

APPENDIX D

SPECIFICATION FOR DRILLING AND INSTALLATION OF MONITORING WELLS USING HOLLOW-STEM AUGER TECHNIQUES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and all other facilities and incidentals required to construct up to 2 alluvial monitoring wells in unconsolidated alluvial deposits.
- B. Furnish all labor, materials, equipment, and all other facilities and incidentals required to develop each monitoring well.
- C. This Specification is intended to give a general description of what is required, but does not cover all variations that may occur during well construction. This Specification is intended to cover the successful completion and testing of the monitoring wells as herein specified, whether every detail is specifically mentioned or not.

1.02 SUBMITTALS

- A. Provide, at least 5 days before beginning the well installation, or at a time and method approved by ENGINEER, the following:
 - 1. A complete list of construction materials and supplies including the name of the manufacturer, for the items listed below:
 - a. Casing
 - b. Well screen
 - c. Gravel pack
 - d. Grout
 - e. Caps
 - f. Protective steel cover
- B. During drilling of each well, a daily detailed driller's report shall be maintained and submitted as requested by the ENGINEER. The report shall give a complete description of the number of feet drilled, number of hours on the job, shutdown due to breakdown, feet of casing set, and other pertinent data requested by the ENGINEER.
- C. During drilling of each well, formation samples shall be collected and provided to the ENGINEER immediately after retrieval in a manner approved by the ENGINEER.
- D. Upon completion of each well, submit to the ENGINEER a report to include the following:

1. The total depth of the completed well.
2. The depth or location of any lost drilling fluid, drilling materials, or tools.
3. Other pertinent data requested by the ENGINEER.

1.03 REFERENCE STANDARDS

- A. Standards shall include, but are not restricted to the following:
 1. American Society for Testing and Materials (ASTM)
 - a. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
 - b. ASTM F480 - Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), Schedule 40 and 80
 2. The latest revisions of the Office of the State Engineer's Rules and Regulations for Water Well Construction, Pump Installation and Monitoring and Observation Hole/Well Construction..
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 QUALITY ASSURANCE

- A. The CONTRACTOR is responsible for employing only competent workmen for the execution of this work and all such work shall be performed under the direct supervision of an experienced well driller who is satisfactory to the ENGINEER.
- B. The well driller shall be capable of maintaining complete and current well logs and daily notes for the well completion report and developing and testing the wells.
- C. The OWNER may make any other investigations deemed necessary to determine the ability of the CONTRACTOR to perform the work and the CONTRACTOR shall furnish to the OWNER all such information and data for this purpose as the OWNER may request.
- D. Complete the work described in this Specification in accordance with applicable portions of the Office of the State Engineer's Rules and Regulations for Water Well Construction, Pump Installation and Monitoring and Observation Hole/Well Construction.
- E. All well materials will be new and in factory wrapping, and will arrive at the site clean and free of oil, grease, or other foreign materials. Augers and all other downhole tools will be clean and free of foreign materials.

1.05 DESCRIPTION OF WELLS AND SITE

- A. Up to two 2-inch diameter PVC monitoring wells will be constructed to a depths of approximately 90 and 100 feet and have well screens up to 20 feet in length. Total depth will be

determined in the field by ENGINEER. The proposed locations of the wells are in the vicinity of Fort Morgan, Colorado.

- B. The drilling sites are anticipated to be located on public rights-of-way or private property and will be accessible for the duration of the drilling and monitoring under agreements to be provided by the OWNER. No electrical or water service is available at the site. It is anticipated that the drilling sites will be accessible to normal drilling equipment without significant grading or road construction. Upon completion of the work, the CONTRACTOR shall disperse all cuttings, debris, drilling fluid, and promptly remove all unused materials, trash, and debris and restore the site as nearly as possible to its original conditions.
- C. The unconsolidated alluvial deposits into which these wells are to be installed are known to contain stiff cohesive clays, swelling clays, and/or flowing/heaving sands or boulders at some locations. It will be the CONTRACTOR's responsibility to control these conditions to the extent necessary to permit proper construction of the wells as outlined in these specifications. The above information regarding subsurface conditions is intended to assist the CONTRACTOR in preparing his bid and the OWNER or ENGINEER does not guarantee its accuracy or that it is necessarily indicative of conditions to be encountered in drilling the wells. No additional compensation will be awarded to the successful bidder for any equipment, time, or and materials required to control such conditions. ENGINEER does not accept liability for any lost, stolen, or broken equipment including lost downhole equipment.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. All parts and materials shall be properly protected so that no damage, deterioration, or contamination occurs from time of shipment until installation is completed.

1.07 PERMITS

- A. The ENGINEER will acquire notifications and permits from the Colorado State Engineer to construct the monitoring wells.
- B. Any permits required to access the drilling site will be provided by the ENGINEER.
- C. Do not perform any work on the well until access is obtained.

1.08 UNDERGROUND AND OVERHEAD UTILITIES

- A. The ENGINEER will secure information concerning the location of underground and overhead utilities at the site, prior to the start of well construction.

1.09 NOTIFICATION

- A. Supply to the ENGINEER in writing at least 10 days before mobilization, the proposed work schedule including the following:
 - 1. The starting date of the well construction.
 - 2. The dates and order of wells that are to be drilled.
 - 3. The completion date of the well drilling.

4. Any anticipated work stoppage of greater than 24 hours with exception of weekends and holidays.
 5. The number of well drilling rigs and personnel to be used on the project. Any change in the number of rigs and personnel shall require written notification of the ENGINEER, 48 hours prior to the change.
- B. The ENGINEER shall be notified one week prior to the start of any construction activities.
- C. No work shall be performed without completing the notification requirements specified above or prior to receiving approval of ENGINEER.

1.10 WELL ACCEPTANCE CRITERIA

- A. All observation wells shall be developed until, in the opinion of the ENGINEER, they are:
1. Producing water substantially free of sand, silt unless otherwise approved by ENGINEER.
 2. Producing water completely free of drilling fluids or grout.
 3. Responsive to water level changes in the aquifer.
- B. All casings, screens, grout, gravel packs, and annular seals shall be set to the depths directed by the ENGINEER.
- C. No payment for the well will be due in the event of failure to meet all above requirements.

1.11 MEASUREMENT AND PAYMENT

- A. Payment for work performed shall be on a basis of unit and lump sum prices bid and actual work performed. The bid items are intended to cover all costs involved in completing the work specified herein. The Bidder shall include all incidental costs in the applicable unit or lump sum prices. Well drilling may be bid at footage rate as measured from the ground surface to the bottom of the installed well structure. Costs for well materials will be based on amounts actually installed.

PART 2 PRODUCTS

2.01 CASING

- A. All observation well casing shall be new, Schedule 40, PVC pipe. Casing shall be 2-inch nominal diameter.
- B. Casing shall meet or exceed the standards according to ASTM F 480.
- C. All casing joints shall be flush threaded with O-ring seals.

2.02 SCREEN

- A. Well screens shall be a minimum of 2-inch nominal diameter, new, mill slotted PVC. Slot size shall be 0.010-inch with a minimum of four rows of slots spaced no more than 1/8-inch apart.
- B. Well screens shall be as manufactured to meet or exceed the standards of ASTM F 480.
- C. The wells shall have screen sections up to 20 feet in length. The actual length of screen for each well will be determined in the field by the ENGINEER.

2.03 GRAVEL PACK

- A. Gravel pack material shall be clean, well-rounded size 10-20 silica sand as manufactured by Colorado Silica Sand Inc., or approved equal, suitable for use with 0.010 slot screen.

2.04 GROUT

- A. Grout used to fill the annular space from the top of the annular seal to ground surface shall be proportioned of Type I/II (ASTM C150) neat portland cement mixed with no more than 8.5 gallons of water and 4.7 pounds bentonite additive per 94-pound sack of cement (5 percent bentonite). All other additives shall have prior approval of the ENGINEER.

2.05 CAPS

- A. Bottom caps shall be new, 2-inch Schedule 40 PVC, attached with flush-threaded joints.
- B. Top caps will be lockable expandable plugs as manufactured Morrison Brothers, or equal.

2.06 DRILLING FLUIDS

- A. No drilling fluid other than clear, fresh water acquired from a potable source will be used during the drilling and installation of the wells. Drilling fluid will only be used with prior approval of the ENGINEER.

2.07 PROTECTIVE COVERS

- A. If required, flush mount vaults shall be a minimum of 8-inches diameter as manufactured by the Universal Valve Co., or approved equal, or a steel stick-up protective casing and bollarda as described below in Sections 3.03 G and H below.

2.08 BASIS FOR PAYMENT

- A. Payment for the well installation materials will be made at the rates specified in Exhibit C. Included in the footage rate will be all well screen, casing, and annular materials described above.

PART 3 EXECUTION

3.01 WELL CONSTRUCTION

- A. The monitoring wells shall be drilled using a nominal 4-inch internal diameter (I.D.) hollow stem augers to depths of approximately 90 and 110 feet or to the top of bedrock, as directed by the ENGINEER. CONTRACTOR may, at his option elect to drill and sample a pilot hole using

smaller augers, then ream the pilot hole to the final diameter with the 4-inch I.D. augers, specified above.

- B. During drilling of each well, formation samples of the *in situ* soils shall be collected by split-spoon sampler at 10-foot intervals, or other equivalent method to be approved by ENGINEER, below the water table. To prevent loss of the core samples by falling out of the coring device, a "sand catcher" or other device suitable to ENGINEER will be used during all coring activity.

3.02 CASING AND SCREEN INSTALLATION

- A. Upon reaching the total depth of the borehole, the borehole shall be cleaned so as to remove cuttings, soil, or sloughed material that may impede placement of the well string, filter pack, or annular sealants.
- B. The string of the casing and screen shall then be lowered through the inside of the hollow stem augers to the depths specified by the ENGINEER in the field.
- C. Every effort shall be made on the part of the CONTRACTOR to assure casing plumbness and centralization within the borehole.

3.03 GRAVEL PACK, ANNULAR SEAL, AND CEMENT INSTALLATION

- A. Install filter pack by pouring the filter pack material between the inside of the augers and outside of the well string while withdrawing the augers until the top of the filter pack material is a minimum of 2 feet above the top of the well string as directed by the ENGINEER in the field. Placement shall be performed such that the filter pack is free from excessive amounts of cuttings, sloughed formational material, or voids.
- B. After placement, predevelop the filter pack by bailing (using an appropriately sized bailer) or swabbing the screened interval while monitoring the filter pack level. If settlement is observed, additional filter pack material will be added as necessary to maintain the specified level. This operation will continue until settlement ceases as determined by the ENGINEER.
- C. After placement of the filter pack, the bentonite annular seal shall be placed to a level of at least 2 feet above the top of the filter pack.
- D. The remainder of the annular seal shall consist of grout placed by tremie, unless only a small amount of water is present inside the augers or CONTRACTOR otherwise determines that conditions are favorable to grout placement from the surface, in which case, the grout mixture may be placed by pouring from the surface. In the event the borehole collapses before grouting, CONTRACTOR will assume responsibility for replacement as described in Section 3.05. If grouting from the surface is permitted, the grout mixing ratio shall be reduced by 1 gallon per sack of cement.
- E. All grouting and sealing of the well shall be performed in the presence of the ENGINEER. The grouting shall be done continuously and in such a manner that will assure the filling of the annular space in one continuous operation. If necessary, grouting will be done during removal of the augers to prevent sloughing of the borehole wall from interfering with continuous placement of grout and to ensure a straight well.

- F. CONTRACTOR will take full responsibility for cementing operations, including volumes to be used and insuring the well screens and gravel packs are not cemented or casing deformed by the heat of curing cement.
- G. A protective steel cover with locking hasp will then be installed over the PVC well casing. The cover shall be set such that it extends 3 feet below the ground surface and be embedded in a concrete pad that extends at least 2 feet on all sides of the protective cover and is sloped to divert water away from the well. The cover shall contain a weep hole above the concrete pad. Alternatively, at some locations the protective steel cover shall consist of a vault mounted flush with the ground surface and embedded in concrete as specified above.
- H. If directed by the ENGINEER, bollards shall be installed to protect the well from traffic. The bollards shall consist of 4-inch diameter steel pipe, 6 feet in length and set to a depth of 3 feet below the ground surface in a 12-inch diameter hole filled with concrete. The pipe shall then be filled with concrete rounded at the upper end and painted with high visibility weatherproof enamel paint.

3.04 WELL DEVELOPMENT

- A. The observation wells shall be developed by surging with a bailer, and/or pumping, or other suitable methods approved by the ENGINEER.
- B. Development of the observation wells shall continue until the wells conform to the Well Acceptance Criteria as stated in paragraph 1.11 above, or as directed by ENGINEER.

3.05 WELL ABANDONMENT OR SALVAGE

- A. Well abandonment or salvage will be required in the event of failure to meet the Well Acceptance Criteria as stated in paragraph 1.11 above, because of loss of tools, cementing well screens, gravel packs, casing collapse, or for other cause. The CONTRACTOR shall abandon the well in accordance with the standards and procedures specified in the Colorado Rules and Regulations for Water Well Construction.
- B. The CONTRACTOR shall receive no payment for time and material for well abandonment and shall receive no compensation for the abandoned well.
- C. Replace the abandoned well at the unit prices outlined in paragraph 1.11, above.
- D. Compensate the ENGINEER for the additional cost of inspection associated with the abandoned or salvaged well. It is understood and agreed that aside from any other liquidated or other damage per day for such delay from such time until the same is completed and accepted as herein provided; all costs of engineering and inspection on behalf of the OWNER will be charged to the CONTRACTOR hereunder and deducted from any estimate or payment otherwise due and payable to him/her from time to time. The costs of engineering and inspection which may be charged to the CONTRACTOR by the OWNER under this article shall be equal to the ENGINEER's charges to the OWNER under the terms of the ENGINEER's agreement with the OWNER.
- E. The CONTRACTOR shall receive payment for the abandonment of the observation wells as specified in the Schedule of Prices if the CONTRACTOR is authorized by the ENGINEER to abandon some or all the monitoring wells for reasons other than stated in paragraph 3.05A

above. The well casings shall be cut off approximately 3-feet below land surface and abandoned with the standards and procedures specified in the Colorado Rules and Regulations for Water Well Construction.

- F. In the event that actions of CONTRACTOR result in the need to redrill or salvage the well, reinstall well materials, remove lost tools from the borehole, or in any other manner take remedial actions to meet the well acceptance criteria stated in paragraph 1.11 above, due to defective equipment or inadequate performance of the CONTRACTOR, the CONTRACTOR shall compensate the ENGINEER for the ENGINEER's additional time and expense of inspection associated with remedial actions requiring more than one hour at a well or an additional site visit by ENGINEER. ENGINEER may deduct or withhold such compensatory sums from any payments or amounts due to CONTRACTOR.

3.06 PROTECTION AND SITE CLEAN-UP

- A. At all times during the progress of the work, use all reasonable precautions to prevent either tampering with the wells or the entrance of foreign material.
- B. Immediately upon completion of the well construction and development, remove all of the equipment, materials and supplies from the site of the work, remove all surplus materials and debris, fill in all holes or excavations and grade the site to elevations of the surface levels which existed before work started. The site shall be thoroughly cleaned until approved by the ENGINEER. Failure to comply with these requirements shall give the authority of other contractors or workmen directed by the ENGINEER to enter upon the site and complete the clean up, grading, etc. The cost of this work shall be deducted from money due or to become due for construction of the wells.

END OF SPECIFICATION