Appendix A

WELL TECHNICAL SPECIFICATIONS
# Table of Contents

1.0 General
   1.1 Scope of Work
   1.2 Definitions
   1.3 Qualifications
   1.4 Performance of Work
   1.5 Contractor Responsibilities
   1.6 Consultant Responsibilities
   1.7 Visitation and Inspection
   1.8 Confidentiality
   1.9 Submittals
   1.10 Daily Driller’s Report
   1.11 Delivery, Storage, and Handling of Materials
   1.12 Rejection of Materials, Work, or Equipment
   1.13 Site Protection
   1.14 Site Safety Plan
   1.15 Dust Control Plan
   1.16 Construction Water Plan

2.0 Well Abandonment and Replacement

3.0 Drilling Fluids

4.0 Surface Casing Drilling, Materials, and Installation

5.0 Pilot Borehole and Reamed Borehole Drilling

6.0 Pilot Borehole Geophysical Logging

7.0 Pilot Borehole Zonal Sampling and Testing

8.0 Reamed Borehole Geophysical Logging

9.0 Production Well Materials and Installation

10.0 Production Well Development

11.0 Production Well Aquifer Testing

12.0 Production Well Spinner Survey
13.0 Production Well Plumbness and Alignment
14.0 Production Well Video Survey
15.0 Acceptance of Work
1.0 General

1.1 Scope of Work

The work includes the installation of a production well that consists of drilling and completing a well to the depth specified in the design plans using the reverse circulation rotary drilling method. The work also includes the collection of drill cutting, performing geophysical logging, zonal sampling and testing to aid in the design of the final production well, which will be developed by the Consultant and approved by the City. After the final design of the well has been completed the Contractor shall install the well casing, screen, and annual materials and develop the well by swabbing, airlifting, and pump and surge methods. Aquifer testing will follow the well development and will include a step-rate pumping test, constant rate pumping test, a recovery test, and a dynamic spinner flow meter survey; followed by a well video and plumbness and alignment test of the well. The Owner reserves the right to drill beyond the depths specified, or to stop at lesser depths, depending on subsurface conditions.

The work includes the furnishing of all labor, materials, equipment, tools, supplies, transportation, appurtenances, drill rigs, pumps, motors, piping, drilling makeup water, and services, unless specifically excepted herein, necessary for the complete and satisfactory drilling, construction, development, and testing and equipping of the well.

The well shall be drilled and completed pursuant to the plans, specifications, and AWWA A100. Any conflicts in these documents shall be brought to the attention of the Consultant for resolution.

1.2 Definitions

A. Owner. Shall be understood to represent the developer and/or property Owner.
B. Consultant. Shall be understood to represent the person, firm, or corporation with whom the Owner will execute an agreement setting forth the terms and conditions for the work to be performed as specified herein.
C. City. Shall represent the City of Surprise.
D. Contractor. Shall represent the person, firm, or corporation with whom the Owner will execute an agreement setting forth the terms and conditions for the work to be performed, as specified herein.
E. Subcontractor. Shall represent the person, firm, or corporation with whom the Contractor executes a secondary agreement for a portion of the scope of work.
F. Geophysical Logger. Shall represent the person, firm, or corporation with whom the Contractor executes a secondary agreement for the geophysical logging of the well.
G. Drilling Fluid Engineer. Shall represent the person, firm, or corporation with whom the Contractor executes a secondary agreement for the control and testing of the drilling fluid.

1.3 Qualifications

The Contractor shall have no less than five (5) years of local (within the Basin and Range geologic province of Arizona) experience using reverse circulation rotary drilling. The Contractor must have successfully completed no less than five (5) separate well installation
projects in the Phoenix, Arizona metropolitan area, within the past three (3) years involving installation of public water supply well with similar casing dimensions and well depths as specified in the plans.

The Contractor shall hold 1) a valid Arizona Department of Water Resources (ADWR) Well Driller’s License in the reverse circulation category; 2) a Registrar of Contractor License type A, A-4, A-16 or L-53; 3) a City of Surprise business license; and 4) all other licenses required by federal, state, county, or municipal rules and regulations. Subcontractors may also hold a valid Well Driller’s License in addition to that of the Contractor but not in lieu of the Contractor’s License.

### 1.4 Performance of Work

The Contractor shall provide all the labor, equipment, and materials necessary to complete the work. The Contractor shall employ only competent employees for the execution of the work. The Contractor work crew shall include no less than three (3) workers at all times when drill pipe is being installed or removed (i.e., at all times while the Contractor work crew is tripping or running pipe). In addition, the Contractor shall maintain no less than three (3) workers on site throughout the well installation operations (including installation of the well casing, well screen, centralizers, filter pack sand, bentonite seals, cement seals, and formation stabilizer). All operations shall be performed under the direct and personal supervision of an Arizona-licensed well driller. The Contractor shall assign a foreman (tool pusher) who has been approved by the Consultant to oversee all work. The Contractor foreman shall be present at the well site at least once daily during each drilling crew shift, during all critical operations, and as requested by the Consultant. The Contractor foreman shall provide to the Consultant a written certification that they have read and fully understands this technical specification prior to mobilization to the well site.

The Contractor shall construct the well in accordance with the Rules and Regulations of the ADWR, Article 8, Well Construction and Licensing of Well Drillers. The well construction shall also comply with the guidelines of the Arizona Department of Health Services Engineering Bulletin No. 10, and all other applicable Federal, State, County, or local regulations.

Rejection of any materials, work, or equipment by the Consultant shall be at the Contractor’s expense, and at no cost to the Owner. Replacement materials, work, or equipment that is in accordance with these specifications and approved by the Consultant will be paid for by the Owner in accordance with this specification.

The Contractor shall provide, at its own cost, all water required for its operations under the contract. This includes, but is not limited to, water used for drinking, dust control, and construction of the well.

The Contractor shall provide, at its own cost, all power required for its operations under the contract.

The Contractor shall provide, at its own cost, trash service at the well site during all operations of this project. The trash service shall be adequately maintained, and shall be made available to the Consultant, Owner, and City personnel for reasonable use, at no cost.

City of Surprise
Production Well
Technical Specification
September 8, 2006
The Contractor shall provide, at its own cost, a portable restroom facility at the well site during all operations of this project. The restroom shall be adequately maintained, and shall be made available to the Consultant, Owner, and City personnel for reasonable use, at no cost.

1.5 Contractor Responsibilities

If a work delay, deficiency of work performance and/or a material deficiency is caused by the Contractor failing to comply with any item of these specifications, the Contractor shall bear the burden of additional expenses, including any additional Consultant charges assessed to the Owner as a direct result of the delay or deficiency. This includes delays due to equipment failure, if the Consultant determines that the equipment failure could have been prevented through proper maintenance.

1.6 Consultant Responsibilities

The Consultant shall obtain the necessary drilling permits from the Arizona Department of Water Resources (ADWR) prior to commencement of drilling. The Consultant will also obtain a National Pollution Discharge Elimination System (NPDES) permit for the discharge of fluids into a local drainage, if needed. The Consultant shall manage the field activities on behalf of the Owner and shall have authority over the Contractor as directed by the Owner. The Consultant shall review and approve invoices submitted by the Contractor.

1.7 Visitation and Inspection

The Consultant, Owner, or City representatives shall, at any reasonable time during the term of work be entitled to review the Contractor’s facilities, its program operation, and the records that pertain to the work.

The Contractor agrees that the Consultant, Owner, or City, or any of their duly authorized representatives, shall have access to the Contractor’s facilities and have the right to examine books, documents, and records of the Contractor involving transactions related to these specifications.

The Contractor further agrees to include in all subcontracts hereunder, if any, a provision that the Subcontractor agrees that the Consultant, Owner, or City, or any of their duly authorized representatives, shall have access to the Subcontractor’s facilities and have the right to examine any books, documents, and records of the Subcontractor involving transactions related to the subcontract and these specifications.

1.8 Confidentiality

The Contractor shall not disclose any information relating to this project or any well site to anyone other than the Owner, Consultant, or City without written permission from the Owner, except as may be required by law. At all times during the performance of the Contractor's services, the Contractor, Subcontractor, and agents shall treat the work conducted by the Contractor and its Subcontractors and the results thereof as confidential and proprietary to the Owner and the City.
Any questions regarding the purpose or scope of work that are directed to the Contractor from individuals or entities other than representatives of the Owner, Consultant, or City while work is being conducted for this project, should be directed by the Contractor to the Consultant or Owner.

The Contractor shall inform its employees of this confidentiality requirement, and shall obtain non-disclosure agreements from all Subconsultants who will have involvement in the performance of any of the work, and provide the Consultant with copies of the executed non-disclosure agreements. This provision shall survive the termination of the contracted work tasks.

1.9 Submittals

The Contractor shall be responsible for the timely and accurate submission of all submittals. This includes all shop drawings, materials, data, records, test results, reports, and invoices.

Shop drawings and material submittals shall be reviewed and approved by the Consultant prior to being ordered, purchased, and installed. This includes, but is not limited to, the following: well casing, well screen, and annular materials. The Consultant may, at its discretion, reject any materials that do not meet the specifications or the requirements of the Consultant and the City.

Data, records, test results, and reports shall be reviewed and approved by the Consultant.

Any additional standby time or other costs incurred by the Contractor as a result of the rejection of a submittal shall not be compensated by the Owner and shall be the sole responsibility of the Contractor.

Approval of a submittal shall not in any way relieve the Contractor of the responsibility for completeness, accuracy, errors, and omissions.

1.10 Daily Driller’s Report

The Contractor shall maintain a daily log of the activities at the site from the time the Contractor mobilizes to the site until the Contractor demobilizes and shall provide a copy to the Consultant daily. The Daily Driller’s Report shall be recorded on forms approved by the Consultant. The reports shall give a complete description of all formations encountered; number of feet drilled; number of hours on the job; shutdown due to breakdown; any occurrence of lost circulation conditions, low penetration, fluid additives used; length and type of casing set; volumes of filter pack and annular seal installed; and such other pertinent data as may be requested by the Consultant. Contractor personnel will submit the reports to the Consultant daily.

1.11 Delivery, Storage, and Handling of Materials

The Contractor shall be responsible for the timely delivery of materials to the work site. This includes, but is not limited to, the following: well casing, well screen, and annular materials. All materials shall be delivered to the site or to an approved storage yard in accordance with the manufacturer’s instructions and requirements, except as modified by the plans, specifications or as directed by the Consultant or the City. The materials shall be stored in such a manner as to
prevent any damage or contamination. Any damage to the materials shall be reported to the Consultant and all repairs must be approved by the Consultant.

1.12 Rejection of Materials, Work, or Equipment

Rejection of any materials, work, or equipment by the Consultant or the City shall be at the Contractor’s expense and at no cost to the Owner. The Contractor shall be responsible for the compliance of all material requirements and any materials that do not meet the material requirements as determined by the Consultant or the City shall be rejected.

1.13 Site Protection

The Contractor shall take all necessary precautions to preserve the each well site, as nearly as practical, in their present condition. The Contractor shall be responsible for replacing any damaged items. The Contractor shall provide, at its own cost, an adequate roll-off bin to contain all debris and trash collected at the site. All litter and debris will be cleaned up daily and placed in the roll-off bin for off-site disposal. The Contractor is responsible for the location and clearance of all underground utilities using Blue Stake, a private utility location service, or both. The Contractor shall be responsible for any damage resulting from its failure to identify and avoid underground utilities.

A plastic tarp (at least 6 mil) and berm shall be placed beneath the drilling rig during mobilization to protect the site and contain any oil or hydraulic fluid spills or leaks, and will remain beneath the rig until demobilization. A plastic tarp and berm shall also be placed beneath other stationary equipment such as air compressors, auxiliary lights, welding devices and fuel tanks, and beneath the pump rig and auxiliary equipment during the well testing activities. Compressed air introduced into the well during drilling, sampling, or well development must be treated by passage through a carbon or coalescing filter to remove organic contaminants (e.g., compressor lubrication oil).

If there is an interruption in work, such as mechanical delay, waiting periods required for cement cure, installation of a test pump, or other instances when the tools are removed from any wells and the well is left unattended, a locking cover, tack-welded steel cover, or other Consultant-approved method of securing the well head shall be installed. During interruptions of work when the tools remain in the well, such as inclement weather or other circumstances, the well opening shall be covered to prevent the introduction of undesirable material into the well and to ensure public safety.

The Contractor shall secure the working area around the well site with temporary chain link fencing to prevent unauthorized access to the site and the accidental injury of people or animals. In addition, all open pits must be fenced or flagged to prevent the accidental injury of people or animals. The Contractor will provide all fencing and flagging at its own cost. All fencing and flagging shall be approved by the Consultant.

Water pumped from the well during drilling, sampling, and development operations shall be directed to an area adjacent to the well site, or as directed by the Owner or Consultant, where it will not cause damage to the property, contamination of other wells or waterways, or creation of a nuisance.
After completion of the work, the Contractor shall remove all debris, waste, trash, oil-stained dirt, and unused materials or supplies and shall obliterate all temporary construction facilities such as temporary work areas, temporary structures, and stockpiles of excess or waste materials and shall restore the site, as nearly as possible, to its original condition. In addition, any residual mineral oil within the well casing resulting from the use of test pumping equipment shall be removed prior to final acceptance of the well. The cuttings disposal and site cleanup must be approved by the Consultant.

1.14 Site Safety Plan

The Contractor must institute a Site Safety Plan for this project, in accordance with applicable Occupational Safety and Health Administration (OSHA) requirements. The Contractor is responsible for assuring that Contractor personnel and Subcontractors are thoroughly familiar with the Site Safety Plan for the proposed work. Contractor personnel are required to have been trained in the use of personal safety equipment required by the Site Safety Plan. A copy of the Site Safety Plan must be kept at the well site and shall be available to all Contractor personnel for review. The Contractor shall be responsible for having sufficient personal safety equipment at the work site for each of the Contractor personnel to comply with provisions of the Site Safety Plan. At a minimum, this shall include the following:

1. A first aid kit;
2. A fully recharged and operable type ABC dry chemical fire extinguisher; and
3. An operable mobile telephone located at each well site. The rig mobile phone will be made available to the Consultant, Owner, and City personnel for reasonable use, at no charge.

The Contractor shall meet the requirements of the Site Safety Plan at its own cost.

1.15 Dust Control Plan

The Contractor is responsible for dust control as required by public authorities and the Owner. The Contractor will be required to adhere to the Owner’s approved Dust Control Plan. Any violations of the Dust Control Plan will be the responsibility of the Contractor and the Contractor shall pay all applicable fines.

The Contractor is responsible to apply water for dust control to work areas or access roads as required to meet State, County, or local dust control ordinances, or as requested by the Consultant or Owner. The Contractor is responsible for acquiring necessary permits required by Maricopa County for dust control and shall meet these requirements at its own cost.

The Contractor shall effectively subdue (palliate) dust in the working area, access roads, and storage areas related to this specification, except during such periods as other Contractors may be performing work in these areas. Such dust palliation shall consist of intermittent watering and sprinkling of such frequency as will satisfactorily allay the dust during all hours that work is being performed.
1.16 Construction Water Plan

Water used for the construction of the well shall be reviewed and approved by the Consultant prior to construction. The Contractor will be responsible for obtaining an adequate flow rate of construction water for all operations under this specification. The Contractor will also be responsible for any and all costs to provide and transport the water, and for any coordination, permits, and/or costs associated with traffic control and road crossings that may be required to convey water to the well site.

The Contractor shall submit to the Consultant a Construction Water Plan for review and approval. At a minimum, the Plan shall identify the source and quantity of water to be used, shall allow for the Consultant to obtain a representative sample of the water for testing, and a drawing showing the location of the well site, the source water location, and the water lines necessary to convey the water to the well site. The drawing shall also include any road crossings and the method used to cross the roads and traffic control.

*** End of Section ***
2.0 Well Abandonment and Replacement

2.1 General

Should the well be lost due to any negligent action on the part of the Contractor or their Subcontractor (as determined by the Consultant), including a result of a material or equipment defect or deficiency, the well shall be abandoned at no cost to the Owner. The Contractor shall credit the Owner for any and all costs associated with the lost well, and this credit shall be applied against any additional Contractor charges associated with the replacement well.

If the loss of the well was not due to any negligent action of the Contractor (as determined by the Consultant), the Owner shall provide reimbursement for the replacement well on the basis of the unit costs presented in the Contractor’s Bid Schedule.

The exact method of the well abandonment shall be reviewed and approved by the Consultant and the City. At a minimum, the well shall be abandoned in accordance with AAC R12-15-816.

The Consultant shall recommend for approval by the Owner and the City a suitable location for the replacement well. The replacement well shall be completed in accordance with the plans, specifications, terms, and conditions herein.

2.2 Submittals

A. Proposed well abandonment plan.
B. Determination by the Contractor of the amount of the credit to be applied against the replacement well costs.

2.3 Measurements and Payments

A. If the loss of the well was due to any negligent action of the Contractor, the Contractor shall credit the Owner for any and all costs associated with the lost well, and this credit shall be applied against any additional Contractor charges associated with the drilling and completion of the replacement well.
B. If the loss of the well was not due to any negligent action of the Contractor, the Owner shall provide reimbursement for the replacement well on the basis of the Contractors unit costs.

*** End of Section ***
3.0 Drilling Fluids

3.1 General

The Contractor shall be responsible for maintaining the quality of the drilling fluid to ensure, at a minimum, the following.

1. Protection of water-bearing and potential water bearing formations exposed to the borehole
2. Representative samples of the formation materials and groundwater
3. Maximum development capacity and optimum potential yield of the completed well
4. Inhibition of the formation and prevention of formation-caused drilling problems (e.g., heaving sands, swelling clays, lost circulation)
5. Protection of the integrity of the borings during drilling, zonal sampling, and well installation operations
6. Complete and accurate geophysical logging of the boreholes

During the drilling of the pilot borehole and production borehole, and the installation of the well casing, screen, and annular materials, the Contractor will be responsible to minimize the chemical and biological disturbance of the vadose zone and saturated alluvial matrix. The use of organic drilling fluid materials (such as starch, guar, or cottonseed hulls) will not be accepted for drilling. Material Data Safety Sheets (MSDSs) from the manufacturer for all drilling fluid additives must be provided to the Consultant for review and approval prior to their use. The Consultant reserves the right to reject any and all proposed additives.

3.2 Makeup Water

The Contractor shall take all necessary precautions to ensure that chemical quality of the construction water is not impaired during transport from the source area to the storage area or well site. The Contractor shall provide the Consultant the ability to obtain samples of the construction water for laboratory chemical analyses to ensure that no contaminants are present and that the water is suitable for drilling and construction of the well. The makeup water shall be reviewed and approved by the Consultant prior to use.

3.3 Drilling Fluid Control Plan

The Contractor shall provide a drilling fluid control plan to the Consultant prior to the start of drilling. The plan will outline specific drilling fluid additives the Contractor plans to use, how anticipated changes in the drilling conditions will affect the drilling fluid control plan, fluid testing procedures, and equipment that will be used. The Consultant must approve the drilling fluid control plan. Drilling fluid additives shall be certified by the National Sanitation Foundation (NSF) and approved by the Consultant.

3.4 Drilling Fluid Testing

The Contractor shall retain an experienced Drilling Fluid Engineer as a Subcontractor. The Contractor’s selection of a Drilling Fluid Engineer will be subject to review and approval by the
Consultant. The Drilling Fluid Engineer will be available within a 2-hour travel time of the site during all drilling and well construction operations.

Drilling fluid tests shall be performed by the Drilling Fluid Engineer during periods when any drilling fluid additives (not only clear water) are being circulated in the borehole. Physical and chemical properties of the drilling fluid are to be measured in accordance with the procedures of the API Standard RP 13B, "Standard Procedures for Testing Drilling Fluids". Samples tested are those collected at the rig discharge line, with care taken to assure a true and representative sample is collected. Drilling fluid tests shall be conducted by the Drilling Fluid Engineer at a minimum of 1) every 24 circulating hours, 2) when significant changes to the drilling fluid are made, 3) whenever conditions appear to have changed or when problems arise, or 4) at the request of the Consultant.

The Contractor shall have an Imhoff Cone, Marsh-type viscosity funnel, and a mud scale at the site and, upon request, will be made available to the Consultant.

The Contractor shall maintain current records at the site at all times to show 1) the time, depth, and results of all drilling fluid tests, 2) all materials added to the system, (i.e., kind, amount, time, and depth), and 3) variances or modifications from the agreed-upon fluid program, such as time, depth, reason, and authorization.

The Contractor is responsible for maintaining an adequate supply of drilling fluid additives at the drilling site and for the removal of all drilling fluids and additives from the borehole during development of the well.

### 3.5 Drilling Fluid Reconditioning

In accordance with applicable provisions of the AWWA Standard A100 for water wells, these specifications, or at the direction of the Consultant, the drilling fluid shall be reconditioned prior to the installation of the filter pack, until it has the following properties.

1. Weight – no greater than 9.1 lb/gal (68 lb/ft³);
2. Viscosity – no greater than 30 seconds per quart; and
3. Sand content – no greater than 1 percent by volume.

At the discretion of the Consultant, the above standards may be exceeded in cases where different drilling fluid properties are required to protect or stabilize the well due to unstable borehole conditions, or other site-specific circumstances. The Contractor shall adhere to the standards listed above, unless otherwise approved by the Consultant.

### 3.6 Mud Pit

The drilling fluids and drill cuttings shall be contained at the site in temporary excavated or above ground mud pits to be provided by the Contractor. The mud pit shall have a minimum depth of 6 feet and a total volume no less than that of the reamed borehole. The pits shall contain at least one baffle, to assist with the separation of cuttings and suspended solids from the drilling fluid. The specific dimensions and design of the mud pits must be approved by the Consultant.
Upon completion of the work, the excavated mud pits shall be drained and allowed to dry to the maximum extent possible before backfilling. The mud pit excavation shall be filled with self-compacting aggregate to avoid future subsidence of the pit area. The compaction of the fill material must meet the approval of the Owner or Consultant. Drilled cuttings shall be spread evenly in a thin layer at the well site, such that they do not pose a threat to the existing vegetation or drainage or impact future construction at the well site.

### 3.7 Lost Circulation

Lost circulation is a loss of drilling fluid to the formation that exceeds the maximum available discharge rate of water into the borehole, to the extent that the fluid level in the annulus outside the drill pipe cannot be maintained to a level above the base of the surface casing for at least one (1) hour, due to no fault of the Contractor.

During pilot borehole or production borehole drilling operations, if lost circulation occurs at no fault to the Contractor the Owner will compensate the Contractor. If circulation is lost due to the actions of the Contractor (e.g., excessive fluid weight) then the Contractor shall regain circulation at no cost to the Owner.

The Contractor is responsible to notify the Consultant immediately upon each occurrence of lost circulation and to document the times, quantities, and circumstances of lost circulation during each occurrence. Failure of the Contractor to promptly notify the Consultant of lost circulation will void the Contractor’s opportunity to implement this clause, but will not affect the Contractor’s responsibility to maintain the integrity of each borehole.

The conditions of this Section shall apply from the beginning of the period of lost circulation, and shall continue only until such time that the drilling fluid level can be maintained within the surface casing. After an initial lost circulation event has occurred, should circulation be lost again, the conditions of this paragraph will go into effect immediately, and continue until such time as drilling fluid circulation is regained.

### 3.8 Submittals

A. Drilling Fluid Log. During the drilling of the borehole, the Contractor shall log the drilling fluid properties. The drilling fluid properties shall be recorded on an American Petroleum Institute (API) approved form. The drilling fluid records shall be available for review by the Consultant, Owner, and City. The drilling fluid log shall be submitted to the Consultant upon completion of each day’s work activities.

B. Drilling Fluid Control Plan.

C. Material Data Safety Sheets (MSDSs) from the manufacturer for all drilling fluid additives must be provided to the Consultant for review and approval prior to their use.

D. The specific dimensions and design of the mud pits must be approved by the Consultant.

### 3.9 Measurements and Payments

A. Payment for all labor, equipment, and materials will be made on a lump sum basis.
B. Lost circulation due to no fault of the Contractor. The Owner will compensate the Contractor for the period of drilling at the Contractor’s hourly rate, in lieu of footage compensation. The Owner will also provide compensation at a rate of cost plus 10 percent markup to the Contractor for all drilling fluid materials and additives used during the period of Lost Circulation Conditions.

C. Lost circulation due to fault of the Contractor. All costs to regain circulation shall be at no cost to the Owner.

*** End of Section ***
4.0 Surface Casing Drilling, Materials, and Installation

4.1 Surface Borehole Drilling

The surface casing borehole may be drilled using the rotary or bucket auger (solid stem auger) drilling method. The borehole shall be drilled to a minimum 36-inch diameter and to a minimum depth of 39 feet or as directed by the Consultant.

4.2 Plumbness and Alignment

The borehole shall be sufficiently straight and plumb as to allow for the unobstructed installation of the surface casing and the uniform placement of the sand cement grout seal.

The surface casing shall be sufficiently straight and plumb as to allow for the uniform placement of the sand cement grout seal and to allow for the unobstructed drilling of the pilot borehole, reaming of the pilot borehole, and installation of the well casing.

The Consultant shall review and determine compliance with the plumbness and alignment requirements. If the borehole or surface casing fails to meet the plumbness and alignment requirements the Contractor must correct the plumbness and alignment to the satisfaction and approval of the Consultant and the City. Plumbness and alignment correction costs will be borne by the Contractor.

4.3 Drill Cuttings

During the drilling of the surface borehole the Contractor shall collect and preserve two (2) unwashed samples of the drill cuttings at ten (10) foot intervals. The first sample shall be a quart-sized sample and shall be placed in a plastic bag and clearly labeled with the sample interval. The second sample shall be preserved in 4½-inch by 6-inch cloth sacks (Hubco or approved equivalent) and clearly labeled with the depth interval. At the completion of the surface borehole drilling the Contractor shall provide the sacked drill cuttings to the Consultant. The remaining drill cuttings shall be spread in a thin layer over the surface of the well site.

4.4 Surface Casing Materials

The surface casing shall be new low carbon steel (LCS) and manufactured in accordance with American Society for Testing and Materials (ASTM) Specification A53 Grade B steel or ASTM Specification A139 Grade B steel and be free from any material defects. The surface casing shall be 40-feet long, 30-inch outside diameter, and have a minimum 0.375-inch wall thickness.

4.5 Cement Grout Seal Materials

The following materials are acceptable for the sealing of the surface casing.

1. Sand Cement
2. Neat Cement
The sand cement grout seal material shall consist of cement slurry containing 5.2 to 6.0 gallons of water per 94-pound sack of Portland cement. The Portland cement shall conform to ASTM Standard C150, Type II. The sand shall not exceed 50 percent by volume of the cement. The cement grout slurry shall not exceed 17.0 pounds per gallon and shall be free of lumps, to the satisfaction of the Consultant. Water used for preparing the cement grout shall be potable. Bentonite may be used as an additive, and must be in powder form and shall not exceed 4 percent by volume of the cement, or cement and sand. Water added for bentonite shall not exceed 1.3 gallons per 1.88 pounds of bentonite (2 percent by weight in cement). Accelerator additives, such as calcium chloride, shall not be used.

The neat cement shall consist of a cement slurry containing 5.2 to 6.0 gallons of water per 94-pound sack of Portland cement. The Portland cement shall conform to ASTM Standard C150, Type II. The cement grout slurry shall not exceed 15.6 lb/gal and shall be free of lumps, to the satisfaction of the Consultant. Water used for preparing the cement grout shall be potable. The neat cement grout slurry may contain pozzolanic material (fly ash) as an additive, which complies with ASTM Standard C618, and which shall not exceed 50 percent by volume of the cement. No non-pozzolanic aggregate, sand, or accelerator additives may be added, unless approved by the Consultant.

The Contractor must provide a cement mix design, the mix water source, and the specific constituents of the cement grout to the Consultant for approval prior to the installation of the cement grout.

The Contractor shall make provisions and allow for the Consultant to collect and preserve a representative sample of the cement grout. The Consultant shall weight the cement grout prior to installation, as an indicator of the cement-water ratio.

Cement grout that does not comply with the above requirements as determined by the Consultant will be rejected.

4.6 Surface Casing Installation

The surface casing shall be placed from 1 foot above the ground surface to at least 39 feet below the ground surface. The surface casing installation shall be conducted under the observation of the Consultant.

4.7 Cement Grout Seal Installation

The installation of the cement grout seal shall be conducted under the observation of the Consultant and placed in the annular space between the well casing and the wall of the surface borehole from the base of the surface casing to the ground surface. The Contractor shall be responsible to maintain an equalization of pressures to the extent necessary to prevent collapse of the surface casing during cement grout installation. The grout seal shall completely fill the annular space and form a uniform continuous seal between the surface casing and the wall of the borehole.
The surface casing shall be maintained centered in the borehole during and after cement grout installation. The Consultant must approve the method of grout installation. A minimum curing time for the surface casing cement grout seal is 12 hours, with the cement grout obtaining a compressive strength of at least 500 pounds per square inch (psi).

4.8 Submittals

A. The Contractor shall submit the required drill cuttings to the Consultant.
B. Prior to the installation of the surface casing, the Contractor shall submit a certified test report to the Consultant demonstrating compliance with the physical and chemical properties of the surface casing.
C. The cement grout must be approved by the Consultant prior to installation.
D. The Consultant must approve the method of the cement grout seal installation.

4.9 Measurements and Payments

Payment for all labor, equipment, and materials will be made on a linear foot basis.

*** End of Section ***
5.0 Pilot Borehole and Reamed Borehole Drilling

5.1 Equipment

The Contractor shall furnish and maintain in safe and efficient working condition all equipment necessary to perform the work. This shall include a drill rig capable of performing the specified operations to the specified depths and auxiliary equipment as specified or required to complete the work.

The Contractor shall submit a statement indicating the drilling equipment to be used. The drilling rig used for the installation of the production well shall have a mast capacity no less than 1½ times the string weight of the well casing and screen. Additionally, the well shall be installed without the use of a float plate. The drill pipe shall have a minimum 5½-inch inside diameter (ID).

The equipment supplied by the Contractor shall include, but not be limited to the following.

1. A wire line depth indicator capable of measuring depths equal to the total depth of the borehole, and equipped with a counter device which provides for a depth measurement accuracy of ± 1 foot
2. A water level sounder that provides for a depth measurement accuracy of ± 0.1 foot
3. Specified devices for measurement of the drilling mud viscosity and weight
4. An operating and accurate 3-degree inclinometer tool
5. An operating and accurate penetration rate indicator (Geolograph or approved equal)
6. An operating and accurate gauge that indicates the hook load (weight) of the drill string

The Contractor shall also maintain at the well, or have the ability to rapidly fabricate, commonly used fishing tools (such as overshots, wall hooks, junk baskets, etc.) to accommodate the event that lost tools in the borehole require fishing operations.

The drilling rig and auxiliary equipment shall be well maintained and shall meet the standards of the Occupational Safety and Health Administration (OSHA). Rig walkways and stairways shall be guarded with rails, and Contractor personnel shall use a safety harness at all times when ascending the rig mast. All high-pressure hoses shall be equipped with a safety chain to protect against the event of hose failure.

Prior to the start of drilling, the Contractor shall decontaminate the drill rig and downhole tools by steam cleaning. The method and extent of steam cleaning must be approved by the Consultant. The Contractor will be required to provide a letter of certification of the decontamination of the Contractor’s equipment, prior to utilization. The Contractor may certify, in writing, the decontamination of critical (downhole) pieces of drilling equipment in lieu of actual steam cleaning, provided the downhole pieces of drilling equipment have not been in contact with any hazardous or toxic materials since the last decontamination. All necessary steam cleaning will be conducted at the Contractor’s expense.
5.2 Plumbness and Alignment

The plumbness and alignment of the pilot borehole and reamed borehole shall allow for the installation of a well that complies with AWWA Standard A100, where the maximum allowable horizontal deviation (drift) of the completed well casing from vertical shall not exceed 10.66 inches per 100 feet of depth (for a 16-inch inside diameter casing).

A magnetic deviation survey or gyroscopic survey shall be conducted after the completion of the pilot borehole and reamed borehole drilling to determine compliance with the plumbness and alignment requirements.

If the boreholes fail to meet the plumbness and alignment requirements, as determined by the magnetic deviation survey or gyroscopic survey, the Contractor must correct the plumbness and alignment to the satisfaction and approval of the Consultant and the City. Plumbness and alignment correction costs will be borne by the Contractor.

5.3 Low Penetration

Low penetration is defined as a drilling rate of less than 4.0 feet per hour for a period of two (2) continuous hours, while at least 1,500 pounds per diameter inch is applied to the drill bit and the drill bit is in good working condition.

The Contractor shall notify the Consultant within one (1) hour of the following drilling condition: a penetration rate of less than 4.0 feet per hour for a period of two (2) continuous hours, while at least 1,500 pounds per diameter inch is applied to the drill bit.

At the request of the Consultant, the Contractor shall trip the drill string out of the hole for inspection of the drill bit by the Consultant.

If the Consultant 1) was notified as outlined above and 2) determines that there is no excessive bit wear then the Contractor shall be compensated on an hourly basis for low penetration conditions and for the time expended to remove and re-install the drill bit.

If the Consultant was not notified, as outlined above, or if the Consultant determines that there is excessive bit wear then this Section will not apply.

5.4 Pilot Borehole Drilling

After the completion of the surface casing, the pilot borehole shall be drilled to the depth noted on the plans and specifications and shall have a diameter no less than 16 inches and no greater than 17½ inches unless otherwise approved by the Consultant. The borehole shall be drilled in compliance with the drilling fluid requirements. During the drilling of the pilot borehole, all operations shall be conducted on a 24-hour per day, 7-day per week basis.
5.5 Reamed Borehole Drilling

After the completion of pilot borehole geophysical testing and zonal sampling operations, the pilot borehole shall be reamed to a diameter of 24-inches and to the depth noted in the plans and specifications, unless otherwise approved by the Consultant. The borehole shall be drilled in compliance with the drilling fluid requirements. During the drilling of the reamed borehole, all operations shall be conducted on a 24-hour per day, 7-day per week basis.

5.6 Inclinometer Survey

As an indication of the plumbness and alignment and not a determination of the plumbness and alignment, the Contractor shall conduct an inclinometer survey during the drilling of the pilot borehole using an inclinometer (TOTCO tool or approved equal) at 100-foot intervals. A 3-degree unit shall be used with the inclinometer. The inclinometer results shall be provided by the Contractor to the Consultant.

5.7 Drill Cuttings

During the drilling of the pilot borehole the Contractor shall collect and preserve a one (1) quart unwashed sample of the drill cuttings at ten (10) foot intervals for inspection by the Consultant.

The Contractor shall provide an acceptable means of sampling the drilled cuttings at the discharge pipe. A sump-type or baffle-type sample catching device shall be provided by the Contractor. Each cutting sample shall be carefully collected from the sampling point, and the sample catching device shall be cleaned of all cuttings after each sample is taken.

The sample shall be placed in a sample storage area on a plastic tarp at least 6 mils thick. The storage area and plastic tarp must allow samples to be maintained in sequence and unmixed with surface material or other samples until they have been examined and logged by the Consultant. During times of inclement weather the samples shall be covered with a plastic tarp at least 6 mils thick.

Each sample shall be laid out in descending order. A portion of each sample shall then be transferred into a 4½-inch by 6-inch cloth sack (Hubco or approved equivalent) and clearly labeled with the depth interval.

Prior to the start of drilling, the Contractor shall submit details of the proposed formation sampling method to the Consultant, including the specific sampling equipment sampling to be used (e.g., sample collection box). The sampling program and equipment must be approved by the Consultant.

5.8 Reports, Logs, and Records

The Contractor shall keep an accurate and legible daily log and record of all drilling, testing, and construction, describing all geologic material encountered during drilling, the depths at which changes in formation occur, and all difficulties or unusual conditions encountered.
5.9 Penetration Rate Log

During the drilling of the borehole, a time log shall be kept showing the actual penetration time required to drill each foot of the borehole. Every foot drilled shall be clearly marked on a geolograph strip chart. The types of bits used in each interval of the borehole shall be noted on this log and whether designed for soft, medium, or hard formations, including approximate weight on the bit, the rotation speed (RPM) of the bit, and any other information that may be requested by the Consultant. These logs shall be available for review by the Consultant throughout the drilling program, and a copy of the log shall be delivered to the Consultant daily.

5.10 Driller’s Log

During the drilling of the borehole, the Contractor shall prepare a detailed driller's log in compliance with the requirements of the Arizona Department of Water Resources (ADWR). The log shall include the reference point for all depth measurements, a generalized description of each formation, the depth at which each formation is encountered, and the thickness of each formation. The lithologic log prepared by the Consultant will be made available to the Contractor to assist in the preparation of the driller's logs. A copy of the driller's log shall be submitted to the Consultant.

5.11 Submittals

A. Prior to the start of drilling, the Contractor shall provide a letter of certification of the decontamination of the Contractor’s equipment, prior to utilization.
B. Formation Sampling Plan
C. Driller’s Log
D. Penetration Rate Log
E. Statement of the drilling rig to be used and the mast capacity.
F. Inclinometer survey results

5.12 Measurements and Payments

A. Payment for the labor, equipment, and materials used to drill the pilot borehole and production borehole will be made on a linear foot basis.
B. Payments for low penetration conditions will be based on the Contractor’s hourly drilling rate in lieu of the linear foot basis. The Owner will also provide compensation at a rate of cost plus ten (10) percent markup to the Contractor for all drilling bits used during Low Penetration Conditions. During Low Penetration Conditions, the Contractor will credit the prorated values of used drilling bits to the Owner.

*** End of Section ***
6.0 Pilot Borehole Geophysical Logging

6.1 General

Geophysical logging of the total depth of the pilot borehole shall be conducted at the completion of the pilot borehole drilling. The Contractor shall retain a geophysical logging company as a Subcontractor. The Consultant shall review and approve the Geophysical Logger prior to the start of logging. All geophysical logging activities shall be conducted under the observation of the Consultant and the City. The geophysical logging suite for the borehole shall include the following.

1. Spontaneous Potential Log (Electric Log)
2. Resistivity Log (Electric Log)
3. Acoustic Log (Sonic Log)
4. Natural Gamma Ray Log
5. Caliper Log
6. Focused Guard Log
7. Magnetic Deviation or Gyroscopic Log

The Contractor shall recondition the drilling fluid prior to the geophysical logging and shall keep the borehole full of drilling fluid at all times during geophysical logging, to stabilize the borehole and provide log integrity. The Contractor shall assist the geophysical logger in rigging of the geophysical survey equipment. The Contractor shall ensure that the logging tools can be run to the total depth of the pilot borehole without interference by obstructions or tight sections in the borehole.

At the request of the Consultant, the Geophysical Logger shall conduct repeat sections of geophysical logs in intervals of the borehole selected by the Consultant. The repeat logging intervals will not exceed 50 feet.

The magnetic deviation log or gyroscopic survey shall be used to determine the conformance of the pilot borehole to the plumbness and alignment requirements. The geophysical logging Subcontractor shall prepare a written plumbness and alignment report. The report shall include numerical values of the well deviation, and also graphical diagrams of the well alignment, from both a profile perspective (both Northing and Easting views), and a vertical perspective. The quality and clarity of the gyroscopic logs must be approved by the Consultant.

6.2 Submittals

A. The Contractor shall submit to the Consultant for review and approval the geophysical logging Subcontractor.
B. The Geophysical logger shall provide five (5) field copies of each geophysical log survey to the Consultant and one (1) field copy to the City upon the completion of logging. Within 10 days after completion of logging, 12 final copies of the geophysical logs shall be provided to the Consultant, as well as an electronic original of the logging data in Windows Metafile and PDF format.
C. The Geophysical Logging Subcontractor shall within 48 hours after completing the gyroscopic survey provide the Consultant with 12 final copies of the gyroscopic survey, plumbness and alignment report; one (1) electronic copy of the gyroscopic survey in a Windows Metafile and a PDF format, and one (1) electronic copy of the plumbness and alignment report in a PDF format.

6.3 Measurements and Payments

Payment for all labor, equipment, and materials will be made on a lump sum basis.

*** End of Section ***
7.0 Pilot Borehole Zonal Sampling and Testing

7.1 General

After the completion of the pilot borehole geophysical logging, the Contractor shall conduct depth specific groundwater sampling, as directed by the Consultant. The results of this testing will aid in the final design of the well. Zonal samples will be collected at locations specified by the Consultant and approved by the City, within the pilot borehole. The Consultant may add or omit zonal samples based on subsurface conditions encountered. The City shall review and approve the depths and number of zonal samples.

For bidding purposes only, it is anticipated to collect seven (7) zonal samples in a 1,500 foot well.

7.2 Equipment

For airlifting purposes, the Contractor shall provide a compressor capable of supplying a minimum of 750 cubic feet per minute and 350 pounds per square inch.

For sample collection purposes, the Contractor shall provide a pump capable of providing a discharge of no less than 50 gallons per minute with the pump set at a depth of 10-feet above the bottom of the borehole.

Pup joints of drill pipe in lengths of 5 and 10 feet (at least one of each) to be available for use during zonal sampling operations. The well screen and drill pipe must have a minimum 4-inch inside diameter and be capable of the installation of a submersible pump and sounding tube.

7.3 Pea Gravel Material

The pea gravel used for zonal sampling shall be a clean durable well-rounded siliceous pea gravel that is smooth and uniform. Samples of the pea gravel shall be provided to the Consultant for approval no less than 24 hours prior to installation.

7.4 Bentonite Seal Material

The bentonite seal material shall consist of sodium bentonite pellets or chips. The bentonite seal material shall contain no hazardous materials or gypsum. Samples of the bentonite material shall be provided to the Consultant for approval no less than 24 hours prior to installation.

7.5 Installation

The sample zone shall consist of a 5 foot bottom bentonite seal, a 30 foot envelope of pea gravel surrounding the screen and casing, and capped with a second 5 foot bentonite seal. The pea gravel and bentonite shall be installed through a tremie pipe, unless otherwise approved by the Consultant.

The well screen shall be approximately 20 feet in length and shall be placed approximately five (5) feet from the top and bottom of the bentonite seals, or as directed by the Consultant. The Contractor shall use pup joints when necessary to set the well screen at the required depth.
The materials and well screen shall be installed to the appropriate depth and measured with a wireline. After the drill string, eductor pipe, gravel pack, and bentonite seals are installed, the interval shall be developed by airlifting and pumping.

7.6 Airlifting

The Contractor shall airlift from the sample zone using an air line inside the drill string. It is anticipated that 10 hours of airlifting will be required for each sample interval. Airlifting of water from the zone will continue to the satisfaction of the Consultant. The discharge from the zone need not be free of sand grains, but must be reasonably clear to the satisfaction of the Consultant.

The specific zonal airlifting procedure and the point of discharge for purged water must be approved by the Consultant.

7.7 Pumping

After the airlifting of the zone, the Contractor shall install a submersible pump and a 1-inch sounding tube. During the pumping of water from each zonal sample interval, the Contractor shall operate the pump and shall assist the Consultant with the collection of water levels and zonal groundwater samples for testing and analysis by the Consultant. It is anticipated that approximately 2 hours will be need to complete the work.

7.8 Submittals

The Contractor shall submit to the Consultant for review and approval the bentonite and pea gravel materials.

7.9 Measurements and Payments

A. Payments for all labor, equipment, and materials will be made on a per zonal sample basis.
B. Payments for all standby time will be made on an hourly basis.

*** End of Section ***
8.0 Production Borehole Geophysical Logging

8.1 General

After the completion of the borehole reaming, the Contractor shall conduct the following geophysical logs of the borehole.

1. Magnetic Deviation Log or Gyroscopic Log
2. Caliper Log

The surveys shall be conducted under the observation of the Consultant and the Consultant shall review and approve the geophysical logging Subcontractor prior to the start of logging.

The Contractor shall keep the reamed borehole full of drilling fluid at all times during geophysical logging, to stabilize the borehole and provide log integrity. The Contractor shall assist the geophysical logger in rigging of the geophysical survey equipment. The Contractor shall ensure that the logging tools can be run to the total depth of the production borehole without interference by obstructions or tight sections in the borehole.

The magnetic deviation log or gyroscopic survey tool shall be centralized in the well and at the request of the Consultant, the geophysical logging Subcontractor shall conduct repeat sections of geophysical logs in intervals of the borehole selected by the Consultant. The repeat logging intervals will not exceed 50 feet.

The magnetic deviation log or gyroscopic survey shall be used to support a determination by the Consultant, of the conformance of the reamed borehole to the plumbness and alignment requirements. The geophysical logging Subcontractor shall prepare a written plumbness and alignment report. The report shall include numerical values of the well deviation, and also graphical diagrams of the well alignment, from both a profile perspective (both Northing and Easting views), and a vertical perspective. The quality and clarity of the gyroscopic logs must be approved by the Consultant.

8.2 Submittals

A. The Contractor shall submit to the Consultant for review and approval the Geophysical Logger.
B. The Geophysical Logging Subcontractor shall provide five (5) field copies of the geophysical logs to the Consultant and one (1) field copy to the City upon the completion of logging. Within 10 day after completion of logging, 12 final copies of the geophysical logs shall be provided to the Consultant, as well as an electronic original of the logging data in Windows Metafile (*.wmf) format and PDF format.
C. The Geophysical Logging Subcontractor shall within 48 hours after completing the gyroscopic survey provide the Consultant with 12 final copies of the gyroscopic survey, plumbness and alignment report; one (1) electronic copy of the gyroscopic survey in a Windows Metafile and a PDF format, and one (1) electronic copy of the plumbness and alignment report in a PDF format.
8.3 Measurements and Payments

Payment for all labor, equipment, and materials will be made on a lump sum basis.

*** End of Section ***
9.0 Production Well Materials and Installation

9.1 General

The well casing, well screen, and annular materials for the well must be approved by the Consultant prior to their installation.

The Consultant and the City will make a final determination of the well screen slot size and the final length and depths of the well casing and well screen will be determined by the Consultant based on analysis of the geophysical logging data and zonal sampling data from the pilot borehole.

The Contractor shall immediately commence well installation operations after the completion of the production well caliper log and gyroscopic survey.

9.2 Well Casing Material

The sump plate, sump casing, well casing, stickup casing, and cover plate shall be new and shall meet the requirements listed below.

<table>
<thead>
<tr>
<th>Description</th>
<th>Steel</th>
<th>Outside Diameter</th>
<th>Wall Thickness</th>
<th>Casing Section Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover Plate</td>
<td>HSLA, ASTM specification A606</td>
<td>----</td>
<td>0.312-inch</td>
<td>----</td>
</tr>
<tr>
<td>Stickup Casing</td>
<td>Type 4, ASTM A139 Grade B</td>
<td>16 3/8-inch</td>
<td></td>
<td>4-feet</td>
</tr>
<tr>
<td>Well Casing</td>
<td></td>
<td>16 3/8-inch</td>
<td></td>
<td>40-feet</td>
</tr>
<tr>
<td>Sump Casing</td>
<td></td>
<td>16 7/8-inch</td>
<td></td>
<td>20-feet</td>
</tr>
<tr>
<td>Sump Plate</td>
<td></td>
<td>----</td>
<td></td>
<td>----</td>
</tr>
</tbody>
</table>

The casing sections shall contain one spiral seam along the casing axis, and shall contain no more than one circumferential seam per 10 linear feet, unless otherwise approved by the Consultant and City. The well casing shall be factory-assembled.

The Contractor shall obtain from the well casing manufacturer, the tensile strength (pounds), collapse strength (psi), weight (pounds per linear foot), and maximum recommended hang weight (pounds) of the casing. This information shall be provided to the Consultant prior to delivery of the casing to the site.

Prior to casing installation, the Contractor shall submit certified test reports to the Consultant to demonstrate compliance with the physical and chemical properties of the well casing that are specified herein.
9.3  Well Screen Material

The well screen for the public supply well shall be new, high strength low alloy steel (HSLA) Full Flo Louvered screen. The well screen shall have a 16\(\frac{5}{8}\)-inch nominal diameter and 0.312-inch wall thickness, with horizontal louvered openings and manufactured in 40-foot lengths.

The horizontal louvered openings shall be factory-installed in the well screen with an approximate 3-inch slot length, in rows that are spaced approximately 1 inch apart in the vertical direction. The openings in the screen shall be machine made, horizontal to the axis of the casing, and of a louver form with the aperture facing downward.

The Contractor shall obtain from the well screen manufacturer, the tensile strength (pounds), collapse strength (psi), weight (pounds per linear foot), and maximum recommended hang weight (pounds) of the screen. This information shall be provided to the Consultant prior to delivery of the well screen to the site.

Prior to well screen installation, the Contractor shall submit certified test reports to the Consultant to demonstrate compliance with the above requirements.

9.4  Welding Collars and Centralizers

The welding collars and centralizers shall be new and shall meet the requirements listed below.

<table>
<thead>
<tr>
<th>Description</th>
<th>Steel</th>
<th>Wall Thickness</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welding Collars</td>
<td>HSLA</td>
<td>0.312-inch</td>
<td>5-inches</td>
</tr>
<tr>
<td>Centralizers</td>
<td>ASTM specification A606 Type 4</td>
<td>----</td>
<td>----</td>
</tr>
</tbody>
</table>

The welding collars shall fit the outside diameter of the well casing within 0.0625-inch diametrical clearance. The welding collars shall be delivered to well site connected to the casing sections at one end with factory-welded connections. The inside edge of the welding collars shall be ground or sufficiently scarified to remove sharp edges or burrs. Three alignment holes shall be provided in each welding collar (spaced at 120°), to ensure proper abutment of the casing sections. The alignment holes shall be no larger than 1 inch in diameter, and shall be completely filled with fillet welding.

9.5  Filter Pack Material

The filter pack shall be Colorado Silica Sand or approved equal, consisting of clean, well-rounded grains that are smooth and uniform. The filter pack shall be siliceous with a limit of 2 percent, by weight, calcareous material. The filter pack material shall be obtained from a source that has been approved by the Consultant, and shall consist of well-rounded particles with an average density of not less than 2.5 grams per cubic centimeter, and have a uniformity coefficient no greater than 1.5. Not more than 1 percent, by weight, of the material shall have a density of 2.25 grams per cubic centimeter or less. The filter pack shall contain no more than 2 percent by weight, thin, flat, or elongated pieces (pieces in which the largest dimension exceeds three times the smallest dimension) determined by hand-packing. The filter pack material shall be free of
shale, mica, clay, dirt, loam, organic impurities of any kind, and shall not contain iron or manganese in a form or quantity that will adversely affect the water quality.

Samples of the filter pack sand and a sieve analysis (percent retained through U.S. standard sieve numbers 4, 8, 10, 16, 30, 40, 50, 100, and 200) of the filter pack material shall be submitted to the Consultant for approval, a minimum of 3 days prior to delivery of the filter pack to the well site. The filter pack material shall be contained in a temporary storage area at the well sites in such a manner as to prevent contamination. The filter pack material shall be bagged in approximately 3,000-pound (about one cubic yard) “super sacks”. Each bag must be labeled with its actual weight. Any filter pack material delivered unbagged or unlabeled will be rejected.

9.6 Disinfectant Material

A liquid sodium hypochlorite solution or granular calcium hypochlorite in accordance with NSF 61 and AWWA Standard C654 for disinfection of wells.

9.7 Pea Gravel Material

The pea gravel shall be clean durable well-rounded siliceous pea gravel that is smooth and uniform. The pea gravel shall be obtained from a source that has been approved by the Consultant. The pea gravel shall be free of sand, silt, clay, shale, mica, dirt, loam, organic matter or deleterious materials of any kind, and shall not contain any materials in a form or quantity that will adversely affect the water quality.

Samples of the pea gravel shall be submitted to the Consultant for approval, a minimum of 3 days prior to delivery of the pea gravel to the well site. The gravel pack material shall be contained in a temporary storage area at the well site in such a manner as to prevent contamination.

9.8 Bentonite Seal Material

The bentonite seal material shall consist of sodium bentonite pellets or chips. The bentonite seal material shall contain no hazardous materials or gypsum. Samples of the bentonite material for the well shall be provided to the Consultant for approval no less than 24 hours prior to installation.

9.9 Sand Cement Grout Seal Material

The sand cement grout seal material shall consist of cement slurry containing 5.2 to 6.0 gallons of water per 94-pound sack of Portland cement. The Portland cement shall conform to ASTM Standard C150, Type II. The sand shall not exceed 50 percent by volume of the cement. The cement grout slurry shall not exceed 17.0 pounds per gallon and shall be free of lumps, to the satisfaction of the Consultant. Water used for preparing the cement grout shall be potable. Bentonite may be used as an additive, and must be in powder form and shall not exceed 4 percent by volume of the cement, or cement and sand. Water added for bentonite shall not exceed 1.3 gallons per 1.88 pounds of bentonite (2 percent by weight in cement). Accelerator additives, such as calcium chloride, shall not be used.
The Contractor must provide a cement mix design, the mix water source, and the specific constituents of the cement grout to the Consultant for approval prior to the installation of the cement grout.

The Contractor shall make provisions and allow for the Consultant to collect and preserve a representative sample of the cement grout. The Consultant shall weight the cement grout prior to installation, as an indicator of the cement-water ratio.

Cement grout that does not comply with the above requirements as determined by the Consultant will be rejected.

9.10 Neat Cement Grout Seal Material

The neat cement grout seal material shall consist of a cement slurry containing 5.2 to 6.0 gallons of water per 94-pound sack of Portland cement. The Portland cement shall conform to ASTM Standard C150, Type II. The cement grout slurry shall not exceed 15.6 lb/gal and shall be free of lumps, to the satisfaction of the Consultant. Water used for preparing the cement grout shall be potable.

The cement grout slurry may contain pozzolanic material (fly ash) as an additive, which complies with ASTM Standard C618, and which shall not exceed 50 percent by volume of the cement. No non-pozzolanic aggregate, sand, or accelerator additives may be added, unless approved by the Consultant.

The Contractor must provide a cement mix design, the mix water source, and the specific constituents of the cement grout to the Consultant for approval prior to the installation of the cement grout.

The Contractor shall make provisions and allow for the Consultant to collect and preserve a representative sample of the cement grout. The Consultant shall weight the cement grout prior to installation, as an indicator of the cement-water ratio.

Cement grout that does not comply with the above requirements as determined by the Consultant will be rejected.

9.11 Well Casing and Screen Installation

During the installation of the well casing and screen the borehole shall be kept full of drilling fluid and be free from any obstructions detrimental to completing the casing installation. The well casing shall be hung in tension throughout the installation of the annular materials. The well casing shall be set centered in the hole so as not to interfere in any way with the installation of the annular materials. The Contractor will be required to work continuously, on a 24-hour per day, 7-day week basis, while installing and completing the well.

The well casing and well screen shall be set by the Contractor at the depth intervals specified by the Consultant and approved by the City. The centralizers shall be secured to the well casing and screen at intervals of not greater than 40 feet.
Joints in the well casing and well screen shall be field welded in accordance with applicable provisions of the AWWA Standard C206 for welded joints. The ends of each casing section shall not vary more than 0.010 inch at any point from a true plane at right angles to the axis of the casing. A welding sequence will be followed that will avoid excessive distortion, voids, and/or air pockets. All well casing joints or overlaps shall be made watertight to prevent the degradation of the water supply by the migration of poor quality water. All welding shall be performed by an experienced welder.

If the casing or screen sections are butt-welded without the use of welding rings, the ends of the casing lengths shall be ground, or sufficiently scarified, to remove sharp edges or burrs. Each casing and screen end shall be beveled at one end to allow complete penetration of the welds.

If the casing or screen sections are joined with welding rings, the ends of the casing lengths shall be ground, or sufficiently scarified, to remove sharp edges or burrs. One end of each casing section shall be furnished with a welding collar.

Prior to installation of the well casing and screen, the Contractor shall submit an installation plan to the Consultant for review and approval. The plan shall include the proposed method to install the well casing and screen.

9.12 Filter Pack and Disinfectant Installation

Prior to the installation of the filter pack and disinfectant, the Contractor shall recondition the drilling fluid. The filter pack shall be placed to completely fill the annulus between the reamed borehole and the well casing.

The drilling fluid shall be maintained throughout the full depth of the well to the land surface and the well casing and screen shall be maintained in tension, until the placement of the filter pack has been completed to the specified level. During the time of placement, fluid circulation shall be maintained through a Consultant approved swab block located no less than 40-feet below the fill depth of the filter pack. The swab block shall be periodically reciprocated to remove fine-grained material, prevent bridging, and aid in settling the filter pack in the borehole. Care shall be taken to avoid bridging during installation of the filter pack.

The filter pack and disinfectant shall be installed with potable water by use of a tremie pipe. At no time shall the bottom of the tremie pipe be located at a distance of greater than 30 feet above the interval being filled during filter pack placement. The level of the filter pack shall be measured periodically during placement with a wireline sounder, as required by the Consultant. Placement of the filter pack and disinfectant will be continuous, except when additional precautions are necessary to prevent bridging, or while measurement of the filter pack level is being conducted.

The quantity of filter pack material placed in the annulus shall not be less than that of the calculated volume as determined by the production borehole caliper survey. Upon completion of the filter pack placement, excess filter pack material will be judged an indication of voids in the sand envelope and corrective measures shall be undertaken at the Contractor’s expense. The specific method of filter pack placement must be approved by the Consultant.
The filter pack shall be disinfected using a Consultant approved disinfectant that provides a chlorine residual of not less than 50 mg/l and no greater than 100 mg/l in the entire volume of the fluid with in the well. The Contractor is responsible for the uniform application of the disinfecting agent throughout the filter pack interval, without relying on subsequent mechanical surging action for dispersing the disinfectant. The specific method used to disinfect the filter pack must be approved by the Consultant.

Prior to installation of the filter pack and disinfectant, the Contractor shall submit an installation plan to the Consultant for review and approval. The plan shall include the proposed method to install the filter pack and disinfectant.

9.13 Bentonite Seal Installation

A bentonite seal shall be installed after the installation of the filter pack. The bentonite seal shall be placed to completely fill the annular space between the well casing and the wall of the borehole. The bentonite seal shall be installed simultaneous with the reverse circulation of drilling fluid down the annulus, until such time that the annulus has been sealed and circulation can no longer be maintained.

Prior to installation of the bentonite seal, the Contractor shall submit an installation plan to the Consultant for review and approval. The plan shall include the method to install the bentonite seal.

9.14 Neat Cement Grout Seal Installation

The neat cement grout seal shall be installed after the installation of the bentonite seal. The cement grout seal shall be placed to completely fill the annular space between the well casing and the wall of the borehole. The well casing shall be hung in tension throughout the grouting operation, until the cement grout has cured sufficiently.

The cement grout shall be placed in one continuous operation from the bottom to the top of the interval to be grouted, forming a continuous seal. The cement grout shall be passed through a ½-inch slotted bar strainer to remove any unmixed lumps and installed by pumping through a tremie pipe. The discharge end of the tremie pipe shall be continuously submerged in the grout until the zone to be grouted is completely filled.

The Contractor is responsible to maintain cement slurry hydraulic pressures and pumping pressures that will not reach excessive levels and cause collapse of the well casing during the installation of the cement grout. The minimum curing time for the cement grout shall be 12 hours or the cement grout obtaining a minimum compressive strength of 500 psi.

Prior to installation of the cement grout seal, the Contractor shall submit an installation plan to the Consultant for review and approval. The plan shall include the proposed method to install the neat cement grout seal.
9.15 Formation Stabilizer Installation

The formation stabilizer consists of alternating 100 foot thick layers of pea gravel and 5 foot thick layers of bentonite.

Prior to installation of the formation stabilizer, the Contractor shall submit an installation plan to the Consultant for review and approval. The plan shall include the proposed method to install the formation stabilizer.

9.16 Surface Casing Cement Grout Seal Installation

The sand or neat cement grout seal shall be installed after the installation of the formation stabilizer. The cement grout seal shall be placed to completely fill the annular space between the well casing and the wall of the borehole. The well casing shall be hung in tension throughout the grouting operation, until the cement grout has cured sufficiently.

The cement grout shall be placed in one continuous operation from the bottom to the top of the interval to be grouted, forming a continuous seal. The cement grout shall be passed through a ½-inch slotted bar strainer to remove any unmixed lumps and installed by pumping through a tremie pipe. The discharge end of the tremie pipe shall be continuously submerged in the grout until the zone to be grouted is completely filled.

The Contractor is responsible to maintain cement slurry hydraulic pressures and pumping pressures that will not reach excessive levels and cause collapse of the well casing during the installation of the cement grout. The minimum curing time for the cement grout shall be 12 hours or the cement grout obtaining a minimum compressive strength of 500 psi.

Prior to installation of the sand cement grout seal, the Contractor shall submit an installation plan to the Consultant for review and approval. The plan shall include the proposed method to install the sand cement grout seal.

9.17 Cover Plate and Access Port Installation

After completion of all testing and surveys, the Contractor shall install the cover plate and access port. The covering plate shall be secured to the top of the well with a watertight welded seam. Additionally, the covering plates will be equipped with a minimum 1-inch diameter access port with a watertight threaded cap, to allow for the measurement of water levels.

9.18 Submittals

A. The Contractor shall obtain from the well casing and screen manufacturer, the tensile strength (pounds), collapse strength (psi), weight (pounds per linear foot), and maximum recommended hang weight (pounds). This information shall be provided to the Consultant prior to delivery of the well casing and screen to the site.

B. Prior to the installation of the well casing and screen, the Contractor shall submit certified test reports to the Consultant to demonstrate compliance with the requirements of this section.
C. An affidavit of compliance with the welding provisions of this section shall be provided to the Consultant prior to the acceptance the well. The affidavit of compliance will certify that all welding was performed in accordance with all applicable requirements.

D. Prior to the installation of the annular materials the Contractor shall submit an installation plan to the Consultant for review and approval.

9.19 Measurements and Payments

A. Payment for the well casing, sump casing, sump plate, centralizers, cover plate, and access port materials shall be made on a linear foot basis for the actual quantities installed.

B. Payment for the well screen and centralizer materials shall be made on a linear foot basis for the actual quantities installed.

C. Payments for the annular materials will be made on a per ton, linear foot, cubic yard, or cubic foot basis for the actual quantities installed.

D. Payments for all labor and equipment to install the well casing, screen, and annular materials shall be made on a linear foot basis.

*** End of Section ***
10.0 Production Well Development

10.1 General

The Contractor shall develop the well after installation of the well casing, screen, and annual materials.

10.2 Equipment

The Contractor shall furnish and maintain in safe and efficient working condition all equipment necessary to perform and complete the well development. The equipment supplied by the Contractor shall include, but not limited to, the following:

A. Test motor,
B. Pump,
C. Column pipe,
D. Discharge pipe,
E. Flow meter and totalizer,
F. Air compressor,
G. Swabbing tool,
H. A wire line capable of measuring the entire length of the well that provides for a depth measurement accuracy of ± 1 foot,
I. Generator,
J. Rossum Sand Sampler, and
K. all other related equipment, materials, and labor necessary to conduct and complete the well development.

For swabbing and airlifting, the air compressor shall be capable of supplying a minimum of 750 cubic feet per minute and 350 pounds per square inch and the airline shall have a minimum 1¼-inch ID in order to accommodate adequate airflow.

The equipment used for the addition of chemical additives must be approved by the Consultant.

Contractor shall also provide and install a Rossum Sand Sampler in accordance with AWWA A100 for measurement of sand production during the pumping well development.

The Contractor shall furnish pumping equipment capable of developing the well during pumping and surging operations. The pump shall be capable of pumping a minimum from 500 to 2,000 gpm with a total dynamic head of 800 feet. The pumping equipment shall be complete with an ample power source and shall be capable of being operated throughout the entire pumping and surging operations.

The discharge pipe shall be equipped with a Consultant approved spigot or valve for water sample collection.
10.3 Dispersant Materials

At the Consultant’s discretion and approval, a non-phosphoric dispersant that will not promote bacterial growth may be added to the well in accordance with the manufacturer’s recommendations, during development operations to enhance dispersive of fine-grained particles for removal during development operations. For example purposes only this could be Johnson Screen product NW-220 or Aqua-Clear MSR. The Contractor shall submit to the Consultant for review and approval any dispersant to be used in the well. The Contractor shall provide the Consultant with an MSDS and information related to NSF approval for all chemical additives used for well development at least 3 days prior to their use. The Consultant must approve the specific type and placement method of any chemical additives, if needed.

The specific methods, chemical additives, and equipment used for well development must be approved by the Consultant prior to commencement of development operations.

10.4 Development

The well shall first be developed using swabbing and airlifting followed by pumping and surging. The swabbing and airlifting shall include an initial quick downward swab followed by swabbing and airlifting starting at the bottom of the well screen and shall proceed upward to the top of the well screen, at a rate of no less than 7.5 minutes per foot of screen, unless otherwise directed by the Consultant. Additionally, a discharge rate of no less than 50 gpm must be maintained. Each section of the well shall be developed until that section is reasonably clear and free of sediment, as determined by the Consultant.

After swabbing and airlift development and prior to pump and surge, the top of the fill material in the well shall be sounded. If substantial fill material is present in the well, as determined by the Consultant, then the fill material shall be removed from the well prior to pumping and surging.

The specific pump-and-surge development method must be approved by the Consultant. The pump-and-surge development program is anticipated to have a 12-hour duration, with pumping rates ranging from 500 to 2,000 gpm. The well shall be pumped and surged until the discharge is reasonably clear and free of sediment, as determined by the Consultant. After pumping and surging has been completed, the top of the fill material in the well shall be sounded. If substantial fill material is present in the well, as determined by the Consultant, then the fill material shall be removed from the well prior to aquifer testing.

Water produced during the well development shall be contained on site. Any offsite discharges shall be approved by the Consultant prior to discharge. Re-use of the discharge water will not be allowed.

10.5 Submittals

A. The specific methods, chemical additives, and equipment used for well development must be approved by the Consultant prior to commencement of development operations.
B. The Consultant shall review and approve the swab and airlift development method and swab tool prior to swab and airlift operations.
C. The Consultant shall review and approve the pump and surge development method prior to pump and surge operations.

10.6 Measurements and Payment

Payment for all labor, equipment, and materials will be made on an hourly and lump sum basis.

*** End of Section ***
11.0 Production Well Aquifer Testing

11.1 General

The Contractor shall conduct aquifer testing in the production well after the completion of the development of the production well.

11.2 Equipment

The Contractor shall furnish and maintain in safe and efficient working condition all equipment necessary to perform the aquifer testing. The equipment supplied by the Contractor shall include, but not limited to, the following:

1. Test motor,
2. Pump,
3. Column pipe,
4. Discharge pipe,
5. Flow meter and totalizer,
6. Calibrated orifice and manometer,
7. A water level sounder that provides for a depth measurement accuracy of ± 0.1 foot,
8. Sounding tube,
9. Generator,
10. Rossum Sand Sampler, and
11. all other related equipment, materials, and labor necessary to conduct the aquifer testing.

The Contractor shall furnish pumping equipment capable of a variable discharge rates up to 2,000 gpm, with a pumping lift (not including pipe friction losses) of 800 feet bless. The pumping equipment shall include satisfactory throttling devices or valves such that the discharge can be adjusted to various rates. The test pump setting shall be determined by the Consultant, based on the final well design. The pumping units shall be complete with an ample power source and shall be capable of being operated without interruption for a period of 24 hours.

The Contractor shall also furnish and install a 1-inch inside diameter sounding tube that extends from the land surface to the top of the pump bowls to facilitate the measurement of water levels using an electric sounder or a Consultant provided pressure transducer. The bottom of the sounding tubes shall be capped, with perforations in the lower 20 feet. The sounding tube shall permit the free and unobstructed passage of the electric sounder and pressure transducer from the wellhead to the bottom of the sounding tube such that accurate water levels measurements can be obtained.

The discharge pipe shall be equipped with a Consultant approved spigot or valve for water sample collection.

The Contractor shall also furnish equipment for measurement of the sand production during pumping. The sand measurement device shall be a Rossum Sand Sampler in accordance with AWWA Standard A100.
The Contractor shall provide and install an approved in-line propeller or magnetic flow meter capable of accurately measuring the amount of water being discharged from the well. The in-line flow meter shall be located in a straight portion of the discharge pipe without any bends, valves, or other obstructions that may interfere with the operation and/or accuracy of the meter for a distance of no less than 10 pipe diameters upstream, and for a distance of no less than 5 pipe diameters downstream (unless otherwise recommended by the manufacturer of the meter). At all times during pumping, the discharge pipe shall be oriented in such a manner as to ensure that the pipe remains full of water at the location of the flow meter. Prior to the performance of the pumping activities, the Contractor shall provide written certification that flow meters and totalizer are calibrated to within the accuracy constraints required by this specification. Additionally, the Contractor shall provide and install a calibrated orifice and manometer in the discharge pipe.

The equipment shall not be removed from the well until after the completion of the recovery test. The Consultant must approve the test pump, motor, metering equipment, and accessories.

11.3 Discharge

The Contractor shall operate the test pump at the discharge rates that have been directed by the Consultant and approved by the City. Discharge from the pump shall be controlled by a gate valve and/or engine throttle. The discharge shall be controlled and maintained at the specified rate for the entire test duration with an accuracy of plus-or-minus 5 percent.

The discharge water from the well shall be directed to a point of discharge that has been approved by the Consultant. The discharge piping shall be watertight and capable of conveying the specified flow rates for the specified pumping periods. The Contractor is responsible for providing adequate piping for the actual distances to the discharge points. The Contractor is responsible for coordination of any required permits, traffic control, and other considerations that may be required to address potential flooding or pipeline crossings of roadways that result from the discharged water.

11.4 Data Recording

The Contractor shall obtain and record the water level measurement, discharge rate, and total discharge in half-hour intervals throughout the duration of the aquifer testing, or as directed by the Consultant.

11.5 Step Test

The step test shall consist of a 10-hour pumping duration. The Contractor shall monitor and adjust the discharge rate as directed by the Consultant. During the step test the Consultant shall collect water levels, discharge rates, total discharge, and water samples for testing and analysis. The Consultant reserves the right to extend the test duration.

11.6 Constant Rate Test

The constant rate shall consist of a 24-hour pumping duration. The Consultant reserves the right to extend or shorten the test duration.
The Contractor shall obtain and record water level measurements, discharge rate, and total discharge in half-hour intervals throughout the duration of the constant rate test, or as directed by the Consultant. The Contractor shall not shut down the pump until the Consultant is on site. The Consultant shall collect water samples for testing and analysis.

11.7 Recovery Test

The recovery test shall immediately follow the constant rate test and shall last for a duration of 24-hours or 90% recovery, whichever is the greater amount of time. The Consultant reserves the right to extend the test duration.

The Consultant shall record water level measurements throughout the duration of the recovery test.

11.8 Sand Production

The amount of sand produced in the first ten (10) minutes after the start of the constant rate test shall not exceed 1 part per million (ppm) by volume.

If the well fails to meet the above requirements due to negligence on the part of the Contractor, the Contractor must correct the sand production to the satisfaction and approval of the Consultant and the City. To correct the sand production the Contractor may repeat the production well development process. Sand production correction costs will be borne by the Contractor and at no cost to the Owner.

During the step test and constant rate test the Consultant shall measure and record the amount of sand produced by the well using the Contractor provided Rossum Sand Sampler in accordance with AWWA Standard A100.

11.9 Submittals

A. The Contractor shall submit to the Consultant for review and approval the test pump, motor, flow meter and totalizer, and accessories prior to aquifer testing.
B. Prior to aquifer testing, the Contractor shall provide a written certification that the flow meter and totalizer are calibrated to the manufactures specifications.

11.10 Measurements and Payments

A. Payment for all labor, equipment, and materials will be made on a lump sum and hourly basis.
B. Sand production correction costs shall be borne by the Contractor at no cost to the Owner.

*** End of Section ***
12.0 Production Well Spinner Survey

12.1 General

After completion of the aquifer testing, the Contractor shall conduct a spinner survey followed by depth-specific water sampling of the well. The spinner survey and water sampling shall be conducted under the observation of the Consultant and the City. Prior to the spinner survey the Contractor shall submit to the Consultant for review and approval the Geophysical Logger. The quality of the spinner survey and zonal samples must be acceptable to the Consultant and the City.

It is anticipated that the spinner survey and sample collection will take 7-hours. The Contractor shall obtain and record water level measurements, discharge rate, and total discharge in half-hour intervals throughout the duration of the spinner survey, or as directed by the Consultant. The Consultant reserves the right to extend or shorten the test duration.

12.2 Equipment

The Contractor shall furnish and maintain in safe and efficient working condition all equipment necessary to perform the aquifer testing. The equipment supplied by the Contractor shall include, but not limited to, the following.

1. Test motor
2. Pump
3. Column pipe
4. Discharge pipe
5. Flow meter and totalizer
6. A water level sounder that provides for a depth measurement accuracy of ± 0.1 foot
7. Sounding tube
8. Access Tube
9. Generator
10. Rossum Sand Sampler
11. All other related equipment, materials, and labor necessary to conduct the aquifer testing

The Contractor shall furnish pumping equipment capable of pumping at a rate of no less than 1,500 gpm, with a pumping lift (not including pipe friction losses) of 800 feet b.s. The pumping equipment shall include satisfactory throttling devices or valves such that the discharge can be adjusted to various rates. The test pump setting shall be determined by the Consultant, based on the final well design. The pumping units shall be complete with an ample power source and shall be capable of being operated without interruption for a period of 24 hours.

To accommodate the spinner and water sampling tool, the Contractor shall furnish and install a 3-inch inside diameter open-ended access tube that extends from the land surface to a minimum of 20 feet below the base of the pump equipment. The access tube must allow the free installation, operation, and removal of the spinner-logging tool and water sampling tool, while the pump is in operation and the Contractor shall ensure that the logging tools can be run to the total depth of the well without interference by obstructions or tight sections in the access tube or well.

City of Surprise
Production Well
Technical Specification
September 8, 2006
The Contractor shall also furnish and install a 1½-inch inside diameter sounding tube that extends from the land surface to the top of the pump bowls to facilitate the measurement of water levels during the spinner flow meter surveys. The bottom of the sounding tubes shall be capped, with perforations in the lower 10 feet.

The Contractor shall provide an approved inline flow meter and manometer in the discharge pipe to measure the rate and total amount of water being discharged during the test.

The discharge pipe shall be equipped with a Consultant approved spigot or valve for water sample collection.

The Contractor shall also furnish equipment for measurement of the sand production during pumping. The sand measurement device shall be a Rossum Sand Sampler in accordance with AWWA Standard A100.

The pump equipment, spinner access tube, and sounding tube shall not be removed from the well until after the completion of the testing. The Consultant must approve the test pump, motor, metering equipment, and accessories.

The Contractor shall furnish equipment for measurement of the sand production during pumping. The sand measurement device shall be a Rossum Sand Sampler in accordance with AWWA Standard A100.

The pump equipment, spinner access tube, and sounding tube shall not be removed from the well until after the completion of the testing. The Consultant must approve the test pump, motor, metering equipment, and accessories.

The Contractor shall maintain the flow rate(s) requested by the Consultant during the course of spinner logging and depth-specific water sampling, and the Contractor shall also assist the spinner logging company with rigging of the logging equipment, as necessary.

### 12.3 Discharge

The Contractor shall operate the test pump at the discharge rates that have been directed by the Consultant. Discharge from the pump shall be controlled by a gate valve and/or engine throttle. The discharge shall be controlled and maintained at the specified rate for the entire test duration with an accuracy of plus-or-minus 5 percent.

The discharge water from the well shall be directed to a point of discharge that has been approved by the Consultant. The discharge piping shall be watertight and capable of conveying the specified flow rates for the specified pumping periods. The Contractor is responsible for providing adequate piping for the actual distances to the discharge points. The Contractor is responsible for coordination of any required permits, traffic control, and other considerations that may be required to address potential flooding or pipeline crossings of roadways that result from the discharged water.

### 12.4 Spinner Logging

The spinner survey shall include three (3) downward logging runs at different line speeds. The spinner logging activities shall be conducted under the observation of the Consultant and the City.
12.5 Water Sampling

The logging Subcontractor will also be required to collect a minimum of three (3) zonal water samples from depth intervals determined by the Consultant and approved by the City. The collection of zonal water samples shall be conducted under the observation of the Consultant and the City. Testing and analysis of the water samples will be conducted by the Consultant.

12.6 Data Recording

The Contractor shall obtain and record the water level measurement, discharge rate, and total discharge in half-hour intervals throughout the duration of the spinner survey, or as directed by the Consultant.

12.7 Submittals

A. The Contractor shall submit to the Consultant for review and approval the test pump, motor, flow meter and totalizer, and accessories prior to testing.
B. Prior to the spinner survey, the Contractor shall provide a written certification that the flow meter and totalizer are calibrated to the manufactures specifications.
C. Water level measurements, flow meter readings, and totalizer readings.
D. The Geophysical logger shall provide five (5) field copies of the spinner survey to the Consultant and one (1) field copy to the City upon the completion of logging. Within 10 days after completion of logging, 10 final copies of the spinner survey shall be provided to the Consultant, as well as an electronic original of the logging data in Windows Metafile (*wmf) and PDF format.
E. The logging Subcontractor shall also provide a written spinner report that includes the amount of discharge from each zone of the well.

12.8 Measurements and Payments

Payment for labor, equipment, materials, and all other costs to complete the spinner survey will be made on a lump sum and hourly basis.

*** End of Section ***
13.0 Production Well Plumbness and Alignment

13.1 General

After the production well aquifer testing and spinner survey, the Contractor shall conduct a plumbness and alignment test of the well.

13.2 Plumbness and Alignment Requirements

The well shall meet all the following plumbness and alignment requirements.

1. AWWA Standard A100.
2. Plumbness tolerance. The maximum allowable horizontal deviation (drift) from vertical shall not exceed 10.66 inches per 100 feet of depth from the top of the well to the bottom of the well.
3. Alignment tolerance. The maximum allowable misalignment or “dogleg” is one that will allow a 40-foot long by 14-inch diameter (OD) dummy cylinder to pass freely and unobstructed from the top of the well to approximately 10 feet above the bottom of the well.

If the well fails to meet the above requirements, the Contractor must correct the plumbness and alignment to the satisfaction and approval of the Consultant and the City. Plumbness and alignment correction costs will be borne by the Contractor at no cost to the Owner.

13.3 Gyroscopic Survey

To demonstrate compliance with the plumbness and alignment requirements, the Contractor shall conduct a gyroscopic survey of the production well under the observation of the Consultant and the City. The quality and clarity of the gyroscopic log must be approved by the Consultant.

The gyroscopic survey logging Subcontractor and the specific gyroscopic logging tool to be used must be approved by the Consultant. The gyroscopic survey tool shall be centralized in the well, and the geophysical logging Subcontractor shall conduct two (2) 50-foot repeat sections to demonstrate accuracy and repeatability of the gyroscopic survey. The Consultant shall determine the location of the repeat sections based on the preliminary results of the gyroscopic survey. It is anticipated that one (1) of the repeat sections may be the location of the proposed pump setting.

13.4 Dummy Cylinder

To demonstrate compliance with the plumbness and alignment requirements, the Contractor may be required to furnish, install, and remove a test cylinder. The test cylinder shall be 40-feet long and 14-inches in diameter (OD).

13.5 Submittals

A. The Contractor shall submit for review and approval by the Contractor the gyroscopic logging Subcontractor and the specific gyroscopic logging tool to be used.
B. The gyroscopic logging Subcontractor shall provide five (5) field copies of the gyroscopic surveys to the Consultant and one (1) field copy to the City at the well site, immediately following the completion of gyroscopic survey.

C. The gyroscopic logging Subcontractor shall within ten (10) working days following completion of the gyroscopic survey submit to the Consultant ten (10) final copies of the gyroscopic survey and an electronic copy of the logging data in a Windows metafile (*.wmf) format, or other format approved by the Consultant. The Consultant shall provide one (1) paper copy and one (1) electronic copy of the gyroscopic survey with the Well Completion Report.

D. The gyroscopic logging Subcontractor shall also provide a written plumbness and alignment report that shall include 1) the numerical values of the well deviation and 2) a graphical diagram of the well alignment from both a profile perspective (both Northing and Easting views) and a vertical perspective.

13.6 Measurements and Payments

A. Payment for the gyroscopic survey will be made on a lump sum basis.

B. Payment for all labor, equipment, and materials for plumbness and alignment correction costs will be borne by the Contractor and at no cost to the Owner.

C. Payment for all labor, equipment, and materials to install and remove the test cylinder will be made on a lump sum basis.

*** End of Section ***
14.0 Production Well Video Survey

14.1 General

After the completion of the plumbness and alignment testing, the Contractor shall conduct a color video survey of the well. Any materials added to the well to improve the water clarity shall be approved by the Consultant prior to use. The video survey camera shall be capable of producing a clear and focused imaged of the well in both the downward-looking and side-view. The video survey shall, at a minimum, consist of a continuous down-hole scan, with periodic side-view scans at intervals requested by the Consultant and the City.

The video survey shall be conducted under the observation of the Consultant and the City and the quality and clarity of the well video must be acceptable to the Consultant and the City.

14.2 Submittals

A. The Geophysical Logger shall submit to the Consultant two (2) copies of the production well video in a DVD format.
B. The Geophysical Logger shall submit to the Consultant two (2) copies of the production well video survey report that includes, at a minimum, the following: depth intervals of blank casing, louvered casing, welds, and water level. The Geophysical Logger shall also provide one (1) electronic copy of the well video survey report in a PDF format.

14.3 Measurements and Payments

Payment for all labor, equipment, and materials will be made on a lump sum basis.

*** End of Section ***
15.0 Acceptance of Work

The Owner, Consultant, and the City shall all agree that the Contractor has completed the work in accordance with the specifications and that the well meets the following requirements.

1. The surface casing shall meet the plumbness and alignment requirements.
2. The production well shall meet the plumbness and alignment requirements.
3. The production well shall meet the sand production requirements.
4. All installed materials shall be new and free from defects.
5. Contractor must provide all records, reports, data, and other information required by the plans, specifications, Owner, Consultant, or City.

*** End of Section ***