

## SECTION 02670

### WELL CONSTRUCTION

#### PART 1 - GENERAL

##### 1.1 DESCRIPTION

###### A. Scope

1. Construct, develop, test and disinfect one (1) new domestic unconfined alluvial water well as indicated on the Drawings and specified herein

###### B. Additional Requirements Specified Elsewhere

1. Section 01340: Shop Drawings, Product Data and Samples
2. Section 01400: Quality Control
3. Section 01600: Materials and Equipment
4. Section 11317: Submersible Well Pump
5. State Board of Examiners of Water Well Construction and Pump Installation Contractors: "Rules and Regulations for Water Well Construction, Pump Installation and Monitoring and Observation Hole/Well Construction"
6. National Water Well Association (NWWA): "Water Well Specifications"
7. American Water Works Association (AWWA): AWWA A100-Deep Wells
8. Well permit issued by Colorado Division of Water Resources
  - a. To be furnished by Owner

##### 1.2 SUBMITTALS

###### A. Shop Drawings and Product Data in Accordance with Section 01340

1. Materials
2. Parts
3. Devices
4. Accessories
5. Installation
6. Development
7. Test pumping

###### B. Colorado Division of Water Resources Well Completion Report

#### PART 2 - PRODUCTS

##### 2.1 PERFORMANCE AND DESIGN REQUIREMENTS

###### A. WWTP Well No. 1

1. Design production rate: Estimated at 5 gpm maximum
2. Bore hole diameter
  - a. 9.5 inches minimum at well screen section

- b. 12 inches maximum at well screen section
- c. 13.5-inches minimum to accommodate grout seal at solid wall casing
- 3. Casing
  - a. Diameter: 6-inch
  - b. Top elevation: Set to accommodate pitless unit as shown on Drawings
- 4. Anticipated total depth of well: 33 feet
- 5. Grout seal: Upper 19 feet of well
- 6. Gravel pack and screen: 19 feet to 33 feet
- 7. Surface or conductor casing: Install if required to stabilize upper segment of bore hole
- 8. Geology: Refer to Drawings and Geotechnical Report
  - a. Information regarding the depth of the formation discussed herein is based on test holes placed on January 2009. The Owner and his representative assume no responsibility for the reliability of the geologic information. It shall be the Contractor's responsibility to ascertain the drilling, development and testing conditions at the well site
  - b. Log illustrates:
    - 1) 0-0.5 feet – Topsoil
    - 2) 0.5-6 feet – Clayey sand
    - 3) 6-11 feet – Silty sand
    - 4) 11-16 feet – Clay, slightly sandy to sandy
    - 5) 16-28 feet – Silty sand
    - 6) 28 feet and greater – Claystone bedrock
- 9. Well measurements and depth
  - a. To be made from an established point on the surface of the ground at the well site established and referenced by Engineer
  - b. Contractor shall verify all measurements of the hole with the Engineer
  - c. Total depth is expected to be approximately 33 feet, 5 feet into shale material
  - d. No minimum footage is implied or guaranteed

## 2.2 MATERIALS

### A. WWTP Well No. 1

- 1. Conductor casing
  - a. Install only if required to stabilize bore hole.
  - b. Install to a depth of 20 feet or as required to prevent loose surficial deposits from sloughing.
  - c. Payment made on vertical foot basis only if the casing cannot be recovered.
- 2. Well casing
  - a. Size: 6.625-inches O.D.
  - b. Steel
    - 1) Wall thickness: 0.188 inches
    - 2) New, mill pipe
    - 3) ASTM A-53, Grade B
    - 4) Ends: Beveled for welding at pitless unit and plain-end or grooved at connection to PVC screen

- c. Polyvinylchloride (PVC)
  - 1) Iron pipe size (IPS)
  - 2) SDR21
  - 3) Conformance: NSF61
  - 4) Design basis: CertainTeed Corporation Certa-Lok™
- 3. Well screen
  - a. Size: 6.625-inches O.D.
  - b. Length: 14 feet; one screened interval
  - c. Material
    - 1) PVC
    - 2) Factory machined slot
      - a) Slot size: 0.020 inches
      - b) Slot spacing: 0.25-inches
      - c) Minimum open area per foot of screen: 12.6 square inches
    - 3) Design basis: CertainTeed Corporation Certa-Lok™ Integral Bell Well Screen
- 4. Grout seal
  - a. Portland cement: ASTM C150, Type V or Type II modified
  - b. Grout mixture proportions
    - 1) Cement: 1 sack
    - 2) Water: 7 gallons per 94 lb. of sack of cement
  - c. Special additives or cements as approved by Engineer
- 5. Gravel pack
  - a. Washed, clean, sound, durable, well-rounded natural basalt or siliceous rock containing no clay, silt, organic material, anhydride, gypsum, mica or calcareous material
  - b. Crushed rock not acceptable
  - c. Specific gravity: 2.5 minimum
  - d. Roundness: >0.6
  - e. Sphericity: >0.7
  - f. Porosity: >39%
  - g. Gradation - Final gradation subject to geologist's review based upon analysis of formation sand samples
    - 1) Design material: Colorado Silica 10-20 Sand
  - h. Uniformity coefficient: 1.30
  - i. Effective size: 1.10-1.15
  - j. Modify gradation as directed by Engineer per field conditions
- 6. Pitless unit
  - a. Application: 6-inch diameter alluvial well
  - b. Design basis: Baker Water Systems, Monitor Division Domestic Pitless (DP) Unit
    - 1) 6-inch well: 4PS67BNCOA
    - 2) Vented watertight well cap: Monitor Part No. 6W
  - c. Bury depth: 4 feet
  - d. Discharge connection
    - 1) Size: 1-inch
      - a) Provide threaded reducers on pitless standard outlet
    - 2) Connection: Treaded
  - e. Sealed conduit connection on well cap

- f. Well casing attachment
  - 1) 6-inch well: Monitor Division Kwikonect™
- g. Install reducer as required for drop pipe and discharge pipe

## PART 3 - EXECUTION

### 3.1 SEQUENCE OF OPERATION

- A. Drill bore hole to a depth 5 feet below water bearing sands and gravels into dry claystone bedrock
  - 1. WWTP Well No. 1: Drill to depth of approximately 33 feet
- B. Take formation samples for total depth of well
  - 1. At 5-foot intervals
  - 2. At any pronounced change of formation
- C. Install casing, screen and pitless unit
  - 1. Final screen slot size to be determined based upon field conditions
  - 2. Screened interval length and location to be confirmed with Engineer before installation
- D. Install gravel pack (final gradation to be based upon field conditions)
- E. Install grout seal
- F. Develop well
- G. Test pump well
- H. Disinfect well
- I. Clean up site, equivalent to or better than preconstruction conditions

### 3.2 WELL CONSTRUCTION

- A. Well Drilling
  - 1. Provide all tools, derricks, equipment, and accessories necessary to drill well
  - 2. Furnish and install conductor casing as required to stabilize the bore hole
  - 3. Drilling to be done using reverse hydraulic rotary or air percussion method
    - a. WWTP Well No. 1: Drill with a minimum 12-inch diameter bit; resulting bore hole to be minimum 13.5-inch diameter
  - 4. Drilling fluid
    - a. Clean water only
    - b. Do not use bentonite, lime, cement, organic matter, or other material to stop circulation losses
  - 5. Protection of water quality

- a. Prevent contaminated water, fuel, oil, equipment, tools and other deleterious substances from entering well, either through opening or by seepage
- 6. Bore hole and casing to be straight and plumb within one degree of vertical
  - a. Conform to AWWA A-100-84, Sections 8.1, 8.2 and 8.3
- 7. If, in the opinion of the Engineer, it is necessary to discontinue work on a pilot hole or well when partially completed by reason of the well being out of alignment or on account of jammed tools, caving ground, or by reason of negligence on the part of the Contractor, the Contractor shall immediately start drilling another well at a nearby location designated by the Engineer. The Contractor will be entitled to no payment for any work done or materials furnished for such an abandoned well
- 8. Cuttings
  - a. The Contractor may furnish and install portable above-grade tankage to prepare, temporarily store and circulate cutting fluid and receive/retain cuttings from the well
  - b. The Contractor may construct and use an earthen basin to circulate drilling fluid and to receive the cuttings from the well
    - 1) Maintain on Owner's site
  - c. The cuttings from the well may remain on-site if no silt or clay exists which will prevent reasonable drainage and consolidation of the cuttings.
  - d. Contractor shall not dispose of hole cuttings or discharge water so as to create damage to public or private property
- 9. Capping of well
  - a. Provide temporary lockable cap during progress of work
  - b. Contractor responsible for preventing
    - 1) Tampering with the well
    - 2) Entrance of foreign matter
  - c. Contractor is responsible for any objectionable materials that may enter well until well is accepted by the Owner

## B. Casing and Screen

- 1. All joints watertight
- 2. Joints
  - a. Casing
    - 1) One continuous piece from pitless unit to top of screen
    - 2) Watertight connection between pitless and well casing
  - b. Screen
    - 1) One continuous piece from connection to casing to bottom cap
- 3. Provide adapters at screen and casing connection as required
- 4. Do not drive or subject casing or screen to impact forces
- 5. Place screen section(s) at location(s) as directed by the Engineer/Geologist
- 6. Install centralizers in accordance with State of Colorado Standards
  - a. At 10-foot intervals on screen, maximum
  - b. At 20-foot intervals on casing, maximum
- 7. Attach bottom cap to screen with mechanical means or solvent welded connection conforming to NSF61 and NSF14

### C. Gravel Pack

1. Fill entire annular space outside casing or screen with gravel pack material to depths indicated in Paragraph 2.1
2. Place in a continuous operation utilizing a tremie pipe
  - a. Tremie pipe to extend to bottom of well casing annulus
  - b. Start placement of gravel pack at bottom of well
  - c. Withdraw tremie pipe as gravel is placed
  - d. Terminate gravel pack, as directed by the Engineer
3. Disinfection: Mix 0.25 lbs calcium hypochlorite per cubic yard of gravel placed

### D. Grout Seal

1. Do not use driller's mud, cuttings, or chips as sealing material
2. Flush drilling mud and other obstructions from annular space prior to grout seal placement operations
3. Place cementing baskets as directed by Engineer
4. Place grout seal from cementing baskets to ground surface
5. Pump cement slurry into annular space between casing and bore hole by a positive displacement method. The cementing will be done as follows:
  - a. Pump slurry through tremie or grout pipe set to the cementing point
  - b. Install in one continuous operation
  - c. Circulate water inside casing to lower temperature during curing and to prevent damage to casing pipe
  - d. Do not use additives that accelerate curing process
6. Form foundation for seal at top of casing
7. Allow 72 hours set prior to developing well

### E. Well Development

1. Surge, bail and develop well to remove mud cake, silt, sand, clay and other materials from well and adjacent formations
  - a. Utilize high velocity jetting, air lift pumping, or high capacity pumping
  - b. Utilize mud-dispersing compounds as required
  - c. Owner will provide water to be used for well development, connections as required by Contractor on adjacent project site
  - d. Method of development is subject to acceptance by the Engineer
2. Development water to be disposed of by the Contractor in a manner acceptable to the Owner, Engineer and local regulatory agencies
3. Decontaminate well with chlorinated water
4. Upon completion, well shall be cleaned to the bottom
5. Test pump may be utilized to complete development if it is of sufficient capacity

## 3.3 CAPACITY TESTING

### A. Equipment and Devices

1. Contractor to furnish and install test pump
  - a. Capable of producing a minimum flow rate of 150 percent of well design production rate when set at anticipated pump setting depth; 5 feet from bottom of screen

2. Test pump discharge pipe to be equipped with
  - a. Valve suitable for throttling rate of discharge to achieve approximately:
    - 1) One (1) gpm increments of discharge
  - b. Discharge rate measuring device
    - 2) Capable of accurate measurement
    - 3) Acceptable to the Engineer
  - c. Calibrated discharge pressure gauge
3. Contractor to furnish electric sounding or pressure transducer probe water level measuring device
  - a. Device to be equipped with
    - 1) Sufficient cable to extend from the ground surface to the intake of the test pump
  - b. Contractor may use an air line pressure gauge device in lieu of an electric probe
  - c. Device to be acceptable to the Engineer
  - d. Automatic recording of time and water level at preset interval
4. Contractor to provide for conveying discharge from test pump to suitable point of discharge
  - a. Final discharge location to be
    - 1) Where water will not pond near well
    - 2) Where discharged water will not damage existing improvements or ground surface
    - 3) Acceptable to the Engineer, Owner and applicable regulatory agencies
    - 4) Drainage ditch or storm inlet
    - 5) Natural drainage: Ditch approximately 120 feet from well location
  - b. Convey pump discharge by
    - 1) Ditching
    - 2) Piping
5. Contractor to furnish all supplies, materials and equipment required for installation, operation and removal of capacity testing equipment
  - a. To include
    - 1) Test pump with electric driven motor
      - a) Test pump shall be powered by Contractor supplied generated power
    - 2) Water level measuring and recording device
    - 3) Test pump discharge measuring and recording device
    - 4) Test pump throttling valve
    - 5) Piping from pump discharge, through measuring and control devices, to final discharge location
    - 6) The layout and equipment utilized for capacity testing shall be acceptable to the Engineer
    - 7) Sand production measurement device(s)

## B. Test Pumping

1. General
  - a. Contractor to have qualified observer(s) on site at all times during pumping and recovery testing
    - 1) Observer(s) to read and record all data as specified herein
    - 2) Include notes regarding
      - a) Changes in pumping rate

- b) Periods of pump stoppage
      - c) Other pertinent events
    - 3) Observer(s) to be acceptable to the Engineer
  - b. Begin capacity testing after
    - 1) Well development is completed
    - 2) Sand- and mud-free water is being produced
  - c. Set test pump intake at level as directed by Engineer
2. Procedure
- a. Pumping test
    - 1) Allow well to recover for 12 hours from any previous work
    - 2) Adjust pump setting as directed by the Engineer
    - 3) Step pumping duration: Estimated to be 1-3 hours
    - 4) Rate: As described below or as directed by the Engineer
      - a) Step test at 2, 4 and 6 gpm
    - 5) Select constant rate pump rate from step pump test data
    - 6) Constant rate pumping duration: 4 hours
    - 7) Record water level and pumping rate at the following intervals and at each step
      - a) 0-10 minutes: Every 1 minute
      - b) 10-90 minutes: Every 5 minutes
      - c) 1½-3 hours: Every 15 minutes
      - d) 3-5 hours: Every 30 minutes
      - e) Adjust frequency as directed by Engineer
    - 8) Observe and record sand production at no less than one-hour intervals
  - b. Final recovery test
    - 1) Observe well recovery for 12 hours after final pumping test
    - 2) Record recovery water level reading at intervals as directed by the Engineer

### 3.4 DISINFECTION

- A. Introduce chlorine solution into well of sufficient strength to provide 100 mg/l residual chlorine in all parts of well
- B. Cap well to prevent entrance of any foreign materials
- C. Surge well for 10 minutes, minimum
- D. Pump water from well until odor and taste of chlorine is not detected
- E. Submit bacteriological sample to laboratory for examination
- F. Repeat disinfection if sample is not free of bacteriological contamination

### 3.5 LOGS, SAMPLES AND RECORDS

#### A. Work-In-Progress Logs and Samples

1. Submit to Engineer
2. Include following as a minimum
  - a. Footage drilled
  - b. Materials installed and locations
  - c. Description of formations encountered and their locations in the well
  - d. Formation samples taken
    - 1) Sampling interval
      - a) Every 5 feet, maximum
      - b) At any pronounced change in formation
    - 2) Sample size: Standard sample bag size, minimum
    - 3) Contractor to furnish sample containers acceptable to the Engineer
      - a) Containers to be completely enclosed
      - b) Label containers with top and bottom section of well represented by sample
    - 4) Or as otherwise directed by the Engineer

#### B. Final Well Logs and Records

1. Four copies of all logs and construction diagrams of the completed production well and all pumping test measurements and records, together with all notes, remarks, and pertinent information required by this specification, shall be submitted by the Contractor one week after all work is completed
2. Final well log shall include, but not be limited to, the following
  - e. Hole depths and diameter
  - a. Casing diameter and wall thickness
  - b. Cemented zones
  - c. Screened zones
  - d. Sand removed during development
  - e. Test results for plumbness and alignment
  - f. Other information from daily logs pertinent to well construction
  - g. Water surface elevation

#### C. File all appropriate records and reports with applicable federal, state and/or local regulatory agencies

1. Colorado Division of Water Resources (CDWR) Well Completion Report
2. Provide 3 copies to Engineer before submitting to CDWR
3. Provide 3 copies of CDWR filed report

END OF SECTION