PIMA COUNTY
WASTEWATER RECLAMATION

SECTION 3
STANDARD SPECIFICATIONS

Standard Specifications and Details for Construction

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Section 3

Standard Specifications

3.1 Earthwork

3.1.1 Description

Any Work under the *Standard Specifications and Details* shall consist of performing all operations necessary to excavate all materials, regardless of character and subsurface conditions; to excavate trenches for Public Sewers; to excavate all materials necessary for the construction of Public Sewer manholes and other structures; to place backfill for Public Sewer lines; to backfill holes, pits and other depressions; to remove and replace unsuitable material; and compaction requirements. These operations shall be performed in accordance with the lines, grades and typical sections designated in the Sewer Plans and the *Standard Specifications and Details* unless otherwise approved by the Field Engineer.

3.1.2 Materials

A. Crushed Stone

Crushed stone shall conform to the requirements of Table 1 in S.D. RWRD-104. This material shall consist of durable particles of crushed stone free of silt, clay, or other unsuitable material, and have a percentage of wear of not more than 40% when tested in accordance with ASTM C131 or C535. When material is subjected to five cycles of the sodium sulfate soundness test in accordance with ASTM C88 - Sodium Sulfate Solution, the weighted percentage of loss shall not exceed 12%. Additional tests for pH and minimum resistivity, in accordance with Arizona Test Method 236b, shall be required for sewer lines where ductile iron pipe and/or ductile iron fittings are used. The value of resistivity shall not be less than that for the existing in-place material or 2,000 ohm-cm, whichever is smaller.

Prior to the start of construction, documentation for materials testing shall be certified for conformance and submitted to the Field Engineer. When this material is obtained from excavation or a source selected by the Contractor, it must be Approved by the Field Engineer and require documentation for materials testing by a third party Geotechnical Engineer.

B. Sand

Sand shall conform to the requirements of Table 1 in S.D. RWRD-104. Additional tests for pH and minimum resistivity, in accordance with Arizona Test Method 236b, shall be required for sewer lines where ductile iron pipe and/or ductile iron fittings are used. The value of resistivity shall not be less than that for the existing in-place material or 2,000 ohm-cm, whichever is smaller.

Prior to the start of construction, documentation for materials testing shall be certified for conformance and submitted to the Field Engineer. When this material is obtained from excavation or a source selected by the Contractor, it must be Approved by the Field Engineer and require documentation for materials testing by a third party Geotechnical Engineer.

C. Excavated Native Material

Excavated native material used for backfill shall conform to the requirements of Table 1 in S.D. RWRD-104. This material shall not contain organic material, rubbish, debris or deleterious material. It shall not contain rocks, frozen earth or solid material larger than 6 inches in greatest dimension. Excavated material shall be well-graded and capable of meeting the compaction requirements of Subsection 3.1.3(F). Additional tests for pH and minimum resistivity, in accordance with Arizona Test Method 236b, shall be required for sewer lines where ductile iron pipe and/or ductile iron fittings are used in conjunction with the rigid pipe trench detail, per S.D. RWRD-104. The value of resistivity shall not be less than that for the existing in-place material or 2,000 ohm-cm, whichever is smaller.

Excavated material from an offsite source selected by the Contractor must be Approved by the Field Engineer and require documentation for materials testing certification by a third party Geotechnical Engineer.

D. Select Import Material

Select import material shall conform to the requirements of Table 1 in S.D. RWRD-104. This material shall not contain frozen lumps, rocks larger than 3 inches in diameter, chunks of clay or other objectionable material. Additional tests for pH and minimum resistivity, in accordance with Arizona Test Method 236b, shall be required for sewer lines where ductile iron pipe and/or ductile iron fittings are used in conjunction with the rigid pipe trench detail per S.D. RWRD-104. The value of resistivity shall not be less than that for the existing in-place material or 2,000 ohm-cm, whichever is smaller.

Prior to the start of construction, documentation for materials testing shall be certified for conformance and submitted to the Field Engineer. When this material is obtained from excavation or a source selected by the Contractor, it must be Approved by the Field Engineer and require documentation for materials testing by a third party Geotechnical Engineer.

E. Controlled Low-Strength Material (CLSM)

Materials comprised of CLSM shall conform to the requirements of Section 1006 of the *PAG Standard Specifications*. CLSM mix designs shall conform to Section 501-2.03 Table 501-1 of the *PAG Standard Specifications,* unless otherwise indicated in the Sewer Plans, or as directed by the Field Engineer.

F. Recycled Asphalt Product (RAP) and Lime

The use of recycled asphalt product or lime for trench materials and other sewer construction is prohibited.

3.1.3 Construction Details

A. Trenches and Embankments

The Contractor shall comply with all OSHA regulations pertaining to trenching operations. When used, trench boxes shall be positioned so that the compaction of trench material is not compromised when the box is advanced with work in progress. The inside walls of the box should be at least two pipe diameters clear on each side of the sewer pipe.

In regards to the completion of backfill operations prior to the end of the Contractor's work day, the maximum length of open trench for all installations shall be either 500 feet, or the Contractor's daily installation length, whichever is greater.

Trench widths for sewer lines installations shall conform to S.D. RWRD-104, unless otherwise noted in the Sewer Plans. The completed trench bottom shall be firm for its full length and width.

In special cases, the Sewer Plans may specify either a longitudinal camber or longitudinal arch along the trench bottom to compensate for the anticipated settlement of the sewer pipe. In such cases, special provisions for grade staking and alignment verification/testing shall be included in the Sewer Plans.

In cases where groundwater is encountered, the method of dewatering shall be determined on a case-by-case basis. In any case, the Contractor shall submit to the Field Engineer, a dewatering plan and a Stormwater Pollution Prevention Plan (SWPPP) for review and Approval, prior to the start of construction. Any modification due to variable soils or groundwater encountered during construction shall be forwarded to the Field Engineer.

If the ground surface elevation over any portion of an existing sewer line will be reduced so that the cover is less than 4 feet, the Contractor shall replace the reach with DIP or an Approved equal. This standard applies during construction, where the lowest elevation attained may be less than the finish grade. It also applies to the reconstruction of streets, the re-grading of Public Sewer easements or any other excavation where the existing sewer line will be subjected to additional loads by heavy trucks or compaction equipment.

B. Foundations

A modified trench foundation is required only when the native soil in the trench bottom does not provide a firm working platform for placement of bedding material, as described in the following cases.

Where rock, hardpan or other unyielding material is encountered at the trench bottom, such material shall be removed at least 12 inches below the trench bottom or as directed by the Field Engineer. The width to be removed shall conform to S.D. RWRD-104 or as indicated in the Sewer Plans, and maintained throughout the over-excavation. The over-excavated material shall be replaced with an Approved foundation material in accordance with S.D. RWRD-104.

Where unsuitable material is encountered that causes the trench bottom to be unstable, the unsuitable material shall be removed to a depth as specified by a Geotechnical Engineer. The width to be removed shall be the width of the trench, as shown on S.D. RWRD-104 or as indicated in the Sewer Plans, and maintained throughout the over-excavation. The over-excavated material shall be replaced with an Approved foundation material in accordance with S.D. RWRD-104.

Foundation material shall be compacted in layers, not exceeding 6 inches in depth, to at least 95% of the maximum dry density and optimum moisture content determined in accordance with the requirements of the applicable test methods of the ADOT Materials Testing Manual or as specified by the Geotechnical Engineer.

C. Bedding

Prior to the placement of bedding material and pipe, all trash, forms, sheeting, bracing and loose rock or loose earth shall be removed from the trench. The thickness of bedding material shall be in accordance with S.D. RWRD-104. Bell holes shall be provided at each pipe joint to permit proper assembly and support of the pipe.

D. Haunching and Shading

Haunching and shading material shall be the same material as that used for bedding.

Haunching shall be completed as the pipe is laid and placed up to the pipe's Springline (50% of the pipe's diameter). The shovel slicing technique shall be used to ensure material is placed under the haunches of the pipe to reduce voids and increase pipe support.

Shading material shall be placed in a manner which will prevent distortion of, damage to, or displacement of the pipe from its horizontal and vertical alignments. Shading material shall be placed over the haunching and pipe to a minimum of 12 inches above the top of the pipe and extend horizontally to the interior walls of the trench.

Haunching and shading material shall be compacted to 95% standard proctor, in accordance with the requirements of the applicable test methods of the *ADOT Materials Testing Manual*, as directed and Approved by the Field Engineer, unless otherwise noted in the Sewer Plans. Compaction through water settling or jetting is not permitted.

E. Backfill

Prior to placement of backfill material, all trash, forms, sheeting, bracing, loose rock or loose earth shall be removed from the trench.

Backfill material shall be compacted in lifts to attain a minimum of 95% standard proctor, in accordance with the requirements of the applicable test methods of the *ADOT Materials Testing Manual*, as directed and Approved by the Field Engineer, unless otherwise noted in the Sewer Plans. Backfill material and compaction shall also conform to the requirements of the Agency having jurisdiction of the Right-of-Way in which Public Sewers are being installed.

Compaction through water settling or jetting is not permitted. Backfill shall not be wheel loaded until 3 feet of cover is provided over the top of the pipe.

Failure of backfill compaction test results will result in rejection of that portion of the pipe installation. Replacement of trench materials and pipe will be at the Contractor's expense.

F. Backfill Density Testing Procedures

Additional density testing procedures for the compaction of backfill shall be provided for sewer construction projects meeting any of the following criteria:

- A cumulative total of 500 LF or more of new Public Sewer lines;
- The depth of either trench excavation or cover is greater than 20 feet;
- The geotechnical report, soil borings or historical records indicate a potential for the presence of groundwater; or
- The Department deems that site soil conditions warrant a geotechnical oversight (e.g. difficult to process soil type).

Density testing services shall be provided by a Geotechnical Engineer. Contact information for the Geotechnical Engineer and the field technicians working under his direction, shall be provided to the Field Engineer at the pre-construction meeting.

The Contractor shall continuously review density test results during backfill activities. Successive lifts of backfill shall not be placed until density test results show conformance to compaction requirements. Failure by the Contractor to adhere to these requirements will result in suspension of inspection by the Department and cancellation of the construction permit.

It is option of the Contractor to select either Procedure A or Procedure B for the density testing of backfill. Each procedure is described in the following Subsections.

i. Procedure A

The Geotechnical Engineer shall prepare and seal a *Geotechnical Quality Control Plan* (GQCP). The GQCP shall include the following:

- Project information;
- Quality Control Organization;
- Resumes;
- AASHTO Laboratory Certificate; and
- Control Procedures (i.e. moisture and density per lift).

The GQCP shall specify the minimum frequencies of random density and moisture tests to be performed for the Project and shall meet the minimum testing requirements of Subsection 3.1.3(F). It shall be submitted to the Field Engineering section for conformance review. A written notice to proceed will be issued by the Field Engineering section when the GQCP is Approved.

The applicable density test method will be dictated by the variability of backfill material to ensure proper compaction values are recorded.

The Contractor and the Geotechnical Engineer shall be equally responsible for ensuring proper backfill compaction is accomplished. Daily density testing results shall be made available upon request to the Contractor and the Field Engineer. Density test results shall meet or exceed minimum compaction requirements and shall be submitted to the Field Engineer on a weekly basis.

Density testing procedures shall conform to the following requirements:

(1) Perform random density and moisture tests in accordance with the GQCP (additional tests may be performed at any given location at the discretion of the Geotechnical Engineer).

(2) Perform a visual inspection of the trench bottom and check for unsuitable materials. If unsuitable material is encountered, it shall be over-excavated and replaced as directed by the Geotechnical Engineer.

(3) Trench Backfill:

- Density testing of trench backfill shall commence at approximately 2 feet above top of sewer pipe and continue to the base of the roadway structural section, or to the base of the stabilized surface, as applicable; and
- For each sewer reach installed, a minimum of one density test shall be taken at every vertical 2 feet of backfill between manholes, or one every 300 feet, whichever is shorter. The field technician shall conduct backfill density tests randomly, both horizontal and vertical, in accordance with the GQCP. These tests shall provide a representation of the compacted effort throughout the sewer reach length.

(4) Perform a visual inspection of each manhole base and check for unsuitable materials. If unsuitable material is encountered, it shall be over-excavated and replaced as directed by the Geotechnical Engineer. Where over-excavation and replacement under a proposed structure base is required, a minimum of one density test shall be taken at the approximate center of the proposed structure, or as directed by the Geotechnical Engineer.

(5) Density testing for backfill around manholes shall consist of one test per lift, and rotating with successive 2-foot increments at 120 degree intervals. Density testing of backfill around formed structures shall require one test per lift, alternating sides with successive 2-foot increments as instructed by the Geotechnical Engineer and in accordance with the GQCP. Density tests will be taken as close as possible to the structure to determine the representative compaction density, but not so close as to interfere with the functioning of the testing equipment.

Upon completion of sewer construction and prior to issuance of the ECC, the Geotechnical Engineer shall provide the Field Engineer with a *Final Compaction Report* (FCR) for review and approval. The FCR shall be certified with a cover letter and include all test data (i.e. re-tests, calibration tests, and test methods) and a map showing testing locations, referenced by station, depth below grade and percent compaction achieved. The Geotechnical Engineer shall also include a statement confirming that the FCR meets the original requirements of the GQCP.

Under the provisions of the compaction testing requirements herein, geotechnical oversight by the Geotechnical Engineer shall be taken to include review of the Sewer Plans, development of the GQCP and the FCR, supervision of and coordination with the field technician(s) performing compaction testing, and review of test results for compliance.

ii. Procedure B

The Geotechnical Engineer shall provide a full-time field technician, working under his/her direction, for observation and collection of the density testing results for sewer construction.

Density testing results meeting or exceeding minimum approved Project requirements shall be demonstrated through a *Daily Observation and Testing Report* (DOTR) prepared by the field technician. The Contractor and Geotechnical Engineer shall effectively communicate density test results to ensure proper backfill compaction is accomplished. The DOTR shall be made available to the Field Engineer and the Contractor by the end of each day.

Upon completion of sewer construction, the Geotechnical Engineer shall compile all DOTRs into a complete package. This package shall also include a sealed cover letter stating that backfill density testing procedures were adhered to in accordance with the Department's requirements.

G. Stabilized Surface Treatment for Public Sewer Easements

Stabilized surface treatment for Public Sewer easements shall conform to S.D. RWRD-111, unless otherwise indicated in the Sewer Plans.

3.2 Sanitary Sewer Pipe

3.2.1 Description

The work under Subsection 3.2 shall consist of furnishing and installing sanitary sewer pipe, and all other appurtenant materials required, including excavation and the furnishing, placing and compacting of bedding and backfill material, all in accordance with the details shown in the Sewer Plans and the requirements of the *Standard Specifications and Details*.

3.2.2 Materials

A. General

At each location where a pipe is to be installed, the pipe material, diameter and length, along with the requirements for each approved option at that location, such as wall thickness, coatings, lining, class and strength, shall be in accordance with the Sewer Plans.

Certification documents from the manufacturer shall be furnished attesting that the pipe and appurtenances (excluding linings and coatings if applied by an independent applicator) meet the requirements set forth in the *Standard Specifications and Details*. All pipe and appurtenances shall be clearly marked with the name or trademark of the manufacturer, the batch number, and the location of the manufacturing plant.

B. Vitrified Clay Pipe (VCP)

VCP shall be new and extra strength. All materials, manufacture and testing for VCP shall meet the requirements of ASTM C700, C1208, ASTM C896, ASTM C301 and ASTM C425.

C. Polyvinyl Chloride (PVC) Pipe

Except as modified herein, all materials, manufacture and testing for PVC gravity sewer pipe and fittings shall conform to ASTM D3034 for diameters of 4 through 15 inches and ASTM F679 for diameters of 18 inches and larger. PVC gravity sewer pipe shall be SDR 35 unless otherwise shown in the Sewer Plans.

PVC gravity sewer pipe shall have a minimum pipe stiffness of 46 psi at 5% deflection, in accordance with ASTM D2412.

PVC gravity sewer pipe and fittings shall be made of PVC plastic having a cell classification of 12454 or 12364, as defined in ASTM D1784. Additives and fillers,

including, but not limited, to stabilizers, antioxidants, lubricants, colorants, etc., shall not exceed 10 parts by weight per 100 parts of PVC resin in the compound.

PVC gravity sewer pipe joints shall be gasketed, bell-and-spigot, push-on type, conforming to ASTM D3212. Because each pipe manufacturer has a different design for push-on joints, gaskets shall be part of a complete pipe section and purchased as such. Gaskets shall conform to ASTM F477 and be factory-installed and locked-in. Lubricant shall be as recommended by the pipe manufacturer.

Standard laying lengths for PVC gravity sewer pipe shall be 14 feet.

Service connections shall be installed with "Tee" or "Wye" fittings, gasketed "Tee" saddles with stainless steel bands, or other tapping devices as Approved by the Field Engineer. Solvent welded "Wye" saddles are not Approved.

All fittings and couplings shall be compatible with the pipe to which they are attached and have an approved interior corrosion protection.

Pipes or fittings may be rejected by the Field Engineer for failure to comply with the requirements herein.

D. Ductile Iron Pipe (DIP)

All materials, manufacture and testing for DIP shall be in accordance with ASTM A746 and the latest revision of ANSI/AWWA C151/A21.51. Each pipe shall be subjected to a hydrostatic pressure test of at least 500 psi at the point of manufacture. DIP shall be manufactured in nominal 18 or 20-foot laying lengths.

DIP shall have standard asphaltic coating on the exterior, unless otherwise specified in the Sewer Plans.

DIP shall have an Approved interior lining installed by the pipe manufacturer or a third-party lining applicator. Refer to the Department's List of Approved Products for the recommended DIP interior lining materials.

The party responsible for applying the interior lining shall provide a certification statement as described in the following:

- *ALL DIP AND FITTINGS HAVE AN INTERNAL LINING COMPRISED OF [insert type of lining]. THE INTERNAL LINING THICKNESS IS 40 MILS NOMINAL (35 MILS MINIMUM) IN THE BARREL AREA, 10 MILS MINIMUM IN THE BELL AREA, AND 10 MILS MINIMUM ON THE EXTERIOR OF THE SPIGOT END.*
- *EACH PIECE OF PIPE AND EACH FITTING HAVE BEEN CHECKED FOR HOLIDAYS UTILIZING A TESTING VOLTAGE OF 7,500 V WITH A DRY CONDUCTIVE PROBE IN THE BARREL AREA AND A TESTING VOLTAGE OF 67.5 V WITH A WET SPONGE IN BOTH THE BELL AREA AND THE EXTERIOR OF THE SPIGOT END, AND THAT NO HOLIDAYS WERE FOUND.*

- *THE [insert lining name] EXTENDS FROM THE BOTTOM OF THE GASKET SOCKET IN THE BELL TO A POINT ON THE EXTERIOR OF THE SPIGOT END OF THE PIPE WHERE THE NEXT PIPE GASKET WOULD OVERLAP THE LINING.*
- *THE [insert lining name] IS INCLUDED ON THE PCRWRD LIST OF APPROVED PRODUCTS FOR DIP INTERIOR LININGS.*
- *A MAXIMUM LINING THICKNESS OF 15 MILS HAS BEEN APPLIED TO BOTH THE GASKET SEAT GROOVE IN THE BELL AREA AND THE EXTERIOR OF THE SPIGOT END.*

The following information shall be clearly marked on the exterior surface of each piece of DIP:

- Name or trademark of pipe manufacturer ;
- Pipe material “DI” or “Ductile”;
- Pressure class or thickness class;
- Date and country of pipe casting;
- Lot or Serial number;
- Name of lining applicator;
- Name of lining product;
- Thickness of lining; and
- Date of lining application.

All pipe shall be furnished with push-on type joints, such as Tyton® or Fastite®. Joints shall conform to the latest revision of ANSI/AWWA C111/A21.11, and shall be furnished complete with all required accessories. EPDM gasket material shall be used for all DIP, unless otherwise specified in the Sewer Plans.

Fittings shall be ductile iron and shall conform to the latest revision of either ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53. Fittings and accessories shall be furnished with either push-on or mechanical type joints in accordance with to the latest revision of ANSI/AWWA C111/A21.11.

Polyethylene wrap in tube or sheet form for piping encasement shall be manufactured from virgin polyethylene material and marked in accordance with the requirements of ANSI A21.5, ASTM D4976 and AWWA C105. The minimum thickness shall be 8 mils.

E. High-Density Polyethylene (HDPE) Pipe

HDPE pipe shall be manufactured from extra high molecular weight polyethylene material, meeting the requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D1248. The pipe material shall meet the requirements of cell classification PE345464C or PE345464E of standard polyethylene code designation PE3408, as defined by ASTM D3350. The manufacturer shall certify that the pipe material has been tested, in accordance with the provisions of ASTM F1473, for greater than 100 hours without failure. The manufacturer shall also

certify that the pipe has a hydrostatic design basis of 1,600 psi at 73° F and 800 psi at 140° F, when tested in accordance with the provisions of ASTM D2837.

HDPE pipe shall have a controlled outside diameter and manufactured to the SDR/DR rating and inside diameter specified by the Sewer Plans. The pressure rating of HDPE pipe shall be in accordance with ASTM D3035 and ASTM F714.

Fittings shall be manufactured using the same pressure rating as the designed piping system. Fittings shall have a controlled outside diameter and the SDR/DR rating for the pressure specified by the Sewer Plans. Fittings shall be specifically manufactured to standardized dimensions noted in the Sewer Plans.

Butt fusion fittings shall be manufactured from the same material as the extruded pipe, shall be rated for a pressure service equal to at least that for the system pipe, and shall have outlets manufactured to the same DR as the system pipe. Molded fittings shall be manufactured in accordance with ASTM D3261 and socket fittings shall be manufactured in accordance with ASTM D2683.

The pipe manufacturer shall have 5 years minimum experience in producing HDPE pipe. The pipe manufacturer shall maintain a continuous quality control program. HDPE pipe and fittings for a project shall be manufactured from the product of a single, approved manufacturer.

A Certificate of Compliance shall be provided by the pipe manufacturer that the HDPE pipe and fittings conform to the requirements of Subsection 3.2.2(E).

F. Fiberglass Reinforced Pipe (FRP)

Except where modified in the *Standard Specifications and Details*, all materials, manufacture and testing for FRP pipe shall conform to ASTM D3262, ASTM D3681-01, ASTM D4161 and ASTM D2412. The minimum pipe stiffness when tested in accordance with ASTM D2412, shall be 46 psi.

The pipe manufacturer shall maintain a continuous quality control program. FRP pipe shall be manufactured from only polyester resin systems with a proven history of performance in the application of gravity sewer pipe installations. The historical data shall have been acquired from material(s) of similar construction and composition as the proposed product.

The reinforcing glass fibers used to manufacture the components shall be of the highest quality commercial grade E-glass filaments with binder and sizing compatible with impregnating resins.

Sand shall be a minimum of 98% silica with a maximum moisture content of 0.2%.

When used, resin additives, such as curing agents, pigments, dyes, fillers, and thixotropic agents shall not detrimentally affect the performance of the product.

Gaskets shall be suitable for the service intended, conform to ASTM F477, and be supplied by a qualified gasket manufacturer.

The pipe shall be manufactured using only the centrifugal-casting process, in order to produce a dense, non-porous, corrosion-resistant, uniform structure. The pipe shall meet the ASTM D3262 standard specification, Cell Limit Type 1, Liner 2 and Grade 3. The manufacturer of pipe and fittings must demonstrate a 10-year history of successful installations in the United States for sanitary sewer service.

Unless otherwise indicated in the Sewer Plans, the pipe shall be field connected with fiberglass sleeve couplings that utilize built-in double fin elastomeric sealing gaskets made of EPDM rubber compound as the sole means to maintain joint water tightness. The joints must meet the performance requirements of ASTM D4161.

For sliplining and tunnel carrier installations, joints at tie-ins, may utilize fiberglass, gasket-sealed closure couplings.

For jacking installations, the joint shall have approximately the same outside diameter as the pipe. When the pipes are assembled, the joints are essentially flush with the pipe outside surface. Joints at tie-ins, may utilize fiberglass, gasket-sealed closure couplings.

The interior surface layer or liner shall consist of a highly flexibilized nominal 40 mil thick polyester resin with a minimum elongation of 50% when tested according to ASTM D638. Interior glass reinforced layers of pipe cannot be the corrosion barrier or liner finish. All pipes shall be tested per ASTM D3681 corrosion test using 1 N sulfuric acid and demonstrating a 0.90% or better strain for 100-year service life design.

Flanges, elbows, reducers, tees, wyes, laterals and other fittings, shall be capable of withstanding all operating conditions when installed. They may be contact molded or manufactured from mitered sections of pipe joined by glass-fiber-reinforced overlays. Properly protected standard ductile iron, fusion-bonded epoxy coated steel and stainless steel fittings may also be used.

Reinforced fiberglass manhole tee base fittings shall be constructed of mitered sections of FRP connected with fiberglass reinforcement laminations. The diameter and length of the tee base through section, and the vertical leg shall be as shown in the Sewer Plans or as agreed between purchaser and supplier, as Approved by the Field Engineer. Pipes used to construct the tee base shall have the same stiffness as the line pipes, but not greater than 46 psi as a minimum requirement. Fabricate the tee base through section with a mitered elbow configuration to achieve the required angles shown in the Sewer Plans. Maximum angle of each miter is 30 degrees except individual alignment changes up to 35 degrees may be 1 miter. Construct drop configurations as shown in the Sewer Plans. Accommodate diameter changes at manholes using a reducer on the upstream side of the tee base. Assemble the tee base to the line pipes using the same gasket-sealed joint as pipe-to-pipe connections or another gasket-sealed joint as approved by the pipe manufacturer.

The actual outside diameter for pipe sizes ranging from 18-inches to 48-inches shall be in accordance with ASTM D3262. For other pipe sizes, the outside diameters shall be in accordance with the manufacturer's literature.

Pipe shall be supplied in nominal lengths of 20 feet. Actual laying length shall be nominal +1, -4 inches. At least 90% of the total footage of each size and class of pipe, excluding special order lengths, shall be furnished in nominal length sections.

For direct bury and sliplining installations, the minimum wall thickness shall be the stated design thickness.

For jacking installations, the minimum wall thickness is determined from the maximum jacking load. This thickness is measured at the bottom of the spigot gasket groove where the wall cross-section has been reduced. The minimum factor of safety against jacking force is 2.5, based on straight alignment.

Pipe ends shall be square to the pipe axis, with a maximum tolerance of 1/8".

The Field Engineer shall be entitled to inspect pipes or witness the pipe manufacturing.

Should the Field Engineer request to see specific pipes during any phase of the manufacturing process, the manufacturer shall provide the Field Engineer with adequate advance notice of when and where the production of those pipes will take place.

Packaging, handling, and shipping shall be done in accordance with the manufacturer's instructions.

G. Reinforced Concrete Pipe (RCP)

RCP for Public Sewers shall be circular and conform to the requirements of ASTM C76. The use of arch or elliptical RCP is not permitted. RCP shall have all of its interior surfaces lined with an Approved lining material or as Approved in the Sewer Plans. Refer to the Department's List of Approved Products for the recommended interior lining materials for RCP. RCP shall have a nominal laying length of 8 to 20 feet, unless otherwise Approved by the Field Engineer.

The wall thickness and reinforcing steel shall conform to ASTM C76 and the designated class of pipe as indicated in the Sewer Plans. When the designated class of pipe is not specified in the Sewer Plans, it shall be determined in accordance with the Concrete Pipe Design Manual by the American Concrete Pipe Association, latest edition. All jacking pipe shall be specifically designed by the pipe manufacturer to withstand all forces that the pipe may be subjected to during jacking operations.

All RCP shall be manufactured in accordance with ASTM C76 and C497, or as specified in the Sewer Plans. A letter from the supplier to the Field Engineer shall be submitted certifying that all RCP is manufactured in accordance with ASTM C76.

The manufacturer shall specify the maximum allowable joint gaps on all conduit sizes for the project and it shall be provided to the Field Engineer. The maximum allowable joint gap is determined as that point where the bevel of the bell and the shoulder of the spigot are vertically aligned and the rubber gasket has achieved the minimum compression necessary to ensure a water tight seal.

A production schedule shall be provided to the Field Engineer at least three Working Days in advance of when the various types of pipe will be cast, so that the casting operation may be inspected and appropriate specimens may be selected for testing in accordance with the Sewer Plans.

Type II Portland Cement complying with the requirements of ASTM C150 shall be used in the production of RCP unless otherwise indicated in the Sewer Plans or Approved by the Field Engineer.

Lifting anchors shall be used on all precast concrete pipe. Lifting holes are not allowed. The use of other lifting mechanisms proposed for handling and placement of RCP shall be submitted to the Field Engineer for Approval.

Details of all fittings and specials shall be submitted for Approval to the Field Engineer prior to construction. Fittings and specials shall be made up of pipe segments having the same structural qualities and the same interior treatment as the adjoining pipe.

Joints shall be formed using rubber gaskets that provide a watertight seal, in accordance with ASTM C443. Joints shall be capable of withstanding the forces caused by the compression of the gasket when joined.

Joints shall be either bell-and-spigot or tongue-and-groove styles. The spigot or tongue shall be grooved to properly contain and seat the rubber gasket. Joint assemblies shall be accurately formed so that when each pipe section is forced together in the trench, the assembled pipe shall form a continuous watertight conduit with a smooth and uniform interior surface. Joints shall provide for slight movement of any piece of the pipeline caused by expansion, contraction, settlement or lateral displacement. The gasket shall be the sole element of the joint providing water tightness. The ends of the pipe shall be perpendicular to the longitudinal centerline of the pipe, except where bevel-end pipe is required. The ends shall be finished so that they are uniform and smooth.

Rubber gaskets for bell-and-spigot joints shall consist of an O-ring rubber gasket, rubber profile gasket, or gasket conforming to the pipe manufacturer's specifications.

Gaskets may be either natural rubber or neoprene and shall conform to ASTM C443. All gaskets shall be stored in a cool place, preferably at a temperature of less than 70 degrees Fahrenheit. In no case shall gaskets be stored in the open or exposed to direct sunlight. No gasket that shown signs of deterioration, such as surface cracking or checking, shall be installed in a pipe joint. When the air temperature is 10 degrees F or lower, the gaskets shall be warmed to a

temperature of 60 degrees Fahrenheit, for a period of 30 minutes, before being placed on the pipe.

In addition to all other requirements set forth in this specification, the following additions shall apply to RCP being jacked: Pipe shall be Class V, unless otherwise specified in the Sewer Plans; grouting nipples shall be spaced no more than 8 feet apart on the installed pipeline; and pipe shall include steel joint rings (bell-and-spigot) conforming to ASTM C361.

The following shall be clearly marked on the interior and exterior surfaces of the pipe:

- Name or trademark of pipe manufacturer;
- ASTM specification designation (C76);
- Class and size;
- Date of pipe manufacture;
- Lot or serial number;
- Name of lining applicator;
- Name of lining product;
- Thickness of lining; and
- Date of lining application.

3.2.3 Construction Details

A. Survey Requirements

i. Survey Cut Sheets

The Contractor shall be responsible for providing survey cut sheets to the Field Engineer in an Approved format and prior to commencing with sewer construction activities. Survey cut sheets shall be sealed by an Arizona Registered Land Surveyor and include all grade stakes to be used for the construction of new Public Sewers. Survey cut sheets shall also include a description for any unusual conditions, such as extra cuts, extra cover, and drainage. Any errors or omissions in the survey cut sheets that result in improper sewer construction shall not be the responsibility of the Department.

Any revisions to the Sewer Plans that may occur during the progress of construction shall require a re-submittal of the survey cut sheets to the Field Engineer.

ii. Construction Survey Stakes

Survey stakes, for the construction of Public Sewers, shall be provided on an appropriate offset line at no greater than 50-foot intervals along the sewer line. At least two survey stakes shall be provided for each manhole and one stake shall be provided for each HCS/BCS cleanout. Each stake shall be marked and match the data provided in the survey cut sheets. The distance and direction of the offset line

(N, S, E or W) shall be shown in relation to the sewer line. For example, if the offset line is ten feet north of the sewer line, then the offset distance and direction shall be "10'N." Stationing shall begin at a known permanent point (such as a monument or property pin) and remain visible after completion of construction.

Survey stakes shall be offset far enough away from excavation to avoid being lost during excavation or cave-ins. It shall be the responsibility of the Contractor to immediately replace lost or damaged stakes.

The Contractor shall provide sufficient checks and verifications of the sewer line grades and alignments during construction to ensure that new Public Sewers are constructed within the allowable tolerances per Subsection 3.2.3(D)(vii).

B. Installation of Pipe

i. General

Sewer pipe and appurtenances shall be handled so as to ensure delivery to the trench in sound and undamaged condition. Sewer pipe shall be unloaded near the location at which it will be installed. Sewer pipe shall not be stored along residential streets for more than 10 days or along a business street for more than 3 days. The interior of the sewer pipe shall be thoroughly cleaned of foreign material before being lowered into the trench.

New sewer system construction shall commence from the downstream point and progress upstream.

Installation of sewer pipe shall be in finished trenches free of water and debris, ~~and commence at the lowest point of the sewer line~~ with the spigot ends pointing in the direction of the flow. Each pipe shall be laid true to line and grade, with uniform support under the full length of the pipe.

Any adjustment of line and grade shall be made by excavating or filling under the pipe. Wedging or blocking under the pipe ends is prohibited.

When work is not in progress, open pipe ends shall be securely closed with an Approved pipe plug or end cap so that no water, earth, animals or other foreign objects will enter the pipe. If any debris is found in the pipe prior to testing, the pipe shall be cleaned by propelling a snug-fitting inflated ball, or other Approved device, through the pipe with water.

Pipes made from unlike materials shall be coupled together in accordance with S.D. RWRD-103.

ii. Vitrified Clay Pipe (VCP)

VCP shall be installed in accordance with ASTM C12 and the latest installation publications available from the National Clay Pipe Institute (e.g. Clay Pipe Engineering Manual).

After a sewer line reach (manhole-to-manhole) has been backfilled to finish grade, it shall be tested for excessive leakage in accordance with the applicable testing requirements of ASTM C828 or ASTM C1091.

iii. Polyvinyl Chloride (PVC) Pipe

PVC pipe shall be installed in accordance with ASTM D2321 and the latest installation publications available from the PVC Pipe Association (e.g. UNI-PUB-9 and UNI-B-6). Embedment requirements for PVC pipe shall conform to S.D. RWRD-104.

Care shall be taken during the transportation of the pipe to ensure that the tie-down methods do not damage or deflect the pipe. PVC pipe shall be delivered to the job site and stored on palletized units, not to exceed 40 inches in height. Stacking of palletized units at the job site shall not exceed 8 feet in height. PVC pipe shall not be removed from the pallet or laid out along the ditch more than 24 hours prior to installation in the trench.

In addition to the tests at the manufacturer's plant, the Field Engineer may require that tests be performed on pipe specimens selected at random at the point of delivery or at the job site. The Department will bear the costs of such tests that shall be in accordance with ASTM D2412 and D2444.

Any imperfections, which, in the opinion of the Field Engineer, may adversely affect the performance of the pipe or joints, shall be cause for rejection of the PVC pipe.

All surfaces of the joint, upon which the gasket may bear, shall be smooth and free of any imperfection that could adversely affect sealing ability. All pipes shall have a “stop-mark” on the spigot end to indicate proper penetration when the joint is made. Pipes at joints are not to be inserted beyond “stop-mark” on spigot end.

A resilient connector per ASTM C923 (i.e. water stop) shall be installed on the PVC pipe where it connects into a concrete manhole. After a reach (manhole-to-manhole) of installed PVC pipe has been backfilled to finish grade, it shall be tested for excessive leakage by a low-pressure air test, conducted in accordance with ASTM F1417.

The testing method selected shall properly consider the existing groundwater elevations during the test. If the test section fails the test for excessive leakage, the contractor shall repair or replace all defective materials and/or workmanship at no additional cost to the Department.

Deflection testing shall be conducted in accordance with Subsection 3.2.3(D).

iv. Ductile Iron Pipe (DIP)

DIP shall be installed in accordance with ANSI/AWWA C105/A21.5 and the latest publications available from the Ductile Iron Pipe Research Association (e.g. Installation Guide for DIP).

The Field Engineer may require field testing of protective linings for DIP. Pipe found with damage or Holidays to the protective lining shall be removed and replaced, or repaired immediately. Repair of damaged areas of the protective lining shall be in accordance with the recommendations of the lining applicator. Repaired areas shall be equal, in all respects, to undamaged lined areas.

An Approved coating material shall be used for field cuts of DIP pipe. A minimum coating thickness of 10 mils shall be applied to the exterior surface of the pipe spigot and overlap the internal lining by 4 inches. The area of lining to be overlapped shall be roughened to a profile roughness height of 3 to 5 mils prior to the coating application. The coating material shall be allowed to dry properly before pipe assembly.

Direct-bury installations of DIP shall be encased with polyethylene wrap. Exposed installations of DIP and ductile iron fittings (e.g. above ground, vaults, wet-wells and casings) shall have an applied exterior coating in accordance with the Sewer Plans or as directed by the Field Engineer.

After a reach (manhole-to-manhole) of installed DIP pipe (gravity) has been backfilled to finish grade, it shall be tested for excessive leakage by a low-pressure air test, conducted in accordance with ASTM C924. Gravity sewer reaches with composite pipe materials (e.g. VCP, PVC and DIP) shall be tested in accordance with Subsection 3.2.3(D)(iii).

For DIP force main installations, after all pipe, fittings and appurtenances have been completely installed, they shall be tested for excessive leakage by a hydrostatic pressure test in accordance with ANSI/AWWA C600.

v. High-Density Polyethylene (HDPE) Pipe

Force main installations with HDPE pipe shall be installed in accordance with ASTM D2774, AWWA M55 and the latest installation publications available from the Plastic Pipe Institute (e.g. Handbook of Polyethylene Pipe).

Prior to the site delivery of the pipe, the Contractor shall provide the following information to the Field Engineer:

- Detailed procedures to be used in joining and installing the piping system, including manufacturers' recommendations;
- Interface of piping system to equipment and appurtenances; and
- Bill of materials, indicating material composition of pipe, pressure rating, nominal size with wall dimensions, and its locations on the piping installation drawing.

HDPE pipe and fitting joints shall be heat fused by a qualified technician trained by an approved manufacturers' representative, in accordance with the manufacturer's recommended fusion procedures. Training shall have occurred in the previous 12 months or submittals verifying field installation experience within the previous 12 months for all technicians performing heat fusion on HDPE pipe and fittings shall be submitted prior to the start of installation.

All necessary precautions shall be taken to prevent damage or contamination to the pipe and other incidental materials during shipment and delivery. All materials shall be securely fastened to the truck or rail car to prevent movement or damage during shipment. The Contractor shall examine all materials before unloading.

All pipe materials shall be handled so as to prevent damage. HDPE pipe shall not be dropped, rolled, or pushed off from any height on delivery, storage, or installation.

All pipe materials shall be stored off the ground in a dry location. Pipe shall be stored to prevent sagging or bending. Stored pipe shall be protected from exposure to ultraviolet light.

All piping shall be inspected to assure that it is free from defects in material and workmanship. The compatibility of all pipes and fittings shall be verified.

Pipes, fittings and accessories that are cracked, damaged, unidentifiable, or in poor condition, shall be rejected. Pipe sections or fittings containing significant scratches, dents or marks that are not in accordance with the manufacturer's criteria for such blemishes, may be cause for rejection at the sole discretion of the Field Engineer.

The Field Engineer shall have free access to all joints, including test joints, for determining the suitability of the joining procedure. Where construction restrictions limit inspection of joints, the Field Engineer may direct the individual joining the pipe and/or fittings to perform a test in a manner that it can be clearly and easily observed. The Field Engineer shall select the method of testing from either visual examination, bent strap testing, or ultra-sonic testing. Ultra-sonic testing shall conform to the requirement of the U.S. Department of Transportation as found in the code of federal regulations 49, Part 192.285(b)(ii) or (b)(iii).

HDPE pipes and fittings shall be heat-fused together to create a homogeneous joint. Joining shall be performed in accordance with the manufacturer's heat fusion recommendations. Solvent weld joints are not permitted.

Personnel responsible for heat fusing the joints shall demonstrate proficiency by fusing trial joints and testing the trial joint by bent strap testing or ultra-sonic testing. Trial joints shall be allowed to cool completely before testing and shall not fail at the joint. During construction, the first fusion of the day shall be a trial fusion that shall be allowed to cool and tested either by a destructive bent strap test or with an ultrasonic testing device. If the joint fails, additional trial joints shall be made and tested until successful fusions are completed. The procedure used to join the trial joint shall be used for the balance of the day's work, provided the procedure is in compliance with that recommended by the manufacturer. The Field Engineer shall provide written notice to the Contractor of the unacceptability of any welding technician who is deemed deficient in welding HDPE pipe. In any case, the welding technician shall not be utilized by the Contractor unless the individual undergoes additional training and re-certification for HDPE pipe welding.

HDPE pipe shall be installed to minimize shear and tensile stresses and in accordance with S.D.s RWRD-104 and -500 or as indicated in the Sewer Plans.

After HDPE piping has been backfilled to finish grade, it shall be tested for field leaks by a hydrostatic pressure test in accordance with ASTM F2164 and A.A.C. R18-9-E301(D)(4)(f).

vi. Fiberglass Reinforced Pipe (FRP)

For direct bury installations, trench construction shall conform to Subsection 3.1.3(A). Bedding and shading material for FRP and FRP fittings shall be in accordance with the Sewer Plans and the manufacturer's requirements. Backfill material shall conform to the requirements of Subsections 3.1.2(C) and 3.1.2(D), as applicable. The placement and compaction of shading and backfill material shall conform to Subsections 3.1.3(E) and 3.1.3(F).

For slip lining and tunnel carrier installations, annular space grouting shall not damage the liner and shall conform to the manufacturer's requirements.

FRP shall be handled with textile slings, other suitable materials or a forklift. Use of chains or cables is not permitted.

The jointing of FRP shall be accomplished as described in following:

(1) Clean ends of pipe and coupling components;
(2) Apply joint lubricant to pipe ends and elastomeric seals of coupling. Use only lubricants approved by the pipe manufacturer;
(3) Use suitable equipment and end protection to push or pull the pipes together;
(4) Do not exceed forces recommended by the manufacturer for coupling pipe; and
(5) For direct bury installations, join pipes in straight alignment then deflect to required angle. Do not allow the deflection angle to exceed manufacturer's limits.

Manholes for FRP shall be constructed using pipe tee base fittings that are encased in concrete. The encasement shall be designed to prevent distortion of the tee base from heavy loads. This encasement shall also serve as the base to support pre-cast or cast-in-place concrete riser structures per Subsection 3.3.3(B)(i).

Where an FRP end must be connected into a concrete manhole, a resilient connector per ASTM C923, or joint coupling per ASTM D4161, shall be installed on the pipe to provide a watertight connection.

Field testing for direct bury, jacking and tunnel carrier installations of FRP shall conform to the following:

(1) Each reach may be tested by low-pressure air per Subsection 3.2.3(D)(iii). The system passes the test if the pressure drop caused by leakage through the pipe or pipe joints is less than or equal to the specified amount over the prescribed time period;

(2) For pipes large enough to enter, individual joints may be pressure tested per Subsection 3.2.3(D)(iv) in lieu of line infiltration, exfiltration or low-pressure air testing; and

(3) Deflection testing shall conform to Subsection 3.2.3(D)(iv).

Field testing for sliplining installations of FRP shall be based on a CCTV inspection per Subsection 3.2.3(D)(viii). The CCTV inspection shall be performed after grouting to assure that all joints are properly assembled, that no damage exists and that any leakage or deformation is within the allowable limits in accordance with Subsection 2.3.2(D)(iv).

vii. Reinforced Concrete Pipe (RCP)

In addition to any deficiencies not covered by the applicable ASTM specifications, individual concrete pipe sections shall be subject to rejection if any of the following occur:

- Surface defects indicating honeycombed or open texture that would adversely affect the function of pipe sections. Onsite repairs may be made, if Approved by the Field Engineer;
- Damaged ends, that would prevent making a satisfactory joint;
- Pipe that has been excessively patched or repaired. The manufacturer may request that the Field Engineer perform an inspection at the plant, prior to delivery, to assess patching and/or repair work on conduits. Pipe damaged during shipment or construction may be repaired with the Approval by the Field Engineer;
- Exposed reinforcement with the exception of the ends of longitudinals, stirrups, and spacers, that are used to position reinforcing steel, and may be repaired with the Approval by the Field Engineer;
- Concrete pipe delivered to the site greater than 5 calendar days prior to the start of sewer construction unless otherwise Approved by the Field Engineer;
- Broken bells or spigots on installed pipeline; and
- Joint gaps greater than manufacturer's allowable limits.

Acceptance of the pipe at point of delivery will not relieve the Contractor of full responsibility for any defects in materials due to workmanship.

RCP shall be installed in accordance with ASTM C1479 and the latest installation guides and procedures of the American Concrete Pipe Association (e.g. Concrete Pipe Installation Guide).

RCP shall be placed with the grove or bell end upstream. Each conduit section shall be set into position and checked for line and grade prior to continuing

placement. The manufacturers' recommendations shall be closely followed during installation.

The Contractor shall ensure that all RCP is kept clean and free from gravel, dirt and debris during and after installation. Precautions shall be taken by the Contractor to eliminate soil and debris from being washed into the sewer prior to completion of sewer construction.

For RCP 30-inches in diameter and greater, if the end-face joint gap is greater than or equal to 65% of the manufacturer's limits, the entire internal joint perimeter shall be grouted with an Approved non-shrink grout product. If the end-face joint gap is greater than the manufacturer's limits at any point around the internal joint perimeter, the adjoining pipe sections will be rejected.

After a reach (manhole-to-manhole) of installed RCP has been backfilled to finish grade, it shall be tested for excessive leakage in accordance with the applicable testing requirements of ASTM C924.

C. Service Lateral (HCS/BCS) Connections

Direct connections of 4-inch service laterals to the Public Sewer line shall be installed in accordance with S.D. RWRD-401 or as Approved per the Sewer Plans. The spacing between a tapping saddle and: another tapping saddle, a pipe joint or a manhole shall conform to the pipe manufacturer's recommendations. No portion of the tapping saddle or service lateral shall protrude into the sewer line.

Where indicated in the Sewer Plan, the connection of 4-inch service laterals into manholes shall conform to S.D. RWRD-402. The connection of 6 inch diameter service laterals and greater into manholes, shall conform to S.D.s RWRD-200 to -204. Drop manhole connections for service laterals shall be avoided, unless indicated in the Sewer Plans or Approved by the Field Engineer. Drop manhole connections service laterals less than or equal to 6 inches in diameter, shall be constructed per S.S.D. RWRD-403. Drop manhole connections for service laterals greater than 6 inches in diameter shall be constructed per S.S.D.s RWRD-229 or -230, as applicable.

~~With exception to wye fittings and saddles, t~~The horizontal alignment of service laterals (HCS/BCS) shall be perpendicular to the sewer line and without bends, unless otherwise indicated in the Sewer Plans or as Approved by the Field Engineer.

The vertical alignment of service laterals shall conform to pipe manufacturer recommendations, local building codes and S.D. RWRD-401. For new or existing underground utilities or other obstacles that will hinder the vertical alignment of a new service lateral, the service lateral may be rerouted per S.D. RWRD-400.

For existing service laterals encountered during non-sewer related construction, the service laterals shall be protected, repaired or rerouted per S.D. RWRD-400, as the situation dictates and at no expense to the Department or the property owner.

Backfill material for service laterals, located within Right-of-Way and Public Sewer easements, shall be compacted in accordance with Subsection 3.1.3(F).

Cleanout risers shall be constructed for 4-inch service laterals per S.D. RWRD-404. For buried cleanout risers (i.e. Type III), the Contractor shall be responsible for completing and submitting a *Memorandum of Understanding for Type III Buried Cleanout Risers* form to the Field Engineer, prior to Construction Acceptance. The completed form must be signed and dated by the owner/developer of the Project and a representative from the home builder. Contact the Field Engineer for the latest version of this form.

Temporary caps shall be furnished and installed at the end of new service laterals. Installed caps shall be capable of withstanding earth loads and low-pressure air testing.

An Approved marking tape for service laterals shall be installed in accordance with S.D. RWRD-401. The marking tape shall have continuous printing stating, "*CAUTION: PRIVATE HCS/BCS*", unless otherwise Approved by the Field Engineer.

The method of disconnection and abandonment for existing service lateral connections will be determined on a case-by-case basis by the Field Engineer.

Any damage to existing Public Sewers as the result of a new service lateral connection shall be reported immediately to the Field Engineering section. On weekends, Holidays or after business hours, immediately report to the Pima County Sheriff's office. Any costs incurred by the Department for repairing damage to Public Sewers will be billed to the Applicant of the new sewer connection. The Agency having jurisdiction over the building codes will be asked not to release permits or certificates of occupancy until the Department has received payment.

D. Sewer Line Testing and Tolerances

The construction of new Public Sewer lines shall be inspected and tested in accordance with the applicable methods specified in AAC R18-9-E301(D) and as required by the Department.

i. General

During the construction of Public Sewers, the Contractor shall provide access to the trench and installed pipe to allow for inspections by the Field Engineer.

ii. Mirror Inspections

Mirror inspections shall be used for identifying alignment deficiencies in a sewer line during the progress of construction and prior to the final CCTV inspection. Each sewer line reach (manhole-to-manhole) shall be visually inspected by directing a beacon of light into the pipe from a light source such as a flashlight or reflecting sunlight with the use of mirrors. If the illuminated interior or "moon" of the pipe indicates deficiencies in alignment such as bellies, sags, reverse slopes or

offset joints, the Contractor shall correct the alignment deficiency prior to the final CCTV inspection.

iii. Low-Pressure Air Testing

After new sewer lines and service laterals (HCS/BCS) are constructed and backfilled to finish grade, each reach shall be tested for no excessive leakage by low-pressure air testing. The requirements for low-pressure air testing shall be in accordance with the applicable methods specified in AAC R18-9-E301(D) and the installed pipe material's air testing requirements. Sewer lines and service laterals found with excessive leakage shall be corrected by the Contractor and re-tested as necessary until the results are passing. Testing results and any required corrections shall be documented by the Contractor and provided to the Field Engineer.

Low-pressure air testing for a reaches sewer line with composite pipe materials (i.e. PVC with DIP sections) shall be in accordance with the predominant pipe material within that reach.

iv. Joint Testing

For sewer lines greater than 48 inches in diameter, low-pressure air testing may be superseded by testing each pipe joint for no excessive leakage in accordance with ASTM C1103 (RCP) and the applicable pipe manufacturer recommendations. Pipe joints found with excessive leakage shall be corrected by the Contractor and re-tested as necessary until the testing are passing. Testing results and any required corrections shall be documented by the Contractor and provided to the Field Engineer.

Specific guidelines for joint testing procedures are provided in the following:

(1) Joint Testing Equipment

The Contractor shall provide all materials, labor and equipment necessary for joint testing.

The joint tester frame assembly shall be constructed of a heavy gauge metal that can be broken down easily into small sections for ease of handling and installation/removal from sewer manholes.

The joint tester shall have either single or double-bladder construction. The single bladder shall be of a one-piece construction within an outer layer of a soft, natural rubber, between the pipe and tester.

The double-bladder tester shall have 2 inflatable bladders constructed of rugged heavy-duty elastomer. The bladders shall be stretched and positioned onto the joint tester frame assembly so that they can be aligned over the joint to be tested. When inflated, the bladders shall create an air-tight seal against the pipe wall.

The control panel for the joint test shall provide a reliable means of controlling and monitoring bladder and center cavity pressures. The control panel shall be conveniently mounted onto the joint tester frame assembly and require only input air from the compressor.

Wheel assemblies shall be mounted to the inside surface of the joint tester frame. The Contractor shall be capable of efficiently moving and centering the joint tester to each pipe joint.

An air reservoir shall be included in the joint test system and shall have a maximum volume of 2.5 cubic feet. Hoses shall be provided to route air from the control panel to the air reservoir and from the air reservoir to the center cavity chamber.

(2) Joint Testing Procedure

The test pressure shall be 3.5 psi unless otherwise specified by the pipe manufacturer.

Position the joint tester so the bladder(s) are properly located over the joint to be tested. Inflate the bladder(s) to 50 psi or in accordance with testing equipment and manufacturer's instructions.

Begin pressurizing the center cavity chamber. When the testing pressure is reached, turn off the pressure source and allow the pressure to stabilize for approximately 10 to 15 seconds.

If the pressure drops less than or equal to 1 psi for a period of 5 seconds, the pipe joint is acceptable. If the pressure drops more than 1 psi for a period of 5 seconds, the joint is defective and shall be repaired and retested.

When the joint test is completed, all pressure must be exhausted from center cavity to 0 psi and then from the bladder(s) to 0 psi. The joint tester can then be transported and positioned on the next joint to be tested.

(3) Sealing of Failed Joints

If Approved by the Field Engineer, the Contractor may seal a joint to ensure that it is watertight instead of a joint test. The sealing method shall consist of the following steps:

- Prime the sides of the concrete joint according to the primer manufacturer's instructions;
- Install a backer rod of a certain size, in the bottom of the joint, so as to leave a ½- to ⅝-inch depth for the flexible sealant; and
- Install a non-sagging, two-component elastomeric sealant in accordance with the sealant manufacturer's instructions.

v. Hydrostatic Pressure Testing

After a new force main is backfilled to finish grade, it shall be tested for no excessive leakage by hydrostatic pressure testing. Water from a potable water source shall be used for this testing procedure. The requirements for hydrostatic pressure testing shall be in accordance with the applicable methods specified in AAC R18-9-E301(D)(4)(f) and the installed pipe material's testing requirements. If the results of the testing indicate excessive leakage in the force main, it shall be corrected by the Contractor and re-tested as necessary until the results are passing. Testing results and any required corrections shall be documented by the Contractor and provided to the Field Engineer.

The Contractor shall verify that all inline valves and air relief valves, located along the test section of the force main, are completely open during filling and testing of the force main with water. After the force main is filled with water, it shall stand under a slight pressure (3-psi) for at least 48 hours prior to performing the hydrostatic pressure test. This retention period is necessary to allow for the release of entrained air and entrapped air bubbles. During this retention period, bulkheads, valves, and other accessible pipe connections shall be examined for leaks and repaired by the Contractor, prior to hydrostatic pressure testing.

vi. Mandrel Deflection Testing

New sewer lines having flexible pipe materials (e.g. PVC, HDPE, FRP), shall be tested for uniformity in shape, by a mandrel deflection test. The mandrel deflection test shall occur at least 7 days after backfill compaction has been completed and prior to Construction Acceptance of the Project. Deflection testing shall be conducted using a deflection testing mandrel (go/no-go mandrel) per S.D. RWRD-107. Mandrels shall be pulled completely through each reach by hand (1 person) and without requiring the use of excessive force (e.g. use of tools, leverage or machinery). If a mandrel becomes caught or bound, the reach shall fail the test. Failed reaches shall be corrected by the Contractor and re-tested as necessary until passing.

For sewer lines greater than 48 inches in diameter, other methods of deflection testing such as direct measurements using extension rulers or the successful completion of joint testing, may be Approved by the Field Engineer.

vii. Slope Tolerances

The Contractor shall make every effort possible to ensure that the constructed slopes of sewer lines conform to the Sewer Plans. If a slope error is found in the Sewer Plans or if the constructed slope of a sewer line does not conform to the Sewer Plans, the Contractor shall notify the Field Engineer immediately. Table 3.1 is provided as a guideline for determining the allowable slope tolerances for 8-inch diameter sewer lines. For larger diameter sewer lines, the allowable slope tolerances will be determined by the Department. In no case, shall slope tolerances allow for constructed slopes to be less than the minimum slopes required per AAC R18-9-E301(D)(2)(e).

For constructed slopes of sewer lines that are not within the slope tolerances specified by the Department, the Contractor may request a Variance in accordance with the *Design Standards*, Subsection 2.3. The Department will review the request and elect one of the following options:

- Approve the Variance request;
- Require the As-Built Plans to be certified by the Design Engineer with a statement indicating that the constructed sewer meets the intent of the design and conforms to R18-9-E301 – 4.10 General Permit; or
- Require unacceptable sewer construction to be removed and reconstructed in accordance with the Sewer Plans.

Table 3.1
Allowable Slope Tolerances for
8-inch Diameter Sewer Lines (ft/100ft)

Slope per Sewer Plan	Tolerable Range	
	Lower Limit	Upper Limit
0.33*	0.33*	0.39
0.34	0.33*	0.40
0.35	0.33*	0.41
0.36	0.33*	0.42
0.37	0.33*	0.43
0.38	0.33*	0.44
0.39	0.33*	0.45
0.40	0.34	0.46
0.41	0.35	0.47
0.42	0.36	0.48
0.43	0.37	0.49
0.44	0.38	0.50
0.45	0.39	0.51
0.46	0.40	0.52
0.47	0.41	0.53
0.48	0.42	0.54
0.49	0.43	0.55
0.50	0.44	0.56
0.51	0.45	0.57
0.52	0.46	0.58
0.53	0.47	0.59
0.54	0.48	0.60
0.55	0.49	0.61
0.56	0.50	0.62
0.57	0.51	0.63
0.58	0.52	0.64
0.59	0.53	0.65
0.60	0.54	0.66
0.61	0.55	0.67
0.62	0.56	0.68
0.63	0.57	0.69
0.64	0.58	0.70
0.65	0.59	0.71
0.66	0.60	0.72
0.67	0.61	0.73
0.68	0.62	0.74
0.69	0.63	0.75
0.70	0.64	0.76
0.71	0.65	0.77
0.72	0.65	0.79
0.73	0.66	0.80
0.74	0.67	0.81
0.75	0.68	0.83
0.76	0.68	0.84
0.77	0.69	0.85
*Minimum slope per AAC R18-9-E301(D)(2)(e)		

viii. CCTV Inspection

Each reach of newly constructed sewers shall be inspected by CCTV after it has passed all other required testing per Subsection 3.2.3(D). The CCTV inspection shall occur at least 7 Days after the compaction of backfill is completed. The CCTV inspection shall serve as a final verification that alignment deficiencies do not exist within the newly constructed sewers. Alignment deficiencies may, include, but are not limited to; bellies, sags, reverse slopes and offset joints. If alignment deficiencies are found during the CCTV inspection, it shall be corrected by the Contractor and the reach re-tested and inspected as necessary until the results are passing.

The Department will be responsible for providing one CCTV inspection service for each reach. The Contractor shall be responsible for subsequent CCTV inspections of any reach. CCTV inspections may occur after the Bill of Sale is issued and during the Contractor's warranty period. The Contractor shall be responsible for providing required corrective actions as a result of alignment deficiencies that may be found.

On the day before the scheduled CCTV inspection, the Contractor shall perform a "water dump" for the reaches to be inspected. The "water dump" shall supply water, from a potable source, to the upstream manholes of the new sewer lines so that water runs completely through. The downstream manhole(s) of these reaches shall be dewatered prior to the CCTV inspection.

The Contractor shall provide sufficient vehicular access to the reach manholes. The Contractor shall ensure that the reaches to be inspected and associated manholes are free of dirt and debris. If dirt or debris is found in a reach, the CCTV inspection for that reach will be abandoned and rescheduled for another day. A remobilization fee will be charged to the Contractor for rescheduled inspections due to dirt or debris within a reach.

If any standing water is found within a reach, the maximum depth and length of the sag will be measured with CCTV equipment. Table 3.2 provides guidelines for determining if corrective actions are required by the Contractor for found sags.

The Contractor shall bear all costs incurred for required corrective actions and subsequent CCTV inspections of repaired reaches. The corrective actions by the Contractor shall minimize the use of repair couplings, as directed by the Field Engineer. Required corrective actions as a result of pipe material defects or other construction defects will be determined the Field Engineer on a case-by-case basis.

Table 3.2
Allowable Tolerances for Sags Found within a Reach

Reach Dia. [inches]	Sag Depth [inches]	Sag Length [feet]	Corrective Action Required
8 to 12	Less than or equal to ⅝ inch	N/A	No
8 to 12	Greater than ⅝, but less than or equal to 1¼ inches	Greater than 10 or more than 3 occurrences within 100 feet	Yes
8 to 12	Greater than 1¼ inches	N/A	Yes
14 to 24	Less than or equal to 1¼ inches	N/A	No
14 to 24	Greater than 1¼, but less than or equal to 2 inches	Greater than 20 or more than 3 occurrences within 100 feet	Yes
14 to 24	Greater than 2 inches	N/A	Yes

Notes:
(a) Corrective actions required will be determined by the Field Engineering section for reach diameters greater than 24 inches having sags greater than 5% of the diameter.
(b) Ponded water as a result of manhole construction shall require corrective action.
(c) For multiple sags, corrective actions shall occur in the order of severity (highest first).

For CCTV inspections services provided by the Department, the Field Engineer shall be responsible for:

- Scheduling CCTV inspections with the Contractor;
- Monitoring “water dumps”;
- Monitoring CCTV inspections;
- Within 1 Day of the CCTV inspection, providing the Contractor with a copy of the CCTV inspection reports and photos of any alignment deficiencies; and
- Within 1 Day of the CCTV inspection, providing the Contractor with a written report disclosing all required corrective actions.

The Contractor shall provide written notice to the Field Engineer, at least 3 weeks in advance, to schedule CCTV inspections.

If possible, the Department will accommodate CCTV inspection scheduling for special circumstances. Such requests shall be arranged with the Field Engineer during the pre-construction meeting. If a CCTV inspection is scheduled less than 3 weeks of the pre-construction meeting, the Department will commit to an inspection date at the pre-construction meeting.

The Contractor shall re-confirm the scheduled CCTV inspection with the Field Engineer a minimum of 2 Working Days in advance. The Field Engineer will also notify the Contractor of any scheduling delays, a minimum of 2 Working Days in advance. If the Contractor cancels a scheduled CCTV inspection less than 2 Working Days in advance, a re-mobilization fee will be charged to the Contractor. CCTV inspections may be phased if Approved by the Field Engineer, however, a mobilization fee will be charged for additional trips.

If the Department cannot commit to a requested date for CCTV inspection, the Contractor may obtain CCTV inspection services by a qualified subcontractor, in accordance with the following guidelines:

- At the time of scheduling, the Contractor shall obtain Approval from the Field Engineer for CCTV inspection services by a subcontractor;
- CCTV inspection by a subcontractor shall be conducted under the observation of the Field Engineer;
- CCTV inspections by a subcontractor shall be conducted in accordance with NASSCO guidelines;
- CCTV inspection reports and a continuous video of each reach (DVD format) shall be provided to the Field Engineer;
- CCTV equipment and software shall be expressly designed for pipeline inspection purposes and operated by NASSCO-certified personnel;
- Subsequent CCTV inspections by a subcontractor shall use the same data management processes as the prior CCTV inspection;
- CCTV equipment and software shall be Approved by the Field Engineer prior to use;
- The CCTV camera shall have a mechanical gauge to record the depth of any standing water; and
- The mechanical gauge shall clearly indicate markings of ⅝-inches and 1¼-inches for reaches having a nominal diameter of 8-inches to 12-inches, and markings of 1¼- and 2-inches for reaches having a nominal diameter of 15 inches to 24 inches.

If the CCTV inspection services by a subcontractor strictly adhere to the Departments standards, it shall serve as the final CCTV inspection. Non-conforming or incomplete CCTV inspections for any reach may require a subsequent CCTV inspection by the Department, prior to Construction Acceptance.

E. Markers and Monuments

Force mains shall be installed with a tracer wire and metallic marking tape in accordance with S.D. RWRD-500 and -501. Test stations per S.D. RWRD-501 and force main monuments per S.D. RWRD-503, shall be located as indicated per the Sewer Plans.

Abandonment monuments per S.D. RWRD-503 shall be located in accordance with the Sewer Plans or as Approved by the Field Engineer.

F. Casing and Carrier Pipe

Casing pipe material for Public Sewer lines shall conform to Subsection 3.4.2 and installed in accordance with S.D. RWRD-100. Casing joints shall be continuous circumferential welds in accordance with AWWA C206. Any casing showing signs of failure shall be rejected and replaced.

All casing spacers and end seals shall be Approved and installed in accordance with S.D. RWRD-100 and the manufacturer's recommendations. Refer to the Department's List of Approved Products for the recommended casing spacers and end seals.

G. Modifications and Repairs

Modifications and repairs to existing sewer lines shall conform to S.D.s RWRD-102 and RWRD-103. All sewer modifications and repairs shall be inspected by the Field Engineer prior to being backfilled. Placement and compaction of bedding, shading and backfill material shall conform to the applicable requirements of Subsection 3.1.3.

The Contractor shall replace "in kind" any existing survey monuments damaged or disturbed during construction (including property pins). This replacement shall be performed by an Arizona Registered Land Surveyor and shall also require a record of survey.

H. Abandonment of Pipe

Existing Public Sewer lines that are to be abandoned shall be removed completely. Where indicated in the Sewer Plans or Approved by the Field Engineer, existing Public Sewer lines that are to be abandoned-in-place shall be filled with grout. Existing Public Sewer lines that are abandoned-in-place shall be marked with an abandonment monument per ~~Subsection 3.2.3(H) and~~ S.D. RWRD-503.

The removal of asbestos cement pipe material and other asbestos containing material shall conform to the requirements of Section 940 of the *PAG Standard Specifications*.

Debris that is generated by the removal of existing Public Sewer lines shall be removed from the site by the Contractor and disposed of at an appropriate solid waste facility. The Contractor shall furnish the Field Engineer the original copy of the dumping receipt. Disturbed areas shall be backfilled with backfill material per S.D. RWRD-104 and compacted to a minimum density of 95% of the standard proctor density in accordance with the provisions of the Arizona Test Method 225 and the compaction standards set forth by the Agency controlling the Right-of-Way.

3.3 Sanitary Sewer Manholes

3.3.1 Description

The work under this subsection consists of furnishing all materials required to construct, modify or adjust sanitary sewer manholes as indicated in the Sewer Plans and the *Standard Specifications and Details*.

3.3.2 Materials

A. Concrete

Portland cement shall conform to the requirements of ASTM C150. Type II Portland cement shall be used for concrete unless otherwise specified in the Sewer Plans or the Special Provisions. All other materials furnished for Portland cement concrete shall conform to the requirements of Section 1006 of the *PAG Standard Specifications*. Concrete design mixture shall be class "S" and have a minimum 28-day compressive strength of 3,000 psi, unless otherwise specified in the Sewer Plans or Special Provisions.

B. Reinforcing Steel

Materials furnished for reinforcing steel shall conform to the requirements of Section 1003 of the *PAG Standard Specifications*.

C. Grout and Mortar

Portland cement shall conform to the requirements of ASTM C150. Type II Portland cement shall be used for grout and mortar, unless otherwise specified in the Sewer Plans or Special Provisions. All other materials furnished for grout and mortar shall conform to the requirements of Section 914-2.03 of the *PAG Standard Specifications*.

Approved non-shrink grout products shall conform to the requirements of Section 1017-4 of the *PAG Standard Specifications*. Refer to the Department's List of Approved Products for the recommended non-shrink grout products.

D. Water

Water shall conform to the requirements of Subsection 1006 of the *PAG Standard Specifications*.

E. Precast Concrete Manhole Sections

Precast concrete manhole sections shall be free from cracks, voids and other defects and shall conform to the requirements of ASTM C478 and AASHTO M199. Precast concrete manhole sections shall include:

- Bases
- Risers

- Cone and Flat Top Transitions
- Cones
- Flat Top Slabs
- Grade Adjustment Rings; and
- Joint Adapters.

F. Interior Corrosion Protection

Refer to the Department's List of Approved Products for the recommended products for the interior corrosion protection of manholes.

G. Steps

Steps for precast and cast-in-place manholes shall be approved and conform to the requirements of ASTM C478, D4101 and A615. Steps shall be reinforced with ½-inch diameter, grade 60 steel and coated with polypropylene plastic. Refer to the Department's List of Approved Products for the recommended manhole steps.

H. Frames, Covers and Hatches

Frames and covers for Public Sewer manholes shall conform to S.D.s RWRD-213 to -218, unless otherwise Approved by the Field Engineer. In these cases, a certificate of compliance with Subsection 3.3.2(H) shall be provided from the manufacturer upon request.

All castings shall be true to pattern, in form and dimension, and free from pouring faults, sponginess, cracks, blowholes, or other defects in locations affecting their strength for the service intended. Castings shall be filleted boldly at angles and the risers shall be sharp and true. Before the castings are removed from the foundry, they shall be thoroughly cleaned and the parting lines, gates and risers shall be ground flush. No plugging or other stopping of holes shall be allowed. The castings shall be thoroughly cleaned of all lumps and shall be subject to a careful hammer test.

Lettering for covers shall be standard raised block type, and shall be 1½ to 2½ inches high. The total width of individual letters are to be such that letters and words are equally spaced and balanced to form a complete circle with spaces before and after words.

The top surface of the cover shall sit flush with the top surface of the frame. A uniform ⅛ inch clearance shall exist between the edge of the cover and the frame. All horizontal bearing surfaces shall be machine finished.

The weight of the frame and cover shall be no more than 2% less than the approximate weight specified in the applicable standard detail for each component.

Frames and covers shall be manufactured from gray iron, conforming to the requirements of ASTM A48, Class 35B. Frames and covers shall be designed for H-20 loading inclusive of the proof load requirements outlined in Section 7 of the American Association of State Highway and Transportation Officials (AASHTO)

Standard Specification for Drainage Structure Castings, ASSHTO Designation M 306.

Frames and covers shall be made from ferrous materials using at least 75% post-consumer waste. The basic design, initial sample castings and first article inspection (also known as first proof load tests) must be Approved by the Field Engineering manager before delivery to suppliers or Contractors.

The bearing surfaces of the frames and covers shall be machine finished so that the covers will seat themselves firmly onto the frame. Vehicular traffic shall not cause the frame to move. A 1/8~~1/8~~ inch annular clearance shall be provided between frame and cover.

The design and construction of private sewers may utilize, or make reference to certain Department specifications and details; however, the covers for private manholes shall not be imprinted with the words "Pima County Sanitary Sewer". Manholes to be owned and operated by a private entity shall be unlabeled or have the following words cast into them "Private Sanitary Sewer", or other appropriate designation.

I. Flexible Joint Gaskets

Preformed flexible plastic gaskets for the sealing the joints of precast concrete manhole sections shall be Approved and conform to ASTM C990 or AASHTO M198B. Refer to the Department's List of Approved Products for the recommended flexible joint gaskets.

3.3.3 Construction Details

A. Excavation and Backfill

Excavation for new manhole construction shall be in accordance with Subsection 3.1.3(A) and Section 203 of the *PAG Standard Specifications*. The foundation for new manhole bases shall conform to Subsection 3.1.3(B) or as Approved by the Field Engineer.

The Department assumes no liability for damage to, or removal of, any vegetation, above ground or below ground facilities, surface treatments, materials, equipment, or structures placed within Public Sewer easement or within 20 vertical feet of its surface.

Backfill material for new manholes shall conform to Subsection 3.1.3(E) and S.D. RWRD-104.

B. Installation of Manholes

i. Manhole Bases

For 48-inch and 60-inch diameter manholes, the base and the flow channel configuration shall be constructed in accordance with S.D.s RWRD-200, -201 and

-202, unless otherwise indicated in the Sewer Plans or as Approved by the Field Engineer. For larger diameter manholes, the base and flow channel configuration shall be constructed as indicated in the Sewer Plans.

In no case shall any pipe within the manhole discharge onto the surface of the bench.

Flow channels shall be constructed to conform in size and shape to that of the interior surface of the connected pipes. Flow channels shall be free of sags and sloped to convey flow from the influent pipes to the outgoing pipes. Flow channels shall not obstruct flow or cause water to pond within the influent pipes.

If additional concrete or mortar is needed after the initial set, the receiving surface shall be primed and mixed with an Approved adhesive in order to secure a surface that is as chip-proof as possible. The base shall be set a minimum of 72 hours before the manhole construction is initiated.

For a new manhole constructed over an existing sewer line, a saw cutter shall be used to remove the top portion of the pipe. This cut-out shall take place under the inspection of the Field Engineer. The Contractor shall be careful to prevent cuttings from falling into the pipe. If this occurs, the Field Engineer may require the Contractor to clean the sewer line. After a cut-out, the edges of the pipe shall be filled and smoothed with mortar.

ii. Block-Outs

Where designated in the Sewer Plans as a provision for the connection of a future sewer line, a block-out shall be built into the manhole per S.D. RWRD-203.

iii. Precast Concrete Manhole Sections

Precast manhole sections shall be installed in accordance with S.D.s RWRD-205 and -206 and the manufacturer's recommendations.

Precast sections will be inspected by the Field Engineer at the job site and may be rejected if any of the following deficiencies exist:

- Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint;
- Defects that indicate imperfect proportioning, mixing, and molding;
- Surface defects indicating honeycombed or open texture;
- Damaged or cracked ends, where such damage would prevent making a satisfactory joint; or
- Any continuous crack having a surface width of 0.01 inches or greater and extending for a length of 12 inches or greater, regardless of position in the section wall.

Proper equipment shall be provided for lowering the precast sections into position. The tongue end of the section shall be placed in contact with the base structure, unless otherwise Approved by the Field Engineer. Not more than two lifting holes

shall be cast or drilled in the wall of each section. All lifting holes shall be filled with an Approved sealing compound on the exterior side of the wall and a minimum of ½-inch deep on the interior side of the wall. Any precast section damaged during transportation or placement shall be repaired or replaced at the option of the Field Engineer and at the Contractor's expense.

All precast manhole section joints shall be sealed with a preformed flexible plastic gasket in accordance with Subsection 3.3.2(I). The gasket shall be installed in accordance with the following requirements:

- The sealing compound shall be packaged in an extruded pre-formed rope-like shape of proper size to completely fill the joint when fully compressed;
- The material shall be protected by a suitable, removable wrapper;
- The joint surfaces shall be clean and free of mud, silt, gravel or other foreign material prior to the installation of the sealing compound; and
- Installation shall be accomplished in accordance with the manufacturer's instructions as to the method of application, quantity of material, quality of material, and the application temperatures.

For manholes located in ground water conditions, the exterior surface of precast sections and joints shall be coated with an Approved waterproofing sealant.

iv. Steps

Steps for precast manholes shall be installed during the manufacture of precast sections and configured per S.D. RWRD-210. Steps within each manhole shall be of the same product and size. Loose steps shall cause rejection of the precast manhole section.

Steps for cast-in-place manholes shall be installed in accordance with the step manufacturer's installation requirements. Holes for step installation shall be properly sized and formed prior to casting, or the holes shall be drilled into the walls after the concrete has fully cured. The use of grout to secure loose steps shall be prohibited.

v. Cast-in-Place Manholes

When specified in the Sewer Plans, manholes with diameters greater than 60-inches may be cast-in-place. Class "S" concrete, having a minimum compressive strength after 28 Days of 3,000 psi, shall be required for manhole bases. Class "S" concrete, having a minimum compressive strength after 28 Days of 4,000 psi, shall be required for manhole walls. Class "B" concrete shall be used for all other portions of the manhole not subjected to corrosive gases (e.g. protective collar). Portland cement shall conform to the requirements of ASTM C150 for Type II cement, unless stated otherwise in the Sewer Plans.

Cast-in-place concrete manholes shall be placed in accordance with the requirements of Section 601 of the *PAG Standard Specifications* and ACI-318. The location of the manhole shall conform to the requirements of the Sewer Plans,

unless otherwise Approved by the Field Engineer and before the placement of concrete.

All absorptive surfaces that may come in contact with the concrete, shall be moistened sufficiently to minimize moisture loss from the freshly-poured concrete.

The trench or excavated area must be free of water, dirt, mud and debris before the concrete is poured.

Floor slabs with walls shall be washed free of sawdust, chips, and other debris, after wall forms are built and immediately before the concrete pour. Should the form work confine sawdust, chips and other loose matter in such a manner that it is impossible to remove by flushing with water, a vacuum cleaner shall be used for removal. Following this action, the cleaned surfaces shall be flushed with water.

Before pouring concrete, the forms shall be coated with a non-staining lubricant to prevent adherence of concrete. All forms and form lumber, once used, shall be thoroughly cleaned and contact surfaces re-coated before being used again. Dirty forms shall not be used. Forms may be either metal or wood, and shall be built true to shape, line and grade. Forms shall be mortar-tight and sufficiently rigid to prevent displacement or sagging between supports. Deformed, broken or defective forms shall not be used and shall be removed from the job site.

Contact surfaces for exposed concrete shall be made from plywood, metal or non-warping fiberboard. The pieces used shall be as large as the form layout permits. Small pieces shall not be patched together.

Square-edge lumber may be used as forms for concrete surfaces that will be buried or not exposed to view after construction is completed.

All form work shall have adequate cleanout openings to permit inspection and easy cleaning after all reinforcement has been placed.

When the forms are removed, no metal form ties shall remain within ¾-inch of the surface of the concrete or any holes larger than ⅞-inch diameter in the surface of the concrete. Ties made from wire shall not be permitted.

All external angles of beams, columns, edges of concrete structures and sides of walls shall have a ¾-inch chamfer unless otherwise indicated in the Sewer Plans.

vi. Grade Adjustment Rings

Adjustments for existing manholes shall conform to S.D.s RWRD-304 and -305. For manholes in paved areas, ~~A~~a minimum of one precast concrete grade adjustment ring, with a minimum height of 3 inches, shall be provided to allow for flexibility in future elevation adjustments. The maximum height of grade adjustment rings shall not be greater than 12 inches (e.g. two 6-inch rings). The inside diameter of the grade adjustment ring(s) shall ~~not~~ be ~~less~~ equal to ~~than~~ the inside diameter of the manhole frame.

vii. Frames, Covers and Hatches

Frames and covers for new manholes shall be installed and adjusted in accordance with S.D. RWRD-205, -206 and -207, as applicable. Frame elevations shall be as indicated in the Sewer Plans unless otherwise Approved by the Field Engineer. Where the frame is located in pavement or a traveled way, its surface shall be flush with the finish grade. A protective concrete collar shall be constructed in accordance with S.D. RWRD-211 if required by the Agency having jurisdiction over the Right-of-Way or if indicated in the Sewer Plans. Where the frame is located outside of pavement or a travelled way, a protective concrete collar shall be constructed in accordance with S.D. RWRD-212, unless otherwise Approved by the Field Engineer.

The Contractor shall thoroughly scrape and clean all foreign materials from the manhole frames and covers prior to their installation. All frames and covers shall be free of grease, oils, asphaltic materials, and any other deleterious materials. All vent holes, pick bars and bolt holes shall be free of dirt, rocks, concrete and other obstructions prior to Construction Acceptance.

Hatch assemblies for larger manholes and vaults shall be cast into the top of the slab, unless otherwise Approved by the Field Engineer.

viii. Interior Corrosion Protection for New Manholes

If interior corrosion protection is required for a new manhole, it shall be applied to the walls, benches and flow channels. All surfaces shall be cleaned and prepared in accordance with the coating manufacturer's recommendations. Concrete surfaces that may be contaminated with oils, grease, or other substances, shall be scarified or chemically cleaned. All cracks and voids shall be filled with an underlayment to provide a smooth surface. All manhole joints, and cracks that exist between the manhole steps and the wall, shall be caulked using a hybrid novolac-epoxy caulk, or other Approved caulk. Trowel marks and other minor surface irregularities shall be removed from all surfaces that will be coated. Any new concrete added to the surface shall receive a dry abrasive brush-off blasting using a minimum pressure of 90 psi to lightly abrade the surface and open up subsurface holes and voids and etch the surface sufficiently (to approximately a 60 grit sandpaper texture) to allow the coating to bond satisfactorily.

An epoxy primer/sealer coat shall be applied to all concrete surfaces before the final coating is applied. The temperature of the existing concrete surfaces shall not vary 15° F or greater, from the top to the bottom of the manhole. The epoxy primer/sealer shall be applied in accordance with the manufacturer's instructions.

The color of the final coat shall be charcoal gray or white, unless otherwise Approved by the Field Engineer. The final coating shall be applied with a minimum dry film thickness coating of 3/16 inches. Spray application of coatings will be allowed if the spray equipment complies with the coating manufacturer's recommendations. A rougher surface shall be provided for the bench by using a short nap mohair paint roller. After the coating has been applied, all surfaces shall be tested for Holidays utilizing a dry conductive probe with a minimum of 17,000

volts. If no Holidays are found, a certification shall be submitted to the Field Engineer.

The Contractor that will apply the coating for the interior corrosion protection of manholes shall meet the following requirements:

- Provide a performance history showing a minimum experience of 5 years in applying either the specified coating or an equivalent coating used in the wastewater industry;
- Have a current AE type license with the Arizona Registrar of Contractors for the application of specialized coatings for sanitary sewer manholes;
- Provide a certification from the manufacturer for the application of the coating that will be applied;
- Provide 3 references relating to the quality of workmanship performed on other Projects that use the same coating that will be applied or an equivalent coating;
- Provide a 3-year warranty, from the date of Construction Acceptance. The warranty shall include a bond that is payable to the Department. The bond shall cover both the material costs and the labor costs associated with the coating. The bond shall be unconditional in nature covering any type of failure in the coating. The bond shall agree to repair or replace the coating at no cost to the Department. The bond and warranty shall not apply to manhole frames and covers. Due to the limits on available bonding terms for coatings, the Contractor may supply a two-year bond, followed by a one-year bond;
- Provide a warranty from the coating manufacturer that is addressed to the bonding company and the Department. At a minimum, the warranty shall state that if the coating is applied in accordance with the manufacturer's recommendations, it will not fail for a period of 5 years, while the coating is immersed in either an acidic or an alkaline solution that is maintained at a temperature of 85° F. The acidic solution shall be considered a 10% by weight concentration of sulfuric acid. The alkaline solution shall be considered a 25% by weight concentration of sodium hydroxide. Blistering, cracking, brittleness or softening of the coating shall constitute failure;

The Department will conduct inspections of the coating and may request any necessary corrections, prior to expiration of the bond.

ix. Reinforced Joints

When specified in the Sewer Plans or as directed by the Field Engineer, precast manhole sections shall be installed with reinforced joints per S.S.D. RWRD-209.

C. Manhole Installation Testing and Tolerances

For pipe deflection angles from 0 to 9 degrees, the flow channel shall not be flat and shall drain into the downstream pipe. For pipe deflection angles from 10 to 45

degrees, the pipe invert elevation tolerance may be plus or minus 0.05 feet. For pipe deflection angles from 46 to 90 degrees, the pipe invert elevation tolerance may be plus or minus 0.10 feet.

In any case where there is a deviation in the constructed pipe invert, the following criteria shall be met:

- Pipe slope tolerances per Subsection 3.2.3(D) are followed;
- Flow is conveyed through the flow channel to the downstream pipe; and
- There is no standing water in the flow channel or in the upstream connected pipes.

The Field Engineer may require testing to verify that the manhole is watertight. Testing shall be conducted after the trench around the manhole has been backfilled. The negative air pressure test, as specified in ASTM C1244, or a water test, as specified in AAC R18-9-E301, shall be used to test all manholes.

Repairs shall be provided whenever leakage exceeds the test limit.

D. Modification of Existing Manholes

Prior to commencing work on any existing Public Sewer manhole, a sewer Construction Permit shall be secured from the Department. The Contractor shall be responsible for payment of all applicable fees associated with the Construction Permit. See Subsection 1.4.1 for more information. Each manhole shall be thoroughly cleaned and kept clean throughout the duration of sewer construction.

The Contractor shall observe all traffic requirements set forth by the Agency having jurisdiction over the Right-of-Way. Streets shall be kept open for passage of traffic. Protection for the public shall be provided when the manhole excavation occurs. The manhole construction work shall be completely and adequately covered when no work is being done. Flow management of wastewater from Public Sewers shall be accomplished by pumping to a nearby existing manhole or to a tank truck for proper disposal.

i. Reset Frame and Cover

Grade adjustments for existing manholes shall conform to S.D.s RWRD-304 and -305. Where an existing manhole will be adjusted for roadway improvements, the Contractor shall contact the Field Engineer as early as possible to arrange for an inspection and identify any additional requirements (e.g. reconstruction).

Prior to any adjustment, the bench and flow channels shall be protected with a cover in accordance with S.D. RWRD-306. The cover shall be removed only after all modification work is completed or as Approved by the Field Engineer.

If and existing frame and cover will be temporarily removed for pavement construction, a steel plate of a size and thickness, Approved by the Field Engineer, shall be placed over the manhole opening. After paving is completed, the steel plate shall be removed by cutting and removing the material above it. Care shall

be taken so that materials are not disturbed beyond the edges of the plate and that debris is kept from falling into the manhole. The frame shall be protected with concrete collar constructed in accordance with S.D. RWRD-211 or as required by the Agency having jurisdiction over the Right-of-Way.

The Contractor shall thoroughly scrape and clean all foreign materials from the manhole frames and covers prior to their installation. All frames and covers shall be free of grease, oils, asphaltic materials, and any other deleterious materials. All vent holes, pick bars and bolt holes shall be free of dirt, rocks, concrete and other obstructions prior to completion of the Project.

Frames or covers that are damaged by other than the Contractor or that cannot be cleaned to the satisfaction of the Field Engineer shall be replaced at no cost to the Department. Existing frames and covers shall be kept in matching order and stockpiled in an orderly fashion as not to cause damage. Extra frames and covers shall be turned into Department's Conveyance Division at the completion of the project.

ii. Damaged Frames and Covers

Existing manhole frames and covers shall be replaced if the age, condition or type of the existing frame and cover warrants such action. Replacement shall be directed by the Field Engineer. Existing manhole frames and covers, which are lost or damaged by the Contractor, shall be replaced at no additional cost to the Department.

iii. Coring

The following procedures shall be followed when connecting a new sewer line into an existing Public Sewer manhole:

- Core through the concrete at the bench level or in the barrel section to accommodate new pipe;
- After the new sewer line is laid, the opening through the wall around the new pipe shall be sealed with material compatible with existing manhole wall components;
- The new bench and channel shall be formed WITH mortar of Class "S" concrete, using an epoxy additive to assure adequate bonding to the existing bench; and
- All surfaces shall be steel-troweled to create smooth, dense surfaces.

iv. Brick Manholes

Grade adjustments for existing brick manholes shall conform to S.D. RWRD-304.

Prior to reconstruction, the Field Engineer will inspect the existing brick walls to assess its condition. The cone section shall be removed to an elevation within the barrel section where the brick and mortar is not deteriorated and as designated by the Field Engineer. Precast concrete manhole sections shall be used to reconstruct the manhole. Prior to installing the precast sections, a concrete leveling course

with a formed joint, per S.D. RWRD-208, is required. Reconstruction of any Public Sewer manhole shall be Approved by the Field Engineer.

v. Connections to Existing Sewers

Where connections to existing manholes are required, the Contractor shall reconstruct the existing bench. All flow channels within new manholes shall be shaped and formed to provide a smooth transition of flow between inlet pipe(s) and outlet pipe(s).

When a new manhole is constructed over an existing sewer line, verification of the horizontal and vertical location is required by the Contractor before the manhole is built. When the horizontal or vertical location of the sewer line does not match the Sewer Plans, the Contractor shall notify the Field Engineer. The Field Engineer may require the Sewer Plans to be updated by the Design Engineer in order to to proceed with construction of the manhole.

vi. Interior Corrosion Protection for Existing Manholes

When an interior corrosion protection is required for an existing manhole, its interior shall be cleaned and prepared, prior to applying a coating in accordance with Subsection 3.3.3(B)(viii). During the cleaning and preparation, reasonable means and methods shall be used to prevent foreign matter from entering existing sewer line. A cover per S.D. RWRD-306, modified with a fine-mesh drain screen, may be allowed with Approval by the Field Engineer.

The interior surfaces of the manhole, including the walls, benches and flow channels, shall receive a wet abrasive blasting using a minimum water pressure of 5,000 psi until all loose and deteriorated concrete has been removed. Only silica sand and water may be used in the wet abrasive blasting. After the wet abrasive blasting has been completed, these areas shall be flushed with water at a minimum water pressure of 5,000 psi to remove any residual sand. Following the wet abrasive blasting, a dry-abrasive blasting shall be done to remove any remaining deteriorated concrete. The dry-abrasive blasting shall use only copper slag and at a minimum pressure of 90 psi. Cleaning and preparation of the manhole shall also conform to the requirements of the coating manufacturer.

A new manhole, constructed over an existing sewer line with a diameter of 18-inches and greater, shall have interior corrosion protection. Any other new manholes, located within 200 feet upstream of the connection to existing, shall also have interior corrosion protection. This requirement does not apply to new 8-inch diameter sewer lines or less that connect into an existing manhole having a sewer line with a diameter of 18-inches and greater.

If a new force main will connect into a manhole, the manhole shall have interior corrosion protection.

All new manholes, or extensions to manholes with existing PVC lining, shall have one of the previously specified coatings applied to both the concrete and the steel

surfaces of the new manhole or the extension to the new manhole. For the purpose of this note, a diversion structure will be considered a manhole.

E. Abandonment of Manholes

Brick manholes to be abandoned-in-place shall be demolished to an elevation at least 3 feet below finished grade. Precast concrete manholes to be abandoned-in-place shall remove the top cone or riser section. The interior of the manhole shall be cleaned and sterilized prior to being filled with backfill material. Backfill material shall conform to Table 1 of S.D. RWRD-104 and be installed in accordance with Subsection 3.1.3(E). The manhole frame and cover shall be salvaged, cleaned and delivered to the Department. All manholes that are abandoned in place shall be marked with a monument per S.D. RWRD-503.

Debris generated by the removal of existing Public Sewer manholes shall be removed from the site by the Contractor and disposed of at an appropriate solid waste facility. The Contractor shall furnish the Field Engineer the original copy of the dumping receipt. The manhole and disturbed areas shall be backfilled with select material and compacted in accordance with the standards set by the Agency controlling the Right-of-Way. In all cases a minimum density of 95% of the standard proctor density, in accordance with the provisions of the Arizona Test Method 225, shall be achieved.

3.4 Other Sanitary Sewer Appurtenances

3.4.1 Piles

Piles for supporting sanitary sewer pipe shall conform to the requirements of S.S.D. RWRD-101. All steel plates shall conform to ASTM A36/A36. All welding electrodes shall conform to ASTM 233-62T and AWS A5.1 grade E70XX. All bolts and nuts shall conform to ASTM A307/A307M.

3.4.2 Casing Pipe

Casing pipe for Public Sewer lines shall be extra strong new steel pipe, Schedule 40.

3.4.3 List of Approved Products for Public Sewers

For a current List of Approved Products for Public Sewers, check the Department's website at: www.pima.gov/wwm/eng/ or contact the Field Engineering section.