosen construction methods and equipment.

Tunnels shall be excavated by use of tunneling shields or tunneling machines or any combination thereof of appropriate design and construction. Intermediate work shafts will be allowed, subject to the approval of the Engineer; all permits, street closing permits, and all other jurisdictional approval shall be the responsibility of the contractor.

The contractor shall be solely responsible for the tunnel and shaft excavation methods he selects.

Acceptable excavation initial support systems shall be either expandable precast concrete segmental lining or expandable steel supports with timber lagging of a design and at the option of the contractor and are not shown on the project plans.

Initial support systems shall be designed in accordance with the criteria specified herein. Other forms of alternative initial support systems will be considered.

The attention of the contractor is directed to the requirements of Division I of the Specifications.

1.02 "A" LINE:

The "A" Line shown on the typical sections of the project plans are lines within which no unexcavated material of any kind and no timbering shall remain. Where concrete final lining is to be installed the entire area between tunnel inside face and the "A" line shall be filled with concrete.

Structural steel rib supports, piles and tie rods may extend within the "A" line. Imbedments shown on the project plans within the "A" Line shall be placed as shown. The contractor may

select any size of excavated tunnel bore, within those limits stated on the plans, provided that the "A" line tolerances are maintained.

1.03 SUBMITTALS DURING CONSTRUCTION:

Submittals during construction shall be made in accordance with Subsection 105.02. All working drawings shall be 36"x22". In addition, the following specific information shall be provided:

(A) WORK PLAN:

Prior to the start of work, the contractor shall submit a work plan to the Engineer for review. The work plan shall include as a minimum, pertinent descriptions, data, and calculations showing the proposed facilities, equipment to be utilized and method of construction. Items shall include but are not limited to the following: hoisting plant, tunnel ventilation, lighting, and drainage; disposal of excavated materials; power supply source; groundwater control methods; temporary or permanent shafts, cuts, ramps, and tunnels; bulkheads; initial support; methods of construction including details of installation of initial support and final lining; method of controlling line and grade of shield and lining; details of procedure for the expansion of initial support including jack pressures and a test for the completion of the expansion.

(B) WORKING DRAWINGS:

Prior to construction the contractor shall provide the Engineer with working drawings showing all facilities designed by the contractor to be used but not incorporated into the finished work, including but not limited to: temporary bulkheads; hoisting plant unless acceptable manufacturers drawings are provided; methods of dewatering, and methods of excavation and support.

(C) SHOP DRAWINGS:

The contractor shall prepare and submit detailed shop drawings and pertinent descriptions, data and calculations for the expansion of initial support including jack pressures and a test for the completion of the expansion.

(D) CONSTRUCTION ACCESS SHAFT DESIGN:

The contractor shall submit working drawings for construction access shaft design for review by the Engineer at least 30 days prior to the start of construction. These drawings shall include the details of tunnel completion at the construction access shaft with calculations confirming the adequacy of the design. Both the working drawings and the calculations shall be sealed by an

Arizona Registered Professional Engineer. The arrangements of space for muck skips, material platforms, personnel elevators, stairways, ladders and utilities shall be shown.

Shoring and bracing for all access shafts shall be designed by the contractor and shall be adequate for the method and procedure of construction and all loading conditions including overburden, groundwater, and superimposed construction loads. The shop drawings shall bear the seal of an Arizona Registered Professional Engineer as provided above.

1.04 DISPOSAL OF SURPLUS MATERIAL:

Disposal of surplus material shall be in accordance with the requirement specified herein under Subsection 107.12.

1.05 RECORDS OF MOVEMENT:

Records of movement shall be kept in accordance with the requirements specified herein under GEOTECHNICAL INSTRUMENTATION.

1.06 INITIAL SUPPORT SYSTEM MINIMUM DESIGN CRITERIA:

Initial support systems shall be designed in accordance with the minimum criteria specified herein and shall be sealed by an Arizona Registered Professional Engineer attesting to the adequacy of design and adherence to the minimum design criteria.

(A) MINIMUM DESIGN CRITERIA:

STEEL AND TIMBER LAGGING:

(1) Sustain full overburden but in no case less than 8,400 psf (assumed soil weight = 130 pcf).

(2) Maximum support spacing = 5'-0" O.C.

(3) Maximum steel stress = 0.6 Fy.

(4) Sustain all combinations of imposed loadings including construction jacking and erection stresses.

(5) Design lagging to sustain a minimum of one half the full overburden load.

PRECAST CONCRETE SEGMENTAL LINING:

- (1) Use ACI-318, Part 4 - General Requirements.
- (2) Sustain full overburden but in no case less than 8,400 psf (assumed soil weight = 130 pcf).
- (3) Sustain a diametral distortion of  $D/D = 0.5$  percent.
- (4) Apply a reduction for relative stiffness to the gross concrete section.
- (5) Include provisions for all loading conditions, including superimposed construction and handling loads.
- (6) Sustain jacking loads induced by Contractor's chosen shield or tunneling machine.
- (7) Maximum segment width = 5'0".
- (8) Concrete  $f'c$  = no greater than 6,000 psi.
- (9) Concrete  $f'c$  = allowable tensile stress = 0.

1.07 TUNNEL FINAL LINING/MINIMUM DESIGN CRITERIA:

Tunnel final lining shall conform to the details shown on the project plans, the minimum design criteria shown below and the requirements specified elsewhere in these Special Provisions under TUNNEL FINAL LINING. Alternative designs may be proposed by the contractor, subject to the criteria set forth.

(A) MINIMUM DESIGN CRITERIA:

- (1) Use ACI-318, Part 4 - General Requirements.
- (2) Sustain full overburden but in no case less than 8,400 psf (assumed soil weight = 130 pcf).
- (3) Disregard beneficial effects of initial support system.
- (4) Sustain a diametral distortion of  $D/D = 0.25$  percent.
- (5) Sustain an internal hydrostatic pressure of 100 feet of water.

(6) Sustain external hydrostatic pressures where appropriate.

(7) Provide for combinations of the loads as applicable for the long-term operation and maintenance of the facility and sustain all loads to which the lining will be exposed during its service life.

(8) Maximum spacing of hoop reinforcement = 12 inches O.C.

(9) Minimum shrinkage and temperature reinforcement  $P_s = 0.002$  (0.2 percent).

(10) Concrete  $f'_c = 4,000$  psi.

(11) Concrete  $f'_c =$  allowable tensile stress = 0.

(12) Reinforcing steel  $F_y = 60,000$  psi.

(13) Reinforcing steel  $f_{ts} =$  maximum tensile stress = 0.75  $F_y$ .

(14) Temperature and shrinkage reinforcement shall be continuous through construction joints.

1.08 JOB CONDITIONS:

(A) EMERGENCY MEASURES:

Whenever there is a condition which is likely to endanger the stability of the excavation, adjacent structures or major streets as determined by the Engineer, the Contractor shall operate for 24 hours a day including weekends and holidays without intermission until those conditions no longer exist.

(B) POWER SUPPLY:

All power machinery and tools, within the tunnel shall be operated by either electricity, compressed air, diesel with approved scrubber or other approved power. All electrical tools and equipment shall be grounded in accordance with the latest requirements of the National Electrical Code.

Temporary electric lights shall be provided to properly and safely illuminate all parts of the tunnel construction area including special illumination at the working faces. Lighting circuits shall be thoroughly insulated and separated from power circuits and all lights shall be enclosed in wire cages. The Contractor shall secure all electrical permits necessary for successful completion of this work.

Prior to construction the contractor shall provide the Engineer with plans for emergency and stand-by electric generating equipment. Independent power supplies from two substations will be acceptable to the Engineer.

(C) SAFETY REQUIREMENTS:

The work shall be performed in a manner which maximizes safety and reduces exposure of men and equipment to hazardous and potentially hazardous conditions, in accordance with the applicable requirements of Section 107.

(D) SURVEILLANCE OF HEADINGS:

Only qualified personnel shall be used to watch for conditions that might threaten the stability of the heading whenever tunnel excavation is suspended or shutdown during periods when the tunnel invert is below the groundwater level.

Acceptable monitoring devices such as closed circuit television may be used to permit continuous monitoring of the conditions at the face by qualified observers outside the tunnel.

(E) AIR QUALITY:

Drilling and tunneling operations shall be accomplished by methods and with equipment which will positively control dust, fumes, vapors, gases, fibers, fogs, mists, or other atmospheric impurities in accordance with all local, state and federal requirements.

Prior to the start of tunneling operations, the contractor shall prepare and submit a plan for detection and control of toxic and flammable gases throughout the underground openings prior to entry of tunnel workmen. The contractor shall provide instrumentation for monitoring the air quality and velocity of the tunnel atmosphere and shall obtain samples under working conditions in accordance with OSHA and other jurisdictional requirements at a minimum of once per week. The plan shall include measures such as control of gases by dilution, suspension of tunneling operations, or evacuation of workmen from the excavation. The contractor shall submit the results of the quality tests to the Engineer on the first of each month.

(F) TUNNEL ILLUMINATION:

The contractor shall maintain illumination in place throughout the underground work during the life of the contract including the substantial completion inspection or until permission to remove illumination is received in writing from the Engineer.

(G) SAFETY ENGINEER:

Prior to the start of construction, the contractor shall employ a competent and experienced safety engineer who shall devote his full time toward accident prevention during construction. The safety engineer shall be fully qualified and possess safety engineering experience in heavy construction or tunnel construction. The qualifications of the individual proposed for safety engineer shall be submitted for review and approval by the Engineer prior to his assignment of work. The safety engineer shall not be removed by the contractor without approval of the Engineer.

(H) FIRST AID AND MEDICAL FACILITIES:

The contractor shall furnish and maintain a suitable fully equipped onsite first aid station in the proximity of all active tunnel portals or working entrances to the tunnels. Each station shall be equipped with all facilities and medical supplies necessary to administer emergency first aid treatment.

During all hours work is in progress, the first aid station shall be staffed by a full time qualified first aid attendant. The contractor shall have standing arrangements for the removal and hospital treatment of any injured person. All first aid facilities and emergency ambulance service shall be made available by the contractor to the Engineer and Department personnel.

Prior to beginning construction, the contractor shall provide the Engineer with an emergency escape and catastrophic disaster plan and a copy of the approved Fire Department plan.

1.09 SUPPORT AND MAINTENANCE OF UTILITIES AND OTHER FACILITIES:

The contractor shall support and maintain-in-place at all times, in a safe and useable condition, all existing utilities and existing facilities. This may include the construction of permanent support or underpinning, temporary support or other means required to maintain continuous service utilizing the existing utilities and facilities. This includes the maintenance at all times of the safety, integrity and stability of any structure of whatever nature regardless of its location which may be affected by the work. Failure to support such utilities does not relieve the contractor of these responsibilities. The contractor shall bear all claims and costs thereof at no additional cost to the Department.

The contractor shall immediately repair all damage to structures, utilities or other facilities caused by the work as needed to restore them to the conditions existing prior to the start of the work.

The contractor shall notify the Engineer, and the Utility or Facility owner of damage to its facilities caused by construction operations. The contractor shall maintain complete in place and protect all building and dwelling service connections as specified in Subsection 107.19.

The contractor shall provide contingency plans or alternative procedures to be implemented if unfavorable performance of utility or facility maintenance is evidenced.

The contractor shall conform all such operations with applicable codes and the requirements of the jurisdictional agencies and utility companies.

Undercrossings of all utilities shall be coordinated with the appropriate agency or utility. Locations of valves, cutoffs and controls shall be determined as appropriate. The contractor shall exercise such emergency shutoffs prior to undercrossing and shall ensure utility personnel are available for emergency response.

The contractor shall perform all such work with qualified personnel under the continuous supervision of a person experienced in this type of work.

1.10 RESTORATION AND REPAIR OF STREETS, CURBS AND GUTTERS:

The contractor shall repair and restore to prior existing condition all streets, sidewalks, curbs and gutters damaged or altered as a result of his work. Temporary pavements shall be placed where necessary and when ordered by the Engineer. At the conclusion of the work, the contractor shall resurface and restore all overlying roadways as directed by the Engineer to the satisfaction of the City of Tempe as specified in Subsection 107.25. Final approval and release shall be obtained from all facility owners and utilities prior to completion of the work.

1.11 EXPECTED GROUND CONDITIONS:

Based on the geotechnical investigations performed for this project, previous subsurface investigations for nearby tunnel projects and the regional geology, the tunnels will be constructed in the "SGC" deposit of sand gravel and cobbles which may possess some apparent cohesion and cementation or may be cohesionless and uncemented. It is anticipated that firm, raveling and running ground conditions may occur. This behavior will vary primarily as a function of the amount and extent of cementation encountered. Raveling and running behavior may be encountered at the advancing face, either singularly or in combination within the length of one shove of the tunneling shield or even within the same heading. The variable and

erratic nature of this stream-transported alluvial deposit material provides continuous variation of conditions, and makes prediction of ground conditions at any one location difficult. Unless ground is adequately supported, runs and raveling behavior, and attendant large losses of ground are likely to occur. In the presence of even small hydraulic gradients caused by water flow to the tunnel excavation, seepage forces may dislodge soil particles, permit soil transport, and may allow flowing ground conditions to develop. In regions adjacent to the Salt River, water table elevations appear directly affected by river flow level and would be expected to fluctuate.

2.00 MATERIALS:

2.01 PRECAST CONCRETE SEGMENTAL LINING:

Precast concrete segmental lining for initial support shall conform to the requirements specified herein under PRECAST CONCRETE SEGMENTAL LINING.

2.02 GEOTECHNICAL INSTRUMENTATION:

Instruments and materials for monitoring ground movements shall conform to the requirements specified herein under GEOTECHNICAL INSTRUMENTATION.

2.03 GROUT:

Grout shall conform to the requirements specified herein under DRILLING AND GROUTING.

2.04 STRUCTURAL STEEL AND BOLTS:

Structural steel ribs, beams, channels and plates shall conform to ASTM A36 Grade 36 unless otherwise noted or approved by the Engineer. All bolts shall conform to the requirements of ASTM A325.

2.05 TIMBER LAGGING:

Timber for blocking, lagging and foot blocks shall be sound well seasoned timber of rectangular cross section. Timber lagging shall have a minimum working stress of 1200 psi.

2.06 PIPE STRUTS:

Pipe struts, where used, shall be either double extra strong pipe or extra strong pipe or other approved material. All pipe struts shall conform to the requirements of ASTM A 53 Grade B or A 501.

3.00 CONSTRUCTION REQUIREMENTS:

3.01 GENERAL:

The work shall be accomplished by means of tunneling with tunnel shields or tunnel boring machines or both as herein provided.

Proposed tunneling shields or machines shall be of a type and design chosen by the contractor and shall be capable of handling and installing an expandable initial support system. The contractor shall be solely responsible for the feasibility of the excavation method he selects to use. The contractor shall not infer that acceptance of the shield or tunneling machine by the Engineer implies that excavation of the entire length of tunnel can be accomplished by such methods.

Before the purchase or rental of the shield or tunneling machine, and for previously purchased equipment, the contractor shall submit documentation including working or manufacturer's drawings showing the design, specifications, method of operation and other pertinent data with respect to the tunnel shields or machines proposed to be used. Documentation submitted shall show conformance to criteria specified herein under 1.03 - Submittal During Construction.

Tunnel construction shall be performed in a manner that will minimize movement of the ground in front of and surrounding the tunnel, and prevent subsidence of the surface above and in the vicinity of the tunnel. During all stages of tunnel construction, the ground shall be continuously supported and controlled in a manner that will prevent loss of ground and keep the perimeters and face of the tunnel stable. The contractor shall be responsible for all settlement resulting from tunnel operations and shall repair and restore damaged property to its original condition.

3.02 TUNNEL BORING MACHINE AND SHIELD REQUIREMENTS:

(A) TUNNEL SHIELDS:

The excavation system shall be compatible with all anticipated ground conditions. The machine shall provide capability for conducting pressure grouting operations ahead of the face. The excavation system shall be capable of fully supporting the face both during excavation, as provided above, and during periods of shut down. The shield shall be steerable and capable of controlling the advance of the heading to maintain line and grade within specified tolerances. The shield's ground support and erection systems, if required, shall be compatible with the configuration and unit weights of the initial support system to be erected. The shield shall be capable of preventing loss of ground between excavation at the face and installation of the initial support system.

Tunnel shields shall be of a design suitable for the work and shall conform to the shape of the tunnel and shall have a uniform exterior surface from the leading edge of the head or poling plates to the rear edge of the tail and be free of projections that will produce over-excavation or voids.

The shield shall have, where appropriate, a hood which projects beyond the shield bottom and a rear overhang or tail long enough to provide at least 12 inches of overlap beyond the last installed element of the initial support system when the shield has been pushed forward to the fullest extent possible. The annular space between the tail and the initial support shall be in accordance with current practice but in no case greater than 1-1/2 inches. The hood shall be designed to sustain loads imposed by boulders and cobbles which are anticipated and shall provide positive means of protection or replacement should deformation or damage occur.

The shield shall include a propulsion system capable of moving the shield in a forward direction while maintaining the construction tolerances with respect to line, grade, and direction. The propulsion system shall be designed so that in the event of failure of any element of the propulsion system there shall be no movement backward and there shall be no overstressing or distortion of the initial support system.

The shield shall be equipped with an erector arm or system capable of handling the largest sizes of initial support elements and of erecting the initial support elements to the required tolerances without causing damage to the initial support elements.

(B) TUNNEL MACHINES:

Tunnel machines shall have the same features as shields except for face support requirements.

3.03 OPERATIONS BY TUNNEL SHIELDS:

On initial set-up, the contractor shall support the tunnel shields on a concrete cradle properly set at lines and grades which will permit the correct installation of the tunnel initial support. During forward movement of the shield, sufficient support at the excavation face shall be provided to prevent movement of any materials except such materials as are physically displaced by the elements of the shield itself. Breasting plates or an approved alternate having the capability of placing continuous force against the face will be required.

The contractor shall control the face efficiently using such support procedures as breasting, poling plates, face jacks, sliding tables, either singly or in combination, spaced as necessary.

The contractor shall advance the excavation for the tunnel in increments sufficient for the erection of one ring of initial support. Initial support shall be installed immediately after each increment of excavation and expanded to obtain continuous contact with the surrounding ground. The Contractor shall carry on excavation in such a manner that voids behind the initial support are held to a minimum.

During shut down periods, the contractor shall support the face of the excavation by positive means. No support shall rely solely on hydraulic pressure.

3.04           INSTALLATION OF STRUCTURAL STEEL RIBS AND TIMBER LAGGING FOR INITIAL SUPPORT:

(A)   GENERAL:

The contractor shall design, furnish, and install structural steel ribs and timber lagging and shall maintain the shape of the tunnel without encroaching beyond the tolerances specified until the final lining is complete and ready to accept loading. The contractor shall be responsible to ensure that the steel ribs and support systems are consistent with his excavation methods, procedures and equipment including provisions for erection and handling loads and jacking reactions. The design shall be prepared and sealed by an Arizona Licensed Professional Engineer experienced in the design of such support systems who shall certify the adequacy of the proposed system.

(B)   EXPANSION OF RIBS:

The contractor shall erect structural steel ribs and timber lagging within the tail of the shield and, upon emerging from the tail, shall immediately expand them outward and upward to produce continuous contact with the surrounding earth.

The Engineer will monitor the expansion process according to the test procedures submitted with the working drawings.

The contractor shall install joints between segments of ribs so that full bearing across the joint is maintained after complete expansion of the rib. Upon completion of expansion, the contractor shall fill the joints with pipe struts or steel wedges or other approved materials in a manner that will not allow relaxation or inward movement of the rib.

(C)   BLOCKING AND BRACING BETWEEN RIBS:

Steel ribs shall be connected positively one to another by blocking, bracing, or tie rods spaced at not more than four feet measured along the centerline of the ribs.

Bracing shall be maintained in place until all tendency of the ribs to distort has ceased.

The contractor shall provide horizontal hog or vertical tie rods as required to maintain the ring geometry upon advance of the tunnel shield or machine.

3.05           INSTALLATION OF PRECAST CONCRETE SEGMENTAL LINING FOR INITIAL SUPPORT:

Installation of precast concrete segmental lining for initial support shall conform to the requirements specified herein under PRECAST CONCRETE SEGMENTAL LINING.

3.06           INSTALLATION OF FINAL LINING:

Cast in place reinforced concrete final lining shall be installed inside of the initial support system to the lines and grades shown on the plans and in accordance with the requirements specified elsewhere in these Special Provisions under TUNNEL FINAL LINING, and Section 601.

3.07           TOLERANCES:

Tolerances for completed tunnel and shaft with final lining in place shall be according to the following:

Maximum departure from established alignment: 12 inches.

Maximum rate of departure from or return to established grade shall not be greater than: 3 inches per 100 feet.

Maximum departure from established grade: 6 inches.

Variation in lining thickness at any point: minus 0.

Variation from inside dimension: 1/2 of 1 percent.

Variations from plumb for shafts and inlets:

In 10 feet: 1/2 inch

In 40 feet or more: 2 inches

3.08           DETECTION OF MOVEMENT:

Detection of movements due to tunneling or dewatering operations shall conform to the requirements specified herein under GEOTECHNICAL INSTRUMENTATION.

3.09 SURFACE SURVEY CONTROL POINTS:

The contractor shall be responsible for all measurements and dimensions necessary for the proper construction of and the prevention of misfittings in the work. The Engineer will check the contractor's alignment control points. The location of all control points established by the contractor and all survey data and notes shall be furnished to the Engineer.

The contractor shall cooperate with the Engineer in checking lines and grades within the underground workings. The Contractor shall furnish the Engineer with access to the tunnel, lights, ventilation, necessary transportation and assistance. The Engineer will make his surveys on off-shifts, weekends or holidays. All assistance to the Engineer in performing surveys within the contract limits shall be at the contractor's expense and incidental to the Contract. The contractor shall furnish and the Engineer will verify all underground control points on a periodic basis.

3.10 REMOVAL AND HAULING OF EXCAVATED MATERIALS:

Removal and hauling of all excavated materials shall conform to the requirements of Subsection 203-2 and as specified herein under Subsection 104.04. In addition, whenever any truck, bucket or other vehicle so used becomes unsuitable, it shall be immediately withdrawn from the work on notification by the Engineer.

3.11 DRILLING AND GROUTING:

Drilling and grouting shall conform to the requirements specified herein under DRILLING AND GROUTING.

3.12 CONTROL OF WATER:

Control of water shall conform to the requirements specified herein under CONTROL OF WATER.

3.13 FINAL CLEANUP:

Prior to the contractor's request for final inspection of the project, or any portion thereof, the contractor shall perform final cleanup. The sites shall be free of all accumulations of waste materials or trash, all tools, scaffolding, concrete forms, and equipment not the property of the Department. All work areas shall be left in a neat manner conforming to the natural appearance or as provided in the Contract.

The tunnel shall be left in a clean, neat and usable state satisfactory to the Engineer. The contractor shall remove all waste material, spoiled grout or concrete and all timber, ties and

construction debris. The contractor shall air water jet tunnel and shaft linings, and any other areas designated by the Engineer. Temporary access shafts to the tunnel shall be removed unless otherwise directed in writing by the Engineer.

4.00 METHOD OF MEASUREMENT:

The tunnel will be measured by linear foot of tunnel constructed, complete in place, measured along the tunnel invert at centerline from the end of the drop structure (Station 10+00 to the beginning of the square (outside) tunnel section (Station 164+71.70). Measurement will be to the nearest foot.

5.00 BASIS OF PAYMENT:

Payment for this work will be made at the contract price a linear foot for ITEM 9300018, which price shall be full compensation for the item complete, including but not limited to: tunnel and access excavation, disposal of excavated materials, control of water; ventilation; lighting; contact grouting; backfill; formwork; final cleanup; initial support systems; cast-in-place reinforced concrete final lining; steel pipe for final lining (Station 10+77.5 to Station 11+24.5); and appurtenances necessary to construct the tunnel.

In no case will partial payment of more than seventy percent (70%) of the unit price per linear foot be paid for excavation and furnishing and installation of the initial support system. The final thirty percent (30%) will be paid for the cast-in-place reinforced concrete tunnel final lining and contact grouting upon completion and acceptance of the work.

No separate measurement or payment will be made for temporary work shafts necessary for constructing the tunnel and connecting dropshaft stubs or blockouts as shown on the project plans. The cost shall be included in the cost of contract items.

Payment for piezometers will be made under Items 93000451 and 93000456.

Payment for consolidation and compaction grouting will be made under Items 9300099, 9300101, 9300111, 9300121 and 9300131 as the case may be.

No measurement or payment will be made for support and maintenance of utilities and other facilities the cost being considered as incidental to the cost of the project.

CONTROL OF WATER:

1.00 DESCRIPTION:

1.01 GENERAL:

The work consists of the control, handling, monitoring, and disposal of groundwater and surface water during construction. This work includes the installation, operation, and removal of all facilities required to maintain the tunnel, shafts, tunnel inlets, open excavations, and trenches in an unwatered condition to permit satisfactory construction operations. This work also includes measures required to control pollutants in water discharged from the work areas.

1.02 WORKING DRAWINGS:

The contractor shall provide the Engineer with complete working drawings and supporting documents showing the type of water control system proposed. The contractor shall obtain the approval of the Engineer prior to installation of the system.

Working drawings and supporting documents shall include:

- o The arrangement and location of the system and complete description of equipment and materials to be used.
- o Installation and operation procedures.
- o Design calculations.
- o Standby equipment and power supply.
- o The location and size of berms, dikes, sumps, and discharge items.
- o Pollution control facilities.
- o Discharge locations.

Working drawings and supporting documents shall be revised and resubmitted for the approval of the Engineer if the system is modified during installation or during operation.

1.03 RECORDS:

The average flow rate and time of operation of each pump used in the dewatering system shall be observed and recorded. Appropriate devices, such as flow meters, shall be furnished and

installed by the contractor for observing the flow rates. The data shall be submitted on a form approved by the Engineer during the period that the dewatering system is in operation on a monthly basis for each well operating during that period.

The elevation of the groundwater in piezometers and previously installed observation wells shall be observed and recorded on a form approved by the Engineer, during the period that the dewatering system is in operation. The contractor shall, jointly with the Engineer, make initial readings on piezometers and/or observation wells as specified herein. Records of water level readings shall be supplied to the Engineer at the first of each month.

Records kept by the Engineer will not relieve the contractor of the requirements specified above.

1.04 SUBSURFACE CONDITIONS:

The results of previous subsurface investigations and groundwater level readings are shown on the project plans.

1.05 PERMITS:

Prior to discharging water into a storm sewer or waterway or dewatering for construction purposes, the contractor shall obtain a permit from the jurisdictional agencies concerned.

Methods of disposal of excess water from within the tunnels utilizing the effluent beneficially for dust control, water table recharging, etc., shall be used preferably over non-beneficial disposition methods. Detention ponds or spray irrigation systems may be utilized within the Departments right-of-way subject to the approval of the Engineer.

Should the contractor find it necessary or desirable to lower the groundwater table elevation during the tunnel boring operations, the following guidelines shall direct his effort:

The contractor shall obtain a permit from the Arizona Department of Water Resources for Groundwater Management in accordance with ARS45-518 prior to commencing his pumping operations. Item 9240010 is established to cover invoice cost of DWR pumping fees if any are applied.

Effluent from the dewatering system shall be de-silted and disposed of by the contractor in accordance with the requirements of these special provisions.

The contractor shall submit a design of the groundwater detention facilities and the method proposed to discharge this water into the City of Tempe storm drains, to the local jurisdictional authority for their approval where appropriate.

If the contractor's proposed method of discharge is approved, the City of Tempe will specify the conditions under which use of their facilities would be allowed and will issue a permit for the use of the storm drains.

Generally, the City of Tempe will only prohibit the use of the storm drains during rain storm peak flow durations. The maximum allowable injection rates shall be less than the maximum capacity of the storm drain, to allow for some dry-weather flow.

1.06 RESPONSIBILITIES:

Measures shall be taken to prevent damage to properties, buildings, structures, sewers and other utility installations, pavement, sidewalks and the work under this Contract.

The water control system installed by the contractor shall be modified at no additional cost to the Department if after installation and while in operation it causes or threatens to cause damage to existing buildings, structures, utilities, facilities, or other adjoining property.

The quality of the discharge from the dewatering system shall be monitored to determine if soil particles are being removed by the system. Water samples shall be tested every three months or as directed by the Engineer for:

- (A) Volatile organics including TCE and TCA
- (B) Pesticides
- (C) Heavy metals
- (D) Sulfides and sulfites
- (E) Chlorides
- (F) Nitrates

Test results shall be recorded by the contractor and copies of all test results shall be furnished to the Engineer.

The contractor shall measure and evaluate movements in adjacent areas caused by the dewatering operations in accordance with the requirements specified herein under GEOTECHNICAL INSTRUMENTATION.

Damage, disruption, or interference resulting directly or indirectly from dewatering operations shall be repaired to the Engineer's approval at no additional cost to the Department.

Plans and details for the protection of work downstream by other contractors shall be submitted where applicable. These plans shall include details of bulkheads, pumping facilities, dikes, and drainage.

All work shall be accomplished in accordance with approved working drawings.

The Engineer shall be advised of any changes made to accommodate field condition.

The contractor shall maintain continuous and complete effectiveness of the installation at all times.

2.00 MATERIALS:

2.01 FILTER MATERIALS:

Filter materials for dewatering shall consist of materials with grain size of the following requirements:

$$R_{50} = \frac{D_{50} \text{ of filter}}{D_{50} \text{ of protected soil}} = 12 \text{ to } 58$$

OR

$$R_{15} = \frac{D_{15} \text{ of filter}}{D_{15} \text{ of protected soil}} = 12 \text{ to } 40$$

Where R = Ratio

Where  $D_{50}$  = Diameter at 50% passing by weight

Where  $D_{15}$  = Diameter at 15% passing by weight

3.00 CONSTRUCTION REQUIREMENTS:

3.01 SURFACE DRAINAGE:

Surface drainage shall be intercepted and diverted away from the excavation, by the use of dikes, curb walls, ditches, pipes, sumps, or other means.

Surface drainage systems shall be designed so that they do not cause erosion on or off the site or cause unwanted flow of water.

The surface drainage system shall be removed when no longer required.

The contractor shall remove debris and restore the work site to its original condition.

3.02 DEWATERING SURFACE EXCAVATIONS:

Ditches of adequate size shall be provided and maintained to collect surface water and seepage which may enter the excavations and divert the water into a sump so that it can be drained or pumped into drainage channels, or storm sewers if approved by the Engineer, and other jurisdictional agencies concerned.

Settling basins or other approved apparatus shall be installed as required to reduce the amount of fine particles which may be carried by water diverted into storm sewers or flowing off the site.

Should a storm sewer become blocked or have its capacity restricted due to the dewatering operations, the contractor shall clean such sewers and appurtenances with the approval of the jurisdictional agency at no additional cost to the Department.

Drainage ditches, sumps, and settling basins shall be backfilled, when no longer required, with granular material or other material as approved by the Engineer.

3.03 DEWATERING SHAFTS AND TUNNEL:

Tunnels shall be drained as necessary to obtain satisfactory working conditions. Pumping shall be provided where gravity flow cannot be secured. The contractor shall have on hand at all times adequate machinery, pipe, power, and supporting equipment. Adequate drains, sumps, and pumps shall be provided to facilitate handling and disposal of water and to conform with the requirements for controlling water when placing lining within tunnels.

Flow data observed and recorded as required for the water control system shall be submitted to the Engineer in a form acceptable to the Engineer.

Ground and surface water shall be disposed of into storm sewers or drainage channels, subject to approval by the City of Tempe and other agencies concerned.

The contractor shall provide necessary drainage and protect the invert with an acceptable traffic surface such as crushed or broken rock, or concrete if the ground at the invert becomes soft because of water or construction traffic, all at no additional cost to the Department.

The contractor shall reduce or stop dewatering the tunnel only after the permanent lining has been installed and the Engineer has given his approval.

3.04           INSTALLING PIEZOMETERS:

Prior to the start of dewatering operations, piezometers of a type and detail approved by the Engineer shall be furnished and installed by the contractor in accordance with the requirements specified herein under Item 9300451. The contractor shall install them at locations indicated or as designated by the Engineer, and to the depths indicated or approved by the Engineer. The Engineer will confer with the contractor as to the suitability of all planned locations.

Depending upon subsurface conditions, the dewatering system shall be operated so that the groundwater level in the piezometer is maintained at all times within prescribed limits to insure adequacy of drawdown.

3.05           GROUTING:

Grouting used for control of water when approved by the Engineer shall conform to the requirements specified herein under DRILLING AND GROUTING.

5.00           PAYMENT:

Control of water will not be paid for separately but the cost thereof will be considered as included in the contract price for Item 9300018 - Tunnel (18').

Payment for piezometers will be made at the contract price a linear foot for Item 9300451.

Payment for piezometer removal will be made at the contract price each for Item 9300456.

Water control by grouting will be measured and paid for in accordance with the requirements specified herein under DRILLING AND GROUTING.

PRECAST CONCRETE SEGMENTAL LINING:

1.00 DESCRIPTION:

The work consist of furnishing and installing expandable precast concrete segments for tunnel initial support.

1.01 DEFINITIONS:

(A) RING:

A ring is an element of the tunnel or shaft initial support assembled within the excavation which, when completed, provides structural support to the surrounding ground around the circumference or perimeter of the tunnel or shaft.

(B) SEGMENT:

A segment is one of the structural components required to construct a ring.

1.02 SUBMITTALS DURING CONSTRUCTION:

Submittals during construction shall be made in accordance with Subsection 108.03 and Subsection 105.02. In addition, the following specific information shall be provided:

(A) SHOP DRAWINGS AND DATA:

The contractor shall submit shop and erection drawings and calculations for each size and type of segment, formwork, reinforcement, anchors, handling inserts, other embedded items, and accessories required for the manufacture, transportation and installation of precast concrete segments. The contractor shall submit a manufacturing schedule and setting sequence for precast segments. The contractor shall submit a description of the proposed handling method with all necessary supporting calculations. No precast segments shall be cast until all design details and construction methods have been reviewed and approved by the Engineer.

(B) SEGMENT MANUFACTURING:

Data about the plant for manufacturing precast concrete segments, and procedures for manufacturing, transporting, storing, and installing precast concrete segments for initial support shall be submitted to the Engineer for review and approval. Information shall include, but not be limited to, the following:

(1) A detailed layout of the plant to be used in manufacturing precast concrete segments.

(2) A detailed plan outlining the contractor's procedure for manufacturing, transporting, storing, and installing the precast concrete segments.

No segments shall be manufactured until details of the manufacturing plant have been submitted to the Engineer and until the Engineer has had the opportunity to inspect and approve the plant.

Any fabrication or procurement of materials performed prior to the Engineer's review shall be at the contractor's risk. Review by the Engineer shall not relieve the contractor of any part of his responsibility to meet the requirements of these specifications or of his responsibility for the correctness of the contractor's details.

(C) CONCRETE MIXTURE PROPORTIONS:

The contractor shall submit concrete mixture proportions to the Engineer for approval. Each mix shall be identified by an appropriate mix or product code. This submittal shall state proportions of all ingredients and the maximum nominal coarse aggregate size to be used in the production of each type of concrete. Proportions shall indicate the weight of cement and water and the weights of aggregates utilized in the design mix. The contractor shall submit laboratory test reports complying with ASTM E 329 for each mix or product used attesting that the selection proportions will produce concrete of the qualities indicated.

No substitution shall be made in material used in the work without additional tests to show that the quality of concrete is satisfactory. Each load shall be accompanied by a batch delivery ticket as specified in Section 1006. Delivery tickets shall be retained by the contractor for all concrete used.

(D) CONCRETE FINISHES:

Formed surfaces shall be smooth form finish.

Unformed surfaces shall be wood float finish.

(E) DIMENSIONS OF SEGMENTED RINGS:

Dimensions of segmented rings shall be as shown on the project plans or as approved by the Engineer in writing.

(F) TOLERANCES:

Segments shall be manufactured to the following tolerances:

Circumferential Length	Plus or minus 1%
Radius of Curvature	Plus or minus 3/4-inch
Thickness (on back surface only)	-0 to +3/4-inch
Width	Plus or minus 3/4 inch
Internal diameter of Ring	No more than 3%

The maximum lapping between adjacent edges of adjacent rings shall not exceed 2-inches unless approved by the Engineer.

The maximum variation in the position of reinforcement (individual members or composite units) shall be plus or minus 3/8-inch. The nominal thickness of concrete cover over reinforcement shall be one inch unless shown otherwise on the Plans. In no case shall the concrete cover over reinforcement be less than 3/4-inch, except internally at bolt holes, grout holes, radial joint connections and sockets. The contractor shall maintain the planeness of joint faces to insure a continuous and tight fit which will preclude soil transport into the tunnel. The contractor shall replace any segment which does not comply with the tolerances indicated at no cost to the Department.

(G) MANUFACTURER'S QUALIFICATIONS:

The manufacturer of precast concrete segments for use as tunnel initial support shall have a minimum of five years experience of similar type manufacturing or shall have in his employ supervisory personnel who have experience over the past five years in the manufacture of precast concrete products of similar nature to close tolerances, or is approved in writing by the Engineer.

(H) TEST SECTION:

Prior to production, a trial ring shall be assembled on a satisfactory concrete horizontal pad or surface to check the dimensional accuracy. A second ring shall be assembled on top of the first. When the Engineer is satisfied that the rings comply with the project plans and Specifications, the top ring shall be dismantled. A minimum of one further ring in every 2000 rings manufactured may be randomly selected to be built upon the trial ring to form a second

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ring. If, in the Engineer's opinion, additional tests are required to assure satisfactory compliance such tests shall be performed at no additional cost to the Department.

If ring measurements fail to meet the requirements, manufacturing shall be halted and resumed only when the cause for failure has been found and corrected, as determined by subsequent test assemblies.

The contractor shall furnish all necessary facilities and do all work required to perform the assembly tests.

(I) ASSISTANCE TO THE ENGINEER:

The contractor shall provide free access for the Engineer to all manufacturing and work areas at all times and provide sufficient office space, workmen, and equipment for the performance of inspection.

The contractor shall provide and make available at all times, master and working templates, gauges, calipers, and other equipment to adequately determine the accuracies and tolerances in the manufacture of precast concrete segments.

2.00 MATERIALS:

2.01 FORMS:

Forms for precast concrete segments shall be designed and fabricated so that production segments shall conform to all dimensions shown on the project plans and to the specified tolerances, and so that production units cast in different forms shall be interchangeable. Forms shall provide a smooth form finish to the concrete. Forms of wood or wood products shall not be used. The contractor shall submit design drawings and calculations for all segment formwork to the Engineer for review.

Concrete shall conform to the requirements of Section 1006 except as modified herein.

Concrete shall have a minimum compressive strength of 5,000 psi; have a three inch maximum slump; contain a water reducing agent; and have a 3/4-inch maximum size coarse aggregate.

2.02 CEMENT:

Cement shall be Type II Portland cement conforming to the requirements of Section 1006.

2.03 ADMIXTURES:

Admixtures shall conform to the requirements specified herein under TUNNEL FINAL LINING.

2.04 AGGREGATE:

Aggregate shall conform to the requirements specified herein under TUNNEL FINAL LINING, except that the maximum coarse aggregate size shall be 3/4-inch.

2.05 WATER:

Water shall be potable and conform to the requirements of Section 1006.

2.06 REINFORCEMENT:

Steel reinforcement shall conform to the requirements specified herein under TUNNEL FINAL LINING. Welded wire fabric shall conform to ASTM A185 and need not be galvanized.

2.07 PIPE STRUTS:

Pipe struts shall conform to the requirements specified herein under TUNNEL AND SHAFT CONSTRUCTION.

2.08 ATTACHMENT DEVICES:

Attachment devices shall be steel which is free from defects impairing strength, durability or appearance.

2.09 INSERTS:

Inserts shall be designed to develop full capacity of inserts and provide attachment to the reinforcing steel as required for erection or transport of segments.

2.10 SPACERS, CHAIRS AND TIES:

Spacers, chairs and ties shall be plastic or noncorrosive metal that will not react with concrete.

2.11 GROUT PIPES:

Grout pipes, fittings, and inserts shall be steel pipe conforming to ASTM A 120, standard weight, Schedule 40, black and as shown in the project plans.

2.12 GROUT PLUGS:

Grout plugs shall be gray cast iron castings, ASTM A 126, Class B, threaded with American Standard Straight Pipe Thread for Mechanical Joints, for external pipe thread. Threads shall be coated with mineral oil.

2.13 MEMBRANE FORMING CURING COMPOUND:

Membrane forming curing compound shall conform to 1006-2.05 for Type 2 compound with Class B vehicle.

3.00 CONSTRUCTION REQUIREMENTS:

3.01 MANUFACTURING PRECAST CONCRETE SEGMENTS:

(A) GENERAL:

Segments shall not be removed from the molds until the concrete has attained a minimum compressive strength of 1,200 psi unless otherwise approved by the Engineer.

All segments shall have an identification number and the date of manufacture clearly marked on both the inner and outer surfaces at the time of manufacture.

All tapered rings shall have each segment marked with the taper and the location or joint designation of each segment within the ring and clearly identified taper side or sides.

All marking materials shall be inert and shall be indelible and clearly readable through manufacture, installation, and final inspection.

All reinforcement shall be bent cold. No heating or rebending will be permitted. Cages may be tack welded at bar intersections.

All segments shall have at least one grout hole which shall be 1-1/2 inches in diameter fitted with grout pipe inserts and plug as shown on the drawings.

(B) PLANT:

No segments shall be manufactured until details of the manufacturing plant have been submitted and reviewed by the Engineer and until the Engineer has had an opportunity to inspect the plant.

(C) CONCRETE MIX DESIGN:

Trial mixes having proportions and consistencies suitable for the work shall be made, using at least three different water cement ratios which will produce a range of strength encompassing those required for the work. Trial mixes shall be designed for maximum permitted slump and air content. The temperature of concrete in each trial batch shall be reported. For 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. Proportions shall be selected so as to produce an average strength  $f'(cr)$  exceeding the specified strength  $f'(c)$  by the amount indicated below. Where the production facility has a standard deviation record determined in accordance with Chapters 3 and 4 of ACI 214, based on 30 consecutive strength tests of similar mixture proportions as proposed, obtained within one year of the time when concrete placing is expected, it shall be used in selecting average strength. The average strength used as the basis for selecting proportions shall exceed the specified strength  $f'(c)$  by at least:

350 psi if standard deviation is less than 300 psi  
550 psi if standard deviation is 300 to 450 psi  
750 psi if standard deviation is 450 to 600 psi  
900 psi if standard deviation is 600 to 750 psi

If the standard deviation exceeds 750 psi or if a standard deviation record is not available, proportions shall be selected to produce an average strength of at least 1,000 psi greater than the specified strength.

(D) CURING:

Concrete shall be cured as soon as the concrete has attained sufficient set to prevent detrimental effects to the concrete surfaces by either water curing or steam curing or other approved curing method.

Concrete shall be cured until it has attained a compressive strength of at least 4,500 psi as determined by test cylinders. Curing by water or steam shall conform to the following requirements. Membrane-forming curing compound may be used where approved by the Engineer.

(E) WATER CURING:

Water curing shall be accomplished by covering exposed concrete surfaces with water-saturated material or by applying moisture using a system which will keep all exposed surfaces

continuously wet until the specified curing strength has been attained.

(F) STEAM CURING:

Immediately after the segments have been cast, they shall be suitably enclosed and saturated steam introduced such that the atmosphere within the enclosure is maintained in a saturated condition until the concrete has attained the specified compressive strength. The enclosure shall be tightly closed to prevent the escape of moisture and shall not be in contact with the concrete in the segments or their immediate formwork such as to prevent full circulation of the saturated vapor.

The ambient temperature under the enclosure and about the segments shall not exceed 100 degrees F within 2 hours after completing the concrete placement. Thereafter, the temperature shall be brought to a minimum of 90 degrees F within a period of 2 hours and maintained between 90 and 160 degrees F until the specified curing strength has been attained. The ambient temperature rise about the segments at any time shall not exceed 40 degrees F per hour. Following the period of steam curing, segments shall be protected from rapid drops in temperature which could damage the concrete.

(G) MEMBRANE CURING COMPOUND:

Curing compound shall be applied in accordance with the requirements of 1006-6.01(C).

3.02 PRODUCTION TESTING:

The compressive strength of concrete shall be determined by using test cylinders approved by the Engineer. Test cylinders shall be made and tested by the contractor. Certified copies of test results shall be submitted to the Engineer.

Prior to the start of manufacture, at least six test cylinders shall be made and cured in the same manner as the production precast segments. These cylinders shall be removed in pairs at appropriate time intervals during the curing period to establish, for the method of curing being used, the duration of curing required to attain the specified curing strength and the time for form stripping. All test cylinders shall be tested in accordance with ASTM C 39 as soon as practicable following removal from curing.

During manufacture of precast segments, two test cylinders shall be made from the concrete for each day's run and cured in the same manner as the segments. These cylinders shall be tested at 28 days' age in accordance with ASTM C 31 and ASTM C 39. The average

compressive strength of the concrete shall be sufficient to ensure that 80 percent of the test cylinders have a 28 day compressive strength in excess of 5,000 psi.

For each 500 cubic yards of production, one or more groups of two test cylinders per group shall be made to determine that the minimum specified curing strength has been attained. These cylinders shall be tested at the end of the established curing period. If the average strength of the two cylinders is less than the specified minimum curing strength, the segments represented by these cylinders shall be cured for an additional time satisfactory to the Engineer to ensure that the minimum compressive strength is attained. All cylinders for testing for compressive strength shall be tested as soon as practicable following removal from curing. All concrete cylinder test results shall be submitted to the Engineer at the first of each month.

3.03 FIELD QUALITY CONTROL:

The contractor shall check dimensions of the first segment cast from each form and where required, make any necessary adjustments to the form. Thereafter, the Contractor shall check two percent of each type segment produced each day, but not fewer than one segment of each type produced each day.

The contractor shall cast a sufficient number of segments to replace loss by breakage or other causes.

The contractor shall mark each segment of a different geometry in a distinguishable manner as approved by the Engineer.

INSPECTION:

The contractor shall notify the Engineer in writing at least 30 days prior to beginning work at the manufacturing plant and make arrangements for inspection by the Engineer. Precast concrete segments may be inspected by the Engineer before being taken underground. Damaged segments that can be repaired as determined by the Engineer shall be repaired by the Contractor at no cost to the Department.

3.04 DELIVERY, STORAGE AND HANDLING:

The contractor shall use supports to store segments in order to avoid damage or undue strain.

The contractor shall prevent damage to segments during storage and delivery and keep wire ropes, chains, or hooks from direct contact with segments.

The contractor shall ship tapered segments in units of complete rings, properly identified and shall inspect segments prior to shipping.

Precast segments shall have attained the specified 28-day compressive strength prior to shipping.

3.05 INSTALLATION OF PRECAST CONCRETE SEGMENTAL LINING:

(A) GENERAL:

The contractor shall install precast concrete segmented tunnel initial support to the dimensions and tolerances for line and grade as specified herein under TUNNEL AND SHAFT CONSTRUCTION in a manner that will not damage the segments.

Utility lines necessary for construction of the tunnel or shaft may be suspended from installed precast concrete segments. Cast-in-holes or embedded anchorages may be used for this purpose. Drilling of additional holes for securing utility lines shall be done only after review and approval by the Engineer.

(B) INSTALLATION:

The contractor shall assemble segments to form a circular section. The contractor shall assemble and install each ring of precast concrete segments inside the tunneling shield and clean all surfaces of segments which will be in contact with each other. At the time of erection, such surfaces shall be free of all material which could interfere with proper bearing. The contractor shall ensure even bearing and distribution of jacking forces through the use of approved jacking shoes or distribution ring. If shims are utilized between segments, they shall be placed in such a manner as to minimize segment cracking under jacking forces.

(C) EXPANSION OF SEGMENTS:

The contractor shall erect segments within the tail of the shield or tunneling machine, and upon emerging from the tail, immediately expand them outward and upward to produce continuous contact with the surrounding ground.

Pipe struts or steel wedges shall be installed between segments so that the full axial thrust capacity of the segments may be transmitted across the joint after expansion of the segments. When expansion is complete, the contractor shall ensure that no relaxation or inward movement of the segment ring occurs.

The contractor shall support the last installed ring with a horizontal tie (hog) rod or stiff internal fitting ring or other approved system which is installed before the tunneling shield is advanced. The support shall be kept in place until contact grouting around the lining has been completed, the grout has set, and no deformation of the segment ring occurs. The first injection for contact grouting shall be completed before shield jacking loads are allowed to act on the segments.

The contractor shall ensure that shield jacking loads are applied only at segment jacking ribs or that the jacking thrust is evenly distributed around the segment ring.

(D) ALLOWABLE TOLERANCES:

The inside dimensions of the segmental tunnel lining rings measured along any diameter shall not vary by more than three percent of the lining diameter.

(E) CHANGES IN ALIGNMENT AND GRADE:

The contractor shall use tapered rings on horizontal and vertical curves and elsewhere as required to maintain tolerances and shall maintain an adequate supply of all such tapered rings on the job at all times.

5.00 PAYMENT:

Precast concrete segmented initial support lining will not be paid for separately, the cost being considered as included in the contract price for Item 9300018 - TUNNEL (18' I.D.).

TUNNEL FINAL LINING:

1.00 DESCRIPTION:

The work consists of proportioning, mixing, transporting, placing, finishing, and curing of all concrete for cast-in-place tunnel final lining and the incorporation in the work of reinforcing steel bars, welded wire fabric, and accessories in accordance with Sections 601, 605, 1003 and 1006 except as modified herein.

1.01 SUBMITTALS:

The contractor shall submit Working Drawings in accordance with Subsection 105.02 showing details of tunnel forms, the number of form sections to be furnished, and details of bulkheads and construction joints; the method and procedure for setting, stripping and moving forms; and design calculations for formwork.

Not less than 30 days prior to commencing concrete placing, the contractor shall submit the following information for the review and approval of the Engineer:

The name and location of the premix concrete supplier, unless the contractor batches concrete on site.

Drawings and details of batch plant and mixing area.

The method to be used for concrete temperature control.

The method for handling and transporting concrete from the surface delivery point to the forms.

The method and procedures for placing and consolidating concrete.

The procedures for finishing and curing concrete.

2.00 MATERIALS:

2.01 CONCRETE:

Concrete shall conform to the requirements of Section 1006 Portland Cement Concrete except that a water reducing agent shall be used in all concrete.

2.02 CEMENT:

Cement shall be Type II Portland cement conforming to Section 1006.

2.03 AIR ENTRAINING ADMIXTURES:

Air entraining admixtures shall conform to Section 1006 except that concrete shall be air entrained to between three and six percent. Air entraining admixtures shall contain no chlorides and shall conform to the requirements of ASTM C 260.

2.04 WATER REDUCING, RETARDING AND ACCELERATING ADMIXTURES:

Water reducing, retarding, and accelerating admixtures shall conform to Section 1006 except for the following:

Depending upon the ambient temperature and the job conditions or when directed by the Engineer, retarding or accelerating admixtures shall be added to portland cement concrete mixtures.

Admixtures shall be compatible with each other and shall be free of chlorides.

Water reducing admixtures shall conform to ASTM C 494, Type A.

2.05 AGGREGATE:

Coarse aggregate shall conform to the requirements of Section 1006.

2.06 FINE AGGREGATE:

Fine aggregate shall conform to the requirements of Section 1006.

2.07 FLY ASH:

Fly ash shall be a Class F conforming to ASTM C-618. Substitution for cement shall not exceed 16 percent replacement of cement by weight.

2.08 STRENGTH OF CONCRETE:

All concrete shall have a minimum 28-day compressive strength of 4,000 psi, and shall contain a minimum of six bags of cement per cubic yard of concrete.

2.09 STEEL REINFORCING:

All reinforcing steel shall conform to Section 1003 and shall be ASTM A615 Grade 60. Reinforcement shall be placed as shown on the project plans.

3.00 CONSTRUCTION REQUIREMENTS:

3.01 GENERAL:

At the option of the contractor, the tunnel concrete final lining may be formed and placed for the full circular tunnel section in one continuous operation or the tunnel invert may be cast separately from the remainder of the tunnel section.

3.02 SLUMP FOR CONCRETE:

Slump for concrete at point of placement, prior to being compacted by approved mechanical vibrators shall conform to the following:

Footings and tunnel invert	3 inches maximum
Tunnel arch and full circle tunnel lining (pumped)	5 inches maximum
All other	4 inches maximum

A tolerance of up to one inch above the indicated maximum will be allowed for individual batches provided that the average for all batches or the most recent ten batches tested, whichever is fewer, does not exceed the maximum.

The Engineer may establish alternative locations for testing of slump depending on the arrangement of tunnel concreting equipment and concrete delivery.

The temperature of plastic concrete shall be between 45 degrees Fahrenheit and 90 degrees Fahrenheit measured at the point of placement.

3.03 FORMS FOR FINAL LINING:

Forms for tunnel concrete final lining shall be made of steel and shall be constructed in such lengths that each concrete placement can be completed without intervening cold joints. Steel forms are not required for junctions or elbows.

Openings for tunnel arch or full circle forms for inspection purposes shall be provided and shall be not less than 24 inches by 18 inches along each sidewall and at the crown, as follows:

Openings in the crown shall be spaced at not more than ten feet on centers and shall be located alternatively on each side of the tunnel centerline.

Openings in sidewall forms shall be located at midheight of the tunnel in each sidewall and shall be spaced at not more than ten feet on centers along each sidewall.

If the full circular section of the tunnel final lining is placed in one continuous operation, the tunnel form shall be constructed so that at least the bottom 60 degrees of the tunnel invert portion of the form can be loosened or removed.

3.04 PREPARATION FOR CONCRETE PLACEMENT:

Cleanup in preparation for placing concrete tunnel final lining shall include:

Removal of timber lagging, blocking and wedges as completely as practicable where they extend within the concrete design line.

Removal of timber spreaders used to brace or wedge steel rib supports or segments.

Segment and other absorptive foundation surfaces shall be moistened thoroughly or otherwise treated as approved by the Engineer to prevent moisture from being drawn from the freshly placed concrete.

Spaces around the posts, ribs and lagging between segments and beyond the limits of the concrete lining shall be filled completely. Spaces which cannot be filled by practical means with concrete shall be filled with grout.

Enlargements of the tunnel excavation beyond the dimensions shown shall be filled either with concrete or with grouted prepacking as approved by the Engineer. Filling enlargements of the tunnel excavations shall be at the contractor's expense.

Concrete shall be forced into close contact with the lagging and steel rib supports or segmental lining.

Placement of the concrete tunnel lining shall be scheduled so that no concrete is placed closer than 500 feet from the tunnel excavation heading, unless otherwise authorized by the Engineer.

Water in the tunnel shall be controlled so that at no time during placement or hardening of the concrete will water wash, mix with, or seep into the unhardened concrete.

All formed and unformed joints inside the neat line of tunnel and shaft concrete final lining shall be treated as construction joints.

The contractor shall remove loose excavation, waste concrete and debris extending inside "A" line.

Adequate electric power and lighting at forms, concrete transfer stations and placing equipment shall be provided.

The contractor shall coat faces of removable forms with a form oil which will not be deleterious to the concrete.

The contractor shall use panning, caulking, wedging, chasing, ducting, or other methods as approved by the Engineer. When ducting, drain pipes shall be placed in the lowest position for water interception. Following placement and curing of cast-in-place concrete tunnel final lining, the contractor shall grout drainage ducts in accordance with the requirements specified herein under DRILLING AND GROUTING.

The contractor shall do all work as may be required to provide surfaces in contact with the concrete which are free from standing or running water, mud, dried mortar or grout, oil, organic debris, frost or ice.

### 3.05 TRANSPORTING AND CONVEYING CONCRETE:

The methods and equipment used for transporting or conveying concrete from the point of delivery and the time that elapses during transportation or conveyance shall be such as will not cause appreciable segregation of coarse aggregate in the concrete as it is delivered to the work nor is detrimental to its quality or workability and shall be as approved by the Engineer. The Engineer shall be notified at least 24 hours in advance of the start of concrete placing. Concrete shall be placed only in the presence of the Engineer.

The contractor shall not place concrete until all formwork, steel reinforcement, installation of embedded parts, and all other preparation is complete and approved by the Engineer.

All concrete pumping work shall be in accordance with ACI 301 and ACI 304, Chapter 9.

### 3.06 CONCRETE PLACEMENT:

Concrete shall be placed continuously and at a uniform rate. The Contractor shall not place concrete which has attained initial set or been mixed more than 90 minutes, unless otherwise approved by the Engineer. The Engineer shall be the sole judge as to the acceptability of the concrete.

Concrete shall be placed in the tunnel arch or for the full circular section by pumping or other methods approved by the Engineer. After the concrete has been built up to the crown, the end of the discharge line shall be kept buried a minimum of five feet into the concrete during placement.

Construction joints for concrete lining placement shall be formed for a height not less than  $0.75D$  above tunnel invert, unless otherwise approved by the Engineer, a sloping joint will be allowed above that height and the joint surface shall be thoroughly cleaned as described below. The sloping joint shall be thoroughly consolidated concrete and shall be thoroughly cleaned with compressed air and water to exposed aggregate, and all debris and loose aggregate removed prior to placing additional concrete.

Cold joints due to unavoidable interruption shall be trimmed to eliminate the feather edge to a neat and vertical surface the thickness of the concrete lining to be placed.

3.07 CONSOLIDATION:

Concrete in the tunnel concrete final lining shall be consolidated to maximum practical density, and shall be free of any pockets of coarse aggregate or entrapped air and shall be filled tightly against the surrounding initial support system. The entire area between the inside face of tunnel and the initial support system shall be filled as much as practical with concrete. Immersion and form type vibrators shall be used. The contractor shall rigidly attach form vibrators to the forms and operate them at speeds of at least 8,000 vpm when vibrating concrete. Form vibrators shall be operated at successive locations close behind the advancing slope of concrete in the sidewalls and shoulders of the arch. The contractor shall coordinate the location of form vibrators at the crown, the position of the end of the discharge line, operation of vibrators, discharge of concrete, and withdrawal of the discharge line so as to obtain maximum filling of the crown with concrete. The contractor shall avoid settlement and flow of concrete from the filled crown due to improperly positioned and timed vibration. Where approved by the Engineer external vibrators may be used. The Engineer reserves the right to require a slugger line if he deems necessary.

3.08 REMOVAL OF FORMS:

Forms may be removed as soon as the concrete has hardened sufficiently to prevent damage or deformation. The time of removal shall be as approved by the Engineer.

3.09 FINISHING:

The finished lining interior surfaces shall conform to the shape, alignment and grades shown on the project plans.

(A) FORMED SURFACES:

Class I finish applies to exposed and waterway formed concrete surfaces. Surface irregularities shall not exceed 1/4 inches for abrupt irregularities and 1/2 inch for gradual irregularities. Abrupt irregularities shall be tested by direct measurements. All other irregularities shall be measured as the departure from the testing edge of an approved ten foot template held parallel to, and in contact with, the surface. The template shall consist of a straight-edge or the equivalent thereof for curved surfaces.

Formed surfaces shall be finished and repaired immediately upon form removal. No sack rubbing will be required. Grinding will be required to reduce protrusions and to correct surface irregularities. Form tie rod holes more than 1 inch deep shall be filled with cement-fine sand dry-pack.

(B) UNFORMED SURFACES:

Unformed surface finish applies to exposed and waterway unformed concrete surfaces. Surface irregularities, measured similar to formed surfaces, shall not exceed 1/4 inch. The surface shall be floated as soon as the screeded surface has hardened sufficiently to obtain a uniform dense surface free of screed marks. Edges and joints shall be tooled as shown on the plans or as directed by the Engineer.

3.10 CURING AND PROTECTION:

Curing of concrete shall be in accordance with Subsection 1006-6.

3.11 HOT WEATHER PROTECTION:

During hot weather conditions, the contractor shall take measures to deliver the concrete to the forms at temperatures of the concrete not to exceed 90°F. After placement, the contractor shall protect the concrete by means and methods approved by the Engineer.

3.12 ACCEPTANCE FOR FINAL TUNNEL LINING THICKNESS:

For the purpose of determining acceptability for tunnel lining, holes and cores shall be drilled by the contractor.

A unit of concrete shall be defined as 250 cubic yards of concrete or 200 linear feet of concrete lining placed whichever is less.

Test concrete cores shall be taken at a rate of two per unit. In no case will less than one core be taken for each day that final concrete lining is being installed. All holes shall have a minimum diameter of 1.5 inches. All cores shall have a minimum diameter of 3 inches. At the discretion of the Engineer, the testing sample rate may be reduced.

The length of the cores will be determined in accordance with the requirements of ASTM C 174, except that the nine measurements will be read to the nearest thousandth of an inch. The average of the nine measurements will be reported to the nearest hundredth of an inch.

In calculating the average length, cores which have a length in excess of the thickness specified on the project plans by more than 0.50 inch will be deemed to have a length of the specified thickness plus 0.50 inch. Field length measurements will be acceptable in lieu of average length measurements in accordance with the requirements of ASTM C 174, provided that the original core in any unit meets or exceeds the specified thickness. Measurements in accordance with the requirements of ASTM C 174 will be required on any questionable thickness measurements.

For the purpose of determining acceptability for lining thickness, one hole shall be drilled within each unit. The thickness will be measured and will be considered acceptable and that unit will be measured for payment provided that the wall thickness equals or exceeds the specified thickness.

If the lining thickness is less than the specified thickness, a core shall be drilled adjacent to the drilled hole. If the length of that core is not deficient in thickness by more than 0.50 inch, that unit will be measured for payment.

If the length of the original core drilled in the unit is deficient by 0.750 inch or more, that core will not be used in determining the average thickness of that unit. Additional cores shall be drilled at intervals not to exceed ten feet in each direction from the deficient core until one core is obtained in each direction which is not deficient by 0.750 inch or more. The lining between these two cores will be evaluated separately from the balance of the lining in that unit. Unless the Engineer allows the lining to remain, it shall be removed and replaced with lining of the specified thickness and no additional payment will be made for lining in the area represented by deficient lengths. No payment will be allowed for deficient concrete lining permitted to remain in place. One

additional core shall be drilled in the unit to represent the quantity of concrete in that unit after deducting the limits of the deficient area if that lining that is represented by the deficient area is allowed to remain. This additional core shall conform to the requirements contained herein and will be considered to be the original core.

In addition, concrete core samples shall be tested at the rate specified above, in accordance with ASTM C 42. The concrete will be considered defective if the core specimens show that the strength is less than 85 percent of the specified strength.

The core holes shall be filled with stiff grout or dry packed and the surface restored to a smooth, even and watertight surface. The cost of core samples, delivery of same to the Engineer and filling of core holes will be considered as included in the cost of the final tunnel lining.

Cores will be tested by the Engineer.

3.13 DEFICIENT SECTIONS:

Where a test core or visual observation discloses concrete which is deficient in depth, or is honeycombed, or not properly consolidated, the Engineer will order additional test cores or inspection holes, as described above, as may be necessary to expose the full extent and seriousness of such deficiencies. Such additional test cores and inspection holes shall be provided by the contractor at his expense.

When test core holes or inspection holes on cast-in-place lining indicate that the space between the inside face of the tunnel and the face of the initial support system has not been completely filled with concrete, such void space shall be filled with grout as specified herein under DRILLING AND GROUTING. The same provisions shall apply to any voids in back of the primary tunnel lining which have been caused by any reason. Where it is disclosed that concrete is honeycombed or deficient in strength, the contractor will be required to remove and replace the defective concrete. Where it is disclosed that there is a deficiency in the specified thickness of the section, the contractor shall remove and replace such deficient sections as described elsewhere in this specification. The cost of work so ordered by the Engineer shall be borne by the contractor.

3.14 DAMAGED WORK:

Before final acceptance of the work, the contractor shall repair damage to surfaces, corners of concrete and the concrete finish.

Damaged places where surface repairs are permitted shall be brought to a smooth, dense, watertight condition to meet specification requirements.

3.15 TOLERANCES FOR CONCRETE CONSTRUCTION:

The final lining shall be constructed to the line and grade indicated on the project plans and shall be constructed to the tolerances outlined herein under TUNNEL AND SHAFT CONSTRUCTION.

Reinforcement shall be placed so that there will be a clear distance of at least two inches between the reinforcement and any anchor bolts or other embedded metal work unless shown otherwise on the project Plans.

3.16 LOCATION MARKERS:

Permanent location markers shall be furnished by the contractor and placed in the completed tunnel final lining. Location markers shall be fabricated from non-corrosive, non-toxic metal such as brass or stainless steel and shall conform to the detail shown on the plans. Appropriate stationing shall be shown on each marker.

The contractor shall place markers at 1,000 foot intervals at approximately 5.5 feet above the tunnel invert, with all on the same side of the tunnel and located within a 1-foot accuracy.

The contractor shall affix markers to the final lining by approved methods so that concrete final lining or initial support system will not be damaged.

3.17 CONTACT GROUTING:

Contact grouting behind the cast-in-place tunnel lining shall be in accordance with applicable portions of the requirements specified herein under DRILLING AND GROUTING. No contact grouting shall be performed behind concrete that has been in place less than 14 days.

3.18 FINAL CLEANUP:

Final cleanup shall be in accordance with the requirements specified herein under TUNNEL AND SHAFT CONSTRUCTION.

5.00 BASIS OF PAYMENT:

Final concrete lining will not be paid for separately, the cost being considered as included in the contract price for Item 9300018 - Tunnel (18').

DRILLING AND GROUTING:

1.00 DESCRIPTION:

This work consists of drilling, drainage and other holes and furnishing materials for grout and injecting grout and patching the finished holes in accordance with these special provisions.

The contractor's work shall also include: all mobilization and demobilization necessary to perform grout hole drilling, redrilling, and grouting; flushing, pressure washing, and water pressure checking of grout holes; the care and disposal of waste water and waste grout; the furnishing, handling, and the transporting and storing of all materials and equipment; mixing and grouts as specified; capping, patching, and plugging the finished grout holes; supplying and installing approved grout header assemblies; the care and disposal of drill cuttings; dewatering; cleanup of water areas; and all other operations incidental to grouting.

All voids behind support systems shall be filled in accordance with these requirements and the requirements specified herein under TUNNEL AND SHAFT CONSTRUCTION.

1.01 DEFINITIONS:

Whenever the following terms are used, the intent and meaning shall be interpreted as stated below.

(A) COMPACTION GROUTING:

Compaction grouting is defined as the injection of soil-cement grout to compact and displace adjacent soils.

(B) CONSOLIDATION GROUTING:

Consolidation grouting is defined as the grouting in certain areas of the work including, but not limited to the area ahead of the tunnel or shaft face or along any reach of tunnel or shaft to control water flows, to consolidate or aid in stabilizing ground and to fill voids in the ground. Consolidation grouting includes chemical grouting.

Consolidation grouting may be performed from the ground surface or from within a subsurface structure.

(C) CONTACT GROUTING:

Contact grouting is defined as injection of grout behind cast-in-place concrete final lining and precast pipe or grouting behind the initial support system to achieve continuous contact between the lining and the ground.

(D) REFUSAL:

Refusal is the point at which grouting is stopped on a grout hole. It is defined as a grout injection rate of zero cubic feet of grout per minute, as measured over a 10 minute interval at 100 percent of the grouting pressure, or a grout injection rate of less than one half cubic foot of grout in a 30 minute interval at 100 percent of the required pressure.

1.02 RECORD KEEPING:

The contractor shall assist and cooperate with the engineer in keeping records of grouting operations including time of each change in the grouting pressures, rate of pumping, amount of cement for each change in water-cement ratio, and such other data as may be deemed necessary.

The contractor shall notify the Engineer at least one week in advance of the date grouting is intended to start.

1.03 QUALIFICATION REQUIREMENTS:

The contractor shall be competent in grouting. He shall submit drawings of his grout plan with the Specifications for major equipment components to be used. All of the contractor's grouting work shall be under the direct field supervision of a qualified grouting specialist or grouting foreman.

The grouting specialist/foreman will receive technical direction from the Engineer. The specialist/foreman shall direct the performance of the work of the contractor's personnel in compliance with these Specifications. The Engineer will approve holes for grouting, direct grouting mixes, pressures, and verify when the hole refusal criteria have been met.

If, in the opinion of the Engineer, an experienced grouting specialist/foreman is not assigned from the contractor's staff, the Engineer will require that the contractor acquire such experienced personnel. Should such action be required, no adjustment in unit prices will be allowed.

2.00 MATERIALS:

2.01 GROUT FOR PRESSURE GROUTING:

Grout shall be a mixture of cement and water or cement, sand, bentonite, and water, of the proper consistency to suit the characteristics of the hole being grouted or the type of grouting being performed.

Water shall be free of sulfates and objectionable quantities of silt, organic matter and other impurities.

2.02 CEMENT:

Cement shall conform to Section 1006 and shall be ASTM C 150 Type II.

2.03 SAND:

Sand shall conform to requirements of ASTM C 33 for fine aggregate modified so that 100 percent passes U.S. Standard Sieve No. 16, not less than 10 percent or more than 30 percent passes a No. 100 Standard sieve, and not more than 5 percent passes the No. 200 sieve unless otherwise approved by the Engineer.

2.04 BENTONITE:

Bentonite shall be suitable commercially processed powdered bentonite. The contractor shall use 2 percent bentonite by weight in grout containing sand.

2.05 GROUT FOR CONTACT GROUTING:

Grout shall consist of portland cement as specified above and an approved admixture.

Grout shall have a minimum compressive strength of not less than 100 psi attained within 24 hours.

Grout shall be fluid enough to be injected through the lining to fill the voids.

Comprising ingredients shall not be corrosive to steel.

The contractor shall submit his grout mix composition and test results to the Engineer for approval prior to grouting. Test specimens of grout shall be made and tested in accordance with ASTM Designation C-109.

2.06 ADMIXTURES:

Admixtures for fluidity or retarding setup shall conform to ASTM C 194, Type A, D or E and shall be as approved by the Engineer prior to its use in the grout. Admixtures shall be compatible with each other.

2.07 CHEMICAL GROUT:

Chemical grout shall be composed of base material, reactant, water, and accelerator if required. The design chemical grout mix shall be such that, when injected in medium dense Ottawa 20-30 sand, the unconfined compressive strength of the grouted soil shall average at least 100 psi and the unconfined initial tangent modulus shall average not less than 10,000 psi.

The chemical grouting material shall have a maximum viscosity of 2 centipoises and the ability to withstand dilution by groundwater of at least 50 percent by volume without significantly affecting the gel time. The gel time shall be controllable from 2 minutes to 240 minutes at grout temperatures from 40 degrees F to 90 degrees F. The grout shall not be adversely affected by pH between 6 and 9.

Base material, catalyst, activator, inhibitor, buffer or soluble additives, shall be non-hazardous and shall be compatible with each other and with the soil and groundwater, and be so tested if required by the Engineer. The gel shall be chemically stable and shall not render surrounding groundwater unpotable. Grout in place shall be chemically stable within the service life of the project. Chemical grout shall be subject to the approval of the Engineer.

Dye tracers added to grout solution shall not adversely influence the gelling and strength development of the grout and shall not have other undesirable effects.

All materials shall be furnished in undamaged, unopened containers bearing manufacturer's original label.

Grout materials shall be handled and stored in accordance with recommendations of manufacturers.

2.08 PRESSURE GAGE:

An accurately calibrated, high precision, pressure gage shall be furnished to the Engineer by the contractor for periodic checking of the accuracy of all gages used in grouting.

2.09 GROUT PIPE AND FITTING:

Pipe and pipe fittings shall conform to ASTM A 120, Standard Weight, Schedule 40, Black.

3.00 CONSTRUCTION REQUIREMENTS:

3.01 GENERAL:

The amount of drilling and consolidation grouting to be performed will depend upon the nature of the materials encountered in the tunnels as the work proceeds. The contractor shall perform drilling and grouting at such locations, at such times, and in such quantities as shown on the project plans or as directed or approved by the Engineer.

Grouting mixes, pressures, the pumping rate and the sequence in which the holes are drilled and grouted will be determined in the field and shall be as approved or directed by the Engineer.

3.02 EQUIPMENT, PORTLAND CEMENT GROUTING:

Equipment and systems used for mixing and injecting grout shall be designed for grouting service.

Grout shall be mixed in a colloidal mixer providing a homogenized mix and having an impeller speed of at least 1500 rpm and a mechanically agitated holding tank.

For feeler, grout, and drain holes either rotary or percussion drilling equipment shall be used.

For pumping grout, an approved pump which is capable of developing a uniform pressure of 1 psi for each foot of overburden to a maximum of 75 psi at the grout hole connection and hoses with a minimum 1-1/2 inch inside diameter shall be used. The arrangement of the grouting equipment shall provide for continuous circulation of grout in the system and shall permit accurate pressure control.

Equipment and lines shall be kept clean by the constant circulation of grout and by periodic flushing with water. Grouting equipment shall be configured so that flushing can be accomplished with the grout intake valves closed, the water supply valve open and the grout pump running at full speed.

A horizontal shaft paddle or colloidal pump type mixer with a minimum capacity of 20 cubic feet and with an accurate meter, reading in cubic feet to the nearest one tenth of a cubic foot for measuring the amount of mixing water added to the grout shall be used.

Two pressure gages, one at the grout pump and the other on the manifold hookup at the collar of the hole being grouted shall be provided. Pressure gages shall have a range to 1-1/2 times maximum specified pressures and accuracy of one psi unless otherwise approved

by the Engineer in writing. Suitable stop valves shall be provided at the collar of the hole for use in maintaining pressure as required until the grout has set.

3.03           EQUIPMENT, CHEMICAL GROUTING:

The chemical grout plant shall be of the continuous mixing type and shall be capable of supplying, proportioning, mixing, and pumping grout with a set time between 2 minutes and 240 minutes. Batch-type systems will not be permitted.

The pumping unit shall consist of two pumps, with discharge not less than 5 gpm at a pressure of 100 psi. Multiple pump units may be used to decrease the grouting time. The arrangement of the pumps and the drive systems shall be such that the pumping rate can be varied between 1.5 gpm and maximum volume without changing the ratio of the components in the grout formula. The arrangement shall also allow variation of the injection period without changing the total volume pumped. Variation of both pumping rate and injection period shall be possible while the pumps are in operation. Grout pumps shall be capable of delivering grout to the point of injection at a pressure equal to 3.0 psi for every foot of overburden.

The pumping unit shall be equipped with manually adjustable relief system which shuts off the main power source at any preset pressure. The pressure range shall be such as to permit operation at any point over the full pressure range of the pumps.

Each main pump shall be equipped with recording positive displacement meters. The meters shall be constructed of materials that are non-corrodable for the intended products and shall operate independent of the viscosity of the metered fluid.

The pumping unit shall be equipped with piping or hoses of adequate capacity to carry the base grout and reactant solutions separately to the point of mixing. The hoses shall come together in a "Y" fitting containing check valves to prevent backflow. The "Y" fitting shall be followed by a suitable baffling chamber. A sampling valve shall be placed beyond the point of mixing and the baffling chamber, and shall be easily accessible for sampling the mixed grout. A water flushing connection or valve shall be placed behind the "Y" to facilitate flushing the grout from hose and baffle chamber between grouting sessions. Distribution of proportioned grout, under pressure, to the grouting locations shall be monitored by separate automatic recording flowmeters and gauges. The flowmeters shall be accurate within 10 percent at a flow rate of 2.5 gpm.

Liquid chemicals shall be stored in metal tanks, suitably protected from accidental discharge by valving and other necessary means. Tank capacity shall be sufficient to provide at least one

day's supply of grouting materials so as to not interrupt the work in the event of chemical delivery delays. Dry chemicals shall be stored in undamaged and unopened packages, or suitable bulk containers.

The contractor shall provide at the site all necessary chemical quality control testing apparatus, including but not limited to hydrometers, balance scales, graduates, viscometers, and other devices that are required to conduct chemical material acceptance tests, chemical proportioning tests, and grout quality tests for proper quality control of the work.

#### 3.04 EQUIPMENT, COMPACTION GROUTING:

The grout plant shall be designed to handle the specified materials for this type of work. The mixer shall be of the pug mixer type, shall ensure complete uniform mixing of the material used and shall be of sufficient capacity to continuously provide the pumping unit with mixed grout at its normal pumping rate. The pumping unit shall be capable of continuously delivering the specified grout materials at a pressure of at least 800 psi. Pressure gages shall be supplied at the pump and at the grout pipe head. An adequate communication system shall be maintained between the grout plant, the injection location and the tunnel heading.

#### 3.05 GROUT HOLES:

The contractor shall drill grout holes in soil or tunnel lining as indicated on the project plans or as directed by the Engineer. Holes for air release shall be located at high points of voids in tunnel excavation. Holes shall be formed by embedding pipe in the concrete during placing of the cast in place concrete final lining or by drilling through the concrete final lining. Grout holes drilled in the concrete final lining shall be two inches in diameter or, if pipe casing is to be set, shall be of sufficient diameter to permit the caulking or grouting of short lengths of two inch diameter pipe into the hole.

The cutting of embedded steel shall be avoided. If steel is encountered, the hole shall be abandoned and patched.

Grout holes drilled in the existing Portland cement concrete pavement and the concrete channel lining as called for in the details on the project plans shall be core drilled. After grouting all holes shall be patched using methods and materials approved by the Engineer. The Contractor is advised that the existing concrete pavement is prestressed and it shall be the contractor's responsibility to determine the exact location of the steel prestressing strands prior to drilling grout holes. Any damage to the prestressed pavement resulting from the contractor's operations shall be repaired as directed by the Engineer at the contractor's expense.

3.06 PREPARATION FOR GROUTING:

Immediately before grouting, grout holes shall be washed with water applied at the same pressure with which the grout is to be applied.

Washing shall be continued as long as there is evidence of washable materials being removed.

3.07 PIPES AND FITTINGS:

The contractor shall place pipes to be embedded in the tunnel lining for consolidation or contact grouting connections and air vents as shown on the project plans or as directed by the Engineer.

The inner end of pipes shall be set not less than two inches back from the finished inside surface and recesses therefrom to the surfaces of the lining. The recesses shall be filled with concrete or mortar after grouting operations have been completed.

Grout pipes shall be set so that grout can flow freely to the voids behind the final lining.

Pipes to be embedded shall be held firmly in position and protected from damage while concrete is being placed. The contractor shall provide and attach caps or other devices to the ends of the pipe to prevent entry of concrete or other foreign materials prior to grouting, and to facilitate locating the grout pipe after forms are removed.

The contractor shall avoid clogging or obstructing the pipes before grout hookups are made. Pipes that become clogged or obstructed shall be cleaned.

Contact grout pipes shall be plugged or capped with standard screw-on fittings. The fitting shall be recessed a minimum of 2 inches from the finished face of concrete. The recess shall be filled with dry pack mortar after completion of grouting operations.

Consolidation grout pipes shall be removed or cut off outside the "A" line prior to placement of cast in place final lining.

3.08 CONNECTIONS:

Connections shall be made so as to prevent leakage.

Plugs on the ends of grout holes or pipes shall be removed to permit escape of air and water and the filling of spaces with grout.

A straightway cock or valve shall be provided at each connection or each manifold port if used.

3.09 GROUTING OPERATIONS:

Grouting operations shall be performed in the presence of the Engineer.

Grout of a consistency to suit the characteristics of the hole being grouted or the type of grouting being performed shall be used.

Pressure at the hole shall be as directed or approved by the Engineer. However, in no case shall the pressure exceed 50 psi.

The grouting of a hole will be considered complete when the hole refuses grout at 90 percent of the highest pressure directed.

Upon completion of the grouting at each connection, the valve shall be closed and left in place until the grout has set.

Grouting shall advance in one direction and the grout shall be injected progressively from lower to higher grout holes. Pumping shall be continued until grout escapes from adjacent open holes or until a maximum pressure of 90 percent of the highest pressure directed is reached.

Grout holes shall be filled with thick grout or dry pack at the completion of the grouting operations to give a smooth finished surface.

Care shall be taken not to block drains or drain lines during grouting operations. Drains shall be cleaned after each grouting operation. Grout waste shall not be allowed to enter the water control system without prior approval of the Engineer and affected jurisdictional agencies.

3.10 CONTACT GROUTING:

Portland cement grout shall be used to fill voids behind cast-in-place concrete.

Contact grouting shall be performed through holes drilled or placed in pipe conduit or as approved or directed by the Engineer.

If not shown or directed otherwise, grout holes shall be located in the tunnel crown at ten feet on center alternating at 15° on either side of tunnel vertical centerline.

Vent pipes shall be provided to suit the conditions encountered.

A maximum pressure for contact grouting shall be used as directed by the Engineer, but in no case shall the pressure exceed 30 psi measured at the point of placement unless specifically ordered by the Engineer.

Grouting shall be continued until a clear grout stream emerges from the vent pipe.

Grouting shall not be performed behind cast-in-place concrete lining in less than 14 days after the concrete has been placed unless the concrete has reached 75 percent of its design strength.

The contractor shall prevent the setting of grout which may escape upon exposed surfaces, and shall remove such grout and restore the surface to its original condition. After the grout has set, the contractor shall remove valves, fittings and metal connections to a depth of at least 2 inches from the face of the concrete and place standard pipe plug. Grout holes in linings shall be filled with dry pack grout at the completion of the grouting operations to give a smooth finished surface.

### 3.11 CONSOLIDATION GROUTING WITH PORTLAND CEMENT GROUT:

Grouting operations shall be performed in the presence of the Engineer.

Grout shall be continuously injected until refusal unless otherwise directed by the Engineer. Grout pumps shall be operated and controlled so that grout is delivered uniformly and without pulsation. The contractor shall grout progressively from pipe to pipe in the sequence required or approved. Grouting will be considered complete when refusal has been reached. The grout injection valve shall be closed upon completion of grouting at each connection and left in place until grout has set.

Consolidation grouting within 50 feet of cast-in-place concrete tunnel lining shall be performed only when the lining has been in place more than 14 days or has reached 75 percent of its design strength.

### 3.12 CONSOLIDATION GROUTING WITH CHEMICAL GROUT:

In the zones to be chemically grouted, as designated on the project plans or as directed by the Engineer, chemical grouting shall be performed in such a way as to produce a continuous cylinder

or mass of structural chemically grouted ground outside the excavation perimeters. Grout in place shall be chemically stable for the environment in which it is placed.

Excavation through grouted areas shall not commence until the chemical grouting work has been completed and provisionally accepted by the Engineer. Regrouting may be required if waterproof grouting is incomplete.

The grout pipes for consolidation grouting from the ground surface with chemical grout shall be of the sleeve port type, with grout ports at minimum 13-inch centers covered by expandable rubber sleeves. After being placed in a borehole, the sleeve port grout pipes shall be encased in a continuous brittle mortar sheath. An internal double packer shall be used to inject grout at a specific grout port.

Chemical grouts shall be injected into the intended grouting zones through properly located grout ports in the sleeve pipes, utilizing double packers. Surface elevation monitoring shall be carried out continuously during grouting. Injection procedures will be adjusted as needed to prevent excessive surface heave.

The method of injection for chemical grouting shall be the continuous mixing method, with the proper amounts of grout base material, water, reactant, and accelerator automatically proportioned and continuously supplied at proper flow rates and pressures. The base material and the water-accelerator-catalyst solution shall pass through parallel separate hoses to a suitable baffling chamber near the top of the grout hole. Suitable check valves shall be placed in the grout lines at the proper locations to prevent backflow and unintentional gelations.

### 3.13 INJECTION PROCEDURES:

Utilizing double packers, chemical grouts shall be injected into the intended grouting zones through properly located grout ports in the sleeve pipes. Temporary very high injection pressures will be permitted to crack open sleeve ports, but these pressures will not be permitted longer than 1 minute durations. In any event, the rate of injection into any port shall not exceed 5 gallons per minute.

### 3.14 GEL TIMES:

All grouts shall have a gel time between 5 minutes and 50 minutes, with most grout having gel times in the range of 20 to 40 minutes. Grout type and gel time shall be selected to bring about the greatest reduction of soil and rock permeability. Samples, taken in the presence of the Engineer, shall be obtained for gel time checks at least once for every half hour of pumping or for every 500 gallons of

grout, whichever is more frequent. Gel samples shall be properly labeled and stored until the completion of the project.

3.15            **COMPACTION GROUTING:**

(A)   **GENERAL:**

The compaction grout mixture shall be a base material with the gradation of sand, approximately two to six sacks of cement per bulk cubic yard of sand, and water as necessary or as directed by the Engineer to achieve a pumpable mix with not more than a 2 inch slump. If agitated continuously, the grout may be held in the grout plant for not more than two hours.

Compaction grouting program shall be performed in coordination with instrumentation monitoring and tunneling operations and under the supervision of a grouting engineer experienced in compaction grouting for settlement control.

Grout pipes shall be steel casing of adequate strength to maintain the hole and to withstand the required installation and pumping pressures. The pipes shall be at least 2.0 inches in diameter in order to adequately handle the specified low-slump material without plugging.

Where directed by the Engineer, grout pipes shall be installed at approximately eight feet to fifteen feet intervals in the area to be grouted. This spacing will vary depending upon the depth of grouting, nature of soils, nature of the structure being supported and the previous driving and/or drilling in such a manner as to ensure the bores are free of soil and debris and that a tight seal is made around the pipe. Pipes shall be installed at least one week prior to tunneling at each area. The contractor shall adequately protect grout pipes from all foreseeable hazards.

After completion of grouting in each area, the contractor shall patch all holes, restore all surfaces to its original condition, and leave the area clean of debris.

(B)   **INJECTION PROCEDURES:**

Compaction grout shall be injected through the grout pipes into the target soil as the shield passes the grout pipe locations so as to recompact loosened adjacent soils and limit surface settlements to acceptable values. If necessary to initiate the flow of grout at the start of pumping, the grout pipe shall be pulled a few feet with the grout pressure applied, or an initial cavity shall be produced by jetting or blowing. Pumping shall proceed continuously at a rate between 0.1 to 4.0 cubic feet per minute. The compaction grouting Contractor must be experienced using the required low-slump compaction grout materials and specialized equipment.

(C) GROUT INSPECTION:

Alteration of the mix, grout pressure, and pump speed throughout the grouting operation to achieve the desired results shall be as approved by the Engineer. Once started, grouting of a hole shall not be interrupted without specific approval of the Engineer. If necessary to relieve premature stoppage, periodic applications of water under pressure shall be made. Under no conditions shall the pressure or rate of pumping be increased or decreased suddenly. The grouting of a hole shall not be considered complete until that hole refuses to take any grout as defined under "Refusal" elsewhere in this section or deformation of the initial support system occurs.

All grout leaks shall be caulked by the contractor as they develop. Caulking shall begin on high volume leaks and progress to those of lesser volume until all leaks are caulked. The Engineer may require caulking of leaks which have shown high volume communication with the tunnel or excavations during water testing prior to grouting. Caulking materials shall be lead wool, oakum, or such other material that the contractor may select subject to the approval of the Engineer.

After the grouting of any stage of a hole has reached refusal, the pressure on the hole shall be maintained with a stop-cock or other suitable device until the grout has set.

If it is found impossible to reach refusal, or the required pressure, after pumping a reasonable volume of grout at the minimum workable water/cement ratio, the Engineer may require the speed of pumping to be reduced and/or pumping to be stopped temporarily to allow the introduction of expandable organics such as sawdust, oats, or similar material. This intermittent grouting shall be performed to allow sufficient time between grout injections for the grout to stiffen. Following the reduction in pumping speed, if the desired result is not obtained, grouting the hole shall be discontinued, the hole shall be cleaned and the grout allowed to set. Additional drilling and grouting shall then be done in this hole or an adjacent area until the desired result is obtained.

4.00 METHOD OF MEASUREMENT:

4.01 CONSOLIDATION GROUTING:

(A) DRILL CONSOLIDATION GROUT HOLES:

Drilling grout holes for consolidation grouting will be measured by the number of linear feet drilled measured to the nearest foot.

(B) FURNISH AND INSTALL GROUT PIPES:

Furnishing and installing grout pipe will be measured by the number of linear feet measured to the nearest foot installed.

(C) GROUT CONNECTIONS:

Connection of the grout supply line to a grout pipe necessary for injection of grout as directed by the Engineer will be measured for each connection made regardless of the amount of grout injected.

4.02 PORTLAND CEMENT IN GROUT:

Portland cement will be measured for payment on the basis of the number of sacks (94 pounds) used for consolidation and compaction grout as ordered by the Engineer and satisfactorily placed. Cement damaged by moisture or due to other causes, or used in improperly mixed grout will not be measured for payment.

4.03 CONTACT GROUTING:

Contact grouting and drilling for contact grouting will not be measured for payment.

4.04 CHEMICAL GROUTING (CHEMICALS):

Chemicals for chemical grouting will be measured by the gallon of chemical furnished and satisfactorily placed as directed by the Engineer. Chemicals wasted except when approved by the Engineer will not be measured for payment.

4.05 GROUT PLACEMENT:

Grout placement will be measured by the cubic foot of approved grout materials pumped through the header for consolidation and compaction grouting.

4.06 COMPACTION GROUTING:

(A) GROUT HOLE DRILLING FOR COMPACTION GROUTING:

Measurement of grout holes for compaction grouting will be by the linear foot of hole drilled.

(B) CONNECTIONS FOR COMPACTION GROUTING:

Connections for compaction grouting will not be measured for payment.

5.00 BASIS OF PAYMENT:

The following contract items, measured as provided above, will be paid for in accordance with the following:

Drill grout holes for consolidation grouting will be paid for at the contract price a linear foot for Item 9300101.

Furnish and install grout pipe for consolidation grouting will be paid for at the contract price a linear foot for Item 9300111.

Grout connections for consolidation grouting will be paid for at the contract price each for Item 9300121.

Portland cement for consolidation and compaction grout will be paid for at the contract price a sack for Item 9300131. No measurement or direct payment will be made for water, fluidifiers, sand, bentonite and other materials required to complete the grout mixture.

Chemicals for chemical grouting will be paid for at the contract price a gallon for Item 9300071. No measurement or direct payment will be made for water and other materials required to complete the grout mixture.

Grout placement will be paid for at the contract price a cubic foot for Item 9300073 which price shall be full compensation for all work necessary to place grout, except contact grout, including but not limited to: connecting, mixing, pumping, cleanup of waste material and any other operations incidental to effective grout placement.

Drill grout holes for compaction grouting will be paid for at the contract price a linear foot for Item 9300099. No measurement or direct payment will be made for connections necessary for compaction grouting.

GEOTECHNICAL INSTRUMENTATION:

1.00 DESCRIPTION:

The work under Items 9300401, 9300411, 9300421, 9300426, 9300428, 9300431, 9300441, and 9300491 consists of furnishing, installing, and reading all geotechnical instrumentation necessary for monitoring of ground movement and includes the regular maintenance of installed instruments.

1.01 GENERAL:

The contractor shall furnish, install, and perform regular maintenance on installed instruments and shall take instrument readings as specified herein. The contractor shall make initial instrument readings in the presence of the Engineer. The contractor shall read instruments, reduce the data, and perform regular calibration and maintenance of readout devices as specified herein.

The minimum instrumentation program required herein does not relieve the contractor of responsibility for providing additional instrumentation if, in the contractor's opinion, such additional instrumentation is necessary to safely accomplish the work. The final extent of the instrumentation program to be provided will depend upon the exact locations of the facilities, the underground structures, layout of the contractor's temporary support system, and the nature of the materials encountered as the work proceeds. The instrumentation work shall be performed at such locations, at such times, and in such quantities, as described herein or as directed by the Engineer.

The contractor shall monitor ground movements at all structures that may be affected by tunneling or dewatering operations to the satisfaction of the Engineer.

Any settlement or horizontal movement shall be reported immediately to the Engineer and immediate corrective or remedial actions shall be taken.

1.02 QUALIFICATION REQUIREMENTS:

Installation and readings of all instrumentation devices shall be performed under the direction of and to the satisfaction of an Arizona Registered Professional Engineer whose qualifications are satisfactory to the Engineer. The contractor shall have a technical representative from the instrument manufacturer available to train his personnel and supervise initial installation.

1.03 SUBMITTALS DURING CONSTRUCTION:

Submittals by the contractor shall be made in accordance with the following:

The contractor shall submit operating and instruction manuals in duplicate for all monitoring equipment. Each operating and instruction manual shall include sections describing the theory of operation, installation procedures, reading or operating procedures, data calculation, and presentation procedures and maintenance procedures.

At least 30 days prior to installing the first of each instrument type, the contractor shall submit detailed step-by-step procedures proposed for installation, including a listing of materials and installation equipment.

The contractor shall, within five days after receipt of each readout device at the site, submit certification that the device has been calibrated at the manufacturer's facility prior to shipment, using calibration equipment certified as meeting standards established by the National Bureau of Standards for that purpose.

The contractor shall, within five days after receipt of each instrument at the site, submit certification that final quality assurance inspections have been made, together with check lists as specified hereinafter.

The contractor shall submit daily, a log of all instrumentation holes drilled and instrumentation installed including material and equipment used for each installation, all instrumentation maintenance activities, and initial instrument readings.

1.04 FACTORY CALIBRATION:

A final quality assurance inspection shall be made of each instrument prior to shipment. During the inspection, a check list shall be completed to indicate each inspection and test detail. A completed copy of the check list shall be supplied with each instrument and submitted to the Engineer.

All readout instruments shall be calibrated at the manufacturer's facility prior to shipment. Certification shall be provided to indicate that the manufacturer's test equipment is calibrated and maintained in accordance with the test equipment manufacturer's calibration requirements, and that with the exception of the inclinometer monitoring system all calibrations have been made with equipment certified as meeting standards established by the National Bureau of Standards for that purpose.

2.00 MATERIALS:

2.01 GUARD CASING:

The contractor shall provide a protective guard casing or cast iron valve box with cover (grouted in place) as hereinafter specified or as directed by the Engineer for all instrumentation installed from the ground surface in drilled holes. The guard casing arrangement shall be complete with locking cap that shall be painted bright orange. The contractor shall key all locks alike.

2.02 INCLINOMETER TUBING AND INCLINOMETER:

Inclinometer tubing shall be grooved plastic guide pipe, 2.75-inch O.D. inclinometer plastic casing as manufactured by the Slope Indicator Company, Seattle, Washington, or Terra Technology Corporation, Redmond, Washington, or an approved equal. The guide pipe shall be complete with necessary rigid self-aligning couplings and end plugs.

The inclinometer monitoring system shall include sensor, indicator, 100 feet of cable, cable storage reel, pulley assembly, and cable hold. The sensor shall be a Digitilt Microtilt Sensor, Model 50325, as manufactured by the Slope Indicator Company, Seattle Washington, or Model MP-20 Series as manufactured by the Terra Technology Corporation, Redmond, Washington, or an approved equal. The indicator shall be a Model 50309 portable field indicator as manufactured by the Slope Indicator Company, or Model TPC-110 as manufactured by the Terra Technology Corporation, or an approved equal.

The cable connecting the sensor and indicator shall have a stranded steel core to take the stress of pulling so as not to break any connectors or wires. The cable shall be jacketed with a waterproof material and marked externally at one-foot intervals for accurate depth determination. The cable guide pulley system shall mount to the top of the inclinometer tubing.

The contractor shall provide a spiral sensor Model 50901 as manufactured by the Slope Indicator Company, Seattle, WA; or equal. The spiral sensor shall be provided as required for testing of the inclinometer tubing, following installation.

2.03 EXTENSOMETERS:

(A) MULTI-POINT BOREHOLE EXTENSOMETER INSTALLED FROM GROUND SURFACE:

Multi-point borehole extensometers installed from the ground surface shall be multi-point rod type, with mechanical reference head, stainless steel reference plate, hydraulic anchors and

tubes, stainless steel flush coupled connecting rods, bayonet disconnect between rods and anchors, protective pipes, grout tube, complete with hydraulic pump and oil for anchor actuation, and depth micrometer and movable stainless steel reading pipe for use while reading. There shall be either two or three anchors per installation. The bayonet disconnects shall be arranged so that rods can be inserted and attached to anchors after installation of anchors and protective pipes, and so that at any time bayonets can be disconnected to check for free rod sliding by gripping the tops of the rods, turning, and lifting. Thread sealing compound shall be provided for all rod threads. Sufficient hydraulic oil shall be provided to fill the annular space between rods and protective pipes, together with a nylon filler tube for tremie filling using the hydraulic pump. The extensometer assembly shall be Model 51886 as manufactured by the Slope Indicator Company, or the RM Series extensometers as manufactured by Terrametrics, Inc., Golden, Colorado, modified by inclusion of bayonet disconnects, 1-inch rod lengths, oil, filler tube, and reading pipe, as specified above, or an approved equal. Two depth micrometers, calibration standards, and movable stainless steel reading pipes shall be provided, in durable carrying cases.

(B) TAPE EXTENSOMETER:

The contractor shall provide a tape extensometer with the capability to monitor shaft/tunnel convergence and support deformations. The extensometer assembly shall be Model 518115 complete with eyebolts and anchors as manufactured by the Slope Indicator Company or Model TE-50 complete with eyebolts and anchors as manufactured by Terrametrics, Inc., or an approved equal. A spare tape shall be provided with the extensometer. The maximum tape length shall be 100 feet.

2.04 SURFACE SETTLEMENT MARKERS:

Surface settlement markers shall be hardened steel markers treated and/or coated to resist corrosion with an exposed convex head and having a minimum diameter of 1/2-inch or an approved equal. In unpaved areas, the surface settlement marker shall be set in the top of a 2-inch by 2-inch by 12-inch long wooden hub driven to grade. The hub locations shall be flagged.

2.05 STRUCTURE SETTLEMENT MARKERS:

Settlement markers on structures shall consist of a 3/16-inch diameter brass or stainless steel rod, 2 inches in length or longer, epoxy grouted into a 1/4-inch diameter hole drilled into the structure. The exposed end of the rod shall have no sharp edges.

2.06 SUBSURFACE SETTLEMENT MARKERS:

Subsurface settlement markers shall be a 1-1/2 inch diameter steel rod driven into the soil within a permanent 4-inch schedule 80 PVC pipe casing. The upper end of the rod shall be a rounded hardened steel head treated and/or coated to resist corrosion. Centering spacers shall be welded to the rod. Other equivalent types of subsurface settlement markers will be considered and may be used subject to the Engineer's approval.

2.07 LOAD CELLS:

Load cells shall be suitable for measuring compressive loads in initial support systems. The instruments shall yield an electrical signal from a full Wheatstone bridge strain gage circuit or operate on the principle of the inductive variation of a transducer. All elements of the system shall be completely waterproof and shall be designed to sustain eccentric loadings. Each load cell shall be equipped with armored signal cables sealed to both the cell case and a waterproof connecting plug of appropriate design for use during construction. Two readout units and any other special tools or accessories necessary to perform the readings shall be furnished by the contractor. Load cells shall be calibrated by the contractor before installation with copies of the calibration curves submitted to the Engineer.

Load cells shall have a capacity range of 100 pounds to 200,000 pounds with a minimum accuracy of 0.2 percent of full scale with a sensitivity of 100 pounds.

2.08 GROUT:

Grout shall conform to the requirements specified herein under "DRILLING AND GROUTING" except as modified herein.

2.09 PIEZOMETERS:

Piezometers shall conform to the requirements specified herein under Item 9300451.

3.00 CONSTRUCTION REQUIREMENTS:

3.01 LOCATION OF INSTRUMENTATION:

The contractor shall install all instrumentation at the locations shown or described herein or as directed by the Engineer. The Engineer may modify the instrumentation plan as described herein at any time. The Engineer will confer with the contractor as to the suitability of all planned instrumentation locations. The Engineer will make the final decision on instrument locations. After

installation of each instrument the contractor shall survey the as-built location to define the vertical and lateral positions of the exposed parts.

Major bridge crossings of the tunnel alignment are planned, under construction, or have been recently completed. These crossings include structures at Southern Avenue, Broadway Road, Southern Pacific Railroad Tracks, Apache Boulevard, Victory Drive, and University Drive. Four structure settlement markers shall be installed at each of these structure locations. Two of the four markers shall be located on the adjacent pier and two located on the adjacent abutment, each on opposite corners.

If major bridge crossings listed above are not in place, the contractor shall install surface settlement markers in sections perpendicular to the tunnel alignment. Markers shall be located at 10-foot increments on each side of the tunnel centerline with the first point located at the tunnel centerline and the last point located at a distance of 60 feet on each side of the tunnel centerline.

In addition, the contractor shall install three sections of surface settlement markers at the existing Superstition Freeway. One section shall be located at each outside curb line and one section shall be located at the Freeway centerline. Sections shall have markers located at 10-foot increments on each side of the tunnel centerline with the first point located at the tunnel centerline and the last point located at a distance of 60 feet from the tunnel centerline.

A minimum of four instrumented tunnel reaches will be designated by the Engineer. Each reach shall consist of a minimum of three initial support rings and shall be instrumented with load cells and tape extensometer points. Two initial support rings shall have load cells installed and located at each lower quarter point or jacking location for a total of four load cells per reach. Each initial support ring shall be instrumental with tape extensometer anchors located at crown and invert ( $0^{\circ}$ ,  $180^{\circ}$ ), each springline ( $90^{\circ}$ ,  $270^{\circ}$ ), and each quarter point ( $45^{\circ}$ ,  $135^{\circ}$ ,  $225^{\circ}$ ,  $315^{\circ}$ ).

Inclinometers, multi-point borehole extensometers and subsurface settlement points shall be installed at locations designated by the Engineer. Subsurface settlement markers shall have tips located 2 to 5 feet above the crown of the tunnel. Multi-point borehole extensometers shall be located approximately 15 feet from the tunnel centerline with tips located at one tunnel diameter below tunnel invert, one tip located at the tunnel springline; and one tip located at the tunnel crown elevation. All inclinometers shall extend to a depth of one tunnel diameter below tunnel invert elevation.

3.02 INSTALLATION SCHEDULES:

Instrument installations shall be completed in accordance with schedules specified herein.

3.03 PROTECTION AND MAINTENANCE OF INSTRUMENTATION:

The contractor shall exercise care during construction so as to avoid damage to instrumentation. All locations shall be flagged and protected. Instrumentation which is damaged as a result of the contractor's operation and/or vandalism shall be repaired or replaced by the contractor at his own expense. The Engineer will be the final authority in determining whether repair or replacement is required. The Engineer may, if instrumentation data are vital to the progress of construction work, require a work stoppage until a damaged instrument has been repaired or replaced.

The contractor shall maintain exposed parts of installed instruments on a regular basis, as directed by the Engineer. The contractor shall perform regular maintenance and calibration of readout instruments.

3.04 LABELING OF INSTRUMENTS:

All installed instruments shall be clearly labeled for easy identification, and shall be clearly visible.

3.05 INSTALLATION OF INCLINOMETER TUBING:

The contractor shall install inclinometer tubing as follows:

A vertical hole shall be drilled to a depth and at a location as directed by the Engineer using either a 6-inch minimum inside diameter casing and wash water or, if approved by the Engineer, using a 6-inch minimum diameter hole and drilling mud.

The inclinometer tubing shall be inserted in the drilled hole, complete with end plug and couplings to the required depth and with tubing grooves in the required orientation, all in a manner acceptable to the Engineer. The bottom portion of the tubing shall be grouted in place to the satisfaction of the Engineer.

If casing has been used to support the hole, the annular space between inclinometer tubing and soil shall be filled either with sand pack or with grout, as the casing is withdrawn. If sand is used, the casing shall be withdrawn in 2-foot increments, and the sand shall be thoroughly tamped at each increment. If grout is used, the contractor shall ensure that grout will not flow into the soil, and grout shall be pumped or tremied through a pipe placed at the bottom of the hole. The grout mix shall be as approved by the Engineer.

All inclinometer tubing shall normally extend not less than 2 feet above the ground surface and in all cases, shall be of sufficient length to prevent inflow of groundwater. The top of each inclinometer tubing shall be covered with a guard casing grouted into place. Inclinometers installed in roadways, parking lots, or on private property shall be terminated below road or ground surface and covered with an approved watertight cast iron valve box with cover (grouted in place) so installed as to prevent damage to or from vehicular traffic, to prevent traffic loads on the inclinometer installed and to permit easy opening for inclinometer monitoring. The valve box shall have a minimum 6-inch inside diameter and a maximum 36-inch casing length.

The top of each inclinometer tubing shall be provided with a cap.

An acceptance test shall be performed as directed by the Engineer after the installation has been completed to ensure that the inclinometer tubing has been properly installed. The acceptance test shall consist of a groove tracking test and a groove spiral survey. For the groove tracking test the inclinometer shall be lowered to the bottom of the tubing in all four possible orientations, verifying that on raising to the top of the tubing the inclinometer orientation is unchanged. For the groove spiral survey, a spiral sensor approved by the Engineer shall be used to survey the groove spiral of the entire length of tubing, and the results shall be reported to the Engineer. The maximum allowable groove spiral at any depth with respect to the top of the tubing shall be 15 degrees.

Installation and testing of each inclinometer tubing shall be completed a minimum of one week prior to any excavation within 200 feet of that inclinometer tubing.

3.06           INSTALLING MULTI-POINT BOREHOLE EXTENSOMETER FROM GROUND SURFACE:

The contractor shall install multi-point borehole extensometers as follows:

A vertical hole shall be drilled to a depth, and at a location as directed by the Engineer using a 3-inch to 4-inch inside diameter casing and wash water or, if approved by the Engineer, using a 3-inch to 4-inch diameter hole and drilling mud.

The extensometer anchors, protective pipes, grout tube, and hydraulic tubes shall be inserted within the drilled hole, the protective pipes shall be filled with hydraulic oil, the stainless steel rods shall be coupled using thread sealing compound and inserted and mated with the anchors, the anchors shall be actuated in turn as any casing is withdrawn, all in a manner acceptable to the Engineer. The drilled hole shall be filled with a cement-bentonite grout

containing 40 percent bentonite by weight. The reference head shall be installed and the rods terminated with four separate 10 inch lengths, for later removal as necessary if settlement occurs.

All extensometers shall normally extend not less than 2 feet above the ground surface and in all cases, shall be of sufficient length to prevent inflow of groundwater. The top of each extensometer shall be covered with a guard casing grouted into place. Extensometers installed in roadways, parking lots, or on private property shall be terminated below road or ground surface and covered with an approved watertight cast iron valve box with cover, grouted in place, installed to prevent damage to or from vehicular traffic, to prevent traffic loads on the extensometer installation and to permit easy opening for extensometer monitoring. The valve box shall have a minimum 6-inch inside diameter and a maximum 36-inch casing length.

After the grout has set, the contractor shall perform an acceptance test by gripping each rod in turn, turning and lifting the rod to check for free sliding, and relocking the bayonet disconnect.

Installation and testing of each extensometer shall be completed a minimum of one week prior to any excavation or dewatering work within 200 feet of that extensometer.

### 3.07 INSTALLATION TAPE EXTENSOMETER POINTS:

The contractor shall install eyebolts or anchors in shafts and tunnel at the locations directed by the Engineer to monitor dimensions of the initial support systems. The installation shall be to the satisfaction of the Engineer. Steel pipe or channel protection shall be provided and installed by the contractor to prevent damage to eyebolts.

Installation of each eyebolt or anchor shall be completed within four hours of the direction by the Engineer to install that eyebolt or anchor.

### 3.08 INSTALLATION OF LOAD CELLS:

Load cells for monitoring axial thrust in the initial support system shall be installed at locations directed by the Engineer and shall be installed to the satisfaction of the Engineer.

### 3.09 INSTALLATION OF SUBSURFACE SETTLEMENT MARKERS:

The contractor shall install subsurface settlement markers as shown and as follows:

A vertical hole shall be drilled to a depth, and location as directed by the Engineer, using a 5-inch minimum inside diameter casing and wash water, or, if approved by the Engineer, using a 5-inch minimum diameter hole and drilling mud.

The 4-inch diameter PVC pipe shall be inserted to the bottom of the drilled hole and grouted in place with cement grout, using a removable bottom plug, as any casing is withdrawn. Immediately after grouting, clean water shall be circulated until the overflow is clear and free of soil and/or grout particles. The 1-1/2 inch diameter steel rod and flat washers shall be inserted within the PVC pipe, the washers shall be greased with heavy grease during insertion, and the pipe driven a minimum of 2 feet below the bottom of the hole. If difficulty is experienced with driving, the rod shall be withdrawn and the hole advanced a minimum of 2 feet below the bottom of the PVC pipe, by drilling through the pipe. The rod shall then be grouted below the PVC pipe using cement grout. The entire installation shall be made in a manner acceptable to the Engineer.

The head shall be attached to the rod. All markers shall normally extend not less than 2 feet above the ground surface and in all cases, shall be of sufficient length to prevent inflow of groundwater. The top of each marker shall be covered with a guard casing grouted into place. Markers installed in roadways, parking lots, or on private property shall be terminated below road or ground surface and covered with an approved watertight cast iron valve box with cover, grouted in place, installed to prevent damage to or from vehicular traffic, to prevent traffic loads on the marker installation and to permit easy opening for monitoring. The valve box shall have a minimum 6-inch inside diameter and a maximum 36-inch casing length.

Installation of each subsurface settlement marker shall be completed a minimum of one week prior to any excavation or dewatering work within 200 feet of that marker.

### 3.10 INSTALLATION OF SURFACE SETTLEMENT MARKERS:

The contractor shall install surface settlement markers on or in the existing pavement at the approximate locations and as directed by the Engineer. The method of installation shall be the contractor's option, however, the marker shall be rigidly affixed so as not to move relative to the pavement. Installation shall be completed a minimum of one week prior to any excavation or dewatering within 200 feet of that marker or as directed by the Engineer.

### 3.11 INSTALLATION OF STRUCTURE SETTLEMENT MARKERS:

Structure settlement markers shall be installed as directed by the Engineer. Permission to install markers shall be obtained from the owner of the structure, by the Engineer, prior to installation. The drill hole shall extend a minimum of 1 inch and a maximum of 2 inches into the structure. The marker shall extend 1/2-inch from the face of the structure, or the minimum distance necessary to allow vertical positioning of an optical survey level rod. The marker shall be installed so as not to damage the surface finish of the structure.

3.12 MONITORING INSTRUMENTS:

The contractor shall be responsible for taking and recording measurements and for reducing measured data. However, the contractor shall provide access to the Engineer to any instrument at any time as requested by the Engineer. The contractor shall jointly with the Engineer, make initial readings for each instrument, and the Engineer and contractor shall jointly agree on initial readings. Subsequent reading of instruments shall be made by the contractor on a schedule approved by the Engineer.

Wherever tunneling occurs within 50 feet of a subsurface settlement marker, a structure settlement marker, a multi-point borehole extensometer or an inclinometer, the instrument shall be read before and after each advance of the tunnel face within 50 feet of the instrument in addition to the schedule approved by the Engineer.

Initial inclinometer readings shall consist of a minimum of two sets of readings in each of the four possible orientations, at 2-foot intervals throughout the depth of the inclinometer tubing. The two sets of readings shall be made a minimum of 48 hours after completion of installation and testing of each inclinometer tubing. The Engineer and contractor shall jointly determine the acceptability of these initial readings, and if unacceptable, the contractor shall participate in two additional sets of readings. The last set of the two sets of readings jointly determined as acceptable by the Engineer and the contractor will be recorded as the initial readings. Records of inclinometer readings shall be submitted to the Engineer in accordance with a schedule approved by the Engineer.

Initial readings of multi-position borehole extensometers installed from the ground surface shall be made a minimum of 48 hours after completing installation and testing of each extensometer. A minimum of three sets of readings shall be taken. The arithmetic average of the sets of readings taken shall be recorded as the initial readings. The Engineer and contractor shall also determine the initial elevation of each extensometer head, using optical leveling procedures as determined by the Engineer. Records of multi-position borehole extensometer readings shall be submitted to the Engineer in accordance with a schedule approved by the Engineer.

Initial readings of tape extensometer spans shall be made within four hours after completing each installation. A minimum of three readings shall be taken. The arithmetic average of the readings taken shall be recorded as the initial reading. Records of tape extensometer readings shall be submitted to the Engineer within 24 hours after measurements are made.

Measurements shall be taken in accordance with the following:

- (A) The contractor shall measure the horizontal width of each rib or segmented ring at the springline ( $90^{\circ}$  to  $270^{\circ}$ ) to within  $\pm 0.01$  foot.
- (B) The contractor shall measure the vertical height of each circular rib or segmented ring from the crown to the invert ( $0^{\circ}$  to  $180^{\circ}$ ) to within  $\pm 0.01$  foot.
- (C) The contractor shall measure the diameter of each circular rib or segmented ring at each haunch quarter point ( $45^{\circ}$  to  $225^{\circ}$  and  $315^{\circ}$  to  $135^{\circ}$ ) to within  $\pm 0.01$  foot.
- (D) The contractor shall measure the crown elevation of each rib or segmented ring and the elevation of the invert to within  $\pm 0.01$  foot.
- (E) The contractor shall take load cell measurements and measurements A, B, and C above within one hour after each rib or segmented ring is expanded or emerges from the tail of the machine or shield.
- (F) The contractor shall take measurement A above within 12 hours after each rib or segmented ring is expanded or emerges from the tail of the machine or shield.
- (G) The contractor shall take measurements on a schedule approved by the Engineer.
- (H) If it is impracticable to obtain these measurements because of the design of the tunneling equipment or the method of construction, an alternative method of measurement shall be used if approved by the Engineer.
- (I) If the measurements indicate excessive deformations are occurring, corrective measures and additional measurements shall be taken on the selected elements and on additional elements as directed by the Engineer.

Initial readings of subsurface settlement markers shall be made a minimum of 48 hours after completing each installation. A minimum of three readings shall be taken. The arithmetic average of the readings taken shall be recorded as the initial reading. Records of subsurface settlement marker readings shall be submitted to the Engineer in accordance with a schedule approved by the Engineer.

3.13 AVAILABILITY OF DATA:

The Engineer may observe the readings at any time or take his own supplementary readings. The Engineer will interpret the data, and make his interpretations available to the contractor as soon as practicable. The contractor may make his own interpretations for his own purposes. Furthermore, the contractor shall install, monitor, and interpret any additional instrumentation that he deems necessary to ensure the safety of his work. Raw data taken by the contractor, whether from specified instruments or from additional instruments, shall be taken in the same manner as provided herein or as approved by the Engineer and shall be made available to the Engineer within one working day of reading. Reduced data taken by the contractor shall be made available to the Engineer as specified herein.

The Department is not responsible for guaranteeing the safety of the work based on the instrumentation data.

3.14 ACCESS:

The Engineer may take additional readings at any time. The contractor shall provide access to the Engineer to all portions of the site, including the tunnel face for observation purposes. The contractor shall provide general access to the Engineer to readout instruments, ladders, scaffolding, work platforms, hoisting equipment, underground transportation facilities, electric power, and any other items which may be required.

3.15 CLEANUP:

The contractor shall clean up all waste materials upon completing instrument installation. At the completion of the job the contractor shall salvage and/or abandon all instruments including casings, tubings, and/or pipes. The contractor shall grout all instrument casings, tubings, or pipes not removed and/or all holes remaining after removal of casings, tubings, or pipes.

The contractor shall comply with all Federal, State, and local laws regarding abandonment of the holes. Remove all settlement points from structures and repair any holes remaining. All salvaged material except readout instruments shall become the property of the contractor.

All readout instruments purchased by the contractor for this contract shall become the property of the Department.

4.00 METHOD OF MEASUREMENT:

Inclinometer tubing, multi-point borehole extensometers (installed from ground surface) and subsurface settlement markers will

be measured by the linear foot of drilling with instruments satisfactorily installed and accepted by the Engineer. Measurement will be to the nearest foot.

Surface settlement markers and structure settlement markers will be measured by the unit for each settlement marker satisfactorily installed and accepted by the Engineer.

Eyebolts or anchors for tape extensometers will be measured by the unit for each eyebolt or anchor satisfactorily installed and accepted by the Engineer.

Load cells will be measured by the unit for each load cell satisfactorily installed and accepted by the Engineer.

5.00 BASIS OF PAYMENT:

5.01 INCLINOMETER TUBING:

Payment for inclinometer tubing, measured as provided above, will be made at the contract price a linear foot for Item 9300401, which price shall be full compensation for the item complete including drilling holes, furnishing and installing tubing with end plugs, couplings and valve boxes as described, and specified herein.

5.02 MULTI-POINT BOREHOLE EXTENSOMETER:

Payment for multi-point borehole extensometer (installed from ground surface), measured as provided above, will be made at the contract price a linear foot for Item 9300411, which price shall be full compensation for the item complete, including drilling holes, extensometer anchors, protective pipe, grout tubes, hydraulic tubes, stainless steel rods, grout, and anything else required for a complete installation as described and specified herein.

5.03 SUBSURFACE SETTLEMENT MARKERS:

Payment for subsurface settlement markers, measured as provided above, will be made at the contract price a linear foot for Item 9300421, which price shall be full compensation for the item complete, including drilling holes, steel rods with centering spacers, and PVC pipes casing as described and specified herein.

5.04 SURFACE SETTLEMENT MARKERS:

Payment for surface settlement markers, measured as provided above, will be made at the contract price each for Item 9300426, which price shall be full compensation for the item complete as described and specified herein.

5.05           STRUCTURE SETTLEMENT MARKERS:

Payment for structure settlement markers, measured as provided above, will be made at the contract price each for Item 9300428, which price shall be full compensation for the item complete as described and specified herein.

5.06           EYEBOLTS OR ANCHORS FOR TAPE EXTENSOMETERS:

Payment for eyebolts or anchors for tape extensometers, measured as provided above, will be made at the contract price each for Item 9300431, which price shall be full compensation for the item complete, including steel pipe, or channel protection as described and specified herein.

5.07           LOAD CELLS:

Payment for load cells will be made at the contract price each for Item 9300441, which price shall be full compensation for the item complete, as described and specified herein.

5.08           READOUT EQUIPMENT FOR INSTRUMENTATION:

Payment for furnishing readout equipment for instrumentation will be made at the contract lump sum price for Item 9300491 which price shall be full compensation for the item complete including furnishing one inclinometer sensor, indicator, cable, cable reel, pulley assembly, cable hold, and for furnishing or renting one inclinometer tubing spiral sensor, two multi-point borehole extensometer depth micrometers, movable stainless steel reading pipes and calibration standards, one tape extensometer and spare tape, and two load cell readout units, as described and specified herein and on the project plans. The contract price for Item 9300491 shall also include the costs of installing and reading each instrument, preparing necessary submittals, furnishing all materials for installation, testing, protection, regular maintenance, replacement or repair of any instruments damaged as a result of the contractor's operation and/or vandalism, cleanup, providing access to the Engineer for taking readings and all other work for which no separate payment is provided, all to the satisfaction of the Engineer.

ITEM 9300451 - PIEZOMETERS:

ITEM 9300456 - REMOVE PIEZOMETER:

1.00 DESCRIPTION:

The work under Item 9300451 consists of furnishing and installing piezometers at the locations approved by the Engineer in accordance with the requirements of these special provisions. The work under Item 9300456 consists of the removal of piezometers at the time directed by the Engineer.

2.00 MATERIALS:

2.01 PIEZOMETER:

Piezometers shall consist of standard 2-inch diameter schedule 80 PVC threaded pipe. The slotted portion of the piezometer shall consist of 5-foot lengths of PVC Pipe with 0.02 inch factory installed slots. The ends of the piezometers shall be capped.

2.02 SAND PACK FOR PIEZOMETERS:

Sand shall be clean natural silica sand from Ottawa, Illinois, graded such that 100 percent of the material passes the No. 20 sieve and 100 percent is retained on the No. 30 sieve.

3.00 CONSTRUCTION REQUIREMENTS:

Piezometers shall be installed in holes drilled without the use of drilling mud. Holes shall be cased down to depth of bottom of piezometer, using a 4-inch minimum inside diameter casing and then cleaned by flushing with clean water through a bit designed to deflect the flow of water upward until the discharge water is free of soil particles. After the wellpoint is positioned in the hole, the casing shall be withdrawn gradually as the filter and backfill materials are placed to ensure against collapse of the side of the hole. Piezometers shall be sealed at the surface with a material approved by the Engineer to prevent surface runoff from entering the piezometer. Fire hydrants shall not be used as a source of water.

Prior to the commencement of excavation or dewatering. The contractor shall demonstrate that each piezometer is functioning properly by adding or removing water and measuring rates of fall and rise of water levels in the standpipes in the presence of the Engineer.

Initial piezometer readings shall be made a minimum of 48 hours after completing installation and testing of each piezometer. Two sets of water level readings shall be taken, at least four hours

apart. If the variation in the water level at any one piezometer exceeds one inch, the two sets of readings shall be repeated on the following day and on subsequent days until the two sets of readings do not vary more than one inch. For each piezometer, the arithmetic average of the two sets of water level readings which do not vary by more than one inch shall be the initial water level. Thereafter, records of observations shall be maintained and submitted as previously specified.

During the time that the tunnel dewatering system is in operation, each piezometer's continued proper functioning shall periodically be demonstrated by performing the rising or falling head tests at least once a month or on a schedule prescribed by the Engineer.

The contractor shall protect and maintain piezometers in good operating condition to the satisfaction of the Engineer until the completion of the project.

Any piezometer that is damaged or destroyed shall be promptly replaced as directed by the Engineer at the contractor's expense.

When directed by the Engineer, the contractor shall terminate the use of the piezometers and shall remove all parts of the piezometer for a depth of at least 2 feet below the ground surface. The contractor shall backfill the voids with a sand cement grout approved by the Engineer and shall then restore the ground surface to its original condition.

#### 4.00 METHOD OF MEASUREMENT:

Piezometers will be measured by the linear foot from the ground surface to the bottom of each piezometer to the nearest foot. Piezometer removal will be measured as a unit.

#### 5.00 BASIS OF PAYMENT:

Item 9300451 and Item 9300456, measured as provided above, will be paid for at the contract price a linear foot and the contract price each, respectively, which price shall be full compensation for the items complete as described and specified herein.

(PANT1002, DC, 07/27/87)

SECTION 1002 - PAINT: of the Standard and Supplemental Specifications is revised to read:

1002-1 GENERAL REQUIREMENTS:

All paints furnished shall be ready mixed at the manufacturer's plant, except for Paint No. 4, which shall be mixed at the project site just prior to application.

Ready-mixed paint shall be homogeneous, free of contaminants, and shall be well ground to a consistency suitable for the use for which it is specified. The pigment shall be finely ground and properly dispersed in the vehicle, according to the requirements for the type of paint, and this dispersion shall be such that the pigment does not settle appreciably, does not cake or thicken in the paint container, and does not become granular, jelled or curdled. Any settlement of pigment in the paint shall be easily dispersed with a paddle so as to produce a smooth uniform paint of the proper consistency. The manufacturer shall include in the paints the necessary additives for control of sagging, pigment settling, leveling, drying, drier absorption and skinning.

Paint shall be furnished in new, unopened air-tight containers, clearly labeled with the exact title of the paint, Federal Specification number when applicable, name and address of manufacturer, date of paint manufacture and the lot or batch number. The containers shall meet U.S. Department of Transportation Hazardous Material Shipping Regulations.

Precautions concerning the handling and the application of the paint shall be shown on the label of paint containers.

The vendor shall submit to the Department, three copies of a Certificate of Compliance and Certificate of Analysis, in accordance with Subsection 106.05, prior to the use of any materials for which these specifications or the special provisions require that such a certificate be furnished. Submissions shall be made in accordance with the requirements of the Materials Testing Manual.

1002-2 SAMPLING AND TESTING:

Paint will be tested in accordance with the requirements of the latest applicable test methods of Federal Test Method Standard Number 141, the American Society for Testing and Materials, and current methods used by the Department.

Paint which is approved by the Department will be identified with a green sticker affixed to it showing project number, lot number and batch number.

Paint will be tested on a lot basis.

At least one sample, not less than one quart in size, will be taken and tested. Random samples may be taken at the discretion of the Department.

1002-3      PAINTS:

All paint vehicles and varnishes shall conform to the requirements of ASTM D 2621.

Raw materials used in paint formulas shall conform to the specifications designated by ASTM or by Federal or Military serial number or paint material code number under the various paint classifications hereinafter specified. Subsequent amendments to the specifications quoted shall apply to all raw materials and finished products. No "or equal" substitutions for any specified material shall be made without written consent of the Engineer.

The volatile portion of the vehicle shall conform to the following requirements by volume:

- (a) Solvents with an olefinic or cyclo-olefinic type of unsaturation shall not exceed 5 percent,
- (b) The total of aromatic compounds with eight or more carbon atoms in the molecule, except ethylbenzene, methyl benzoate, and phenyl acetate, shall not exceed 8 percent,
- (c) The total of ethylbenzene, toluene, and branched-chain ketones shall not exceed 20 percent,
- (d) A solvent which may be classified into more than one of the above groups shall be considered a member of the group having the lowest allowable concentration,
- (e) The total of (a), (b), and (c) shall not exceed 20 percent,
- (f) The volatile solvents shall contain no benzene or halogenated compounds,

- (g) All paints shall be completely miscible with mineral spirits conforming to Grade II of Federal Specification TT-T-291,
- (h) Mineral spirits, conforming to Grade II, of Federal Specification TT-T-291 shall be the preferred thinner for all paints specified in this Subsection. If necessary, other paint thinners conforming to the requirements of (a) through (f) above may be used,
- (i) Only alkyd-modified phenolic varnishes that require mineral spirits as the sole solvent shall be used. Unmodified para-phenolic varnishes that require aromatic and polar solvents shall not be used.

Alkyd-phenolic spar varnish shall conform to the following requirements:

Type	- Oleoresinous Alkyd
Solids by Weight (%)	- 49 to 51
Viscosity (G-H)	- D to F
Weight per Gallon (Lbs)	- 7.34 - 7.55
Color (G)	- 12 Maximum
Kauri Reduction	- Passes 120%
Complete, with driers.	
Type of Oil	- Tung, Soya
Type of Resin	- Phthalic Alkyd-Phenolic
Type of Solvent	- Mineral Spirits
Mineral Spirits Tolerance	- Over 1000%
Solids by Volume	- 42%
Air Drying Time @77 degrees F.	
Set to Touch	- 1 to 1 1/2 Hours
Dry Hard	- 5 to 6 Hours

Lead and lead compounds shall not be used as raw materials in the paint formulas specified under this Section. Lead and lead compounds shall not be added to any paint formulas specified under this Section.

1002-3.01 PAINT NUMBER 1 - ALKYD PRIMER:

This paint shall meet or exceed in performance the requirements of SSPC Paint Specification No. 11 except that it shall contain no lead compounds or zinc chromate. The color shall be grey.

1002-3.02 PAINT NUMBER 2 - ALKYD:

This paint shall conform to the requirements of SSPC Paint Specification No. 104, Type 1.

1002-3.03 PAINT NUMBER 3 - SILICONE ALKYD:

This paint shall conform to the requirements of SSPC Paint Specification No. 21, Silicone Alkyd Paints, Type I, High Gloss. The color shall be a visual match to Federal Standard 595A, Color Chip No. 20318.

1002-3.04 PAINT NUMBER 4 - ZINC:

This paint shall be a zinc-dust, zinc-oxide primer conforming to the requirements of Federal Specification TT-P-641G and shall be one of the following types:

- Type I - Zinc-dust, zinc-oxide linseed oil primer.
- Type II - Zinc-dust, zinc-oxide phthalic alkyd resin primer.
- Type III - Zinc-dust, zinc-oxide phenolic resin primer modified to conform to requirements (a) through (i) of Subsection 1002-3.

1002-3.05 SSPC PAINT NO. 27, BASIC ZINC CHORMATE - VINYL BUTYRAL WASH PRIMER:

This paint shall be as described in "Systems and Specifications, Steel Structures Painting Manual, Volume 2", Steel Structures Painting Council.

1002-3.06 TINTING:

- (a) Paint Number 4 - Zinc

If modified colors are required, non-lead containing pigments shall be used in amounts not exceeding 10 percent of the total pigment weight and replacing an equal weight of zinc oxide.

- (b) Paint Number 2 - Primer Coating, Zinc Chromate, Low-moisture-sensitivity, Color Modified:

If modified colors are required, non-lead containing pigments shall be used in amounts not exceeding 10 percent of the total pigment weight and replacing an equal weight of silica.

1002-4 ENAMELS:

The following enamels shall conform to the requirements of Federal Specification TT-E-489-G (Enamel, Alkyd, Gloss). The color of enamel specified shall be a visual match to the standard color chip in Federal Standard No. 595A, Colors. The color match shall be made with non-lead containing materials. The class and composition of the enamels shall be Class A-Air Drying and Composition G-General Use.

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.01	Dull Black Enamel	(Color Chip No. 37038).
.02	Gloss Black Enamel	(Color Chip No. 17038).
.03	White Enamel	(Color Chip No. 17875).
.04	Yellow Enamel	(Color Chip No. 13538).
.05	Dark Olive Green Enamel	(Color Chip No. 14087).
.06	Light Gray Enamel	(Color Chip No. 16187).
.07	Buff Enamel	(Color Chip No. 30257).
.08	Green Enamel	(Color Chip No. 34108).
.09	Tan Enamel	(Color Chip No. 20318).
.10	Dark Grey	(Color Chip No. 26081).

(PCC1006, 6, 04/17/86)

SECTION 1006 -PORTLAND CEMENT CONCRETE:

1006-2.03(A) GENERAL REQUIREMENTS: of the Standard Specifications is modified to add:

The handling and storage of concrete aggregate for Class P concrete at the job site shall be such as to minimize segregation. Stockpiles shall be neat and regular in form and shall occupy as small an area as possible. Stockpiles shall be constructed by first distributing the aggregate over the entire base and then building upward in successive layers not more than five feet in depth. Aggregate shall not be dumped or spilled over the side of the pile. When a conveyor is used to stockpile aggregate, it shall be equipped with an adequate rock tremie or rock ladder to reduce segregation and it shall be moved continuously across the stockpile. The distance the material drops from the tremie shall not exceed ten feet. Aggregate shall be distributed over the stockpile so that the formation of conical piles higher than 10 feet is prevented.

Contamination of concrete aggregate for Class P concrete by contact with the ground at the job site shall be positively prevented. The contractor shall take the necessary measures to prevent such contamination. Such preventive measures shall include, but not necessarily be limited to, placing aggregate on hardened surfaces consisting of portland cement concrete, asphaltic concrete, or cement treated material.

1006-2.04 (D) FLY ASH: of the Standard Specifications is revised to read:

Fly ash shall conform to the requirements of ASTM C 618 for Class C or F mineral admixture, except that the loss on ignition shall not exceed 3.0 percent.

Fly ash, when used as a replacement for portland cement, shall have an R factor less than 2.5. The R factor is defined as  $(C-5\%)/F$ , where C is the calcium oxide content expressed as a percentage and F is the ferric oxide content expressed as a percentage. Calcium and ferric oxide content shall be determined in accordance with the requirements of ASTM C 311.

1006-3.01 DESIGN CRITERIA: the eighth paragraph of the Standard Specifications is revised to read:

Coarse aggregate for Class P concrete used to construct portland concrete pavement without load transfer dowels shall be separated into two sizes meeting the requirements of size designation

No. 57 and No. 4 except that the percent passing the one inch sieve shall be 10 to 55. The percent of crushed faces for each size shall be at least 30 when tested in accordance with the requirements of Arizona Test Method 212. At the time of proportioning for mixing, the aggregate in each stockpile shall be measured by weight and proportioned so that the resulting mixture of coarse aggregate meets the requirements for size designation No. 467.

Coarse aggregate for Class P concrete used to construct portland cement concrete pavement with load transfer dowels and adjacent shoulders shall meet the requirements for size designation No. 57. The percent of crushed faces shall be at least 30 when tested in accordance with the requirements of Arizona Test Method 212.

1006-4.03(B) MIXING IN A STATIONARY MIXER: the last paragraph of the Standard Specifications is revised to read:

Discharge from nonagitating trucks shall be completed within 45 minutes from the time concrete is batched. Concrete hauled in open-top vehicles shall be protected against access of rain, or exposure to the sun for more than 30 minutes when the ambient temperature exceeds 85 degrees F.

Acceptability of concrete from non-agitating vehicles will rest solely with the Engineer. A time limit will not be required. The mix must be homogeneous, pumpable and not started its initial set.

1006-7.02 SAMPLING AND TESTING FOR COMPRESSIVE STRENGTH (CAST-IN-PLACE CONCRETE): of the Supplemental Specifications is modified to add:

Samples of concrete for test specimens will be taken in accordance with requirements of AASHTO T 141. All test cylinders will be fabricated in accordance with the requirements of AASHTO T 23. Testing for compressive strength will be in accordance with the requirements of AASHTO T 22.

A strength test will consist of the average strength of two cylinders or 95 percent of the higher strength cylinder, whichever is greater.

1006-7.03 SAMPLING AND TESTING FOR COMPRESSIVE STRENGTH (Precast Concrete): the third paragraph of the Standard Specifications is revised to read:

Samples of concrete for test specimens will be taken in accordance with requirements of AASHTO T 141. All test cylinders will be fabricated in accordance with the requirements of AASHTO T 23. Testing for compressive strength will be in accordance with the requirements of AASHTO T 22.

A strength test will consist of the average strength of two cylinders or 95 percent of the higher strength cylinder, whichever is greater.

1006-7.05 ACCEPTANCE FOR COMPRESSIVE STRENGTH: of the Standard Specifications is revised to read:

(A) CLASS P CONCRETE:

All concrete represented by a strength test of at least 75 percent of the required 28-day compressive strength will be acceptable for Class P concrete, subject to the further requirements of Section 401. All concrete failing to meet this requirement or otherwise rejected in accordance with Section 401, shall be replaced with concrete meeting the requirements of these specifications. Concrete rejected wholly, or in part, due to deficiency in strength, may be accepted if the contractor, at his own expense, can submit evidence that the strength test(s) is (are) not representative of the concrete placed. If such evidence consists of cores, the contractor shall obtain three cores from each area represented by a failing test and submit them to the Engineer in time to allow complete testing within 42 days of placement. All cores shall be obtained and tested in accordance with the requirements of AASHTO T 24. All cores will be tested in the wet condition. Strength test results of the cores will be utilized, along with the provisions of Section 401, to determine acceptability and appropriate pay factor.

(B) CLASS S AND CLASS B CONCRETE:

Concrete represented by a strength test of at least 95 percent of the required 28-day compressive strength will be acceptable for cast-in-place and precast concrete. All concrete failing to meet this requirement will be rejected in accordance with the provisions of Subsection 106.11 unless the contractor, at his own expense, can submit evidence that will indicate to the Engineer that the strength and quality of the concrete is such that the concrete should be considered acceptable. If such evidence consists of concrete cores, the contractor shall obtain three cores from the concrete represented by the failing strength test and deliver them to the Engineer in time to allow complete testing of such cores within 42 days after the placement of the concrete. All cores shall be obtained and tested in accordance with the requirements of AASHTO T 24. All cores will be tested in the wet condition unless, based on the service conditions of the structure, the Engineer decides that they should be tested in other than the wet condition. The concrete represented by the cores will be considered acceptable if the numerical average of the compressive strength of the three cores is at least the required 28-day compressive strength. If the average compressive strength does not meet this requirement, all concrete so represented shall be

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removed at the contractor's expense unless permitted to remain in place by the Engineer. No payment will be made for concrete permitted to remain in place when the average compressive strength of the three cores fails to meet the required 28-day compressive strength.

EXHIBIT "C-1"

AGREEMENT BETWEEN THE SOUTHERN PACIFIC  
TRANSPORTATION COMPANY  
AND THE CONTRACTOR

IN CONNECTION WITH THE CONSTRUCTION OF \_\_\_\_\_  
ACROSS THE TRACKS OF  
THE SOUTHERN PACIFIC TRANSPORTATION COMPANY

Southern Pacific Transportation Company  
400 East Toole Avenue  
Tucson, Arizona 85701-1899

Attention: General Manager

Reference: State Project No. \_\_\_\_\_

Gentlemen:

Reference is made to the agreement dated \_\_\_\_\_, 19\_\_\_\_, between you and the State of Arizona, under which the State is constructing \_\_\_\_\_ across the right-of-way, property, track and appurtenances of your Railroad, in the County of \_\_\_\_\_, State of Arizona, commonly known as \_\_\_\_\_.

The undersigned has entered into a contract dated \_\_\_\_\_, 19\_\_\_\_ with the State of Arizona for the performance of certain work in connection with the construction of said \_\_\_\_\_. In the performance of which work the undersigned will necessarily be required to conduct operations within your right-of-way and property. The agreement between you and the State provides that no work shall be commenced within your right-of-way or property until the Contractor employed in connection with said work for the State shall have executed and delivered to you a letter agreement in the form hereof and shall have provided insurance of the coverage and limits specified therein. If this letter agreement is executed by other than the Owner, General Partner, President or Vice President of undersigned firm, evidence is furnished to you herewith certifying that the signatory is empowered to execute this agreement for the firm.

Accordingly, as one of the inducements to and as part of the consideration for your granting permission to the undersigned to enter upon your right-of-way or property for the performance of so much of the work as is necessary to be done within your right-of-way or property, the undersigned has agreed and does hereby agree with you as follows:

1. That the undersigned has procured and will maintain in force insurance meeting all of the requirements outlined in these Special Provisions for and in said contract, and there is handed you herewith original and/or certified copies as specified, with coverage and limits as follows:

(a) Contractor's Public Liability and Property Damage Liability Insurance (certified copy):

With respect to the operations to be performed within, or adjacent to, the Railroad's right-of-way, regular Contractor's Public Liability and Property Damage Liability Insurance, containing no clause or endorsement that will exclude Liability for Contamination or Pollution and providing for coverage of the same limits as specified under (d) below.

(b) Contractor's Protective Public Liability and Property Damage Liability Insurance (certified copy):

With respect to the operations to be performed by subcontractors within, or adjacent to, the Railroad's right-of-way, regular Contractor's Protective Public Liability and Property Damage Liability Insurance, in behalf of the contractor, containing no clause or endorsement that will exclude Liability for Contamination or Pollution, and providing for coverage of the same limits as specified under (d) below.

(c) Contractor's Contractual Liability Insurance (certified copy):

With respect to Contractor's Contractual obligations contained in paragraph 2 hereof Contractor's Contractual Liability Insurance, containing no clause or endorsement that will exclude Liability for Contamination or Pollution and providing for coverage of the same limits as specified under (d) below.

(d) Railroad's Protective Public Liability and Property Damage Liability Insurance (original):

With respect to the operations to be performed by the contractor or by his subcontractors within, or adjacent to, the railroad's right-of-way, Railroad Protective Liability Insurance Policy in favor of the Southern Pacific Transportation Company, 400 E. Toole Avenue, Tucson, Arizona 85701-1899 with coverage and limits specified in the Railway-Highway Insurance Protection Required of Contractors, dated 7-11-67 and made a part hereof by reference.

2. That the undersigned agrees to release and indemnify you from and against all costs, expenses, claims and liability for injury to or death of any persons and for damages to or loss of any property, however caused, resulting from, arising out of, or in any way in connection with the work under said contract upon, or adjacent to The Southern Pacific Transportation Company's property, whether or not caused or contributed to by the operation of trains on The Southern Pacific Transportation Company adjacent track, or by any negligence or alleged negligence on the part of any of The Southern Pacific Transportation Company's agents or employees. This section shall include any other railroad company using The Southern Pacific

Transportation Company's property, with The Southern Pacific Transportation Company's consent, and any affiliate, subsidiary or lessor of The Southern Pacific Transportation Company.

3. That the undersigned will comply with your rules and regulations and the instructions of your representatives in relation to the proper manner of protecting your track and right-of-way and the traffic moving on your track, as well as the wires, signals and other property belonging to you or your tenants or licensees at or in the vicinity of the work during the period of construction and shall perform the work under the supervision and control of your Assistant General Manager-Engineering or other designated officer, in such manner and at such times as shall not endanger or interfere with the safe operation of your track and such other facilities.

4. That the undersigned will ascertain from your Assistant General Manager-Engineering the class of our personnel which will necessarily be employed in the protection of your facilities and property and the movement of your trains, it being understood that upon request of the undersigned you will furnish an estimate of the cost of forces to be provided and work to be done by you at the expense of the undersigned, which shall include without limitation any expense incurred by you for falsework to support your track and for flagmen to protect your traffic and inspectors you consider necessary to inspect the work that the undersigned performs under the said contract upon or adjacent to your property.

5. That the undersigned shall give you at least five days notice in advance of any work done upon, or adjacent to, The Southern Pacific Transportation Company's property under said contract. The undersigned shall notify you of the date said work is completed, and upon completion of the work, the undersigned will promptly remove from your premises all tools, implements and other materials whether brought thereon by the undersigned or any of its subcontractors or the employees or agents of either, and will cause said premises to be left in a clean and presentable condition.

6. That the undersigned will observe and comply with all the provisions, obligations and limitations to be observed by the contractor which are contained hereinbefore and will pay all costs incurred for any damages to Railroad roadbed, tracks and/or property in performance of work covered by contract referred to in the second paragraph, sheet one of this Agreement.

Kindly acknowledge receipt of this letter and of the insurance showings herein provided to be furnished to you, by signing and returning to the undersigned, through the State, a copy of this letter, which shall thereupon constitute an agreement between us.

Yours truly,

\_\_\_\_\_  
(Contractor)

By: \_\_\_\_\_

Receipt of the foregoing letter and of the policies and certificates of insurance therein provided to be furnished is hereby acknowledged this \_\_\_\_\_ day of \_\_\_\_\_, 19\_\_\_\_

THE SOUTHERN PACIFIC TRANSPORTATION COMPANY

By: \_\_\_\_\_

Its \_\_\_\_\_

ARIZONA DEPARTMENT OF TRANSPORTATION

HIGHWAYS DIVISIONS

CONTRACTS AND SPECIFICATIONS SERVICES

BIDDING SCHEDULE

Project No.  
RAM 600-1-507

Termini  
Outer Loop Highway

Location  
Price Road Drainage Tunnel

Fund Code  
83701

Item No.  
444

County  
MARICOPA

Gross Length  
15,533.20' = 2.98 miles

Net Length  
15,533.20' = 2.98 miles

Prepared By  
HNTB

ITEM NO	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
1					
2	2060001 Furnish Water Supply	L. Sum	1		
3	2070001 Dust Palliative	M. Gal.	5,000	8.00	40,000.00
4	5011033 Pipe, Reinforced Concrete, Class III, 30"	L. Ft.	436		
5	5011105 Pipe, Reinforced Concrete, Class V, 108"	L. Ft.	150		
6	5030185 Drop Structure (A)	Each	1		
7	5030186 Drop Structure (B)	Each	1		
8	5050013 Manhole (C-18.10)(Modified)	Each	1		
9	5060100 Pump Station	L. Sum	1		
10	5060500 Pump Station Electrical System	L. Sum	1		
11	5060510 Pumps, Electric Motors and Related Equipment	L. Sum	1		
12	7010001 Maintenance and Protection of Traffic	L. Sum	1	50,000.00	50,000.00
13	9010001 Mobilization	L. Sum	1		
14	9020021 Chain Link Fence, Type 2, (72")	L. Ft.	7,435		
15					
16					
17					

	ITEM NO	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
1	9020128	Chain Link Fence Gate, Type 2 (Double 10' wide)	Each	2		
2	9240010	Force Account Work (ADWR Pumping Fees)	L. Sum	1	25,000	25,000
3	9260004	Engineers Field Office	L. Sum	1		
4	9300007	Tunnel Access Shaft	L. Sum	1		
5	9300018	Tunnel (18' I.D.)	L. Ft.	15,472		
6	9300071	Chemical Grouting (Chemicals)	Gallon	133,000		
7	9300073	Grout Placement	Cu. Ft.	20,200		
8	9300099	Compaction Grouting (Drill Grout Holes)	L. Ft.	1,200		
9	9300101	Consolidation Grouting (Drill Grout Holes)	L. Ft.	12,500		
10	9300111	Consolidation Grouting (Furnish and Install Grout Pipe)	L. Ft.	12,500		
11	9300121	Consolidation Grouting (Grout Connections)	Each	275		
12	9300131	Consolidation and Compaction Grouting (Portland Cement for Grout)	Sack	1,825		
13						
14						
15						
16						
17						

	ITEM NO	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
1	9300401	Inclinometer Tubing	L. Ft.	525		
2	9300411	Multi-Point Borehole Extensometers (Installed from Ground Surface)	L. Ft.	525		
3	9300421	Subsurface Settlement Markers	L. Ft.	500		
4	9300426	Surface Settlement Markers	Each	1,550		
5	9300428	Structure Settlement Markers	Each	24		
6	9300431	Eyebolts or Anchors for Tape Extensometers	Each	100		
7	9300441	Load Cells	Each	16		
8	9300451	Piezometers	L. Ft.	600		
9	9300456	Piezometers Removal	Each	6		
10	9300491	Readout Equipment for Instrumentation	L. Sum	1		
11						
12						
13		TOTAL				
14						
15						
16						
17						



# ARIZONA DEPARTMENT OF TRANSPORTATION

## HIGHWAYS DIVISION

206 South Seventeenth Avenue Phoenix, Arizona 85007

EVAN MECHAM  
Governor

CHARLES L. MILLER  
Director

November 20, 1987

W.O. FORD  
State Engineer

### ADDENDUM (1)

TO ALL CONTRACTORS AND OTHERS INTERESTED IN PROJECT RAM 600-1-507  
NORTHEAST OUTER LOOP (SR117) (PHOENIX URBAN AREA) (PRICE ROAD DRAINAGE  
TUNNEL).

#### REVISIONS TO THE SPECIAL PROVISIONS:

Sheets 7, 8: Maricopa Association of Governments Specifications and  
Standards are no longer available from the Arizona Department of  
Transportation.

Sheet 12: Subsection 101.26 - MAJOR ITEMS is hereby deleted.

Sheet 14: Subsection 102.16 - ESCROW BID DOCUMENTATION is hereby  
added:

#### ESCROW BID DOCUMENTATION:

All bidders shall submit with their bids in a separate, sealed  
container all the backup information used to establish their costs for  
all items in the bidding schedule.

This backup information is herein described as Escrow Bid  
Documentation and referred to hereinafter as "documentation." The  
documentation shall clearly itemize the costs for all items for which  
a unit price is solicited as well as the costs for all lump sum  
items. All costs such as labor, materials, equipment, fixed costs on  
site, fixed costs off site, and any and all other "items" contributing  
to the cost of each item shall be clearly and specifically identified  
by item number. The documentation shall include copies of all quotes,  
memoranda, narratives, and all other similar data utilized in the  
determination of the cost of each item, including those items expected  
to be performed by subcontract. Verbal quotations shall be put in  
writing.

Addendum (1)  
RAM 600-1-507  
Sheet 1 of 10  
November 20, 1987





# ARIZONA DEPARTMENT OF TRANSPORTATION

## HIGHWAYS DIVISION

206 South Seventeenth Avenue Phoenix, Arizona 85007

EVAN MECHAM  
Governor

CHARLES L. MILLER  
Director

November 20, 1987

W.O. FORD  
State Engineer

### ADDENDUM (1)

TO ALL CONTRACTORS AND OTHERS INTERESTED IN PROJECT RAM 600-1-507 NORTHEAST OUTER LOOP (SR117) (PHOENIX URBAN AREA) (PRICE ROAD DRAINAGE TUNNEL).

#### REVISIONS TO THE SPECIAL PROVISIONS:

Sheets 7, 8: Maricopa Association of Governments Specifications and Standards are no longer available from the Arizona Department of Transportation.

Sheet 12: Subsection 101.26 - MAJOR ITEMS is hereby deleted.

Sheet 14: Subsection 102.16 - ESCROW BID DOCUMENTATION is hereby added:

#### ESCROW BID DOCUMENTATION:

All bidders shall submit with their bids in a separate, sealed container all the backup information used to establish their costs for all items in the bidding schedule.

This backup information is herein described as Escrow Bid Documentation and referred to hereinafter as "documentation." The documentation shall clearly itemize the costs for all items for which a unit price is solicited as well as the costs for all lump sum items. All costs such as labor, materials, equipment, fixed costs on site, fixed costs off site, and any and all other "items" contributing to the cost of each item shall be clearly and specifically identified by item number. The documentation shall include copies of all quotes, memoranda, narratives, and all other similar data utilized in the determination of the cost of each item, including those items expected to be performed by subcontract. Verbal quotations shall be put in writing.

Addendum (1)  
RAM 600-1-507  
Sheet 1 of 10  
November 20, 1987



The documentation shall be clearly marked with the name and address of the bidder, the date of the submission, the project numbers and labeled Escrow Bid Documentation. The documentation shall be accompanied with a notarized affidavit signed by the person authorized to submit the bid stating that the documentation was used to develop the cost of all items and that he has satisfied himself that the documents are in the container and are correct and complete and reflect the requirements of the special provisions.

The documentation submitted by the apparent successful bidder will be examined by the Department in the bidder's presence prior to any award of contract. This examination is only to ensure that the documentation is as specifically required and complete. The examination does not constitute approval of proposed construction methods or the reasonableness of any assumptions or interpretations of any documents made available by the Department and upon which costs were developed. After the examination, the documentation will be itemized.

If the Department determines that the documentation does not fully meet the requirements specified herein, the bidder shall submit within three calendar days from the date of the Department request such documentation as requested in writing. Such documentation shall also be submitted in a sealed container labeled "Supplemental Escrow Bid Documentation" and be accompanied by a notarized affidavit as hereinbefore specified. The bidder may elect to be or not to be present at such examination. After the examination, the supplemental documentation will be itemized.

The documentation and any supplemental documentation of the contractor to whom the award is made will be held in escrow for the duration of the contract and will be used solely for the purpose of determining how the cost of each item was established. The documentation will only be used in cases involving cancellation, suspension or breach of contract, major contract changes, or to resolve major disputes or claims. The receipt of all documentation will be acknowledged in writing by the Department. The cost of escrow will be borne by the Department.

Failure to submit either documentation or supplemental documentation as required herein may be cause for the rejection of the bid.

The contractor to whom the award is made hereby understands and agrees, as a condition of the award, that the complete documentation submitted, examined, itemized, and placed in escrow constitute all of the data, information, etc., used in developing the cost of each item and that no other data, information, etc., shall be considered.

The documentation of all unsuccessful bidders will be returned unopened to the address shown on the submission within 30 days following the date of execution of the contract.

The documentation is and shall remain the property of the contractor, subject to use by the Department as provided herein. Consent of both the Department and the contractor will be required for access to the documentation and neither party shall refuse or frustrate access for the purposes stated herein provided that written notice as set forth herein is given.

The documentation will be returned after final payment has been made provided that no claims against the Department are reserved by the contractor. In the event that any claims are reserved, the documentation will be held in escrow for use until such claims have been resolved or, in the event of litigation, until the litigation is concluded.

Examination of the documentation is subject to the following conditions:

A. These documents are confidential in nature and shall be treated as such by those designated to review them.

B. Each party shall designate not less than three local representatives who are authorized to review the Escrow Bid Documentation.

C. Either party shall be given at least 24 hours written notice prior to seeking access to the documents so that the other party may witness the removal and examination of them. Each party shall designate a representative to receive such notice and the address at which such notice may personally be made.

D. The contractor or his representative may have access to the documents only in the presence of a designated Department representative.

E. Consultants engaged specifically for resolution of claims related to this contract may review the documents in the presence of designated representatives of the contractor and the Department.

Sheet 26: Subsection 107.17 is modified to add: The City of Tempe shall be named as an additional insured on the Certificate of Insurance.

Sheet 27: Subsection 107.19 is modified to add: Prior to performing any work on the 72" sewer line connection the contractor shall obtain a permit from the City of Tempe.

SECTION 109 - MEASUREMENT AND PAYMENT:

109.10 LUMP SUM PAYMENT FOR STRUCTURES: of the Standard Specifications is modified to add:

The Department will compensate the contractor for construction of each of the following structures or groups of structures on the basis of a lump sum amount:

- (A) Drop Structure (A)
- (B) Drop Structure (B)
- (C) Pump Station
- (D) Tunnel Access Shaft

Measurement and payment for the work will be made in accordance with the requirements of LUMP SUM PAYMENT FOR STRUCTURES under SECTION 109 - MEASUREMENT AND PAYMENT.

Sheet 42:

Item 5030185 - DROP STRUCTURE (A): is revised to read:  
Item 9300007A - DROP STRUCTURE (A):

Sheet 43:

4.00 METHOD OF MEASUREMENT: is deleted.

5.00 BASIS OF PAYMENT: is revised to read:

Payment for this work will be made in accordance with the provisions of Subsection 109.10. The contract price for ITEM 9300007 - DROP STRUCTURE (A) shall include the cost of backfilling, grout, connection to tunnel and site grading.

Item 5030186 - DROP STRUCTURE (B): is revised to read:  
Item 9300007B - DROP STRUCTURE (B):

Sheet 44:

4.00 METHOD OF MEASUREMENT: is deleted.

5.00 BASIS OF PAYMENT: is revised to read:

Payment for this work will be made in accordance with the provisions of Subsection 109.10. The contract price for ITEM 9300007B - DROP STRUCTURE (B) shall include the cost of backfilling grout, steel lined connection to tunnel, miscellaneous metals for anchoring, manhole steps and site grading.

Item 5040571C - SLUICE GATE:

1.00 DESCRIPTION:

The work under this item consists of furnishing all materials and installing complete and functioning sluice gate in accordance with the details shown on the project plans and the applicable requirements specified under Materials and Construction Requirements for ITEM 9300007C - PUMP HOUSE.

4.00 METHOD OF MEASUREMENT:

Measurement will be for each sluice gate furnished and installed complete in place.

5.00 BASIS OF PAYMENT:

Payment will be as specified under ITEM 9300007C - PUMP HOUSE.

Sheet 45:

Item 5060100 - PUMP STATION: is revised to read:  
Item 9300007C - PUMP STATION:

Sheet 50:

5.00 BASIS OF PAYMENT: is revised to read:

Payment for this work will be made in accordance with the provisions of Subsection 109.10. The contract price for ITEM 9300007C - PUMP STATION shall include the cost of backfilling, site grading, and trash racks.

Sheet 63: (D) Pump Test is hereby deleted through paragraph (6).

Sheet 64: The first paragraph is revised to read: The Contractor will provide a certified report from the pump manufacturer attesting that the pump will dynamically operate under 110 feet of head with no loss of electrical integrity.

7370430C - TRANSFORMER (With Pad):

7379029C - MOTOR CONTROL CENTER (With Sensors):

1.00 DESCRIPTION:

The work under these items consists of furnishing all materials and installing a transformer and motor control center at the locations shown on the project plans in accordance with the applicable requirements specified under Materials and Construction Requirements for ITEM 9300007C - PUMP HOUSE.

Addendum (1)  
RAM 600-1-507  
Sheet 5 of 10  
November 20, 1987

4.00 METHOD OF MEASUREMENT:

Measurement will be for each transformer and each motor control center installed complete in place including sensors and concrete pads.

5.00 BASIS OF PAYMENT:

Payment will be as specified under ITEM 9300007C - PUMP HOUSE.

ITEM 8081410B - PIPE (Ductile Iron) (4") (Class 52):  
ITEM 8081417A - PIPE (Ductile Iron) (6") (Class 52):  
ITEM 8081473C - PIPE (Ductile Iron) (24") (Class 52):"

1.00 DESCRIPTION:

The work under these items consists of furnishing and installing ductile iron pipe at the locations and in accordance with the details shown on the project plans and the applicable requirements specified under Materials and Construction Requirements for ITEMS 9300007A, 9300007B and 9300007C.

4.00 METHOD OF MEASUREMENT:

Ductile iron pipe will be measured by the linear foot of pipe installed.

5.00 BASIS OF PAYMENT:

Payment will be as specified under ITEMS 9300007C, 9300007B, and 9300007C.

ITEMS 9140038A, B, C - GRATE (With Frames):

1.00 DESCRIPTION:

The work under these items consist of furnishing all materials and installing grates, including platforms, complete with rails at the location and in accordance with the details shown on the project plans and the applicable requirements specified under Materials and Construction Requirements for ITEMS 9300007A, 9300007B, and 9300007C.

4.00 METHOD OF MEASUREMENT:

Grates and platforms will be measured by the square foot of grates and platforms installed complete in place.

5.00 BASIS OF PAYMENT:

Payment will be as specified under ITEMS 9300007A, 9300007B and 9300007C.

ITEM 9140081A, B, C - LADDER (Fixed):

1.00 DESCRIPTION:

The work under these items consists of furnishing all materials and installing fixed ladders, including cages, at the locations and in accordance with the details shown on the project plans and the applicable requirements specified under Materials and Construction Requirements for ITEMS 9300007A, 9300007B and 9300007C.

4.00 METHOD OF MEASUREMENT:

Fixed ladders will be measured by the linear foot of ladder installed complete in place.

5.00 BASIS OF PAYMENT:

Payment will be as specified under ITEMS 9300007A, 9300007B, and 9300007C.

ITEM 9140083A - LADDER (Retractable):

1.00 DESCRIPTION:

The work under this item consists of furnishing all materials and installing retractable ladders, including safety cages, at the location and in accordance with the details shown on the project plans and the applicable requirements specified under Materials and Construction Requirements for ITEM 9300007A.

4.00 METHOD OF MEASUREMENT:

Retractable ladders will be measured as a unit for each retractable ladder system complete in place.

5.00 BASIS OF PAYMENT:

Payment will be as specified under ITEM 9300007A.

ITEM 9141701C - HATCH COVER:

1.00 DESCRIPTION:

The work under this item consists of furnishing all materials and installing a hatch cover at the location and in accordance with the details shown on the project plans and the applicable requirements specified under Materials and Construction Requirements for ITEM 9300007C - PUMP STATION.

4.00 METHOD OF MEASUREMENT:

Hatch covers will be measured as a unit for each hatch cover installed complete in place.

5.00 BASIS OF PAYMENT:

Payment will be as specified under ITEM 9300007C.

Sheet 97: The first paragraph is revised to read:

(D) Telephone. Four separate phone lines for the exclusive use of Department and consultant personnel: three for the Resident Engineers office facility and one for the facility to be located at the tunnel inlet.

Sheet 98: Paragraph 2, the third sentence is revised to read: It shall be equipped with lavatory, toilet, two showers and six vandalproof lockers.

The list of office furniture following paragraph 3 is revised to read:

- 9 - Suitable office desks with drawers and locks and chairs.
- 12 - Office chairs.
- 3 - Fire-resistant cabinets, 4-drawer, as specified in "M" above.
- 3 - Drafting-type tables, each three feet by six feet, supported by wall brackets and legs or standard free standing.
- 3 - Draftsman's stools.
- 1 - Office table three feet by 12 feet (conference type).
- 2 - Vertical filing plan rack for four sets of 22" x 36" plans.
- 7 - Extension telephones.
- 6 - Bookcases with 4 shelves (3' x 6').
- 2 - Bookcases with 2 shelves (3' x 4').
- 2 - Bookcases with 8 shelves (4' x 7').
- 3 - Chalk Boards (4' x 8')
- 5 - Office Tables (2 1/2' x 5')
- 1 - Storage cabinet 72" x 36" x 18" with locks.
- 1 - Tack board 24" x 38".
- 5 - Office type 4 drawer file cabinets
- 1 - Typewriter standard electric with pica type and 16 inch carriage.
- 1 - Photocopying Machine. Desk top, heavy duty, electric, dry process photocopying machine capable of using bond paper for sizes up to and including 11" x 17" and an adequate supply of copy paper. The supply of copy paper shall be replenished by the contractor as required by the Engineer.

Sheet 99: Paragraph 2 is modified to add: The contractor shall also be responsible for the installation and monthly utility costs of the water, sewer and electricity for the field laboratory. This Department supplied unit will be located in proximity to the Resident Engineer's Office.

Sheet 100:

ITEM 9300007 - TUNNEL ACCESS SHAFT: is revised to read:  
ITEM 9300007D - TUNNEL ACCESS SHAFT:

5.00 BASIS OF PAYMENT: is revised to read:

Payment for this work will be made in accordance with the provisions of Subsection 109.10. The contract price for ITEM 9300007D - TUNNEL ACCESS SHAFT shall include the cost of backfilling and site grading.

Sheet 104: PRECAST CONCRETE SEGMENTAL LINING:

Line (3) is revised to read: Sustain a diametral distortion of  $\Delta D/D = 0.5$  percent.

Line (9) is revised to read: Concrete  $f't =$  allowable tensile stress = 0.

(A) MINIMUM DESIGN CRITERIA:

Line (4) is revised to read: Sustain a diametral distortion of  $\Delta D/D = 0.25$  percent.

Sheet 105: Line (11) is revised to read: Concrete  $f't =$  allowable tensile stress = 0.

Sheet 132: The first paragraph is revised to read:

The contractor shall support the last installed ring with a horizontal tie (hog) rod or stiff internal fitting ring or other approved system which is installed before the tunnel shield is advanced. The support shall be kept in place until no deformation of the segment ring occurs.

REVISIONS, ADDITIONS AND DELETIONS OF PROJECT PLANS SHEETS:

The following sheets are revised as indicated:

1. DWG No. S-2 In Note 4, Delete the words "Location of dropshaft" and replace with "Ringbeam".
2. DWG No. S-5.1 This drawing has been reissued. Please exchange the original sheet with it's replacement included in this addendum.

3. DWG No. S-5.3 (1) Change all #11@8" references to #11@9".  
Change #11@4" reference to #11@4-1/2".
- (2) Add the following:
- "Note: Both bottom layers of #11 bars in floor slab (Section M) shall extend 6'-9" into sidewalls, resulting in #11's at 4-1/2" spacing.
4. DWG No. S-6 In upper left corner of Section A:
- Change the vertical dimensions shown as 14'-8" to 14-1-1/2".
5. DWG No. S-8 (1) In Plan-Dropshaft Boxed End Inflow Structure, delete the work "Future" in the phrase, "Future 1/2" expansion joint . . .".
- (2) In Section A:
- (a) Change "Sheet 37D" to "Dwg No. S-9".  
(b) Change "Inv Elev per site plan" to "Inv Elev 1164.00"
- (3) In Section B, change the phrase, "Inv Elev per site plan" to "Inv Elev 1164.05".
6. DWG No. S-10 In Section A and Section B replace all measurements listed as "10'-0" Max" with "12'-0" Max".

REVISIONS TO THE BIDDING SCHEDULE:

Attached are revised sheets 1 through 9 of the bidding schedule. Remove the original sheets 1 through 4 from your Proposal Pamphlet and attach the revised sheets.

DALLIS B. SAXTON, Engineer  
Contracts and Specifications Services

SHEET 1 OF 9

DATE 11/20/87

Addendum No. 1

ARIZONA DEPARTMENT OF TRANSPORTATION

HIGHWAYS DIVISIONS

CONTRACTS AND SPECIFICATIONS SERVICES

BIDDING SCHEDULE

Project No. RAM 600-1-507	Termini Northeast Outer Loop (SR117) (Phoenix Urban Area)	Location Price Road Drainage Tunnel	Fund Code 83701	Item No. 444
County MARICOPA	Gross Length 15,533.20' = 2.98 miles	Net Length 15,533.20' = 2.98 miles	Prepared By HNTB	

ITEM NO	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
1					
2	2060001 Furnish Water Supply	L. Sum	1		
3	2070001 Dust Palliative	M. Gal.	5,000	8.00	40,000.00
4	5011033 Pipe, Reinforced Concrete, Class III, 30"	L. Ft.	436		
5	5011105 Pipe, Reinforced Concrete, Class V, 108"	L. Ft.	150		
6	5050013 Manhole (C-18.10)(Modified)	Each	1		
7	5060500 Pump Station Electrical System	L. Sum	1		
8	5060510 Pumps, Electric Motors and Related Equipment	L. Sum	1		
9	7010001 Maintenance and Protection of Traffic	L. Sum	1	50,000.00	50,000.00
10	9010001 Mobilization	L. Sum	1		
11	9020021 Chain Link Fence, Type 2, (72")	L. Ft.	7,435		
12					
13					
14					
15					
16					
17					

PROJECT NO. RAM 600-1-507

BIDDING SCHEDULE

SHEET 3 OF 9

DATE 11/20/87

Addendum No. 1

ITEM NO	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
1	9020128 Chain Link Fence Gate, Type 2 (Double 10' wide)	Each	2		
2	9240010 Force Account Work (ADWR Pumping Fees)	L. Sum	1	25,000	25,000
3	9260004 Engineers Field Office	L. Sum	1		
4	9300018 Tunnel (18' I.D.)	L. Ft.	15,472		
5	9300071 Chemical Grouting (Chemicals)	Gallon	133,000		
6	9300073 Grout Placement	Cu. Ft.	20,200		
7	9300099 Compaction Grouting (Drill Grout Holes)	L. Ft.	1,200		
8	9300101 Consolidation Grouting (Drill Grout Holes)	L. Ft.	12,500		
9	9300111 Consolidation Grouting (Furnish and Install Grout Pipe)	L. Ft.	12,500		
10	9300121 Consolidation Grouting (Grout Connections)	Each	275		
11	9300131 Consolidation and Compaction Grouting (Portland Cement for Grout)	Sack	1,825		
12					
13					
14					
15					
16					
17					

PROJECT NO. RAM 600-1-507

## BIDDING SCHEDULE

SHEET 4 OF 9

DATE 11/20/87

Addendum No. 1

ITEM NO	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
1	9300401	Inclinometer Tubing	L. Ft.	525	
2	9300411	Multi-Point Borehole Extensometers (Installed from Ground Surface)	L. Ft.	525	
3	9300421	Subsurface Settlement Markers	L. Ft.	500	
4	9300426	Surface Settlement Markers	Each	1,550	
5	9300428	Structure Settlement Markers	Each	24	
6	9300431	Eyebolts or Anchors for Tape Extensometers	Each	100	
7	9300441	Load Cells	Each	16	
8	9300451	Piezometers	L. Ft.	600	
9	9300456	Piezometers Removal	Each	6	
10	9300491	Readout Equipment for Instrumentation	L. Sum	1	
11					
12					
13		Tunnel and Misc. Items Total			
14					
15					
16					
17					

PROJECT NO. RAM 600-1-507

BIDDING SCHEDULE

SHEET 5 OF 9

DATE 11/20/87

Addendum No. 1

ITEM NO	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
1	DROP STRUCTURE (A)				
2	2030501A Structural Excavation	Cu. Yd.	4,820		
3	6010004A Structural Concrete (Class S) (f'c = 4,000 psi)	Cu. Yd.	3,420		
4	6050002A Reinforcing Steel	Lb.	815,300		
5	8081417A Pipe (Ductile Iron) (6") (Class 52)	L. Ft.	44		
6	9140038A Grate (With Frames)	Sq. Ft.	540		
7	9140081A Ladder (Fixed)	L. Ft.	60		
8	9140083A Ladder (Retractable)	Each	1		
9	9300007A Drop Structure (A)*	L. Sum	1		
10					
11	* The lump sum amount for this item shall equal the sum of the				
12	amount for the preceding items.				
13					
14					
15					
16					
17					

ITEM NO	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
1	DROP STRUCTURE (B)				
2	2030501B Structural Excavation	Cu. Yd.	1,180		
3	6010004B Structural Concrete (Class S) (f'c = 4,000 psi)	Cu. Yd.	500		
4	6050002B Reinforcing Steel	Lb.	171,040		
5	8081410B Pipe (Ductile Iron) (4") (Class 52)	L. Ft.	70		
6	9140038B Grate (With Frame)	Sq. Ft.	105		
7	9140081B Ladder (Fixed)	L. Ft.	76		
8	9300007B Drop Structure (B)*	L. Sum	1		
9					
10	* The lump sum amount for this item shall equal the sum of the				
11	amount for the preceding items.				
12					
13					
14					
15					
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17					

ITEM NO	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
1	PUMP STATION				
2	2030501C Structural Excavation	Cu. Yd.	730		
3	5040571C Sluice Gate	Each	1		
4	5050101C Manhole Frame and Cover	Each	1		
5	6010004C Structural Concrete (Class S) (f'c = 4,000 psi)	Cu. Yd.	139		
6	6050002C Reinforcing Steel	Lb.	24,540		
7	7370430C Transformer (With Pad)	Each	1		
8	7379029C Motor Control Center (With Sensors)	Each	1		
9	8081473C Pipe (Ductile Iron) (24") (Class 52)	L. Ft.	60		
10	9140038C Grate (With Frames)	Sq. Ft.	150		
11	9140081C Ladder (Fixed)	L., Ft.	5		
12	9141701C Hatch Cover	Each	1		
13	9300007C Pump Station*	L. Sum	1		
14					
15	* The lump sum amount for this item shall equal the sum of the				
16	amount for the preceding items.				
17					

ITEM NO	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
1	TUNNEL ACCESS SHAFT				
2	2030501D Structural Excavation	Cu. Yd.	1,950		
3	6010004D Structural Concrete (Class S) (f'c = 4,000 psi)	Cu. Yd.	600		
4	6050002D Reinforcing Steel	L. Sum	94,400		
5	9300007D Tunnel Access Shaft*	L. Sum	1		
6					
7	* The lump sum amount for this item shall equal the sum of the				
8	amount for the preceding items.				
9					
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PROJECT NO. RAM 600-1-507

BIDDING SCHEDULE

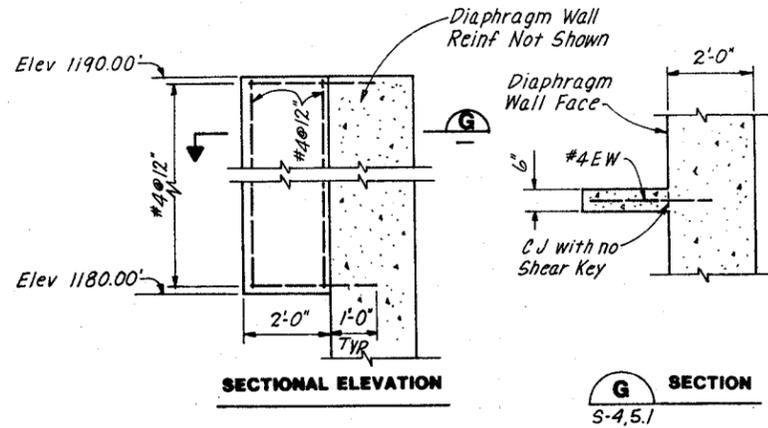
SHEET 9 OF 9

DATE 11/20/87

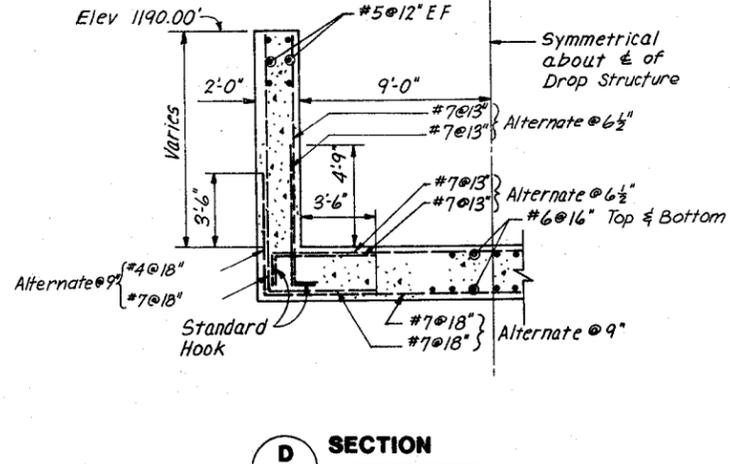
Addendum No. 1

ITEM NO	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
1	SUMMARY				
2					
3	Tunnel and Miscellaneous Items				
4	Drop Structure (A)				
5	Drop Structure (B)				
6	Pump Station				
7	Tunnel Access Shaft				
8					
9	TOTAL BID				
10					
11					
12					
13					
14					
15					
16					
17					

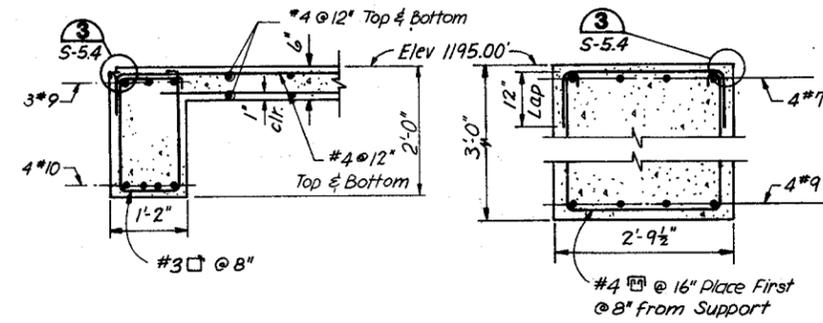
F.H.W.A. REGION	STATE	PROJECT NO	SHEET NO	TOTAL SHEETS	AS BUILT
9	ARIZ.	RAM-600-1-507	24	60	



**1 ANTI-VORTEX WALL**  
S-4 Scale  $\frac{1}{2} = 1'-0"$

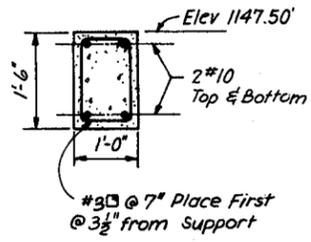


**D SECTION**  
Various Scale  $\frac{1}{4} = 1'-0"$



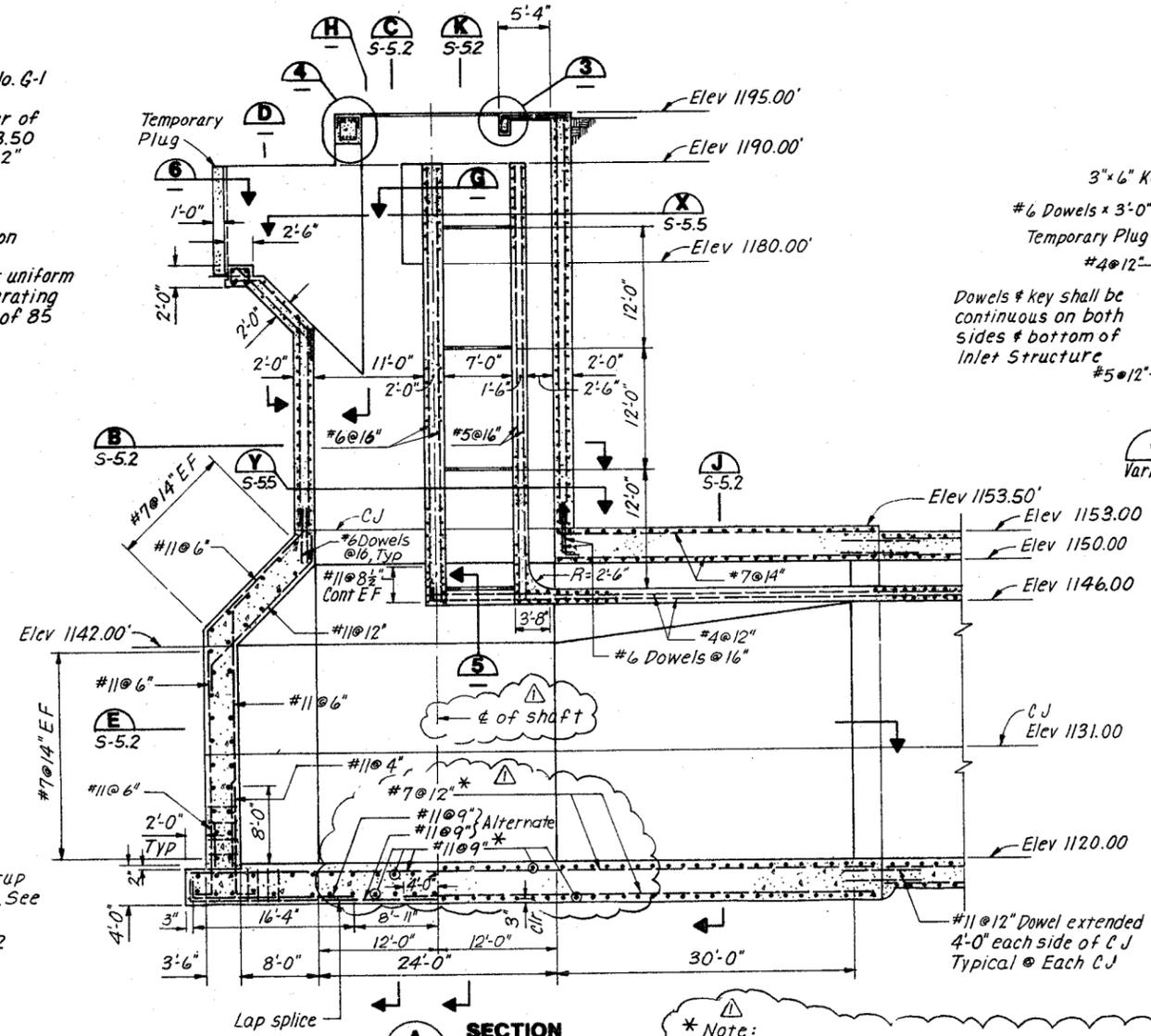
**3 DETAIL**  
S-4, 5.1 Not To Scale

**4 DETAIL**  
Various Not To Scale

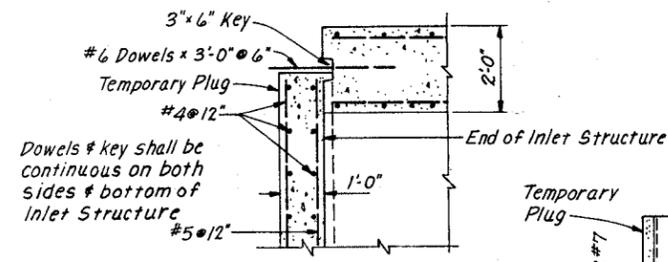


**5 DETAIL**  
Various Not To Scale

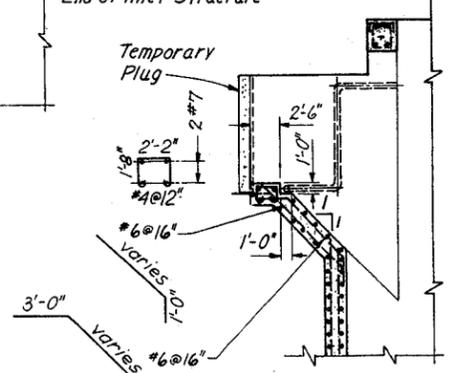
- NOTES**
1. For General Notes See Drawing No. G-1
  2. Reinforcement below elev 1153.50 shall have a minimum clear concrete cover of 3", and reinforcement above elev 1153.50 shall have a minimum clear cover of 2" unless otherwise indicated.
  3. 2'-0" Typ hook for #11 bars.
  4. 4'-0" Typ Lap for #11 bars.
  5. Roughen all horizontal construction joints.
  6. Top grating has been designed for uniform load of 250 lbs per sq ft. Landing grating shall be designed for uniform load of 85 lbs per sq ft.



**A SECTION**  
S-4, 5.2 Scale  $\frac{1}{8} = 1'-0"$



**6 DETAIL**  
Various Scale  $\frac{1}{2} = 1'-0"$



**H SECTION**  
S-4, 5.1

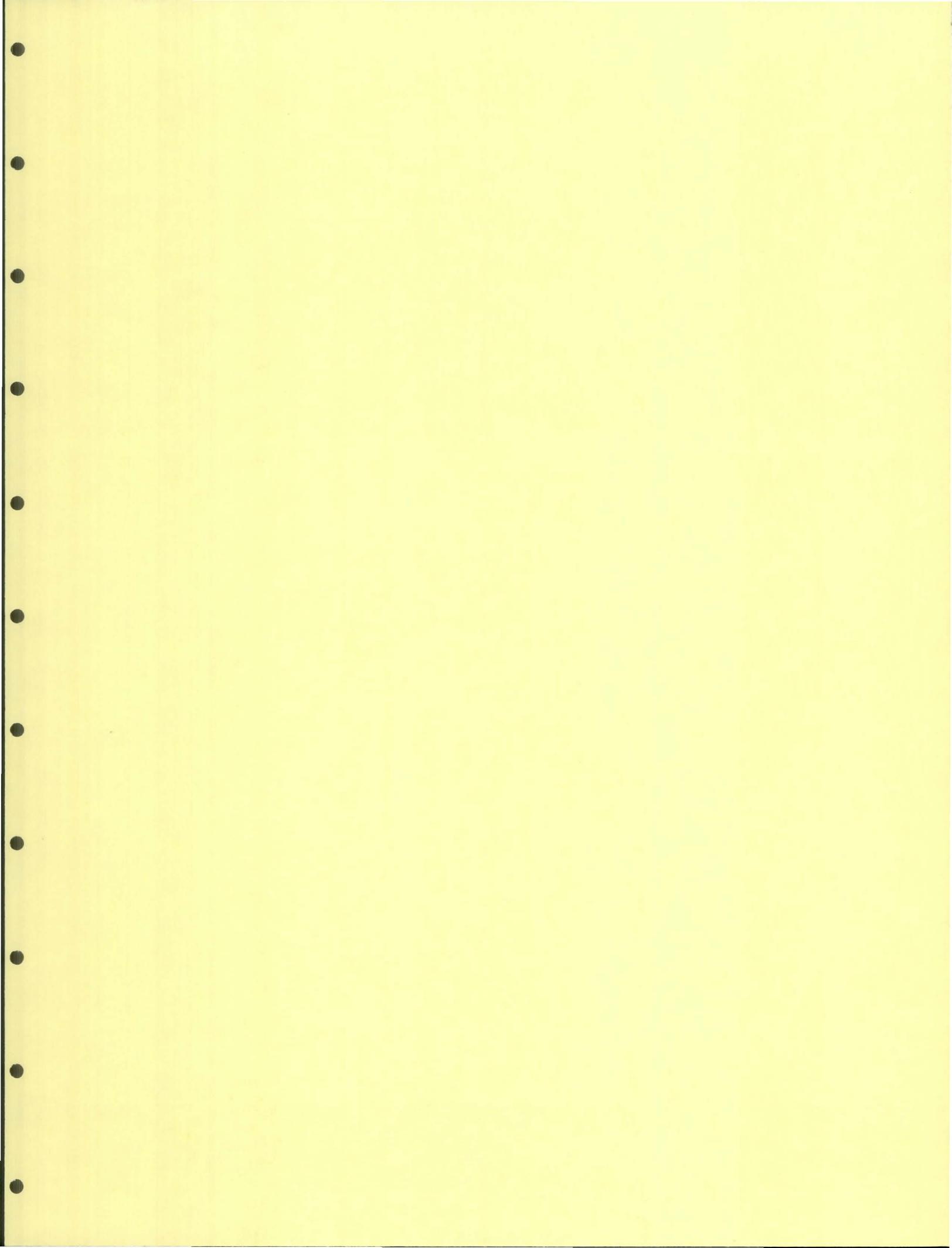
**AIR SLOT AND VENT PIPE**  
Scale  $\frac{1}{8} = 1'-0"$

\* Note:  
Longitudinal steel to right of  $\epsilon$  of shaft to be #7.  
Longitudinal steel to left of  $\epsilon$  of shaft to be #9.

**REDUCED NOT TO SCALE**

For Stirrup locations. See sect C S-5.2

	DESIGN	dqq	APPENDUM 11-19-87 JMC ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAY DIVISION OUTER LOOP HIGHWAY RAM-600-1-507 PRICE RD. DRAINAGE TUNNEL <b>SECTIONS &amp; DETAILS</b> <b>DROP STRUCTURE A</b> STA 8+16.00	ROUTE	MILEPOST	LOCATION OR STRUCTURE NO	DWG. NO.
	DRAWN	JMC		SR117			<b>S-5.1</b>
	CHECKED	dqq					
	APPROVED	dqq					





# ARIZONA DEPARTMENT OF TRANSPORTATION

## HIGHWAYS DIVISION

206 South Seventeenth Avenue Phoenix, Arizona 85007

EVAN MECHAM  
Governor

CHARLES L. MILLER  
Director

December 3, 1987

W.O. FORD  
State Engineer

### ADDENDUM

(2)

TO ALL CONTRACTORS AND OTHERS INTERESTED IN PROJECT RAM 600-1-507 NORTHEAST OUTER LOOP (SR117) (PHOENIX URBAN AREA) (PRICE ROAD DRAINAGE TUNNEL).

THE BID OPENING DATE HAS BEEN REVISED TO TUESDAY, 12 JANUARY, 1988, AT 11:00 A.M.

#### REVISIONS TO ADDENDUM NO. 1:

Sheet 6: BASIS OF PAYMENT: for the Ductile Iron Pipe Items is revised to read:

Payment will be as specified under ITEMS 9300007A, 9300007B, and 9300007C.

Sheet 8: of the Bidding Schedule: on line 4 the UNIT is revised to read "Lb."

#### REVISIONS AND ADDITIONS OF PROJECT PLANS SHEETS:

1. Dwg. No. G-2

BID ITEM 5030185 is revised to read BID ITEM 9300007A  
BID ITEM 5030186 is revised to read BID ITEM 9300007B  
BID ITEM 5060100 is revised to read BID ITEM 9300007C  
BID ITEM 9300007 is revised to read BID ITEM 9300007D

2. Dwg. No. C-11

This drawing has been revised. Please exchange the original sheet with its replacement included in this addendum.

DALLIS B. SAXTON, Engineer  
Contracts and Specifications Services

Addendum (2)  
RAM 600-1-507  
Sheet 1 of 1  
December 3, 1987





# ARIZONA DEPARTMENT OF TRANSPORTATION

## HIGHWAYS DIVISION

206 South Seventeenth Avenue Phoenix, Arizona 85007

EVAN MECHAM  
Governor

CHARLES L. MILLER  
Director

December 3, 1987

W.O. FORD  
State Engineer

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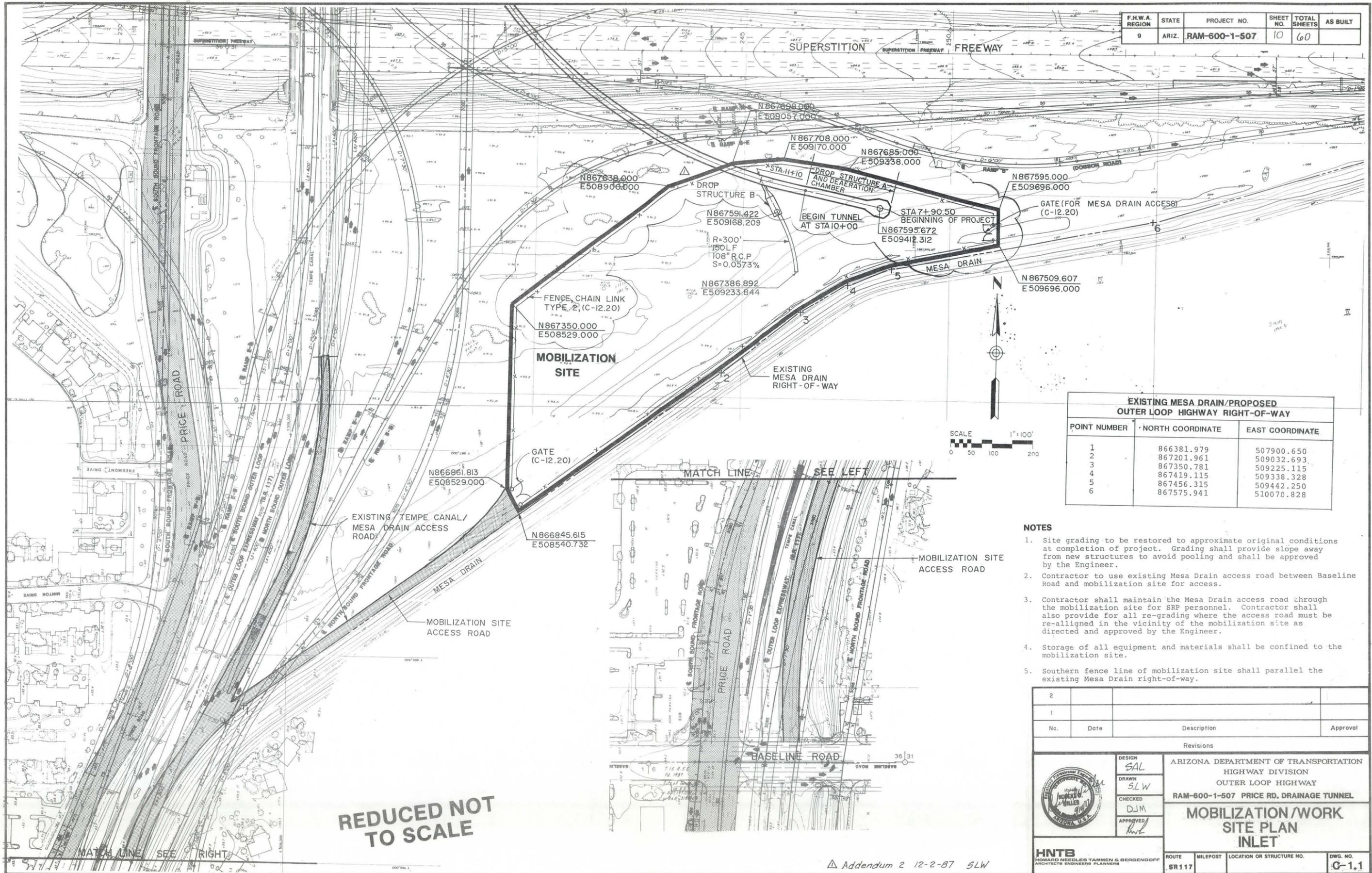
This drawing has been revised. Please exchange the original sheet with its replacement included in this addendum.

DALLIS B. SAXTON, Engineer  
Contracts and Specifications Services

Addendum (2)  
RAM 600-1-507  
Sheet 1 of 1  
December 3, 1987



F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
9	ARIZ.	RAM-600-1-507	10	60	



**EXISTING MESA DRAIN/PROPOSED OUTER LOOP HIGHWAY RIGHT-OF-WAY**

POINT NUMBER	NORTH COORDINATE	EAST COORDINATE
1	866381.979	507900.650
2	867201.961	509032.693
3	867350.781	509225.115
4	867419.115	509338.328
5	867456.315	509442.250
6	867575.941	510070.828

- NOTES**
1. Site grading to be restored to approximate original conditions at completion of project. Grading shall provide slope away from new structures to avoid pooling and shall be approved by the Engineer.
  2. Contractor to use existing Mesa Drain access road between Baseline Road and mobilization site for access.
  3. Contractor shall maintain the Mesa Drain access road through the mobilization site for SRP personnel. Contractor shall also provide for all re-grading where the access road must be re-alligned in the vicinity of the mobilization site as directed and approved by the Engineer.
  4. Storage of all equipment and materials shall be confined to the mobilization site.
  5. Southern fence line of mobilization site shall parallel the existing Mesa Drain right-of-way.

2			
1			
No.	Date	Description	Approval
Revisions			
		ARIZONA DEPARTMENT OF TRANSPORTATION HIGHWAY DIVISION OUTER LOOP HIGHWAY RAM-600-1-507 PRICE RD. DRAINAGE TUNNEL	
DESIGN: SAL DRAWN: SLW CHECKED: DJM APPROVED: [Signature]		<b>MOBILIZATION/WORK SITE PLAN INLET</b>	
<b>HNTB</b> HOWARD NEEDLES TAMMEN & BERGENSON ARCHITECTS ENGINEERS PLANNERS		ROUTE: SR117	MILEPOST: 36 31 LOCATION OR STRUCTURE NO.: DWG. NO.: C-1.1

**REDUCED NOT TO SCALE**

△ Addendum 2 12-2-87 SLW