

SECTION 33 21 00

DRINKING WATER WELL REQUIREMENTS

PART 1 GENERAL

1.01 DESCRIPTION OF SCOPE

- A. Construction and installation requirements for drinking water production well.
- B. Contractor shall furnish all equipment, labor, materials and incidentals necessary for the drilling, installation, development and testing of the production well by reverse or direct rotary method.
- C. Contractor shall adhere to all state and local permit and well standard requirements.

1.02 WELL LOCATION

- A. The well shall be drilled in the general location as provided by the Engineer. The Engineer will indicate the exact location in the field with a wooden stake marked "Well #XX".

1.03 ACCESS TO WELL SITE

- A. Contractor shall be responsible for clearing, cutting and providing physical access to the well site.

1.04 WELLHEAD PROTECTION

- A. The well shall be located away from potential sources of contamination in accordance with state or local regulations.
- B. Any well in an area of known contamination or salt water intrusion is required to have doublecased well construction as follows:
 - 1. The outermost well casing shall be constructed into the first significant confining layer which separates the water supply from any such contamination. This casing shall extend at least 20 feet into the confining layer or to the base of the confining layer.
 - 2. The annular space between the casing and the borehole and all subsequent well casings shall be permanently sealed to protect all underlying aquifers as well as the water supply.

3. All wells with casing that extends through salt water into fresh water shall be doublecased.

1.05 SUBMITTALS

A. Submit following Section 01 33 00:

1. Proposed method for disposal of debris
2. The Contractor shall supply as-built drawings or schematics, Manufacturer's operations and maintenance manuals, parts lists and vendor information for all equipment installed for this project. Information shall be compiled into a comprehensive document for the Engineer and Plant personnel use.

B. Submit data following section 01 33 00 for the following:

1. Sand
2. Cement (including ANSI/NSF 61 certification)
3. Well casing and screen
4. Submersible pumps and associated electronics and piping

C. Copies of valid drillers licenses,

D. Copies of valid well drilling, construction, installation, replacement and any other permits required by the state in which the work is being performed.

E. Design calculations for gravel pack, pump size and other calculations as applicable.

F. Results of yield and drawdown tests

G. Results of water quality tests

PART 2 PRODUCTS

2.01 MATERIALS FOR PRODUCTION WELL

A. General

1. Examine all material for defects. Do not install material which is known or thought to be defective.
2. AW reserves the right to inspect all material and to reject all defective material shipped to the job site or stored on the site. Failure of AW to detect damaged material shall not relieve the Contractor from Contractor's total responsibility for the completed work, if it leaks or breaks after installation.
3. All water used in the construction, alteration, and repair or decommissioning of any well shall be of drinking water quality.

4. All well drilling rigs, tools, pipe and other drilling equipment shall be maintained in a clean and operational state to prevent contamination to the well or work site.
5. All steel casing shall be manufactured to conform with the American National Standards Institute (ANSI) dimensions.
6. All materials used for the maintenance, replacement, repair or modification of any well shall meet the following requirements:
 - a. All well casing shall be approved for its intended use by the National Sanitation Foundation (NSF) and either the American Water Works Association (AWWA) or the American Society for Testing and Materials (ASTM)

B. Well Casings

1. All well casings shall be new. They shall be manufactured of steel pipe, ASTM Designation A-53 or A120 or the American Petroleum Institute (API) Specifications 5A or 5L. The casings shall be joined by welding in accordance with the standards of the American Welding Society.
2. Conductor and inner casing shall meet dimension requirements of AWWA Standard Specification A100-90.

C. Well Screen

1. Prior to initiation of work, the Engineer shall notify the Contractor which type of well material and well screen shall be used in the well.
2. Well screen shall be continuous-slot wire-wound screen. Slot size shall be determined based on results of sieve analyses.

D. Gravel Pack

1. The gravel pack material shall consist of clean, insoluble material, properly graded for the aquifer material.
2. Contractor shall provide for the disinfection of the gravel with a 50 mg/l free-chlorine strength solution of potable water during installation.
3. All gravel for packing shall be hard, water-worn gravel washed clean of silt, sand, dirt, and foreign matter. Crushed gravel will not be accepted. All gravel shall be well-rounded, graded, and selected; Colorado silica sand gravel or an engineer equivalent grade will be accepted. Gravel thus furnished shall be subject to approval by the Engineer.

4. Sufficient samples of the proposed gravel shall be delivered to the Engineer by the Contractor at least seven (7) days prior to anticipated placement of the material in the well. The Engineer may elect to have a testing laboratory perform a sieve analysis to verify conformance with the specified gradation. Failure of the sample to meet gradation requirements shall be grounds for rejection.

E. Grout Seal

1. All cement used in the work shall be a standard brand Portland cement conforming to the "Specifications for Portland Cement" ASTM Designation C150 Type II.
2. The grout seal shall be either a neat cement or a sand cement grout:
 - a. Sand Cement Grout - A mixture of Portland Cement (ASTM C150), sand and water in the proportion of not more than two parts by weight of sand to one part of cement with not more than seven (7) gallons of clean water per bag of cement (one cubic foot or 94 pounds) or proportion as per local regulatory requirements, shall be used. The use of special cements, bentonite to reduce shrinkage; or other admixtures (ASTM C494) to reduce permeability, increase fluidity, and/or control time of set, and the composition of the resultant slurry, must be approved in advance by the Engineer.
 - b. Neat Cement Grout - A mixture of Portland Cement (ASTM C150) and not more than seven (7) gallons of clean water per bag (one cubic foot or 94 pounds) of cement or proportion as per local regulatory requirements, shall be used. The use of special cements; bentonite to reduce shrinkage; and other admixtures (ASTM C494) to reduce permeability, increase fluidity, and/or control time of set; and the composition of the resultant slurry, must be approved in advance by the Engineer.
3. Cement shall conform to ANSI/NSF Standard 61.

F. Drilling Fluid and Testing and Handling Facilities

1. Only fresh water from an approved source shall be used in drilling fluids, whether employed alone or in combination with approved drilling additives. Any drilling additives must be approved by the Engineer prior to use and must be NSF approved.
2. The Contractor shall either excavate mud pits or use portable steel pits. The pits shall be equipped with baffles to trap cuttings or settling devices so that no cuttings or fine sand are allowed to recirculate into the hole. The pits shall

be cleaned as needed to provide adequate volume for settling of cuttings and proper fluid circulation.

3. In the event of hole stability problems, acceptable drilling fluid constituents to be used include high-yield bentonite, synthetic polymers, inorganic-phosphate thinning agents, and drilling detergents and foaming agents. Use of weighting materials should be avoided if possible. Lost-circulation materials shall not be used without prior approval of the Engineer. Use of polymer mud without some bentonite to contribute to wall-cake development is not recommended.
4. Drilling fluid discharged from the hole shall flow across a shale shaker equipped with appropriately sized screens to remove all but the finest sand, silt, and clay particles.

G. Test Pump and Accessory Equipment

1. Contractor shall provide a temporary test pump and power source capable of discharging up to 120% of the permanent pump capacity. All equipment shall be reliable for periods of 24 hours of continuous operation at the test rate.
2. An in-line flow meter capable of accurately measuring up to 120% of the permanent pump capacity continuously shall be installed on the test pump discharge line to determine the discharge rate. A control valve shall be installed so that the discharge rate can be controlled and will not vary more than 5 percent from the average rate.

H. Temporary Cap

1. The temporary cap shall be made of at least 1/4-inch thick mild steel.

I. Pump, Discharge Piping and Electrical Equipment

1. Subcontractor shall provide all labor, materials, equipment, machinery and tools necessary to put into satisfactory operation all pump and electrical equipment specified and in accordance with the General Electrical Requirements Standard Specification 26 00 10.
2. All water system piping shall meeting ASTM and NSF standards for drinking water.

- J. For potable water supply wells installed in unconsolidated formations:
1. All well casing shall be no less than four inches in inner diameter and no less than 50 feet in depth, or as per local regulatory requirements.
 2. The diameter of any well screen shall not be less than two inches
 3. All wells shall have a minimum length of 50 feet , or as per local regulatory requirements, of grout seal extending from the top of the gravel pack or top of the well screen to grade.
 4. When used, all well screens shall be properly sized to produce water free of sand and silt at the well head to the extent that the sand and silt will not interfere with the intended use and operation of the well water system.
- K. For potable water supply wells installed in consolidated formations:
1. All well casing shall not be less than six inches in inner diameter
 2. Each well shall have a minimum of 50 feet , or as per local regulatory requirements, of casing and be constructed with a minimum of 20 feet of casing set into unweathered rock.
 3. All wells shall have a minimum length of 50 feet , or as per local regulatory requirements, of grout seal extending from the bottom of the casing above to grade.
 4. If broken rock, mud seams, etc., are encountered when drilling below the base of the permanent casing, the driller shall pull out the permanent casing, ream the hole to below the problem zone and reinstall the well casing.
- L. All well casings shall extend a minimum of 12 inches above grade and shall be equipped with pitless adapters or pitless well units. The pitless adapter or pitless well unit requirement does not apply to wells equipped with a turbine pump. Exceptions to this 12 inch requirement are those well casings located in a well pit or pump house where adequate protection from surface drainage or contamination is provided and those located in driveways as flush mount installations provided with a water tight lid

- M. All wells shall be equipped with a down facing casing vent located at least 12 inches above the flood level. All vents shall be screened to prevent the entry of insects
- N. Any repairs made to existing wells or pump systems, where the well head terminates below ground, shall include extending the well casing above the land surface and installing a pitless adapter. Extending the well casing above grade shall be accomplished by either welding additional casing on the existing casing, or the use of a gasketed, watertight casing adapter

PART 3 EXECUTION

3.01 WELL SITE LOCATION

- A. Well site location shall be approved by the Engineer prior to any work.

3.02 PROVIDE ACCESS

- A. Contractor shall be responsible for any cutting, clearing and disposal of material necessary to gain access and transport all required equipment and materials to each well site.
- B. Any cutting, clearing or other physical disturbance conducted to gain access to the well sites shall be done only as necessary in order to minimize local environmental impact from the work required.

3.03 MOBILIZATION/DEMOBILIZATION

- A. Contractor shall furnish all vehicles, equipment, supplies, labor and incidentals to move his rings and related equipment and materials to and from the site.

3.04 PRODUCTION WELL CONSTRUCTION

- A. General
 1. Contractor shall furnish all equipment, supplies, labor and incidentals required to drill, install and develop the production well.
 2. A state licensed well driller shall be onsite to directly supervise the well drilling operation.
 3. The work shall be performed with equipment that is adequate to complete all phases of well construction. If, in the opinion of the Engineer, the Contractor's equipment is not capable of satisfactorily performing the work provided

for in these Specifications, the Contractor at his own expense shall substitute equipment satisfactory to the Engineer.

4. Contractor shall dispose of any drilling fluids, cuttings, and discharge waters in accordance with applicable environmental regulations.
5. A well shall not be screened or gravel packed in more than one water bearing unit or across a confining layer.
6. All parts of the well water system shall be properly tested, installed, designed, located and constructed in accordance with all applicable federal, state and local regulations.
7. Adequate protection shall be provided for at the top of the casing to prevent surface contamination from entering the well during the drilling operation and when the driller is not at the drill site.

B. Installation of Conductor Casing

1. Each section of the conductor casing shall be joined to another section by lap welding in the field.
2. Suitable steel guides or spacers similar to casing guides shall be provided in order to center and hold the conductor casing in its proper position until the cement grout has been placed.
3. All field welding shall be performed in accordance with American Welding Society Standards and in such a manner as to avoid any warping. Special care shall be exercised to insure a straight and plumb casing.
4. After the conductor casing has been placed, it shall be sealed off by filling the annular space between the reamed bore wall and the conductor casing with grout.
5. The cement grout shall be pumped under pressure from the bottom of the reamed hole.
6. The seal shall be effective against infiltration of all water from the surface to the bottom of the conductor casing. The cement grout shall reach the surface of the ground around the entire perimeter of the conductor casing.

C. Pilot Bore

1. A pilot borehole, having a minimum diameter of 8-inches, shall be drilled at the well site in order to provide an indication and classification of geologic formations encountered and to allow geophysical logging to the specified depth. The exact depth to which the pilot hole shall be bored will be deter-

mined by the Engineer. The Contractor shall take all measures necessary to protect the top portions of the pilot bore from caving or raveling.

2. In order to insure the drilling of the pilot bore to alignment specifications, the Contractor shall furnish and employ a self-checking, mechanical drift indicator to measure hole deflection. The drift from vertical shall be not more than 0.5 degree. Any deviation shall be corrected by the Contractor at Contractor's expense.
3. The Contractor shall collect representative sample of the cuttings at 10-foot depth intervals.
4. The Contractor shall label and preserve each sample. All containers are to be labeled to indicate the depth intervals of the collected sample, and stored in a manner to prevent breakage or loss.
5. A complete lithologic drilling log and shift record of construction activities including drilling rate shall be prepared by the Contractor for the Engineer. Upon completion of the log, copies shall be furnished to the Engineer.
6. A record shall be maintained showing any variation in the addition and amount of approved clays or chemical products or water required during drilling. The depths at which such changes are required shall be shown in the daily reports.
7. Permanent records of all drilling and related operations shall be made by the Contractor in accordance with State or local laws.

D. Downhole Geophysical Survey

1. Upon completion of the pilot hole, the Contractor shall conduct the geophysical logging of the pilot borehole. The Contractor shall allow for log interpretations after logging has been completed prior to proceeding with any additional work.
2. The Contractor shall perform, or have performed (logging firm shall be approved by the Engineer), the following logs for the pilot borehole:
 - a. Spontaneous Potential and Resistivity Log (Electric Log)
 - b. Acoustic Log
 - c. Gamma Log
 - d. Caliper Survey
 - e. Neutron Log.
3. The interval to be logged shall be the total depth of the borehole, subject to satisfactory borehole conditions, the limitations of the logging technique, and/or other directives from the Engineer.

4. The well log header shall include:
 - a. well location and elevation
 - b. owner's name
 - c. OSE permit file number
 - d. type, weight, resistivity, and temperature of drilling fluid
 - e. resistivity of the filtrate and any other information necessary for proper interpretation of the logs.
 5. Copies of each log, including a digital copy, shall be furnished to the Engineer.
 6. The sampling interval shall be no greater than 0.5 feet.
- E. Reaming Pilot Bore for Well Casing
1. The pilot hole shall be reamed based on well design after the pilot hole is completed and logs interpreted.
 2. A record shall be kept showing any variation in the addition and amount of water, and other additives required during the reaming operation. The depths at which such changes are observed shall be shown in the daily reports.
- F. Caliper Survey
1. Upon completion of the drilling operations, the Contractor shall conduct or arrange for the borehole to be surveyed for the hole cross-section.
 2. If the caliper survey indicates that the hole is smaller than the specified diameter by more than one inch at any point, the hole shall be re-reamed and resurveyed. If corrective measures are required, the Contractor shall provide and pay for all corrective measures and additional surveys.
 3. After the caliper survey has been made, and the survey approved by the Engineer, installation of the well casing shall commence.
- G. Installation of Well Casing
1. When the drilling operation has been completed to the satisfaction of the Engineer, the blank and screen casing shall be installed. The lengths and intervals of each casing type shall be determined by the Engineer.
 2. The casing shall be centered in the hole. All field joints shall be properly lap-welded during installation with a continuous 1/2-inch fillet weld. Bar holes in the casing are prohibited and shall not be used.

3. The bottom of the casing shall be at a sufficient distance above the bottom of the bore hole to ensure that the casing will not be supported by the bottom of the boring.
 4. If, for any reason, the casing cannot be landed in the correct position or at a depth acceptable to the Engineer, the Contractor shall remove the casing from the borehole and correct problems at the Contractor's expense.
 5. If the Contractor is not successful at constructing the well to specification, Contractor shall construct another well on the site at the direction of the Engineer and complete this well in accordance with the specifications and drawings at no additional cost.
 6. If the casing should collapse prior to well completion, it shall be withdrawn and replaced at the Contractor's expense.
 7. All work required to be repeated, and all additional materials, labor and equipment required, shall be furnished at the expense of the Contractor, and no claim for additional compensation shall be made or be allowed therefore.
 8. Centralizing guides shall be installed by the Contractor immediately above and below the perforated section of the casing and every 60 feet thereafter. The guides shall be welded to the casing at the top and bottom with 2-inches minimum standoff from the casing.
- H. Well Screen
1. The location of the sections of well screen shall be determined by the Engineer after a study of the driller's log and the drilling cuttings.
 2. Prior to initiation of work, the Engineer shall notify the Contractor which type of well screen shall be used in the well.
- I. Installation of Gravel Pack
1. Gravel, as specified by the Engineer, shall be installed in the annular space between the bore hole and the casing. The gravel shall be carefully installed to insure complete filling of the annular space from the bottom of the bore hole to the bottom of the grout seal..
 2. Contractor shall provide for the disinfection of the gravel during its placement as detailed in Section 2.01-D-2 of these specifications.
 3. The gravel pack shall not extend into any confining layer above the screen:

- a. For well screens less than or equal to 20 feet in length, the filter pack shall not extend more than 10 feet above the top of the well screen.
 - b. For well screens greater than 20 feet in length, the filter pack shall not extend more than 50 percent of the length of the well screen itself above the top of the well screen. The filter pack shall not extend more than 50 feet above the top of any well screen.
4. During the entire gravel packing operation, clean water shall be circulated through the perforated casing and up the annular space outside of the casing. When the gravel has been placed, a swab shall be carefully worked opposite all perforated sections of casing while circulating with clean water. As the gravel settles, more shall be added. This operation shall be continued until there is no further measurable settlement of the gravel, and the gravel has been washed clean.
 5. A gravel refill pipe shall be installed and terminate above the ground surface, are sealed in place, are provided with water tight caps and the well casings are eight inches or greater in diameter. Upon completion of the well development the annulus shall be refilled with gravel.
 6. The volume of gravel used shall be no less than the calculated volume of the annular space between the casing and the wall of the hole based upon the caliper survey. The Contractor shall supply the devices required to measure the gravel.
 7. A cement seal shall be placed on top of the gravel pack.
- J. Alignment of Well
1. Tests to determine the plumbness and alignment of the screen and casing shall be made by the Contractor after the well has been completed, but prior to its being accepted.
 2. The wells shall be constructed sufficiently round, straight and plumb so that the maximum size pump can be installed without difficulty.
 3. The standard for plumbness shall be that the axis of the well casing not deviate from the vertical in excess of one half the inside diameter of the casing per 100 feet of depth.
 4. If Engineer determines that the plumbness or alignment is outside the specifications, it will be corrected by the Contractor at Contractor's expense.
- K. Placement of Cement Grout

1. Installation of the grout shall be carried out by pumping with hydraulic or pneumatic pressure in a continuous operation through a feed line inserted between the casing and the wall of the hole.
2. The feed line shall be lowered to within two feet of the bottom of the zone to be grouted. The line shall be slowly withdrawn as the annulus fills with grout, but care shall be taken to insure that the discharge end of the feed line remains submerged a minimum of five feet in the grout at all times while grouting operations are in progress. After any section of grout has been placed, it shall be allowed to set for a period of 24 hours, or longer as directed by the Engineer, before further operations are undertaken.

3.05 DEVELOPMENT OF THE WELL

- A. Contractor shall develop the well in order to remove native silt and clay, drilling fluid residue, and the finer fraction of the gravel pack and aquifer material. The objective of the development process is to assure maximum specific capacity and sand free water.
- B. Well Development by Bailing and Swabbing
 1. Development by bailing and swabbing to clean the gravel pack and remove wall-cake material shall begin immediately after the gravel pack is in place. The Contractor shall initiate development with a bailer equipped with a foot valve suitable for removing fill material from the bottom of the well. The Contractor shall proceed with care to bail fluid from the well, starting at the top of the fluid column.
 2. The Contractor shall bail the well until the fluid level is at static head. The Contractor shall then lower the bailer into the perforated section of the well, gently raising and lowering the bailer through the perforated section to initiate flow through the perforated casing. After the Contractor has sufficiently shown that unrestricted flow through the perforated casing is occurring, he shall bail any fill from the bottom of the well to within 3-feet of the shoe.
 3. After the initial bailing is performed, the Contractor shall develop the well by line swabbing. Development by line swabbing shall be performed with a rubber-flanged swab of a diameter no more than 1/2-inch smaller than the inside diameter of the casing and screen. The swab shall be equipped with a valve that will open to allow rapid fall of the swab but will close when being pulled upward through the perforated casing. The Contractor shall take care not to exert undue differential pressure on the well casing and perforated casing while swabbing.
 4. After initial development by swabbing is performed, the Contractor shall treat the well with an NSF approved solution of sodium phosphate (SAPP). Treatment shall be per manufacturer's specifications.

5. The Contractor may be required to periodically interrupt development by swabbing to bail fill material from the well. Development by swabbing shall continue until the Engineer is satisfied that the well is adequately developed and there is no movement of the gravel pack level over a period of one-hour of swabbing.
 6. At the conclusion of swabbing, the Contractor shall remove any fill material from the bottom of the well within 3-feet from the shoe.
- C. Development by Pumping and Surging
1. The Contractor shall furnish, disinfect, install, operate, and remove a deep-well turbine pump for developing the well.
 2. The prime mover shall be a variable speed type. The Contractor shall furnish and install discharge piping for the pumping unit of sufficient size and length to conduct water to the discharge point selected and identified by the Engineer.
 3. The Contractor shall furnish and install a device to measure instantaneous flow total flow. Water levels shall be measured by an electric-line probe calibrated to 0.01 ft. increments.
 4. The initial pumping rate shall be restricted and, as the water clears, shall be gradually increased until the maximum rate is reached.
 5. At proper intervals as determined by the Owner's Representative, the pump shall be stopped and the water in the pump column shall be allowed to surge back through the pump bowls and through the casing perforations.
 6. The cycle of pumping and surging shall be repeated until the discharged water is clean of sand, silt, and mud and until there is no increase in specific capacity during at least 12 hours of continuous pumping and surging.
 7. The Contractor shall continue development until the following conditions have been met:
 - a. Sand production is less than 15 ppm within 20 minutes after commencement of pumping at the maximum rate.
 - b. Average sand production does not exceed 5 ppm for a two-hour cycle after commencement of pumping at the maximum rate.
 - c. Specific capacity of the well is essentially stable for a minimum of 2 hours and the specific capacity is the same for all of the different flow-rate steps after equal amounts of time.
 8. The Contractor shall keep independent records of pumping time, flow rate, pumping level, sand production, and other discharge characteristics.

3.06 8-HOUR PRELIMINARY PUMPING TEST

- A. Contractor shall furnish all equipment, labor, supplies and incidentals required to conduct an 8 hour step drawdown pumping test on the production well, including all pipelines, meters, orifices, gages and temporary utilities.
- B. The pumping test shall be conducted under the supervision of the Engineer.
- C. Contractor shall provide a temporary test pump with a capability of discharging up to 120% of the rated capacity of the permanent production pump. The temporary pump shall have sufficient throttling devices so that the rate of discharge may be controlled. The permanent production pump shall not be used for the pumping test.
- D. The flow from the test shall not cause significant erosion at the discharge point. There shall be no trace of chlorine residual at the start of the pump test.
- E. Pump rates will be conducted using a step method. Data obtained from this test shall be used to design the permanent pumping equipment. The Contractor shall gather enough information to be able to determine the setting for the new pump, and prepare a plan for the 24-hour pump test.

3.07 24-HOUR PUMPING TEST

- A. Contractor shall furnish all equipment, labor, supplies and incidentals required to conduct a 24 hour constant rate pumping test on the production well, including all pipelines, meters, orifices, gages and temporary utilities.
- B. The pumping test shall be conducted under the supervision of the Engineer. If the test is less than 24 hours, the Contractor will be paid by unit price as specified in the Bid Section.
- C. Contractor shall provide a temporary test pump with a capability of discharging up to 120% of the rated capacity of the permanent pump. The temporary pump shall have sufficient throttling devices so that the rate of discharge may be controlled. The permanent production pump shall not be used for the pumping test.
- D. The flow from the test shall not cause significant erosion at the discharge point. There shall be no trace of chlorine residual at the start of the pump test.
- E. The 24 hour pump test shall be conducted in accordance with the following guidelines:
 - 1. Static water levels must be measured and recorded in the pumping well immediately before the start of the test.

2. The time intervals for reading water levels are suggested as in Table 1 given below and they should be followed as close as possible during the 24-hour draw-down pump test and subsequent recovery test. There should be at least 90% recovery in the pumped well.

Table 1

TIME INTERVALS FOR WATER LEVEL
MEASUREMENTS DURING 24-HOUR PUMPING TEST

<u>Time into Test</u>	<u>Measurement Interval</u>
0 to 5 minutes	Every 1/2 minute
5 to 15 minutes	Every 1 minute
15 to 60 minutes	Every 5 minutes
60 to 120 minutes	Every 10 minutes
120 to 480 minutes	Every 30 minutes
480 to 1440 minutes	Every 60 minutes

3. Pumping rate should be recorded at least every 10 minutes for the first hour and every half hour thereafter. Necessary adjustments should be made to keep the pump rate constant throughout the test.
4. The selected pumping rate for the pump test should exceed the design pumping rate by 20%.
5. After the pump is stopped, measure and record recovery water levels following the above schedule.
6. Contractor must submit a pumping test plan for review and approval prior to conducting the test. This shall include a sketch of the well field with dimensions between wells, anticipated flow rates, means of discharge, equipment to be used, method of reading water levels, and all other pertinent information. Analysis of data with conclusions must be submitted by the Contractor to the Engineer.
7. The 24 hour pumping test is a continuous test, no partial payments will be made to the Contractor for test interruptions that are caused by the Contractor.

3.08 DISINFECTING THE WELL

- A. Following the conclusion of the development pumping, Contractor shall disinfect the well according to the procedures established by local, state or federal regulatory agencies.
- B. The well shall be thoroughly clean of all foreign substances before disinfection. Oil, grease, or joint dope shall be removed by swabbing the casing with an alkaline solution if necessary.

- C. The well shall be disinfected with a chlorine solution using a calcium hypochlorite compound with 70 percent solution available chlorine. The hypochlorite shall be dissolved in a solution at the ground surface and applied so that a concentration of at least 50 ppm of available chlorine is available in all parts of the well.
 - D. The disinfecting solution shall be allowed to stand in the well for at least one hour and then pumped until the discharge contains no residual chlorine.
 - E. Chlorinated water shall be disposed in accordance with state and/or local regulations by the Contractor
- 3.09 DISPOSAL OF DRILLING WASTES
- A. The Contractor shall provide all facilities, equipment, and materials required for the removal of drilling wastes and excess development materials from the well site.
- 3.10 DISPOSAL OF DEVELOPMENT AND TEST WATER
- A. The Contractor shall provide all pipeline and facilities for discharging pumped water from the well site. The Contractor shall so design his system that no erosion results from the discharge.
- 3.11 INSTALLATION OF TEMPORARY CAP
- A. Contractor shall furnish all equipment, labor, supplies and incidents to install a temporary cap on the production well.
- 4.0 WELL HOUSE
- A. The Contractor shall provide all equipment, labor, supplies and incidents to install a well house for the production well and associated piping and electrical equipment.
 - B. The Contractor shall construct the well house in accordance with design requirements specified by the Engineer. The building shall be designed and installed to permit access for the removal and repair of the pump and related appurtenances.
 - C. The building shall meet all building codes and shall be constructed to properly secure the well and all components of the pumping system against vandalism, flooding and other identified hazards.
 - D. The area surrounding the well house shall be fenced and locked. Chain link and barb wire fencing shall be used.
- 5.0 PUMPS AND ASSOCIATED ELECTRICAL AND PIPING

- A. Pumps and electrical equipment in remote areas shall be protected against electrical surge and, where necessary, lightning strikes.
- B. Pumps shall be designed based on required demand and well capability.
- C. Well pumps and appurtenant equipment shall be designed and installed to ensure adequate protection of the water supply and protection against freezing of the water
- D. Each well pump shall have a check valve
- E. In a screened well, the well pump setting and suction inlet shall be located so that the pumping level of the water cannot be drawn below the top of the screen
- F. Each pump shall be mounted so as to minimize vibration and noise and to minimize damage to the pump.
- G. A pressure switch and a thermal overload switch shall be included on all pump installations.
- H. A pressure switch is required on all positive displacement pumping systems.
- I. Pump controls or accessories shall either be housed in a secured building or be enclosed in a weatherproof, locked cabinet.
- J. All well systems shall be connected to the facilities SCADA system as specified by the Engineer.

6.0 WELL ABANDONMENT

- A. All boreholes and completed wells that require abandonment shall be abandoned in accordance with State and local requirements
- B. Contractor shall furnish all equipment, labor, supplies and incidentals required to properly abandon the borehole or well and shall include:
 - 1. Concrete, cement grout, bentonite, or sealing clay shall be used as primary sealing materials and shall be placed from the bottom upward by methods that will avoid segregation or dilution of material.
 - 2. Complete, accurate records shall be kept of the entire decommissioning procedure.
 - 3. The depth of each layer of all sealing and backfilling materials shall be recorded.
 - 4. The quantity of sealing materials shall be recorded.

5. Any changes in the well made during the sealing, such as perforating casing, shall be recorded in detail..

7.0 EXCEPTIONS

- A. Any exceptions from this standard to the material or material standard specification, installation, well or pump design, well development or testing shall be at the discretion of the Engineer and only with Engineer's written approval.

8.0 SAFETY DURING CONSTRUCTION

- A. All equipment shall be maintained in a safe manner during construction. The work area shall at all times be kept neat and free from hazards.

END OF SECTION