SECTION 02555
PRODUCTION WELLS

1.0 GENERAL

A. Description

Water production wells shall be double cased, lap or fully double cased construction, drilled by the mud rotary or reverse rotary drilling methods, unless otherwise specified in the Contract Documents. A drawing depicting the general design of a water production well can be found at the end of this section.

B. Related Work Included Elsewhere

C. Quality Assurance

1. Materials

a. Materials supplied for Water Production Wells shall be as outlined in the American Water Works Association Standard for Water Wells (AWWA A100-84), unless otherwise specified in the Contract Documents. The Chief Engineer will inspect all materials before installation to ensure compliance with Contract Documents.

2. Construction Standards

a. Construction of water wells shall be done in accordance with AWWA A-100-84, Code of Maryland, Title 26 Department of the Environment; Subtitle 04 Water Supply, Sewage Disposal and Solid Waste, Chapter 04 Well Construction (COMAR 26.04.04) and as specified herein.

3. Testing

a. Testing for well plumbness and alignment, production and efficiency and water quality shall be in accordance with AWWA A-100-84 and the United States Environmental Protection Agency Safe Drinking Water Act as it pertains to ground water and as specified herein.

4. Acceptance Standards

a. In order to assure that the Commission is provided with a sand-, silt-, bacteria- and turbidity-free and efficient well, certain minimum standards shall be met before the well is accepted. The Chief Engineer may waive the acceptance level of a certain standard if it is determined by the Chief Engineer that the failure to meet the standard was beyond the Contractor's control and/or will not materially affect the long-term use of the completed well.

b. Minimum acceptance standards are:

1) Sand and silt content: Each Group A water sample shall have a concentration of less than 3.0 mg/l total suspended and settleable solids one minute after water from the screen area arrives at the sampling point or any time thereafter.

2) Turbidity: Each Group A water sample shall have a turbidity concentration of 5.0 NTU or less one minute after water from the screen area arrives at the sampling point or any time thereafter.

3) Chlorine Residual: The chlorine residual shall be less than 0.1 mg/l when determined in the field at the time of all bacteriological sampling.

4) Bacteria: Each Group B sample shall have no indication of residual chlorine and shall have less than 1 coliform organism per 100 ml of sample using the membrane filter method of analysis. In addition, the total plate count analysis of each Group B sample shall indicate that bacteria organisms are equal to or less than two (2) organisms per 100 ml of sample.

5) Efficiency: The production well shall be at least 80% efficient, unless otherwise specified in Contract Documents, as determined by the Chief Engineer and based on the results of the long-term pumping test. The values of aquifer transmissivity (T) and storativity (S) used in the determination of well efficiency shall be based solely on data gathered during the construction and long-term pump testing of the production well.

The efficiency of the well shall be determined by comparing the actual drawdown in the production well with the theoretical drawdown in the production well, calculated at a distance equal to the inside diameter of the well screen. The theoretical drawdown in the production well shall be calculated using the Theis nonequilibrium well equation. Partial penetration of the aquifer will not be considered in the determination of efficiency if 75% or more of the aquifer is screened.

In the event that an observation well, which is screened over the same interval as the production well, is available during the long-term pumping test, values of aquifer transmissivity and storativity will be determined from the drawdown data collected in the observation well. In the absence of an observation well, aquifer transmissivity will be calculated using the Time/Time vs. Residual Drawdown method, and aquifer storativity will be estimated from published data, previous reports or other appropriate sources as determined by the Chief Engineer.

The comparison of theoretical and actual drawdown will be made at a specific time, determined by the Chief Engineer, during which long-term pumping test data was used to calculate aquifer parameters. The percentage well efficiency will be calculated as:

(Theoretical Drawdown/Actual Drawdown) x 100

c. Should the Contractor fail to meet any one of the acceptance standards the Contractor may be allowed to continue development or test pumping and/or disinfection of the well for a reasonable period of time, in order to meet the standards, as agreed upon by the Chief Engineer. The well shall then be re-tested, if necessary. Any additional development, test pumping, disinfection or other work will be at the Contractor's expense and will include the Commission's costs for consulting and inspection

services. Should the Contractor not be able to meet any of the required acceptance standards, the Chief Engineer may reject that portion of the Work and require the Contractor to vacate the site.

5. Permits

   a. The Contractor shall arrange for, obtain and pay for all permits, inspections and tests necessary for the proper execution of the work, in accordance with all Federal, State and Local rules, regulations and codes. Copies of the well permit and all other permits shall be presented to the Chief Engineer upon receipt and shall be posted, if required, at the project site. A copy of all completion reports sent to the State of Maryland or other agencies shall be submitted to the Chief Engineer along with the driller's own reports and logs.

6. Warranty

   a. The Contractor warrants that all workmanship, material and equipment furnished and installed by the Contractor shall be free of detects or failure for a period of one (1) year after the well is placed into regular service and, should such defects appear, the Contractor shall repair such defects at no cost to the Owner.

D. Submittals

1. Driller's Report: During construction, the Contractor shall maintain, on a daily basis, a report of all activities pertaining to the work. The report shall be submitted on report forms approved by the Commission. The Daily Report form shall be completed and signed by the Contractor's Licensed Driller in charge of the work and submitted to the Chief Engineer during the Chief Engineer's inspection of the work.

2. Driller's Logs: During installation of the pilot hole, the Contractor shall prepare and keep a complete log of the formations penetrated on a Driller's Log form approved by the Commission. The Driller's Log form shall be prepared and signed by a driller licensed in the State of Maryland. The Driller's Log shall be submitted to the Chief Engineer upon the completion of the pilot hole.

3. Sieve Analysis: Copies of the sieve analysis from selected pilot hole formation samples shall be submitted upon receipt to the Chief Engineer. Sieve analysis shall be performed by the well screen manufacturer or person experienced and qualified to perform such analysis.

4. Shop Drawings: In addition to the shop drawings required in the "General Provisions", the Contractor shall, prior to the installation of any casing or well screen, submit to the Chief Engineer a detailed cross section of the well. The drawing shall indicate exact lengths, diameters, materials, slot sizes, depths and other dimensions of the casing, screens, adapters, blank sections, riser pipe, gravel pack, grout and all other appurtenances pertaining to the well.

5. Manuals and Manufacturer's Literature: After construction, the Contractor shall furnish copies of any documents, certifications, manuals, specifications and manufacturer's literature pertaining to the materials and/or equipment installed permanently or temporarily during the Work. Three copies of these documents shall be submitted to the Chief Engineer.

6. Gravel Pack: The Contractor, prior to delivery, shall submit to the Chief Engineer samples of the gravel pack proposed for use along with a current sieve analysis of the gravel showing gradation and uniformity coefficient.

7. Well Profile: Upon completion of testing, the Contractor shall submit a well profile to the Chief Engineer.

8. Water Samples and Analysis

   a. Sampling Coordination: The Contractor shall notify the Commission 48 hours prior to collecting samples. The State of Maryland Department of the Environment shall also be notified (in the time frame required by them) so that they may collect water samples as required by their regulations.

   b. Analysis Required: The Contractor shall furnish the following water analyses of samples collected at various times during testing. The analyses are grouped according to the times of collection and where the analysis will be performed. The cost of the analysis is to be included in the Lump Sum Amount bid. Samples shall be taken and analyzed in accordance with the requirements of COMAR 26.07.01. The following is a list of parameters to be tested for, however this list is not to be construed as a release from the requirements of COMAR 26.04.01.

      1) Group A: turbidity (NTU) and total suspended and settleable solids.

      2) Group B: total coliform (membrane filter), total plate count and chloride residual.

      3) Group C: pH, eH (redox potential), specific conductance, 3 temperature, M.O. and P alkalinity ($CaCO_3$), free carbon and turbidity.

      4) Group D: chloride, fluoride, total hardness, total iron, nitrate nitrogen, manganese, sodium, total dissolved solids, arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, copper, zinc, carbonate, bicarbonate, magnesium, sulfate, calcium, color, foaming agents, odor, Langlier Index, silica, potassium, volatile organic compounds EPA Method 524.2, radio nuclides, EPA Method 60014-75-008 including beta, radium 226, radium 228, radon EPA Method 600-75-012 and all other compounds regulated under Phase I, Phase II and Phase V amendments to the Safe Drinking Water Act.

      5) Group E: Required samples provided to the Maryland Department of the Environment.

   c. All sample analyses shall be performed by a certified laboratory having all state and/or federal approvals necessary under the Safe Drinking Water Act for the constituents requested. A laboratory representative shall collect the samples in Groups C and D. The Contractor is permitted to collect the samples in Groups A and B using bottles and sample preservation techniques provided by the laboratory. The chlorine residual shall be determined by the Contractor in the field at the time the Group B samples are collected using an approved field test kit capable of

detecting chlorine residual to 0.1 mg/l. The analysis of samples in Group C shall be performed in the field by a laboratory representative as soon as possible after they are collected.

d. Submit results of all water sample analyses.

9. Certificate of Potability from MDE.

10. Pumping test data and recovery test data.

11. Material Warrantees

12. Well Completion Report

2.0 MATERIALS

A. Materials furnished by the Commission

1. The Commission will not furnish any materials for Production Well Construction.

2. The Contractor may obtain water from the Commission's system, if available, for well construction purposes. Water used will be invoiced to the Contractor at prevailing rates. The Contractor shall contact the Commission's Department of Fiscal Services, Meter Section for requirements. A backflow prevention device must be placed in accordance with the Standard Details prior to drawing Commission water.

B. Contractor's Option

The Contractor may furnish any of the specified materials or "equal" materials as approved by the Chief Engineer unless otherwise noted in the "SPECIAL PROVISIONS".

C. Detailed Materials Requirements

1. Surface or starter well casings shall be made of non-galvanized steel and shall be of such a size to allow proper grouting of the outer well casing.

2. Outer well casings shall be new. They shall be made of non-galvanized steel and conform to ASTM Class A53 and AWWA A-100-84 specifications. Casings shall be I.P.S. "STANDARD" schedule wall thickness, unless otherwise specified.

All casings shall be plain end and machine beveled for welded connections. Casing diameters are outlined in the Contract Documents. All steel pipe used in well construction shall bear mill markings that will readily identify it.

3. Stainless steel well screens shall be new, continuous slot, wire wound screen (Johnson Filtration Systems, Inc. or equivalent). The screen shall be constructed of wound wire, reinforced by longitudinal bars. The bars shall have a cross-section that will form an opening between each adjacent coil of wire that is shaped in manner as to increase in size inward. The wire shall be firmly attached to the bars which in turn, will be attached to a coupling adapter. The well screen shall be constructed of Type 304 stainless steel. The screen dimensions are outlined in the contract documents. Water entrance velocities for the screen selected shall not exceed 0.1 feet per second at the anticipated pumping rate stated in the Contract Documents.

4. Blank sections between screen sections, cellar or sump sections, transition sections from the top of the well screen to the relief screen and inner casing shall be the same diameter and constructed of the same material as the well screen, unless specified otherwise. Solid pipe blank sections and inner casings shall be I.P.S. "STANDARD" schedule wall thickness, unless otherwise specified.

5. Relief screens shall have the same slot size and be the same diameter and constructed of the same material as the well screen, unless specified otherwise.

6. The end plate for the well screen, cellar or sump section shall be constructed of the same material as the well screen, unless specified otherwise.

7. Well screens, blank sections, inner casing, relief screens, cellar or sump sections and end plates shall be connected with Type 304 stainless steel welding rings or shall be plain end machine beveled for welded connections.

8. Centralizers shall be made of steel half moon sections or 304 stainless steel expandable straps.

9. The filter gravel for the gravel pack shall consist of material that is composed of sound, durable, subrounded to rounded rock and mineral fragments. The particles shall consist mainly of quartz and/or quartzite and shall contain no limestone or other calcareous material, such as shell fragments and no organic material, such as wood fragments or lignite. The gravel shall be purchased from a commercial supplier who shall certify that the material is suitable for use in potable water wells. The gravel pack material shall be graded and sized to be suitable and compatible with the formations present and screen slot size(s) selected. The gravel shall meet industry standards for sorting and size distribution within the stated range. The uniformity co-efficient of the gravel pack materials shall be no greater than 1.7. The gravel pack material shall be delivered to the site in bags or in bulk. If delivered in bulk, it shall be placed on 6 mil. plastic sheeting at a raised location so as not to be subjected to any type of surface run-off. The material shall be kept clean and dry at all times.

10. Neat cement for grouting production well outer casings shall consist of a mixture of Portland Cement ASTM C-150 Type 2 or Type 3, and water, with not more than 6 gallons of clean water per bag of cement used. If premixed cement is purchased, a certificate of composition must be presented to the Commission Engineer upon delivery. The use of special cement or other admixtures (ASTM C-494) to reduce permeability, increase fluidity and/or control time of set and the composition of the resultants slurry, must be submitted to the Chief Engineer for review and approval prior to use.

D. Material Storage Note: Materials shall be stored in order to insure the preservation of their quantity, quality and fitness for Work. The Contractor shall place materials on wooden platforms, or other hard, clean surfaces, not on the ground, and the materials shall be placed under cover when directed by the Owner. Stored materials shall be located in order to facilitate prompt inspection by the Owner. Lawns, grass plots, or other private or public property shall not be used for storage purposes without written permission of the owner or lessee. Unless directed or noted otherwise in the Contract documents, there will be no payment for stored materials.

3.0 EXECUTION

A. PREPARATION

1. The Contractor shall notify the Chief Engineer one week prior to all Work and tests called for in these specifications, including the start of drilling and the start of pumping tests. The Maryland Department of Natural Resources and the Department of the Environment shall be notified within the time frames required by these Departments, prior to the long-term test, so the test may be observed and samples collected.

2. The Contractor shall be responsible for all necessary measures to prevent erosion or sedimentation on or adjacent to the site as a result of the Work. Settling basins and/or traps shall be employed as necessary during the drilling operation in order to re-use the fluids required for drilling. The Contractor is not permitted to bury cuttings on-site. All supernatant fluid shall be removed from the mud pits and trenches, and the pits filled with clean earth and allowed to stabilize. Obtaining suitable off-site disposal of all discarded fluids and other materials shall be the responsibility of the Contractor. The requirements of this section in no way relieve the Contractor from complying with any site specific soil and sediment erosion control plans for this work.

3. All measurements indicated in these specifications are from the surface of the ground at the site. Actual depths used during the proposed Work will be dependent upon information obtained from drilling. All measurements made in the field during drilling and testing shall be made from a well defined referenced point. A complete description of this reference point (or sampling point) shall be included on all submittals provided by the Contractor. The elevation of each reference point used shall be specified with respect to ground surface and some permanent benchmark established by the Chief Engineer at each site. All depth measurements shall be within +/- 0.1 feet except water-level measurements which shall be +/- 0.01 feet.

4. The Contractor shall employ only competent workers for the execution of this Work and all such Work shall be performed under the direct supervision of an experienced and licensed Master Well Driller (State of Maryland) satisfactory to the Chief Engineer.

B. DRILLING FLUID

1. Only potable water from a source approved by the Chief Engineer shall be used during construction. If available, arrangements may be made with the Commission to secure a source of water from the Department's distribution system as described in Section 02555.02.A.2.

2. Material used by the Contractor to prepare the drilling fluid shall be composed of fresh, non-polluted water and sodium bentonite type drilling clay commercially processed to meet or surpass the viscosity specifications in the American Petroleum Institute "Std. 13-A for Drilling Fluid Materials". Any other drilling fluid additives to be used must, prior to use, be approved by the Chief Engineer. Their use shall comply with recognized industry standards and practices and they shall be applied and used as recommended by the manufacturers. It is expressly understood that toxic and/or dangerous substances shall not be added to the drilling fluid.

3. The drilling fluids program shall be agreed to by the Contractor and the Commission prior to use. Selection and use of the drilling fluid materials shall be a part of this agreement. The Contractor shall be responsible for maintaining the quality of the drilling fluid to assure:

a. The protection of water bearing and potential water bearing formations exposed in the borehole.

b. That representative samples of the formation materials are obtained.

c. That water, free of bacteria and other contaminants, as later described in these specifications, is obtained from the finished well.

C. PILOT HOLE DRILLING

1. A pilot hole, for formation sampling and geophysical logging, shall be drilled from ground surface to a depth and diameter as outlined in the Contract Documents. The sediments penetrated shall be sampled as specified herein.

2. During the drilling of the pilot hole, sediment samples shall be collected as follows:

a. The Contractor shall obtain return flow samples by removing from the circulating drilling fluid a representative sample of the formation by either collecting the samples in a cutting sample box, sediment shaker, a baffle in a ditch, or catching them in a bucket and allowing the sample to settle out. Care shall be taken so that the sampling device is not contaminated with sediments other than those being obtained from the sampling interval. Provision shall be made to determine the exact depth of the formation from which the cuttings are derived by exact measurements of the drill pipe and calculation of up-hole velocity of the drilling fluid. When collecting samples, at a prescribed collection interval, drilling shall be suspended and the drilling fluid circulated for the time required to bring the sample to the collection point. The method of collecting samples and the time interval required for bringing the samples to the collection point must be approved by the Chief Engineer prior to the start of drilling.

b. Formation samples shall be collected at 10-foot and 5-foot intervals as outlined in the Contract Documents. Samples shall also be collected at any pronounced change of formation. Special care shall be used when collecting samples from the aquifer.

c. Two representative samples shall be obtained for each sampling interval of 10 feet. At least three representative samples shall be obtained when the sampling interval is 5 feet.

d. Immediately after retrieval, formation samples shall be placed in suitable containers, securely closed to avoid spillage and contamination and clearly labeled in a permanent manner with at least the following information:

1) Location of the well.

2) Name or number of the well.

3) Depth interval represented by the sample.

4) Date taken.

e. One set of samples collected from the aquifer and selected in conjunction with the Chief Engineer shall be delivered to an approved soils testing facility so that sieve analysis can be performed for tentative selection of the well screen. The remaining samples shall be safely stored until they area accepted by the Chief Engineer.

D. GEOPHYSICAL LOGGING

1. At the conclusion of pilot hole drilling the Contractor shall conduct geophysical logs in the pilot hole and submit results to the Commission.

2. Caliper logs shall be performed, by the Contractor, after the pilot hole has been reamed to accept the outer casing and after the formation area has been reamed to accept the well screen. Results shall be submitted to the Commission.

3. If a geophysical logging tool is lost and not retrievable, the Contractor may drill out or drill by the tool, if in the Chief Engineer’s opinion doing so will not materially effect the well. If the Contractor is unable to drill out or bypass the tool, the Contractor shall abandon the hole, in accordance with the regulations of the Maryland Department of the Environment and shall redrill to the designated diameter and depth.

4. If the geophysical tool is lost due to Contractor negligence or problems with the drilled hole, the Contractor shall reimburse the Chief Engineer for the lost equipment and shall perform the necessary abandonment and redrilling at no additional cost to the Commission. Any cost for additional geophysical logging required due to the Contractor's negligence or problems with the drilled hole shall be borne by the Contractor.

E. WELL CONSTRUCTION

1. The outer casing shall extend to the top of the water bearing aquifer, or as otherwise shown on the drawings.

2. All surface (starter) casing and outer casings shall be grouted in place with a minimum of 2 inches of grout surrounding the casings.

3. Well screens shall be gravel packed in place with a minimum of 4 inches of gravel surrounding the well screen.

4. If the Contractor decides to install a surface (starter) casing, it shall in no way infringe on grouting the outer casing or obtaining a proper seal. Any surface (starter) casing used shall be left in place and shall be included in the Lump Sum bid price.

5. Screen slot size, configuration, setting and gravel pack size shall be selected by the Contractor and approved by the Chief Engineer based on all previous work and the intent of these specifications. The Contractor shall check the driller's logs, geophysical logs, and sieve analysis of the samples obtained from pilot hole to reach a decision concerning screen slot size, gravel size and screen placement.

6. The well casings and screen sections shall be installed in the pre-drilled hole in such a manner as to be suitably aligned and plumb. They shall be grouted or gravel packed in place as required. Centralizers shall be installed between the inner and outer casing at three equal distance points, or as otherwise shown on

the drawings between the bottom of the outer casing and the top of the inner casing. Installation of the casing, grouting same and installation of the well screen and gravel packing same, shall be done around the clock until completion. Well casings and screen connections shall be welded in accordance with the current standardize procedures of the American Welding Society.

7. The outer casing shall be set round, plumb, and true to alignment. The tests for alignment in the outer casing shall be made following the setting of the casing and before the installation of grout. Alignment shall be tested by lowering into the well a section of 6-inch diameter or larger pipe which is 40 feet long with guides on each end and in the middle. The outer diameter of the guides shall not be more than 1/2-inch smaller than the diameter of that part of the casing being tested. The guides shall be a minimum of 1.0 feet long.

8. Immediately after the Contractor has performed the alignment test, the test for plumbness shall be made by the Chief Engineer with a plummet suspended from a tripod on the drill rig. The plummet shall be approximately 1/2-inch smaller in diameter of the well casing being tested. The Contractor shall assist the Chief Engineer in making the test for plumbness.

9. Should the alignment dummy or the plummet fail to move freely throughout the entire length of the casing being tested, or should the well depth vary from the vertical in excess of 2/3 of the smallest inside diameter of that part of the well being tested, per 100 foot in depth, the plumbness and/or alignment of the well shall be corrected by the Contractor at the Contractor's own expense. Should the Contractor fail to correct the faulty plumbness and/or alignment, the Commission may refuse to accept the well and require that another well be constructed at another location on the property. The inside and outside of the existing casing or borehole, if the casing is removed, shall then be abandoned (as specified) at the Contractor's expense. The Chief Engineer may waive the requirements for plumbness and alignment if, in the Chief Engineer's judgment, the defect is due to circumstances beyond the Contractor's control and/or the utility of the completed well will not be materially affected. Any retesting or alignment or plumbness shall be done at the Contractor's expense including the Commission's cost for consulting and inspection services.

10. The annular space between the drilled hole and the outer casing shall be sealed by pressure grouting from the bottom of the casing to ground level. This may be accomplished by the use of a Tremie pipe set to the bottom of the casing or by some other method recommended by the Contractor and approved by the Chief Engineer.

11. After the inner casing and well screen are securely positioned in the well, the Contractor shall furnish and install a gravel pack between the screen and borehole. The Contractor shall be responsible for ensuring that the gravel pack material is adequately disinfected during installation. The gravel pack shall be placed adjacent to the screen using the Tremie Pipe Method, so that the entire open space between the screen and borehole is uniformly filled with gravel. The borehole shall be continually flushed with chlorinated water to remove drilling mud and natural clays, prior to and during gravel packing.

F. WELL DEVELOPMENT

1. A method of development shall be used which will result in the removal of fine material in the vicinity of the well screen, increase the material porosity of the undisturbed formation and remove the mud cake and drilling fluid from the

borehole. This is to be accomplished with a method of development which will cause a reversal of flow through small sections of the well screen combined with pumping to remove color and fine materials. Initial development shall be accomplished by either air surging with a tight fitting double block surge and educator pipe, with the surge blocks spaced no more than 5 feet apart or by a combination of high velocity jetting and pumping. The maximum rate of development, utilizing either of these methods, shall be 5 feet of well screen per hour. After initial development other methods of development such as, but not limited to, mechanical surging, air pumping or high capacity pumping with a test pump may be utilized. Development, by either of the above described initial methods, must be done prior to installing a test pump.

2. Chemical and other development aids to improve the efficiency of the well and to assist in its development may be permitted subject to the prior approval of the Chief Engineer. Concentrated discharges from the well shall be disposed of in a safe and acceptable manner in accordance with these specifications and any applicable State or Federal regulations.

3. The Contractor as part of this Work may conduct tests periodically to check the progress of development and well efficiency. All of these tests shall be included in the Lump Sum bid amount.

4. Development shall be sufficient to provide a minimum acceptable efficiency for the well as defined under the Acceptance Standards outlined in the "Quality Assurance" section of these specifications. After the pumping tests, the Contractor may continue to develop the well for a period of 30 days in order to attain minimum requirements. All additional development and re-testing necessary to meet the Acceptance Standards shall be at the Contractor's expense, including the Commission's cost for consulting and inspection services.

G. TEST PUMPING

1. When the Contractor, at the Contractor's own determination, feels the well can meet the acceptance standards, the well shall be pumped to determine aquifer characteristics, well efficiency and to collect representative water samples from the aquifer. Testing shall be accomplished as follows:

   a. General Equipment: The Contractor shall furnish all labor, tools, pumps, piping, electric cable, controls, generators, flow measuring devices and other appurtenances necessary for the performance of test pumping as required by these specifications. The Contractor shall furnish the necessary pumping equipment and measuring instruments to pump at stepped rates, as outlined in the Contract Documents with throttling control satisfactory to the Chief Engineer, measure the discharge rate in a manner satisfactory to the Chief Engineer and carry the pumped water to an acceptable discharge point as directed. The pump intake shall be set at the depth outlined in the Contract Documents or at some other depth, recommended by the Contractor and approved by the Chief Engineer, determined as a result of tests conducted during development. The pumping unit shall be complete with ample power source, controls, and appurtenances and shall be capable of operation without interruption for a period of at least 24 hours. The test pump shall be fitted with a foot valve or check valve, at the pump head, to prevent the flow of water back into the well during recovery. Oil lubricated test pumps shall not be used for well development or testing.

b. Water-Level Measurement: A clearly marked convenient reference point shall be established at the top of a water-level measuring pipe which the Contractor shall insert in the pumped well along with the test pump.

c. Flow Measurement: The discharge from the well shall be measured using a pipe, piezometer tube and orifice plate. The configuration of this equipment shall meet industry standards and also be acceptable to the Chief Engineer.

d. Sampling Port: The Contractor shall furnish a 1-1/4-inch IPT opening in the discharge pipe before the beginning of the orifice pipe for the installation of sampling equipment to be furnished by the Chief Engineer. The discharge pipe shall be free of valves, changes in pipe diameter or other obstructions for a distance of 24-inches shall be free of any external obstruction except for the discharge pipe itself.

e. Step Test: An initial pumping test shall be conducted in the well at stepped rates as outlined in the Contract Documents and in the field by the Chief Engineer. The total test period for the step test will be 6 continuous hours. The Contractor shall operate the pump and vary the discharge as directed by the Chief Engineer.

f. Long-Term Test: After a rest period of at least 12 hours, during which the well has recovered from the step test, a constant rate test shall be conducted by pumping the well at a rate as outlined in the Contract Documents or as directed by the Chief Engineer, for a period of 24 hours, followed by a recovery test period of 12 hours. The pumping rate for the 24 hour test shall be selected so as to provide maximum drawdown in the well using the following criteria:

1) Results of the step test.

2) Capacity of test pump as stated in the Contract Documents.

3) The available capacity at a pumping level as stated in the Contract Documents.

The long-term test shall be composed of two parts, a drawdown portion and a recovery portion. The Contractor shall wait 24 hours after shut down to remove the Contractor's pump and to allow for the collection of water-level data.

g. Water-level measurements shall be obtained in the pumped well and a test/observation well (if available) by the Contractor as directed by the Chief Engineer. Measurements of water level during the pumping and recovery period shall be made as follows:

Elapsed Time	Measurement Taken
0- 20	every minute
0- 40	every 2 minutes
40- 100	every 5 minutes
100- 240	every 10 minutes
240-1450	every 25 minutes

During testing, the Chief Engineer may designate a frequency which varies somewhat from the above. The Contractor shall provide at least

one (1) person to measure and record pumping test data at times when the Chief Engineer is not present at the site.

h. During the initial step test and during the constant rate 24-hour test, failure of pump operation during the first 150 minutes of pumping or for more than 15 minutes at anytime thereafter shall require suspension of the test until the water level in the pumped well has recovered to its original level. The time of the restart of the test shall be approved by the Chief Engineer and shall take into account staff scheduling and water sampling. The Chief Engineer shall be the sole judge as to whether recovery has been completed and when the pump shall be restarted. During the test, the pumping rate shall not fluctuate more than one (1) percent of the designated rate or the test may be terminated. Any retesting shall be done at the Contractor's expense including the Commission's cost for consulting and inspection services.

i. Water discharged during the pumping test shall be conducted to a point of acceptable disposal as approved by the Chief Engineer and in accordance with State and Local sediment and erosion control regulations. The Contractor shall be responsible for correcting, at the Contractor's own expense, any damage caused by the discharged water.

H. WATER SAMPLING ARRANGEMENTS

1. Water samples for quality analysis, as required under the "Submittals” Section of these specifications and in accordance with COMAR 26.04.01, shall be collected during the long-term pumping test as follows:

a. Group A: Two samples; the first one minute after water from the screen area arrives at the sampling point. The time lapse from the start of pumping to taking this sample shall be determined by the capacity being pumped and the upward velocity of the water in the well casing and the pump discharge column. The second sample shall be taken during the last 30 minutes of the pumping test.

b. Group B: Three samples; one during each of the last 3 hours of the pumping test.

c. Group C: One sample during the last 30 minutes of the pumping test with the analysis conducted in the field at the time of sampling.

d. Group D: One sample during the last 30 minutes of the pumping test for transport to the laboratory for analysis.

e. Group E: Assist in the collection of necessary samples by the State of Maryland during the last hour of the test.

I. WELL DISINFECTION

1. The Contractor shall furnish all labor, materials, transportation, tools supplies, plant equipment and appurtenances necessary for the satisfactory disinfection of the well. Disinfection of the well shall be as provided by "AWWA Standard for Deep Wells A-100-84". The chlorine solution used for disinfecting the well shall be of such volume and strength and shall be so applied that a concentration of at least 100 PPM is established in the well in accordance with the directions of, and to the satisfaction of, the Chief Engineer and shall remain in the well for a period

of at least 12 hours. After the required disinfection period and with the approval of the Chief Engineer, the chlorinated water from the well shall be pumped to a discharge location as approved by the Chief Engineer. The well shall also be disinfected at various times during the Work as deemed necessary by the Contractor.

2. Upon removal of the test pumping equipment, a sufficient amount of disinfectant shall again be added to the well prior to capping to provide a chlorine residual in the well of 50 ppm.

3. All chlorinated waters pumped from the well shall meet the conditions set forth in the Maryland Department of Environment Water Supply Bulletin entitled "Discharge of Chlorinated Waters", July 31, 1989, before being released to any drainage system.

J. TV SURVEY OF THE COMPLETED PRODUCTION WELL

1. At the conclusion of testing and prior to capping the production well, the Contractor shall conduct a TV survey of the well to confirm construction details and dimensions. A copy of the survey shall be submitted to the Commission for review and acceptance.

2. The Contractor shall be responsible to take whatever steps are necessary to clear the water in the well so a clear TV picture is obtainable.

K. WELL CAPPING

1. Whenever the well is left unattended, a temporary well cap or drill tool with suitable plates shall be placed on the well to prevent entry. Upon completion, the well shall be capped to prevent unauthorized entry.

L. WELL ABANDONMENT

1. If the Contractor deems it necessary, or if instructed by the Chief Engineer that the drilled hole or a partially constructed well must be abandoned, it shall be done in accordance with the regulations of the State of Maryland, Department of Environment.

4.0 METHOD OF MEASUREMENT

A. Outer Casing

RESERVED FOR FUTURE USE

B. Well Screens and Blank Section

RESERVED FOR FUTURE USE

5.0 BASIS OF PAYMENT

A. General

RESERVED FOR FUTURE USE

END OF SECTION 02555