Standard Specifications for Well Drilling, Construction, Development, and Testing

NOT FOR CONSTRUCTION

San Miguel, California

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Prepared for: San Miguel Community Services District

STANDARD SPECIFICATIONS

WELL DRILLING, CONSTRUCTION, DEVELOPMENT, AND TESTING

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STANDARD SPECIFICATIONS
WELL DRILLING, CONSTRUCTION, DEVELOPMENT, AND TESTING

PART 1 WELL CONSTRUCTION

1.01 MOBILIZATION

A. GENERAL

1. This section includes the procedures and materials associated with the mobilization and demobilization from a well site of all personnel, equipment, and materials required to complete construction of a new potable water supply well.
2. Mobilization shall include the following:
    a. Obtaining all required permits.
    b. Preparing required submittals and plans.
    c. Transporting personnel, equipment, and materials.
    d. Installing and maintaining all temporary facilities.
    e. Setting up equipment.
    f. Providing site security.
    g. Demobilizing from the drill/well site upon completing site cleanup.

B. EQUIPMENT AND MATERIALS

1. General
    a. At no time during the drilling and construction of the production well shall the CONTRACTOR use lubricants, adhesives, or any other substances that could introduce trace amounts of heavy metals or organic chemicals into the borehole/production well in concentrations that would be detectable in groundwater quality samples from the completed well. Drilling fluids shall be NSF/ANSI 60 compliant.
2. Drilling Equipment
    a. The CONTRACTOR shall drill borehole using the flooded reverse circulation method in which the borehole is always filled with a drilling fluid. CONTRACTOR will provide a complete drilling unit, all tools, accessories, power, lighting, water, other equipment, and experienced personnel necessary to conduct efficient drilling operations at the well site.
    b. The drilling equipment shall be in good condition and of sufficient capacity to drill the borehole(s) required by this section to the anticipated total depths. All drilling equipment, including mast and draw-works, air compressors, drilling fluid pumps, drill pipe, etc., must be of requisite size, sufficient capacity, and in suitable condition to drill, set casing, and develop the well to the anticipated depth specified by the Engineer of Record and approved by the District. The mast and all running gear (hoists, cables, etc.) shall have sufficient and demonstrated capacity to lift two (2) times the buoyant weight of either the drill string or the blank and screened well casing assembly, whichever is greater. The drill rig utilized must have the ability to fully lift and land the anticipated casing loads without the use of cranes, float plugs, or other similar methods.
    c. The CONTRACTOR shall disinfect all downhole drilling equipment on-site prior to use. The CONTRACTOR shall obtain approval from the Engineer of Record for the methods, chemicals, and dosages employed. The CONTRACTOR shall 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.

C. EXECUTION

1. The CONTRACTOR shall provide, mobilize to the well site, set up, operate, maintain in good working condition, and demobilize from the well site all the equipment listed in this section, and all other equipment necessary to complete the work.

2. At completion of the work, the CONTRACTOR shall restore all areas where the work was performed to their approximate original condition and ready for use.

1.02 NOISE CONTROL

A. GENERAL

1. This section covers the installation of noise control barrier walls and other measures required to meet specified noise limits.

B. EQUIPMENT AND MATERIALS

1. General

a. Each internal combustion engine shall be equipped with a muffler of a type recommended by the manufacturer as a minimum for noise control. No internal combustion engine shall be operated without said muffler.

b. CONTRACTOR shall provide, mobilize to the project site, install, maintain in good working condition, and demobilize from the project site all other materials and equipment necessary to comply with all local noise control and noise level rules, regulations, and ordinances.

2. Noise Control Barrier Walls

a. Noise control barrier walls shall consist of fiberglass-filled curtains and shall have adequate transmission loss. The minimum wall height shall be as specified by the Engineer of Record and approved by the District. The length, height, and location of noise control barrier walls shall be adequate to assure proper acoustical performance.

b. Noise control barrier walls shall be designed by a registered civil engineer. The design shall preclude structural failure due to such factors as winds, shear, shallow soil failure, earthquakes, and erosion.

C. EXECUTION

1. Noise Control Plan

a. CONTRACTOR shall prepare a Noise Control Plan that includes the following minimum components:

1) A list of the applicable local sound control and noise level rules, regulations and ordinances.

2) A description of the equipment and measures that the CONTRACTOR will utilize to comply with these rules, regulations and ordinances. Measures must meet or not exceed noise requirements set forth in the city of San Miguel noise ordinance.

2. Noise Control Barrier Walls

a. Noise control barrier walls shall be installed prior initiating pilot borehole drilling and remain in place until the end of the pumping period for the constant-rate discharge test or until all nighttime operations have been completed.

b. CONTRACTOR shall keep curtains or doors for ingress and egress to the work area closed at all times except when equipment or personnel are entering or exiting the well site.

3. Mufflers and Insulation

a. Each internal combustion engine shall be equipped with residential approved mufflers of a type recommended by the manufacturer as a minimum noise control. No internal combustion engine shall be operated without a muffler.

b. Air compressors and generators shall be insulated to further reduce noise levels.

4. Additional Measures

a. In addition to installing the noise control barrier walls as specified, the CONTRACTOR shall undertake necessary measures to comply with applicable local sound control and noise level rules, regulations and ordinances. Such measures may include:

1) Reconfiguring equipment at the site to minimize the noise traveling off-site.

2) Limiting excessively noisy operations to daytime hours.

3) Providing additional sound blankets or barriers around noisy equipment.

1.03 CONDUCTOR CASING AND SANITARY SEAL

A. GENERAL

1. This section includes the procedures and materials associated with the installation of a conductor casing and sanitary seal for the well.

2. The CONTRACTOR shall install a permanent conductor casing.

B. EQUIPMENT AND MATERIALS

1. Conductor Casing

a. The diameter shall be large enough to accommodate the drilling of the diameter of the pilot borehole.

b. Conductor inside diameter shall be as specified by the Engineer of Record and approved by the District. Conductor shall consist of 3/8-inch wall mild steel casing manufactured in accordance with ASTM A139 Grade B and applicable parts. The casing shall be factory assembled in not less than 20-foot lengths. Section ends shall be machined with a beveled edge at one end, to facilitate proper alignment of joined casing sections.

2. Centralizers

a. Conductor casing centralizers will provide at least 1-foot length of bearing surface at the wall of the borehole.

b. All centralizer materials shall be new and of the same steel type as the conductor casing.

c. Welding shall be performed with shielded arc electrodes.

3. Grout Seal

a. Sand-cement grout shall consist of a mixture of Portland cement (ASTM C150, Type II) or Portland-Limestone cement (ASTM C595 Type IL), sand, and water in the proportion of not more than 2 parts, by weight, of sand to 1 part of cement with not more than 7 gallons of clean water per 94 pounds sack of cement. This is equivalent to a “10.3-sack mix” of sand cement, unless otherwise approved by County of San Luis Obispo Department of Environmental Health and the Engineer of Record.

b. No fly ash shall be used as an additive in the cement mixture.

c. No more than two (2) hours shall pass from the time of mixing the sand-cement grout at the batch plant to the time of installation. The grout seal mix shall be free of clots and gravel which exceed 2-inches in diameter.

C. EXECUTION

1. Conductor Borehole

a. The conductor casing borehole diameter shall be as specified by the Engineer of Record and approved by the District. Conductor casing borehole shall be drilled to a minimum depth of 50 feet below ground surface (ft bgs). The conductor casing borehole may be drilled using the rotary or bucket auger drilling method.

2. Casing Joints

a. The conductor casing joints shall be secured by butt welding techniques and shall be watertight.

3. Centralizers

a. Weld four (4) steel guides positioned 90 degrees apart horizontally to the exterior of the conductor casing. Place the first set of guides 5 feet from the bottom of the conductor casing, the second set 15 feet from the top of the conductor casing. All guides shall be aligned to allow installation of a temporary rigid, flush-threaded tremie pipe to the bottom of the conductor casing borehole.

4. Grout Seal

a. Fill the open annular space between the conductor casing and the borehole with the specified grout mix using a tremie pipe. Do not allow the grout to free fall into the annular space. The grout seal shall extend to the ground surface.

b. Record the volume of grout used. The volume shall not be less than the calculated volume of the annular space between the wall of the borehole and the casing. Significant differences between estimated and actual volume of cement installed may be grounds for conductor casing installation rejection.

c. After grouting operations are completed, leave the grout undisturbed for a period of not less than 24 hours.

1.04 PILOT BOREHOLE DRILLING

A. GENERAL

1. This section includes the procedures and materials associated with the drilling of a pilot borehole by the flooded reverse circulation method.

2. The Work described in this section also includes furnishing all materials, labor, tools, and equipment required to collect formation samples, maintain circulation, and protect the pilot borehole from caving.

B. EQUIPMENT AND MATERIALS

1. Drill Rig

2. Solids Control Equipment

a. System shall minimize recirculation of drill cuttings.

b. Design to facilitate retrieval of representative samples from the discharge with a minimum of recirculation of material.

c. Include settling tanks of adequate size, a sampling trough, a shaker table, and a desanding/desilting system.

d. Equip with a shaker table and desander/desilter system with enough cones capable of handling the capacity of drilling fluid system.

e. Desander/desilter system shall have pump capable of supplying a minimum of 40 pounds per square inch (psi) at 80 gallons per minute (gpm) per cone minimum.

f. Sampling device (e.g., “sluice box” or equivalent) shall be designed to retrieve formation samples that are representative of the full grain size distribution encountered during drilling.

3. Settling Tanks

a. Use of excavated drilling fluid ("mud pits”) is not permitted.

b. Vessels used for mixing drilling fluids shall be clean and free of contaminants and extraneous materials prior to their use in drilling operations.

c. Use above-ground tanks for mixing, circulation, and inclusion of approved additives.

d. Use proper controls to prevent spillage of mud or additives onto the ground.

4. Drilling Fluid Measurement Kit

a. The CONTRACTOR shall provide a standard drilling fluid ("mud") kit that shall be always on site. This kit shall be equipped with a marsh funnel viscometer, a plastic measuring cup, a metal mud balance, half-area filter press, filter press filter paper, pH strips, digital stopwatch, and a sand content kit.

5. Water Storage Tanks

a. The CONTRACTOR shall utilize storage tanks, with the volume approved by the Engineer of Record for the retention and reduction of turbidity of fluids generated during the course of the work, prior to discharging fluids. The tanks shall be joined in series such that water flows between the tanks to maximize settling time and minimize disturbance of settled materials. Water storage and clarification facilities utilized shall be sufficient to meet water discharge requirements of the District's approved National Pollutant Discharge Elimination System (NPDES) permit. Pipelines or hoses used to link the storage tanks and convey clarified water to the point of discharge shall be of a capacity sufficient to handle the maximum quantity of water that can be produced from the well during mechanical and pumping development along with production testing as required.

6. Discharge Piping

a. The CONTRACTOR shall provide temporary discharge piping and appurtenances (including necessary equipment to allow timely discharge of water) of adequate capacity and length to convey water pumped during well development and testing to the point of water discharge.

7. Borehole Drift Indicator

a. The CONTRACTOR shall provide a 3-degree Eastman, Totco, or Martin-Decker (or approved equivalent) mechanical drift indicator and all equipment and supplies necessary to measure drift during pilot borehole drilling.

C. EXECUTION

1. Pilot Borehole Drilling

a. Drill a minimum 17.5-inch diameter (or as otherwise specified by the Engineer of Record and approved by the District) pilot borehole using the flooded reverse circulation drilling method. This shall be drilled to a depth as specified by the Engineer of Record. The depth of the pilot borehole may be increased or decreased at the direction of the Engineer of Record.

b. Maintain controlled drilling fluid characteristics during the entire operation of pilot borehole drilling. If drilling fluid additives are used, the Engineer of Record may require that the CONTRACTOR retain or employ an experienced and qualified mud engineer on the job during all operations to supervise and maintain drilling fluid characteristics and to conduct daily mud checks in accordance with API Standard RP 13B-1, "Standard Procedures for Testing Drilling Fluids". Mud property checks may also be requested to be completed in the presence of the Engineer of Record. The CONTRACTOR shall have at the well site the equipment necessary to measure drilling fluid weight, marsh funnel viscosity, and sand content and shall monitor and record on the daily drilling reports said characteristics in maximum intervals of four (4) hours. CONTRACTOR shall maintain a drilling fluid with the average properties given below.

i. Mud Weight: 8.6 – 9.1 pounds per gallon (lbs./gal.)

ii. Marsh Funnel Viscosity: 28 - 40 seconds per quart (sec./qt.)

iii. Sand Content: less than 2 percent (%) by volume

For bentonite drilling fluids:

iv. Filter Cake Thickness (30 minutes at 100 PSI): 1/32 to 2/32 inch

v. Water Loss/Filtrate (30 minutes at 100 PSI): less than or equal to 15 milliliters

c. If lost circulation conditions occur, CONTRACTOR shall use only lost circulation drilling additives that can be retrieved or “broken down” during development of the borehole isolated aquifer zones. Lost circulation drilling additives shall be Magma Fiber or approved equivalent.

d. In the presence of the Engineer of Record, the CONTRACTOR shall make field checks of borehole drift at 100-foot intervals as pilot borehole drilling proceeds using an approved mechanical drift indictor.

e. The CONTRACTOR shall maintain detailed records during the pilot borehole drilling and shall furnish these records to the Record of Record daily. These records shall include the following:

i. Drilling penetration rate.

ii. All measurements of drilling fluid properties.

iii. Time, depth, quantity, and description of any fluids and additives to the drilling fluid.

iv. Difficult or unusual drilling conditions, including variation in the addition and amounts of chemical products or water required during drilling.

v. Depth and description of formation samples.

vi. Time and reason for any interruption of the borehole drilling.

f. The completed borehole shall be of sufficient diameter and plumbness to allow for the successful completion of borehole geophysical logging and isolated aquifer zone tests.

g. The CONTRACTOR shall not drill beyond the specified total borehole depth, unless otherwise approved by the Engineer of Record. No payment shall be made for unapproved borehole drilling below the specified depth or for backfilling up to the specified depth.

2. Formation Sampling

a. CONTRACTOR shall collect a representative formation sample at each interval of 10 feet and at each change in formation. Label and preserve each sample in the specified containers. Clearly mark each container with well designation, date, time, and depth interval represented. Store the samples on site in a manner that prevents breakage or loss. CONTRACTOR shall not be required to retain the formation samples after the completion of the work.

b. Prepare a complete lithologic drilling log of the formation samples and submit to the Engineer of Record within 24 hours of the end of borehole drilling. The drilling log shall include the depth interval and a description of each distinct formation type encountered during the borehole drilling.

c. CONTRACTOR shall provide the Engineer of Record with grain size distribution analyses results. The depth intervals of the formation samples shall be selected by the Engineer of Record. Analyses shall be performed by an independent (or approved equal) qualified soils laboratory subcontracted to the CONTRACTOR. Analyses shall be performed in accordance with ASTM D-422, "Standard Method for Particle-Size Analyses of Soils" as applicable to drill cuttings.

d. Engineer of Record will provide the District with chip trays of drill cutting samples and a sample of gravel pack.

3. Conditioning of Drilling Fluids

a. Upon completion of the pilot borehole drilling, the CONTRACTOR shall circulate and condition the drilling fluid until the fluid properties are achieved:

i. Mud Weight: 8.9 lbs./gal.

ii. Marsh Funnel Viscosity: less than 30 sec./qt.

b. The CONTRACTOR shall continue to circulate the drilling fluids until all the following have occurred:

i. Fluid circulated out of the pilot borehole does not contain drill cuttings.

ii. Circulation has continued for a minimum of one (1) hour or until two (2) pilot borehole volumes have been circulated, whichever is greater.

iii. Three (3) consecutive measurements of drilling fluid properties taken a minimum of 30 minutes apart confirm the specified drilling properties have been achieved.

D. PERFORMANCE REQUIREMENTS

1. The drift from vertical (i.e., deviation) shall be not more than one-half (1/2) degree. Any deviation shall be corrected at the CONTRACTOR's expense before continuing to drill deeper.

1.05 BOREHOLE GEOPHYSICAL LOGGING

A. GENERAL

1. Upon completion of the pilot borehole, the CONTRACTOR shall run geophysical logs by a SUBCONTRACTOR firm retained by the CONTRACTOR and approved by the Engineer of Record.

B. EQUIPMENT AND MATERIALS

1. The geophysical logs of the borehole shall be plotted on a 5-inch per 100-foot vertical scale, shall be provided as PDF and .LAS files, and shall consist of the following:

a. Spontaneous potential curve.

b. Resistivity curves with electrode spacing at 16- and 64-inches.

c. Gamma ray/spectral log

d. Sonic velocity

e. Laterolog 3 resistivity

2. The completed geophysical logs shall show the resistivity and temperature of the drilling fluid at the time of logging.

C. EXECUTION

1. Preparation

a. Before running geophysical logs, cease drilling and circulate drilling fluid for a minimum of one (1) hour with the drilling bit at the bottom of the borehole.

2. Geophysical Logging

a. Geophysical surveys shall be run to the full depth of the borehole.

b. The geophysical logs shall become the property of the District at the time the logging is completed. Geophysical logging shall be performed in the presence of the Engineer of Record. Provide a copy of the field logs to the Engineer of Record at the time of logging and obtain approval of the log prior to releasing the logging company.

c. Provide whatever assistance may be required to accomplish the geophysical logging including fluid circulation, removal of drill string, and operation of drilling rig as needed to support logging cable sheave wheel.

3. Evaluation Period

a. CONTRACTOR shall allow for a maximum of five (5) calendar days, excluding weekends and holidays after the geophysical surveys to allow the Engineer of Record to interpret the geophysical surveys and borehole lithology and provide the final well design.

1.06 ISOLATED AQUIFER ZONE CONSTRUCTION AND TESTING

A. GENERAL

1. The CONTRACTOR shall furnish all equipment and materials required to construct and purge isolated aquifer zones within the pilot borehole at depth intervals designated by the Engineer of Record. Refer to information from the Engineer of Record regarding location and number of isolated aquifer zones, which will be tested in a pilot borehole. The Engineer of Record may add or omit zones based on the analysis of a lithologic log of the formation samples and borehole geophysical logs.
2. The CONTRACTOR shall provide a means of temporarily isolating the borehole from the fluid circulation reservoirs during isolated aquifer zone testing such that measurement of fluid levels within the borehole can be completed without an influence from fluids added to replenish the reservoirs.
3. The CONTRACTOR shall collect a water sample from each isolated zone. The CONTRACTOR shall be responsible for the collection, storage, and transport of water samples collected from each isolated aquifer zone. Analyses of collected water samples will be performed by a certified testing laboratory. A list of the required water quality analytical suite will be provided by the Engineer of Record or the District.
4. After the zonal water sample is collected, the CONTRACTOR will then standby while the Engineer of Record performs a falling head test for the zone. A minimum of three (3) falling head tests will be completed for each isolated zone which is anticipated to require a total of approximately two (2) hours per zone.

B. EQUIPMENT AND MATERIALS

1. Slotted Eductor Sampling Tool
   a. The tool used shall consist of a minimum 4-inch inside diameter (I.D.) steel eductor pipe that is perforated (0.06-inch openings) in the bottom 20 feet and capped at the bottom end.
2. Air Compressor
   a. The compressor used for airlifting shall have the capacity for the anticipated conditions.
3. Submersible Pump
   a. A high-capacity submersible pump, capable of producing a minimum of 20 gpm, or a flowrate and a maximum lift as specified by the Engineer of Record and approved by the District. The use of pump chambers may be necessary to avoid excessive head losses around the pump and motor.
   b. Discharge line for the submersible pump shall include a calibrated flowmeter equipped with a totalizer reading in tens of gallons and a valve for accurate measurement and control of the flow rate during isolated aquifer zone testing.
   c. A sampling port consisting of a ¾-inch hose bib shall be installed at an accessible location on the pump discharge line to facilitate collection of zonal groundwater samples.
   d. The pump and column pipe and sampling port shall be clean and disinfected prior to use and assembled using a threaded joint compound approved for environmental use.
4. Gravel Pack
   a. Gravel pack materials installed around the slotted sampling tool shall be coarse-grained sand or pea gravel that is washed clean of fine-grained sediment and sized larger than the perforations of the eductor sampling tool.

5. Annular Seals

    a. Fill material used to seal the annulus at the top and bottom of the slotted sampling pipe shall include bentonite chips or pellets of size and type that are suited for the hydration times specified.

6. Water Level Sounder

    a. Water level sounder shall be an electric wireline sounder capable of water level measurements to the nearest 0.01-foot.

7. Water Quality Meter

    a. Handheld field meter or meters for real-time measurement of pH, temperature, and conductivity of water. Meter shall be calibrated for each above parameter in accordance with the manufacturer's instructions.

C. EXECUTION

1. General

    a. Upon completion of the downhole geophysical logging, the Engineer of Record will prepare a schedule of testing and sampling for specific isolated aquifer zones. The schedule will specify the number and depth of individual zones to be tested, depth intervals for gravel pack and seals, specific sampling requirements and method of pumping for sample collection (airlifting or submersible pump).

    b. All fill materials (gravel pack and bentonite seals) shall be installed in the annulus using a tremie pipe and procedures approved by the Engineer of Record.

    c. The CONTRACTOR shall measure (tag) the top of all fill materials (gravel pack and bentonite seals) installed with a wireline or other device approved by the Engineer of Record.

    d. The CONTRACTOR shall furnish all labor, materials, equipment, and services necessary to separate solid matter and to neutralize any residual chlorine and/or added chemicals in the development and testing water prior to allowing water to be discharged from the well site. The turbidity level and residual chlorine in the neutralized effluent water shall meet all discharge requirements. Discharging any development/testing water into the street, sewer, or gutters is not permitted.

2. Construction and Sampling of Individual Isolated Aquifer Zones

    a. General procedures for zone construction and testing include:

        i. Install the slotted eductor sampling tool to the specified depth.

        ii. Install gravel pack materials to approximately 30 feet below the lowest-most slots of the 20-foot sampling tool. Measure and record the depth of the top of gravel pack. Install a 10-feet thick lower bentonite seal in the borehole above the gravel pack. After a minimum hydration time of 30 minutes, the CONTRACTOR shall measure and record the emplacement depth of the lower bentonite seal.

        iii. Install gravel pack materials above the lower annular seal to approximately 10 feet above the upper-most slots of the 20-foot sampling tool. Next, install a minimum 20-foot-thick upper bentonite seal in annulus above the gravel pack. After a minimum hydration time of 30 minutes, install a 10-foot-thick layer of gravel pack materials in the annulus above the upper seal**.** Upon completion, the CONTRACTOR shall allow sufficient time (minimum of 2 hours) for the bentonite seals to hydrate and set up before beginning to purge (develop) the isolated zone.

        iv. Once a zone test interval has been determined to be adequately constructed, the CONTRACTOR shall install an airline inside the sampling tool string to a depth below the measured static water level. Begin airlifting to initially develop the isolated aquifer zone and to verify that the zonal seals are adequate. Airlift development shall begin at a low flow rate, increasing

with time for a minimum of two (2) hours. The seals for an isolated zone test will be considered adequate when the following conditions are met:

(a) Water levels in the conductor casing and fluid circulation reservoir maintains a stable level as determined by the Engineer of Record, and

(b) Water discharged from the isolated zone consistently improves with respect to turbidity, and

(c) Upon completion of airlift development, the water level measured in the zone test tool remains stable for a minimum of 30 minutes.

v. Install a submersible pump within the drill pipe, above the zone test tool. Begin to purge the isolated aquifer zone by pumping at low discharge rates. Continue to increase the pumping rate until the discharge water is essentially free of drilling mud and fine sediment and the desired measurements of temperature, pH, and specific conductance are obtained to the satisfaction of the Engineer of Record. During this time, record at 30-minute intervals the depth to water (pumping level), instantaneous discharge rate (in gpm), flowmeter totalizer, turbidity, pH, specific conductance, and temperature of the discharge water, and the data and time (hours and minutes).

vi. After the zonal interval to be sampled has been purged to the satisfaction of the Engineer of Record, the CONTRACTOR shall collect the groundwater samples from the sampling port installed on the submersible pump discharge line. The CONTRACTOR shall deliver all samples to the laboratory under Chain of Custody for analyses provided by the Engineer of Record or the District. The cost of all water quality sampling and laboratory analyses shall be borne by the CONTRACTOR.

vii. After groundwater sampling is completed, the CONTRACTOR shall cease pumping, and allow the water level in the isolated zone to stabilize. The CONTRACTOR shall measure and record the stabilized water level.

3. Falling Head Tests

a. Upon completion of groundwater sampling, the CONTRACTOR shall assist and/or standby while the Engineer of Record performs three (3) falling head tests on an isolated aquifer zone. This process will consist of installing an electronic pressure transducer (provided by the Engineer of Record) below the water level, injecting a “slug” of water of known volume (less than 20 gallons), and recording the change in water level until the water level has returned to static condition.

b. After the falling head tests are completed for an isolated zone, the CONTRACTOR shall remove the sampling pump and repeat the above procedures described in Step 2 to construct and test the next isolated aquifer zone interval provided by the Engineer of Record.

D. PERFORMANCE REQUIREMENTS

1. The bentonite seals above and below the zonal sample interval must remain intact throughout the purging and sampling period, to the satisfaction of the Engineer of Record. If it is determined by the Engineer of Record that one or more bentonite seals was breached during purging, all time spent purging prior to the breach will be at the CONTRACTOR’s own expense.

2. If an isolated aquifer zone is improperly set, the CONTRACTOR will be required to remove the sampling tool and clean out the pilot borehole back down to the base of the sample interval at the CONTRACTOR’s own expense.

3. The CONTRACTOR may be required to reimburse additional Engineer of Record’s fees that are the direct result of a breached bentonite seal and/or an improperly set isolated aquifer zone if such an event is determined by the Engineer of Record to result from negligence by the CONTRACTOR.

1.07 PILOT BOREHOLE REAMING

A. GENERAL

1. This section includes the procedures and materials associated with reaming of the pilot borehole by the flooded reverse circulation method. No other drilling method will be authorized.
2. This work includes materials, labor, tools, and equipment required to maintain circulation and protect the final (reamed) borehole from caving.
3. Upon receiving the approved final design for the production well from the Engineer of Record, the CONTRACTOR shall proceed with reaming the pilot borehole.
4. Upon completion of the final borehole, any remaining pilot borehole interval not backfilled with drill cuttings generated during borehole reaming shall be filled with a bentonite-sand seal at the request of the District or Engineer of Record. Bentonite-sand seal shall extend to the bottom depth of the final borehole.

B. EQUIPMENT AND MATERIALS

1. In addition to the necessary bits, weight collars, etc. required to ream the pilot borehole in accordance with the final well design, the CONTRACTOR shall furnish the same drilling equipment and materials as specified in these Technical Specifications.

C. EXECUTION

1. Borehole Reaming
    a. Using the reverse-circulation drilling method, the CONTRACTOR shall ream the pilot borehole to minimum diameters and depths which are specified by the Engineer of Record and approved by the District:
    b. CONTRACTOR shall use a 17.5-inch pilot bit as the leading bit when reaming.
    c. The completed borehole must be of sufficient diameter and sufficient plumbness such that when the well casing and screen assemblies are installed as specified and in compliance with the alignment requirement, there is a minimum of approximately five (5) inches of annular space between the well casing and screen assemblies and the borehole wall at all points.
    d. The CONTRACTOR shall not ream below the specified total depth without prior approval from the Engineer of Record. Should the CONTRACTOR drill below the specified depth, the CONTRACTOR shall backfill the borehole to the specified depth by installing bentonite chips via tremie pipe, unless otherwise approved by the Engineer of Record. No payment shall be made for borehole reaming below the specified depth, or for backfilling to the specified depth.
    e. During reaming, the CONTRACTOR shall select a drilling assembly (including weight collars) and drilling speed that allows the CONTRACTOR to maintain the plumbness and alignment of the borehole. CONTRACTOR is encouraged to make field checks of plumbness during borehole reaming.
2. Drilling Fluid Control
    a. Drilling fluid control shall be as specified.
3. Final Conditioning of Drilling Fluids
    a. Once the CONTRACTOR has reamed and cleaned the borehole as specified, the CONTRACTOR shall circulate and condition the drilling fluid until the drilling fluid properties are within the following ranges:
        i. Mud Weight: less than 8.9 lbs./gal.
        ii. Marsh Funnel Viscosity: less than 30 sec./qt.
    b. The CONTRACTOR shall continue to circulate drilling fluids, conditioning the fluids as necessary, until all the following have occurred:
        i. Fluid circulated out of the borehole does not contain drill cuttings.

ii. Circulation has continued for a minimum of 60 minutes or until two (2) borehole volumes have been circulated, whichever is longer.

iii. Three (3) consecutive measurements of drilling fluid properties, made a minimum of 30 minutes apart, confirm that the specified drilling fluid properties have been achieved.

1.08 CALIPER SURVEY

A. GENERAL

1. Upon completion of the reaming operations, a caliper survey shall be run by a SUBCONTRACTOR retained by the CONTRACTOR and approved by the Engineer of Record. The cost of the survey shall be borne by the CONTRACTOR.

2. The intent of the caliper survey is to provide an assessment of the condition of the borehole and zones of over breakage and to assist with determining the volume of annular materials needed to construct the well. CONTRACTOR shall, upon inspection of the caliper survey, assess how to successfully land the casing to the required depths on the basis of this inspection. Based on an inspection of the caliper survey, the CONTRACTOR shall also submit to the Engineer of Record estimates of the volumes of gravel and cement required.

B. EQUIPMENT AND MATERIALS

1. Drawworks for Running Geophysical Surveys

a. The drawworks shall measure the depth of the measurement tool to the nearest foot.

b. The drawworks shall be calibrated such that the error in depth measurement does not exceed 1%.

c. The CONTRACTOR shall verify calibration of the drawworks upon request. Calibration shall be to within 0.25%.

2. Caliper Logging Tool

a. The caliper logging tool shall be equipped with a minimum of three (3) measurement arms. Each measurement arm shall operate independently and shall be separated by 120 degrees.

b. The caliper logging tool shall be capable of measuring borehole diameters of up to a value which is specified by the Engineer of Record and approved by the District.

C. EXECUTION

1. Caliper survey shall be run to the full depth of the borehole in the presence of the Engineer of Record.

2. The caliper survey must be run in the full diameter borehole.

3. Caliper survey shall be run at a maximum rate of 40 feet per minute (ft./min.).

4. The horizontal scale for the caliper plot shall be 10-inches diameter per inch and the vertical scale for the caliper plot shall be 20 feet per inch.

5. The caliper survey shall measure the borehole diameter and shall be presented in a manner that allows the Engineer of Record to fully evaluate the size of the borehole for the purpose of analyzing borehole volume.

6. The caliper survey shall present an estimate of the total borehole volume and annular volume in cumulative cubic feet from the bottom of the borehole to the bottom of the conductor casing or to ground surface.

7. Upon completion of the caliper survey, the CONTRACTOR shall provide the Engineer of Record with five (5) field copies of the caliper survey and electronically, as a PDF file, to the Engineer of Record no later than 48 hours after completion of the survey.

The caliper survey shall become the property of the District at the time the logging is completed.

8. The CONTRACTOR shall provide the Engineer of Record with an estimate of the volume of gravel required to construct the well as specified based on the actual borehole diameter as measured by the caliper survey.

9. Immediately upon completion of the caliper survey, the CONTRACTOR shall install tremie pipe to the full well depth and begin to circulate drilling fluids. Alternately, if the CONTRACTOR is not prepared to begin well construction, the CONTRACTOR may make a wiper pass of the borehole and circulate until construction is ready to commence.

10. The CONTRACTOR shall allow for a maximum of one (1) hour of idle time after the caliper survey to allow the Engineer of Record to determine that the final borehole diameter is sufficient for construction of the production well. No stand-by time shall be paid for the one (1) hour of idle time.

D. PERFORMANCE REQUIREMENTS

1. If the caliper survey shows the borehole is less than the specified depth or could impede the construction of the well to State standards, the borehole shall be re-reamed or re-drilled and an additional caliper survey shall be completed. If corrective measures are required, the CONTRACTOR shall provide and pay for all corrective measures and additional caliper survey required by Engineer of Record.

1.09 WELL CASING AND ANCILLARY TUBING

A. GENERAL

1. This section specifies materials and installation of the blank well casing, well screen, sounding pipe, and gravel make-up pipe for the well.

2. CONTRACTOR shall furnish and install new factory assembled well casing, well screen, and ancillary pipes as designed by the Engineer of Record and approved by the District and described herein.

3. The exact blank and screened intervals and slot size shall be confirmed by the Engineer of Record after the lithologic and geophysical logging has been completed and reviewed. Slight modifications may be made after interpreting the logs.

4. All well casing, screen, and ancillary tubing shall comply with NSF-61 certification.

B. EQUIPMENT AND MATERIALS

1. Blank Well Casing

a. Furnish High-Strength Low-Alloy (HSLA) steel blank well casing with an O.D. as specified by the Engineer of Record and approved by the District. Blank casing shall be manufactured specifically for water supply wells. Well casing shall be manufactured in accordance with applicable parts of ASTM A 139 with the following additions:

i. Welding shall be by the automatic submerged-arc process using at least one pass on the inside and at least one pass on the outside.

ii. The steel from which the casing is manufactured shall conform to ASTM A 606 Type 4.

b. Casing joints shall be furnished with a HSLA steel collar for welding. Machine bevel the ends of each plain end casing joint perpendicular to the casing axis to ensure the straightness of each assembled section. Three inspection windows must be provided in each collar to assure proper connection of the sections.

c. Furnish casing centralizers made of the same materials as the casing shall be installed. The centralizers shall be 2-inches wide by 30-inches long by 5/16-inches thick and be welded to the casing at the joints in order to center and hold the casing in proper position until the annular materials (cement, bentonite or

gravel) are in place. There shall be three (3) centralizers equidistantly spaced (120 degrees) around each well casing.

d. Perform welding with shielded arc electrodes compatible with the casing material and shall be performed by certified welders in accordance with American Welding Society Standards.

2. Well Screen

a. Furnish HSLA steel louvered well screen casing with an O.D. which is specified by the Engineer of Record and approved by the District. Louvered screen casing shall be manufactured specifically for water supply wells, such as the Roscoe Moss Company or approved equal. Primary tubes for screen shall be manufactured in accordance with the aforementioned blank casing requirements.

b. The well screen openings shall be machine made, horizontal to the axis of the casing and of a louver form with the aperture facing downward.

c. The aperture size of the well screen shall be as specified by the Engineer of Record and approved by the District. The aperture size shall be determined from data obtained from pilot borehole drilling.

d. Ensure that the inside diameter of the well screen casing is the same as the inside diameter of the blank well casing that it is welded to.

e. Joints for the well screen shall meet the same specifications as for the blank well casing.

3. Bull Nose (End Cap) and Centralizers

a. The bottom of the casing string shall be closed with a semi-elliptical bull nose manufactured of the same material and wall thickness as the bottom section of blank casing and to which it shall be welded.

b. Centralizers intended for use shall be submitted by the CONTRACTOR to the District to review and approve. Centralizers shall be placed no greater than every 40 feet such that the blank casing and screen maintain separation to the ground surface. The centralizers shall position the well in the center of the borehole, the spacers shall be fixed in place so that they stay in position. Casing centralizers and bottom end cap shall be provided as determined by the Engineer of Record and approved by the District.. The centralizers and bottom end cap shall be of the same physical and chemical properties as the well casing materials.

4. Sounding/Camera Access Tube

a. A 4-inch diameter, Schedule 40, HSLA steel sounding/camera access tube shall be installed with the well from the ground surface to a depth as specified by the Engineer of Record and approved by the District. The top of the tube shall extend three (3) feet above ground level and be capped.

b. The bottom of the sounding/camera access tube shall terminate in a 7-foot-long fabricated steel box welded to an opening in the well casing throughout a depth range as specified by the Engineer of Record and approved by the District. The transition box shall be installed onto a section of blank well casing by the casing manufacturer. CONTRACTOR shall submit to the Engineer of Record a detail of the proposed transition box into the well casing prior to the commencement of borehole reaming.

5. Gravel Make-up Tube

i. A 3-inch diameter, Schedule 40, HSLA steel gravel make-up pipe shall be installed with the well from the ground surface to a depth as specified by the Engineer of Record and approved by the District. The top of the pipe shall extend three (3) feet above ground surface (feet abs) and be capped.

C. EXECUTION

1. General

a. The Engineer of Record shall provide the CONTRACTOR in writing the final well design. While the well design is being performed, no additional payment for rig time or idle time shall be made. The final well design shall specify where the casing and screen intervals, gravel pack interval, and annular seal intervals shall be placed in the reamed borehole.

b. Prior to installation of any well casing and screen, the CONTRACTOR shall inspect for and remove any tags, labels, or other deleterious matter attached to the interior and exterior of the blank casing and well screen sections delivered to the project site.

c. Installation of well casing and screen shall commence after all well construction materials delivered on site have been examined and approved by the Engineer of Record for compliance with the final well design.

d. When the borehole reaming and caliper survey have been completed, CONTRACTOR shall install the blank casing, well screen, and ancillary tubes. Do not float casing and screen into place in the borehole.

e. Casing installation shall be by an approved method so that no damage occurs to either the casing, ancillary tubing, or the drilled borehole.

f. Prior to final acceptance of the completed well, the CONTRACTOR shall demonstrate the gravel make-up tube is in working order by allowing water to flow into the tube without overflowing at the ground surface.

g. If any of the casings or screen should collapse prior to completing installation, the CONTRACTOR shall withdraw them and replace at no additional cost to the District.

h. CONTRACTOR shall protect the installed well casing and screen assembly and ancillary tubing and prevent foreign material from entering the well casing or tubing.

2. Welding Program

a. All welding shall be performed by certified welders.

b. All welding rods and techniques shall be appropriate for the materials being welded.

c. All well casing and screen joints shall be attached with collars secured by welding in accordance with these Technical Specifications. All joints shall be watertight.

d. All accessory pipes (tubing) shall be butt-welded together and tack-welded with “U”-shaped clamps to each well casing collar to hold it in place.

3. Inspection Windows

a. All collar inspection windows shall be welded closed as the casing and screen are installed.

4. Centralizers

a. Weld three (3) HSLA steel guides positioned 120 degrees apart horizontally to the exterior of casing and screen at intervals of not more than 40 vertical feet and at well screen joints to centralize and hold the casing in the proper position until the annular materials (cement grout, transition sand, bentonite-sand seal, and gravel pack) are installed. Place the first set of guides five (5) feet from the bottom of the casing with end cap. All guides shall be aligned to allow installation of a temporary tremie pipe to the bottom of the well.

5. Construction and Tremie Pipe

a. The tremie pipe must be rigid and have flush-threaded ends.

b. A temporary construction tremie pipe shall be installed in the borehole prior to installation of the well casing assembly.

c. The tremie pipe shall be used to install gravel pack and annular seal materials in the annulus between the well casing and borehole.

d. The tremie pipe shall be completely removed after placement of the upper annular seal.

6. Installation of Well Casing Assembly

a. Suspend the well casing, screen, and ancillary tubes in tension from the surface by means of a clamp. The bottom of the casing shall be at a sufficient distance above the bottom of the reamed borehole as to ensure that none of the casing assembly shall be supported from the bottom of the hole.

b. The well casing and screen assembly, when installed to the specified depth, shall extend three (3) feet above ground surface.

c. Orientation of the accessory pipes shall be determined by the District during the preconstruction meeting. The orientation will be provided to the CONTRACTOR by the Engineer of Record. The accessory pipes shall be clearly identified using a form of labeling.

d. The gravel make-up pipe shall be installed in the borehole before the well casing is installed. All joints shall be clamped for alignment and then welded. The gravel make-up pipe, when installed to the specified depth, shall extend three (3) feet above ground surface.

e. The sounding/camera access pipe shall be welded to the sounding port and installed concurrently with the well casing and screen. The sounding/camera access pipe shall be retained against the well casing and screen assembly using “U”-shaped brackets that are welded to the well casing, retaining the pipe parallel to the well casing and screen assembly but allowing for some vertical movement of the pipe. The brackets shall be spaced no more than 40 feet apart. The sounding access pipe shall not be welded to the brackets or to the well casing and screen assembly. The sounding access pipe shall not be retained against the well casing and screen assembly within 40 feet of ground surface. A spacer bar shall be welded between the blank well casing and the sounding/camera access pipe just below ground surface so the pipe rests against the conductor casing at ground surface. The sounding/camera access pipe, when installed to the specified depth, shall extend three (3) feet above ground surface.

1.10 GRAVEL ENVELOPE

A. GENERAL

1. This section includes materials and installation of gravel pack.

2. A gravel pack envelope shall be installed in accordance with the approved final well design. The gravel pack is used to fill the annulus between the borehole wall and well casing and screen.

B. EQUIPMENT AND MATERIALS

1. Gravel Pack

a. Final gradation and uniformity required shall be specified in the final well design submitted by the Engineer of Record after examination of the lithologic log and sieve analyses of drill cuttings.

b. All gravel or coarse-grained sand for packing shall be hard, water-worn, and washed clean of silt, fine sand, dirt, and foreign matter. Crushed rock and other angular material shall not be accepted. The gravel shall be well-rounded and well-graded, free of shale, mica, clay, or other organic matter and subject to the approval of the Engineer of Record.

c. CONTRACTOR shall have a certified testing laboratory perform sieve analyses of the gravel delivered on-site to verify conformance with the final gravel specification. Failure to meet the gradation specified in the final well design shall

be grounds for rejection. If rejected, the CONTRACTOR shall correct the gradation to meet the specified requirements.

d. Gravel pack materials shall be delivered to and contained on-site in appropriate size bags (“super sacks”) and shall be protected to eliminate contamination from rain, dust, and deleterious materials. Gravel pack materials that contact the ground shall not be installed.

e. Any material delivered to the site shall be accompanied with a certified weight ticket detailing the weight of the material. Any loads not meeting the characteristics as approved by the said submitted data sheets and samples shall be rejected at the expense of the CONTRACTOR.

2. Sodium Hypochlorite

a. Sodium hypochlorite (12.5%) shall be provided in a liquid solution. No powder or pellet products will be allowed. Use of calcium-based disinfection materials will not be allowed.

b. Sodium hypochlorite shall be newly purchased and comply with NSF-60 certification.

c. Sodium hypochlorite shall be delivered to the well site in sealed containers and bearing the product labeling indicating the percentage of available free chlorine by the manufacturer.

C. EXECUTION

1. General

a. All gravel pack materials, if stockpiled at the well site, shall be kept free of all foreign matter.

b. Prior to installation of the gravel pack, the CONTRACTOR shall provide the method that will be used to the Engineer of Record. Acceptable methods include use of a circulating system with one or more positive displacement pumps or a gravity feed system.

c. Prior to installation of the gravel pack material, the CONTRACTOR shall submit an estimate of the volume of annular space between the borehole wall and the well casing and tubing assemblies.

d. Gravel pack shall be installed through a tremie pipe and pumped from the bottom of the borehole to the specified depth.

2. Gravel Envelope Installation

a. Prior to placement of the gravel pack, the drilling fluid shall be thinned with clean water. Clean water (not from a mud circulation pit) shall be circulated during gravel installation.

b. Gravel pack, as specified, shall be installed in the annular space between the borehole and well casing and screen. Gravel shall be carefully installed to obtain complete filling of the annular space for the depth interval specified in the final well design.

c. Gravel pack material shall be installed by means of a tremie pipe. Under no circumstance shall the gravel pack be installed through the gravel make-up pipe. The tremie pipe shall be installed to within 10-feet of the bottom of the borehole before beginning gravel placement. The tremie pipe shall be removed in approximately 20-foot intervals when the gravel pack in the borehole reaches the bottom of the tremie pipe. At no time shall the end of the tremie pipe be greater than 30 feet above the top of the gravel envelope during placement. Gravel shall be placed in a continuous manner without creating voids, separations, or bridging.

d. Gravel pack material shall be installed in the annular space between the borehole and the well casing and screen assembly using the method approved by the

Engineer of Record. Under no circumstance will the gravel pack be allowed to free-fall into the annular space.

e. During filter pack installation, the CONTRACTOR shall "sound" or "tag" the top of the gravel pack depth at regular intervals. CONTRACTOR shall maintain a log of gravel placed and the corresponding depth of placement.

f. The rate of gravel installation shall proceed without interruption until completion.

g. During the entire gravel packing operation, circulate clean water along with 12.5% sodium hypochlorite through the well screen and up the annular space outside the well casing in accordance with AWWA C-654.

h. Throughout the gravel pack placement operations, a swab shall be installed into the well and worked opposite all screened sections to induce settlement of emplaced gravel pack material. As the gravel pack settles, add more. Continue this operation until there is no further measurable settlement of gravel, and the gravel has been washed clean.

i. The CONTRACTOR shall measure and bring the level of gravel pack material inside the gravel make-up tube to that of the gravel pack in the borehole annular space. Gravel pack shall not be added to the gravel make-up tube, unless otherwise directed by the Engineer of Record.

j. Record the volume of gravel pack used. The volume shall not be less than the calculated volume of the annular space between the wall of the borehole based upon the caliper survey and the casing and screen diameters. A quantity less than the computed volume shall be considered as an indication of potential voids and measures shall be taken by the CONTRACTOR to eliminate the voids. Significant differences between estimated and actual volume of gravel pack installed may be grounds for well rejection.

k. Immediately after completing installation of the gravel pack, the well shall be gently swabbed while circulating clean water.

1.11 ANNULAR GROUT SEALS

A. GENERAL

1. This section includes materials and installation of a transition sand layer and annular grout seals.

2. A bentonite grout seal shall be installed in accordance with the approved final design. The grout seal serves to separate the gravel pack envelope from the sand-cement grout upper annular seal, and to seal off the annulus between the borehole and well casing.

3. A fine sand layer shall be installed in accordance with the approved final design to provide a transition from the bentonite grout seal to the sand-cement grout upper annular seal.

4. A sand-cement grout annular seal shall be installed in accordance with the approved final design to fill the annulus between the borehole/conductor casing and well casing.

B. EQUIPMENT AND MATERIALS

1. Bentonite Grout

a. Bentonite grout shall consist of a mixture of 3/8-inch bentonite chips (Baroid Holeplug® or equivalent) and gravel. The gravel used in the mixture shall be the same gravel specified for the gravel pack envelope or other material approved by the Engineer of Record. Bentonite chips and gravel shall be pre-mixed dry prior to placement in the annulus at a ratio of approximately 4 parts sand to 1 part bentonite chips.

2. Transition Sand

a. Sand utilized for the mixture shall be of 30-mesh gradation and consist of clean, non-reactive materials and free of vegetative matter and other foreign material. Crushed aggregate will not be allowed.

3. Sand-Cement Grout

a. Materials used for the annular seal outside the casing and above the transition sand layer shall be a sand-cement grout.

b. Sand-cement grout shall consist of a mixture of ASTM C150, Type II cement, sand, and water in the proportion of not more than 2 parts, by weight, of sand to 1 part of cement with not more than 7 gallons of clean water per 94 pounds sack of cement. This is equivalent to a “10.3-sack mix” of sand cement.

c. Maximum particle size of the sand used in the sand-cement sealing mixture should conform to gradation of ASTM C 33-03 “Standard Specification for Concrete Aggregates” (or latest revisions thereof) or Caltrans gradation specifications for “fine aggregate.” Custom blends of finer sands are also acceptable.

d. Sand shall be clean, hard, dense, and durable, consisting of uncoated rock particles, and shall not contain injurious amounts of dirt, organic matter, or other deleterious substances.

e. The use of additions to reduce shrinkage, permeability, or increase fluidity, and/or setting time must be approved by the Engineer of Record.

f. Sand-cement grout shall be mixed thoroughly to provide uniformity and ensure that no “lumps” exist.

C. EXECUTION

1. General

a. All bentonite and sand materials, if stockpiled at the well site, shall be kept free of all foreign matter.

b. Prior to installation of the annular seals, the CONTRACTOR shall provide an estimate of the volume of annular space between the borehole wall and the well casing assemblies. A record of the actual depth and volume of bentonite-sand mixture, transition sand, and neat cement installed shall be kept. The volume shall not be less than the calculated volume of the annular space between the borehole and well casings.

c. The CONTRACTOR shall take all measures necessary to protect the borehole from caving or collapsing during placement of the annular seals.

d. The CONTRACTOR shall be responsible for determining the collapse potential of the well casing during grouting and shall take whatever precautions are necessary to prevent casing collapse. In the event the casing collapses prior to completion of seal installation, the CONTRACTOR shall take whatever steps are necessary to place the seal as required by the final well design. Any such remedial action shall be conducted at the CONTRACTOR’s sole expense.

2. Installation of Annular Seals and Transition Sand

a. A bentonite grout seal, transition sand layer, and sand-cement grout shall be placed into the annular space above the gravel pack envelope as described herein and in accordance with the final well design.

b. The grout seal and transition sand materials shall be placed by installing a tremie pipe and placing the materials at the specified depths by pumping with hydraulic or pneumatic pressure in a continuous operation through said feed line inserted between the casing and the borehole wall. The bottom of tremie pipe shall not exceed a maximum of 30 feet above the level of material being emplaced. The feed line shall be lowered to within 5 feet of the bottom of the zone to be filled. The line shall be slowly withdrawn as the annular space fills with the backfill

materials. Tremie shall remain submerged in sand-cement grout throughout the entire seal emplacement process.

c. Upon completion of installing the cement grout, the CONTRACTOR shall leave the well undisturbed for a period of not less than 24 hours.

d. Record the volume of grout and sand materials installed. The volumes shall not be less than the calculated volumes of the annular space between the wall of the borehole and the well casing. Significant differences between estimated and actual volume(s) of grout and sand materials installed may be grounds for well rejection.

1.12 INITIAL WELL DEVELOPMENT

A. GENERAL

1. This section includes development of the well by open-ended airlifting and dual swab-airlifting for the minimum times specified or until the performance requirements are met, whichever is longer.

B. EQUIPMENT AND MATERIALS

1. Water Storage Tanks and Discharge Piping

a. The CONTRACTOR shall anticipate and provide enough water storage tanks to temporarily store on-site purged water from the well casings during development.

b. The CONTRACTOR shall provide the temporary discharge piping required to convey well development water to the appropriate holding and/or disposal area. The discharge piping at the well head shall include a valve for controlling flow rates and a sample port for collecting groundwater samples.

2. Air Compressor

a. CONTRACTOR shall provide an air compressor of adequate capacity in both volume (CFM) and pressure (PSI) to maintain airlifting efficiency at all depths during mechanical development.

3. Dual Swab-Airlifting Tool

a. The swab-airlifting tool shall attach to the end of the drill pipe and shall consist of 2 rubber flanges spaced a maximum of 10-feet apart. The body of the tool shall be perforated with enough open area to allow effective airlifting to occur within the well. The O.D. of the rubber flanges shall be no more than 1/8-inch smaller than the I.D. of the well screen.

b. An Imhoff cone shall be used to check and estimate the sand production during airlift-swab development.

4. Dispersant Polymer

a. The dispersant polymer shall be either AQUA-CLEAR™ PFD or Nu-Well 220®. No other dispersant chemicals may be used without prior approval. Dosage shall be per the manufacturer’s guidelines.

5. Water Level Sounder

a. Water level sounder shall be an electric wireline sounder capable of water level measurements to the nearest 0.01-foot.

C. EXECUTION

1. General

a. CONTRACTOR shall not begin development until solids settlement and discharge facilities are installed to the satisfaction of the Engineer of Record.

2. Records

a. CONTRACTOR shall keep detailed records during well development and shall make these records available to the Engineer of Record.

b. CONTRACTOR shall measure and record static water level at the beginning of each day of well development by swab-airlifting (prior to moving water from the well).

c. CONTRACTOR shall measure and record the following parameters a minimum of 30 minutes during swab-airlifting development:

1) Time (measured to the nearest minute)

2) Flow rate (estimated to the nearest 100 gallons per minute)

3) Water level (measured to the nearest foot)

4) Sand production observations/estimations

5) Any observations of unusual or changed conditions (e.g., odor, gas bubbles, color, etc.)

3. Open-Ended Airlifting

a. Initial mechanical development shall be completed by open-ended airlifting through the drill pipe no less than 24 hours following the placement of the cement grout annular seal to avoid damaging the annular seal before it has sufficiently set.

b. Open-ended airlifting shall start gradually to remove sediment and heavy drilling fluids from the well casing. Open-ended airlifting shall continue for a minimum of four (4) hours or until all the following have occurred:

1) Drilling fluids are removed from the well.

2) No measurable settling of the gravel pack envelope occurs with further open-ended airlifting.

c. Upon completion of open-ended airlifting, the well shall be accurately sounded in the presence of the Engineer of Record to determine the level of accumulated sediment in the well. The sediment shall be recorded and removed from the well prior to beginning swab-airlifting development.

4. Dual Swab-Airlifting

a. CONTRACTOR shall begin dual swab-airlifting development after open-ended airlifting is completed.

b. Swab-airlifting shall begin at the bottom of the screen section. Swab-airlifting shall be conducted by moving the swab-airlift tool slowly and uniformly up and down over one length of drill pipe for the specified time before continuing upward.

c. Swab-airlifting shall be performed as follows:

1) Swab-airlift for a minimum of eight (8) minutes per foot of well screen.

2) Swab in the specified amount of diluted dispersant polymer evenly over the well screen.

3) Allow the well to remain idle for a minimum of 12 hours.

4) Swab-airlift for a minimum of six (6) minutes per foot of well screen.

d. CONTRACTOR shall continue swab-airlifting beyond the minimum requirements until the Engineer of Record provides approval for completion of mechanical development and the CONTRACTOR is confident that the turbidity and sand production requirements will be met after development pumping.

e. Upon completion of swab-airlift development, the well shall be accurately sounded in the presence of the Engineer of Record to determine the level of accumulated sediment in the well. The sediment shall be recorded and removed from the well prior to beginning test pump development.

1.13 MOBILIZATION AND DEMOBILIZATION OF TEST PUMP

A. GENERAL

1. This item includes mobilization and demobilization of equipment, materials and personnel for pumping well development and well pumping tests.

B. EQUIPMENT AND MATERIALS

1. Test Pump

   a. CONTRACTOR shall furnish, install and remove a vertical turbine test pump that is powered by a diesel or gasoline engine. The prime mover shall be a variable-speed type equipped with a suitable throttling device to control the discharge rate within a range specified by the Engineer of Record and approved by the District .

   b. The vertical turbine pump is anticipated to be set at a depth specified by the Engineer of Record and approved by the District for secondary well development prior to performing the well pumping tests.

   c. No foot valve shall be installed on the pump column pipe.

2. Test Pump Engine and Drive Shaft

   a. The test pump engine and drive shaft assembly shall be capable of continuously operating as required to produce the specified minimum flow rate and discharge head.

   b. The test pump engine and drive shaft assembly shall be capable of pumping and surging and shall not have a non-reverse ratchet installed.

3. Discharge Assembly

   a. The discharge assembly shall be of suitable size, length, and configuration to direct the water discharged from the well during secondary development and pump tests to the specified location without generating nuisance water at the project site.

   b. The discharge line shall include an in-line flowmeter with six-digit, straight reading totalizer, registering in units of 100 gallons with a rate of flow indicator dial which reads in gpm, and is suitable for flow range specified in this section. The discharge assembly shall also be equipped with a ¾-inch hose bib for collecting water quality samples, and an orifice plate and manometer for measuring well discharge pressure.

   c. CONTRACTOR shall use an adjustable gate valve for controlling the flow rate and to allow for the totalizer and flowmeter to function properly at all flow rates. Only a gate valve will be allowed. A butterfly valve will not be permitted.

   d. The discharge assembly shall be capable of withstanding pressures exerted on the discharge assembly from well development and test pump events. The CONTRACTOR shall submit to the Engineer of Record a specification sheet or design document which indicates the maximum pressure rating of the discharge assembly.

   e. The CONTRACTOR shall provide the approved erosion control BMPs at the discharge point.

4. Water Level Sounder

   a. Water level sounder shall be an electric wireline sounder capable of water level measurements to the nearest 0.01-foot.

5. Sand Tester

   a. Furnish a centrifugal sand separating meter (Rossum or equivalent) for measuring the amount of sand produced during pumping.

6. Well Cover

   a. CONTRACTOR shall provide a lockable, removable well cover that secures the wellhead during execution of the work. The well cover shall be adequate to prevent tampering with the well or the introduction of foreign materials into the well, and to ensure that the well is not a hazard. The cover shall prevent rainwater

from entering the well but need not be watertight. CONTRACTOR shall provide a lock and key for the well cover.

C. EXECUTION

1. Prior to installing the test pump, the bottom of the well shall be bailed or pumped clean of any sediment or at the approval of the Engineer of Record.

2. The CONTRACTOR shall provide, mobilize to the project site, set up, operate, maintain in good working order, and demobilize from the project site, all of the equipment listed in this section.

1.14 SECONDARY WELL DEVELOPMENT

A. GENERAL

1. This section includes development of the well by surge pumping using a test pump. Pumping development shall commence immediately after installation of the test pump, or as approved by the Engineer of Record. Pumping development shall be conducted during daylight hours, 12 hours per day, 7 days per week until completion.

2. If pumping development is not commenced within five (5) days of completing mechanical development, or there are other delays or interruption to this activity, CONTRACTOR shall conduct, without additional cost to the District, pumping development for length of time in excess of five (5) days within completing mechanical development or for the length of time pumping development activities were delayed or interrupted without Engineer of Record approval.

B. EQUIPMENT AND MATERIALS

1. Requirements for the test pump, discharge line, and other equipment for pumping development are provided in the previous section, Mobilization and Demobilization of Test Pump.

C. EXECUTION

1. General

a. CONTRACTOR shall not commence development until solids settlement and discharge facilities are installed to the satisfaction of the Engineer of Record.

b. Water generated during well development shall be conveyed in accordance with the CONTRACTOR’s approved waste disposal plan in these Technical Specifications.

2. Records

a. CONTRACTOR shall maintain detailed records during well development and shall make these records available to the Engineer of Record upon request.

b. CONTRACTOR shall measure and record static water level and depth to gravel pack envelope (to the nearest foot) at the beginning of each day of well pumping development (prior to moving water from the well).

c. CONTRACTOR shall measure and record the following parameters during pumping development:

1) Time (measured to the nearest minute)

2) Flow rate (estimated to the nearest 100 gallons per minute)

3) Flowmeter totalizer reading per pumping cycle (measured to the smallest unit on the totalizer gauge)

4) Pumping water levels before surges (measured to the nearest 0.01-foot)

5) The number of surges per cycle

6) Sand production per pumping cycle at 15 minutes following surging (measured to the nearest 0.01-cubic centimeter)

7) Turbidity (measured to the nearest 1.0 Nephelometric Turbidity Unit, NTU)

8) Any observations of unusual or changed conditions (e.g., odor, gas bubbles, color, etc.)

3. Pumping Development

a. CONTRACTOR shall commence secondary (pumping) development within 5 days after completing initial development.

b. Pumping development shall commence by alternately pumping and surging at 25% of the anticipated design capacity of the well until pumping and surging at that flow rate produces visibly clear water.

c. Pumping development shall then be gradually increased to 150% of the anticipated design capacity of the well.

d. Pumping development shall continue until all the following have occurred:

1) The pumped water complies with the turbidity and sand content requirements.

2) No movement of the gravel envelope has occurred during the last eight (8) hours of development.

3) Specific capacity remains constant.

e. CONTRACTOR shall continuously flush the gravel make-up pipe with clean potable water (not from the pumping well) during well development.

f. CONTRACTOR shall lower a weighted bar within the gravel make-up pipe to confirm that it is open and clear and to measure the depth to the top of gravel pack envelope which shall equal the bottom depth of the gravel make-up pipe.

g. The gravel make-up pipe shall always remain empty, and the depth of the gravel pack envelope shall not be higher than the bottom of the gravel make-up pipe.

h. If the gravel pack level is determined to be below the bottom of the gravel make-up pipe the CONTRACTOR shall only add additional gravel pack material through the gravel make-up pipe.

i. The gravel make-up pipe shall meet the design functions to the satisfaction of the Engineer of Record. If the water level after flushing remains relatively stable at ground surface, then the gravel make-up pipe shall be considered as being clogged and the CONTRACTOR shall be required to remove any material blocking the gravel make-up pipe by a way of airlifting and/or other equivalent method.

j. CONTRACTOR shall lower a weighted bar with a brush to the top of the entry port of the sounding pipe to confirm the pipe is open and clear.

D. PERFORMANCE REQUIREMENTS

1. Sand Content

a. The measured sand content of water pumped at the design capacity of the well during any 5-minute period shall not exceed 5 parts per million (ppm) during the first 30 minutes of continuous pumping and not more than 1 ppm for any 5-minute period after 30 minutes of continuous pumping.

2. Turbidity

a. Turbidity measured after 15 minutes of continuous pumping at the design capacity of the well shall not exceed five (5) NTU.

1.15 WELL PUMPING TESTS

A. GENERAL

1. This section includes a step-drawdown test with increasing discharge rates, and a constant rate time drawdown test.
2. The step-rate discharge test shall include pumping the well at stepped rates of discharge for specified periods. The constant rate discharge test shall include pumping the well at a fixed rate of discharge for a specified period, and monitoring water level recovery in the well after the pump is stopped.

B. EQUIPMENT AND MATERIALS

1. Test Pump and Discharge Assembly
   a. The discharge line shall include taps not more than 20 feet from the well; one equipped with a standard water valve for collection of water samples, and the other for measuring sand content.
2. Water Level Sounder
   a. Water level sounder shall be an electric wireline sounder capable of water level measurements to the nearest 0.01-foot.

C. EXECUTION

1. Testing Schedule
   a. After well development with the test pump is complete, commence the well pumping tests. Schedule all tests sufficiently in advance so that the Engineer of Record can be on-site throughout each testing period.
2. Records
   a. CONTRACTOR shall measure and record the depth to water at the pumping well during the step-drawdown test, constant-rate test and recovery test on forms to be provided by the Engineer of Record according to the following schedule:
      1) Measure and record depth to static water level.
      2) Turn pump on as requested by the Engineer of Record, at time (t) = 0.
      3) Accurately measure and record depth to water at the pumping well and at each change in flow rate as follows:
         (a) Each minute, from t = 1 to t = 12
         (b) Each 2 minutes, from t = 14 to t = 20
         (c) Each 5 minutes, from t = 25 to t = 50
         (d) Each 10 minutes, from t = 60 to t = 120
         (e) Each 15 minutes, from t = 135 to t = 1440
   b. In case of failure of the pump operation for a period greater than one percent of the elapsed pumping time from t = 0, the test shall be suspended until the static water level again has been attained. Should the test be aborted as a result of a deficiency, malfunction, or other reason on the part of the CONTRACTOR's equipment or personnel, all time consumed in waiting for complete water level recovery and in resuming the pump test to the point where it was aborted or suspended shall be at no cost to the District.
3. Step-Drawdown Test
   a. For this well test, operate the pump initially at a rate specified by the Engineer of Record and approved by the District. The pumping rate shall then be increased by increments specified by the Engineer of Record and approved by the District at uniform 2-hour intervals until the well has been tested at a maximum rate as specified by the Engineer of Record and approved by the District.
   b. During the test, the CONTRACTOR shall record the time, pumping level, discharge rate, and rate of sand production.
4. Constant Rate Pumping Test

a. A constant rate, time-drawdown test shall commence not less than eight (8) hours and not more than 24 hours after the completion of the step-drawdown test. The rate of pumping shall be as specified by the Engineer of Record and approved by the District. CONTRACTOR shall ensure that the pumping rate selected remains constant throughout the test. The test duration shall be a minimum of 24 hours (or as specified by the Engineer of Record and approved by the District) or of a duration that shall result in a straight-line plot of at least four (4) hours of consecutive measurements of water level drawdown when plotted against the logarithm of elapsed time.

b. When the test is completed and the pump stopped, the CONTRACTOR shall measure recovery of the water level in the well for a period of approximately four (4) hours.

c. During the constant rate test if the rate of water pumped falls below or above the designated flow by 5% or more for a period of greater than 15 minutes, discontinue the test until the water level in the well recovers and stabilizes. Repeat the test. No payment shall be made for an uncompleted test.

d. Prior to ending the constant rate test, the CONTRACTOR shall collect representative water quality samples of pumped groundwater. The CONTRACTOR shall deliver all samples to the laboratory under Chain of Custody for analyses of the analytes specified by the Engineer of Record or the District. The cost of all water quality sampling and laboratory analyses shall be borne by the CONTRACTOR.

5. Aborted Tests

a. Whenever continuous pumping at a uniform rate has been specified, failure of pumping operations for a period greater than 1% of the elapsed pumping time shall require suspension of the test until the water level in the pumped well has recovered to its original level. Recovery shall be considered “complete” after the well has been allowed to rest for a period at least equal to the elapsed pumping time of the aborted test, except that if any three successive water level measurements spaced at least 20 minutes apart show no further rise in the water level in the pumped well, the test may be resumed immediately. The Engineer of Record shall be the judge as to whether this latter condition exists. CONTRACTOR shall not be paid for any re-testing done if the specified time or recovery requirements for the aborted test are not first met. All aborted tests will be considered as invalid and shall not be construed as a test.

b. No payment shall be made to the CONTRACTOR for pumping tests interrupted by the malfunction or failure of pumping equipment or failure to maintain the rate of pumping within the prescribed limits. If a test is interrupted, the well water level shall be allowed to fully recover, after which the test shall be restarted.

1.16 FLOWMETER SURVEY

A. GENERAL

1. A flowmeter survey shall be performed to determine the amount of groundwater entering the well at all depths of the well screens.

2. The survey shall be conducted by a SUBCONTRACTOR retained by the CONTRACTOR and approved by the Engineer of Record.

3. The survey shall be completed during the latter part of the pumping portion of the constant rate pumping test.

B. EQUIPMENT AND MATERIALS

1. Flowmeter

a. Maximum 1-11/16-inch diameter to be of appropriate dimension to pass through a 2-inch I.D. slotted PVC temporary access tube.

b. Type that utilizes a magneto-restrictive counter or other nonmechanical device to sense rotation.

c. Capable of operation in either continuous traverse or stationary mode.

d. Capable of sensing flow rates between 0.25 foot per second to 10 feet per second in a straight pipe with a diameter matching that of the well casing.

e. Time-drive recording for stationary mode operations.

f. Use basket-type meter for the purpose of increasing sensitivity if requested by the Engineer of Record.

g. Equipped with line speed indicator capable of indicating variations in line speed of 10 percent.

C. EXECUTION

1. General

a. Prior to commencing the constant rate test, the Engineer of Record and CONTRACTOR shall set a start time for the flowmeter profile survey.

b. Downhole equipment required to complete the flowmeter profile survey shall be installed inside the well casing through a temporary access tube.

c. CONTRACTOR shall provide whatever assistance as may be required to accomplish the flow profile logging including operation of the test pump and drilling rig as needed to support logging cable sheave wheel.

d. The flowmeter profile survey shall be run at the rate of discharge selected for the constant rate pumping test. Unless agreed otherwise by the Engineer of Record prior to installation of the survey equipment, the flowmeter profile survey completed shall include both stationary (stop counts) and dynamic tests. Stationary tests shall consist of 2-minute readings made at 10-foot increments. Dynamic tests shall be conducted at a rate of 1-foot per second. The record for each test shall indicate either meter speed or percentage of total meter speed with depth.

e. The flowmeter used for the survey shall be calibrated in the uppermost and lowermost blank sections of the well.

f. Survey results shall become the property of the District at the time the survey is completed. The survey shall be run in the presence of the Engineer of Record.

g. When the pumping tests, water level recovery test, and the flowmeter survey log are complete, the CONTRACTOR shall remove the test pump and clean the well of all accumulated sediment and foreign material.

1.17 VIDEO CAMERA SURVEY

A. GENERAL

1. This section includes a downhole color video camera survey over the full depth of the well. Video survey results shall serve as a final inspection document for the well. The survey shall be conducted by a SUBCONTRACTOR retained by the CONTRACTOR and approved by the Engineer of Record.

B. EQUIPMENT AND MATERIALS

1. Camera

a. The camera used for the survey shall be equipped with vertical- and side-view cameras and with centralizers. The equipment used to complete the video survey shall produce a tape with an automatic depth indication to the nearest 0.1-foot.

b. The survey shall be performed using a video camera with two (2) camera lenses (“dual-cam”) accompanied by the appropriate light sources. One lens shall be the conventional fisheye and the other shall be a side scan wide-angle lens for viewing the interior of the casing directly.

C. EXECUTION

1. General

a. The video survey shall be conducted after removal of the test pump and before final disinfection of the well.

b. Prior to conducting the survey, the CONTRACTOR shall introduce clear water into the well for a sufficient period and at sufficient quantity to produce clear viewing conditions during the survey to the satisfaction of the Engineer of Record.

c. Should the survey fail to produce a clear picture of the internal casing conditions, additional clear water shall be introduced, and additional surveys conducted until a clear video is obtained to the satisfaction of the Engineer of Record. All re-surveys performed due to this condition shall be conducted at the CONTRACTOR's own expense.

d. CONTRACTOR shall run a color video camera survey of the entire well, from top of casing to total depth, in the presence of the Engineer of Record. The survey shall be recorded in color which shall be representative of actual colors of the interior of the well, show the date of survey, and include a continuous forward and reverse display of the depth of the camera.

e. CONTRACTOR shall provide whatever assistance may be required to accomplish the camera survey and shall take whatever steps are necessary to establish the desired clarity of the well water.

f. Survey results shall become the property of the District at the time the survey is completed.

D. PERFORMANCE AND REQUIREMENTS

1. The depth of static water level, well screens, sounding port, and well bottom, as measured by the video survey, shall be provided in the report, along with the depth counter reference point and depth difference between the side scan and downhole views.

2. All welded joints shall be inspected by the video survey. No voids shall be present in any welded joint observed.

3. All materials, including the sounding/camera access tube connection, shall be undamaged and in suitable condition to allow the full use of the well for its intended purpose.

4. All well screen openings shall be free of excessive mud or other incrustation, as determined by the Engineer of Record.

1.18 ALIGNMENT AND PLUMBNESS TESTS

A. GENERAL

1. The section includes alignment and plumbness testing of the installed well casing and screen assembly. The alignment and plumbness tests shall be conducted throughout the entire length of blank and screened well casing.

2. The alignment and plumbness testing of the well casing shall be performed following the completion of the downhole video camera survey on the final well casing.

B. EQUIPMENT AND MATERIALS

1. Alignment Tool

a. The alignment tool shall be 40 feet long and shall be rigid.

b. The outside diameter of the alignment testing tool shall be 1 inch less than the inside diameter of the blank well casing.

c. The alignment tool shall be one of the following configurations:

1) The length of pipe with the specified outside diameter.

2) A “dummy”, consisting of a rigid spindle with a diameter specified by the Engineer of Record and approved by the District. The spindle shall be fitted with three, 12-inch-long sections of pipe (“rings”) of a diameter appropriate for the well casing I.D. The rings shall be rigidly attached to the spindle so that the axis of the spindle is in line with the axes of the rings. The rings shall be located at each end of the base pipe, and in the center of the base pipe.

2. Plumbness Tool

a. The plumbness testing shall be performed with a gyroscopic-type tool as approved by the Engineer of Record.

b. Gyroscopic probe features:

1) Capable of reaching a depth which is specified by the Engineer of Record and approved by the District in a well casing filled with either air or liquid. The well casing shall have a nominal diameter as specified by the Engineer of Record and approved by the District

2) Azimuth Range: 0 degree to 360 degrees.

3) Azimuth Accuracy: Meet or exceed 2 percent.

4) Inclination Range: 0 degree to 30 degrees.

5) Inclination Accuracy: Meet or exceed 0.25 percent.

6) Probe shall measure borehole inclination and borehole azimuth (compass direction) at maximum 10-foot depth intervals in order to derive horizontal borehole deviations.

C. EXECUTION

1. General

a. Plumbness and alignment testing may be performed at any time after the annular seal has cured and the video survey is performed.

b. The tests shall accurately measure the alignment and plumbness of the completed well and shall be presented in a manner that allows the Engineer of Record to fully evaluate whether the well meets the requirements.

c. Alignment Testing

1) Alignment testing shall be performed by lowering the alignment tool into the well from the ground surface to approximately 5-feet from the bottom of the well.

2) Installation of the test pump to the specified depth may serve as supplemental evidence of acceptable alignment of the well casing, but only to the depth that the pump was installed.

d. Plumbness Testing

1) Plumbness testing shall be performed by an approved geophysical logging company.

2) Plumbness testing shall be performed by lowering the plumbness tool into the well from the ground surface to the full well depth.

3) Plumbness testing shall be run twice such that repeatability of the survey can be assessed.

4) Measurements shall include station depth, inclination, azimuth, true vertical depth, departures, and plane of closure (displacement). Measurements shall be made every 10 feet from ground surface to the total depth of the well.

5) Upon completion of the plumbness testing, the CONTRACTOR shall provide the Engineer of Record with six (6) field hard copy reports and one (1) electronic PDF and LAS format copies of the plumbness test.

D. PERFORMANCE REQUIREMENTS

1. Alignment

a. The alignment tool must pass freely from the top of well casing (ground surface) to the lowest anticipated depth for the permanent pump intake.

2. Plumbness

a. The horizontal deviation of the well from vertical shall not exceed 0.0067 times the smallest inside diameter of the well casing and screen per foot of depth for the entire depth of the well.

1.19 WELL DISINFECTION

A. GENERAL

1. The well shall be disinfected after completion of the downhole video camera survey and alignment and plumbness tests.

2. The well shall be deemed properly disinfected only if the sample analysis results indicate the absence of total coliform bacteria, absence of fecal coliform bacteria, and a heterotrophic plate count of less than 500 colony forming units per milliliter (CFU/mL).

B. EQUIPMENT AND MATERIALS

1. Disinfectant

a. Chlorine product in accordance with NSF/ANSI 60 and approved by state or local agencies and the Engineer of Record shall be used to disinfect the well. Chlorine products used shall be recently purchased and delivered on the well site in original closed containers with original labeling indicating the percentage of available chlorine. During storage disinfectants shall not be exposed to the atmosphere or to direct sunlight.

b. Sodium hypochlorite in liquid form shall be used for disinfecting the well and shall be of such volume and strength to develop a concentration of at least 100 milligrams per liter (mg/L) of chlorine in all parts of the well water plus the borehole volume at the well screens.

c. Disposable plastic sampling bailers shall be used for the collection and analysis of groundwater samples. Bailers shall be delivered to the well site in their original packaging. The bailers shall be removed from their original packaging just prior to their use.

C. EXECUTION

1. General

a. All materials and tools including sampling bailers and associated hardware shall be disinfected in the presence of the Engineer of Record prior to being lowered into the well.

b. CONTRACTOR shall dose the well by adding the chlorine solution into the well to obtain a minimum concentration of 200 ppm but no greater than 500 ppm.

c. The chlorine solution shall be introduced into the well by placement through a tremie, double swab tool or nylon brush. Chemicals may be introduced by either pumping or gravity feed methods and chemicals shall not be poured into the casing from ground surface. CONTRACTOR shall introduce the chlorine solution at multiple depth intervals in measured proportional volumes. Immediately following dosing, the water column shall be thoroughly agitated using the double swab tool or nylon brush.

d. Following the introduction of chlorine solution into the well the water in the well shall be tested by the CONTRACTOR for residual chlorine using a small sampling bailer. If the residual chlorine concentration is less than 100 ppm, steps “b” and “c” shall be repeated. If necessary, additional chlorine solution may be added to the well. The procedure shall be repeated until the residual chlorine is at least 200 ppm.

e. Unless pre-approved otherwise by the Engineer of Record, all chlorinated water discharged from the well shall be dechlorinated in accordance with the District’s NPDES discharge permit prior to disposal.

1.20 WELLHEAD COMPLETION

A. GENERAL

1. Upon completion of the well disinfection, the CONTRACTOR shall secure the well casing, gravel feed tube, and sounding/camera access tube with steel plates welded to the open ends.

2. The conductor casing shall be finished at a height of 0.5 feet above ground surface (ft ags), and the well casing, sounding tube, and gravel make-up tube shall be finished at a height of three (3) ft ags.

B. EQUIPMENT AND MATERIALS

1. Well Casing and Accessory Tube Covers

a. Steel plates consisting of the same properties as the well casing and accessory tubing.

C. EXECUTION

1. General

a. The well casing and all accessory tubing shall be capped with welded steel plates consisting of the same properties as the casing and tubing. Each cap shall completely cover the opening to the well casing and accessory tubing and be sufficiently welded to the entire circumference of each respective pipe connection to prevent entry into the well by unauthorized personnel and the introduction of foreign material or contaminating substances.

b. The CONTRACTOR shall install a temporary vent in the top of the cover plate welded to the well casing which shall have a diameter specified by the Engineer of Record and approved by the District. The vent shall be positioned in the center of the cover plate. Steel mesh shall be secured over the open end of the vent to prevent foreign debris, animals, etc. from entering the well.

1.21 BOREHOLE ABANDONMENT – OPTIONAL

A. GENERAL

1. This section describes abandonment procedures for the pilot or reamed borehole. Abandonment hereunder shall include either of two methods:

a. Abandonment due to actions of the CONTRACTOR, or

b. Abandonment due to the request of the District.

B. EQUIPMENT AND MATERIALS

1. Sealing Materials

a. Acceptable impervious sealing materials that may be employed in abandonment procedures include neat cement, sand-cement grout, or equal to be approved by the Engineer of Record.

1) Sand-cement grout shall be composed of not more than 188 pounds of sand and one 94-pound sack of Portland cement (2 parts sand to 1-part cement by weight) and with not more than 7 gallons of clean water. This

is equivalent to a “10.3-sack mix.” Pozzolan (“fly ash”) shall not be included in the mix.

2) A neat cement mixture shall be composed of one 94-pound sack of Portland cement to 5 to 7 gallons of clean water.

C. EXECUTION

1. Abandonment Prior to Installation of Well Casing Assembly

a. Abandonment Due to Actions of the CONTRACTOR

1) If abandonment of the pilot or reamed borehole is, by reason of any actions of the CONTRACTOR, including, but not limited to, such causes as losing tools, uncontrolled sloughing or caving, incorrect application of drilling fluids and/or use of lost circulation materials, borehole misalignment, or any other cause attributed to careless or poor workmanship, the borehole shall be abandoned in accordance with Federal, State, and County requirements, and local City ordinances. In this event, no payment will be made to the CONTRACTOR for drilling and filling the hole so abandoned, or for mobilization and demobilization, for this procedure. CONTRACTOR shall drill a new hole as specified by the District and/or Engineer of Record.

b. Abandonment at District’s Request

1) If abandonment of the pilot or reamed borehole is specifically requested by the District in writing, including but not limited to such causes as total lack of potential aquifers, insufficient number of potential aquifers, or unacceptable water quality, the borehole shall be abandoned in accordance with federal, state, and county requirements, and local city ordinances. In this event, the CONTRACTOR will be paid for mobilization and demobilization at this site, as well as for the footage of drilling completed. Payment for borehole abandonment, if required, and if specifically requested by the District, as set forth above, shall be made on a unit price per linear foot, and shall be considered full compensation for all time, materials, and equipment required to complete the abandonment.

END OF SECTION