

SECTION 02555**PRODUCTION WELLS****02555.01 GENERAL****A. Description**

Water production wells will 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

1. Protection of the Environment; Section 01500.

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 Department's Representative will inspect all materials before installation to ensure compliance with Contract Documents.
2. Construction Standards
 - a. Construction of water wells will 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 will be in accordance with AWWA A-100-84 and the United States Department of Environmental Protection Safe Drinking Water Act as it pertains to ground water and as specified herein.
4. Acceptance Standards
 - a. In order to assure that the Department is provided with a sand, silt, bacteria, turbidity, free and efficient well, certain minimum standards must be met before the well is accepted. The Contractor shall meet these standards with in his base bid price or, failing to do so, shall receive no payment for his Work and all monies advanced in progress payments will be refunded to the

Department. The Department's Representative, with the consent of the Department, may waive the acceptance level of a certain standard if it is determined by the Department's Representative 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 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 will have zero coliform organisms per 100 ml of sample using the membrane filter method of analysis.
- 5) Efficiency: The production well will be at least 80% efficient, unless otherwise specified in Contract Documents, as determined by the Department's Representative, 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 will be based solely on data gathered during the construction and long-term pump testing of the production well.

The efficiency of the well will 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 will 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 Department's Representative.

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

$$(\text{Theoretical Drawdown}/\text{Actual Drawdown}) \times 100$$

- c. Should the Contractor fail to meet any one of the acceptance standards he 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 Department and the Department's Representative. 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 Department's costs for consulting and inspection services. Should the Contractor not be able to meet any of the required acceptance standards, the Department may reject that portion of the Work and require the Contractor to vacate the site, in which case the Department shall not owe any monies for the Work done. Any previously paid monies shall be refunded by the Contractor.

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. In particular, the Contractor will complete, submit and pay for the well drilling permit, which must be obtained from the Anne Arundel County Health Department, Division of Environmental Health. Copies of the well permit and all other permits shall be presented to the Department's Representative 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 will be submitted to the Department's Representative 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 him shall be free of defects 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 will be submitted on

report forms provided by the Department, a sample copy of this form is shown can be found at the end of these specifications. The Daily Report form will be completed and signed by the Contractor's Licensed Driller in charge of the work and submitted to the Department Representative during his inspection of the work.

2. Driller's Logs: During installation of the pilot hole, the Contractor shall prepare and keep a complete a log of the formations penetrated on a Driller's Log form provided by the Department, a sample copy of this form can be found at the end of these specifications. The Driller's Log form shall be prepared and signed by a driller licensed in the State of Maryland. The Driller's Log will be submitted to the Department's Representative 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 Department's Representative. 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 Department's Representative 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, adaptors, 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. Six copies of these documents shall be submitted to the Department's Representative.
6. Gravel Pack: The Contractor, prior to delivery, shall submit to the Department's Representative 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 Department's Representative. A sample copy of this form can be found at the end of these specifications.
8. Water Samples and Analysis
 - a. Sampling Coordination: The Contractor will notify the Department's Representative 48 hours prior to collecting samples. The State of Maryland Department of the Environment will 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 analysis of samples collected at various times during testing. The analysis 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.

- 1) Group A: turbidity (NTU) and total suspended and settleable solids.
- 2) Group B: total coliform (membrane filter), and chloride residual.
- 3) Group C: pH, eH (redox potential), specific conductance, temperature, M.O. and P alkalinity (CaCO₃), 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 analysis 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 can collect the samples in Groups A and B using bottles and sample preservation techniques provided by the laboratory. The chlorine residual will 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 .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.

02555.02 MATERIALS

A. Materials furnished by the County

1. The County will not furnish any materials for Production Well Construction.
2. The Contractor may obtain water from the County's system, if available for well construction purposes. Water used will be invoiced at prevailing rates. The Contractor shall contact the County's Department of Public Works, Meter Section for requirements.

B. Contractor's Option

The Contractor may furnish any of the specified materials or "equal" materials as approved by the Department's Representative 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 will be constructed of Type 304 stainless steel. The screen dimensions will be outlined in the contract documents. Water entrance velocities for the screen selected will 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 will be I.P.S. "STANDARD" schedule wall thickness, unless otherwise specified. Tight Wound well screen may be used in place of solid pipe blank sections between well screens.
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 will 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 should 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. Gravel shall be as supplied by the Jessie Morie Co. or approval equal. 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 Department's Representative 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 Department's Representative for review and approval prior to use.

02555.03 EXECUTION

A. PREPARATION

1. The Contractor shall notify the Department's Representative 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 Department's, 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 will not be permitted to bury cuttings on-site. All supernatant fluid is to be removed from the mud pits and trenches and the pits are filled with clean earth and allowed to stabilize. Obtaining suitable off-site disposal of all discarded fluids and other materials will be the responsibility of the Contractor. The requirements of this section in no way relieves 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 Department's Representative at each site. All depth measurements shall be within ± 1 feet except water-level measurements which shall be ± 0.01 feet.

4. The Contractor shall employ only competent workmen 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 Department's Representative.

B. DRILLING FLUID

1. Only potable water from a source approved by the Department's Representative will be used during construction. If available, arrangements may be made with the Department to secure a source of water from the Department's distribution system.
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 additive to be used must, prior to use, be approved by the Department's Representative. Their use will comply with recognized industry standards and practices and they will be applied and used as described by the manufacturers. It is expressly understood that toxic and/or dangerous substances will not be added to the drilling fluid.
3. The drilling fluids program shall be agreed to by the Contractor and the Department's Representative 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 good 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 Department's Representative prior to the start of drilling.
- b. Formation samples shall be collected at 10-foot and 5-foot intervals as outlines 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 Department's Representative shall be delivered to Johnson Filtration, Systems Inc. (or equivalent 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 are accepted by the Department's Representative and the State of Maryland Geological Survey.

D. GEOPHYSICAL LOGGING

- 1. At the conclusion of pilot hole drilling the Department's Representative will conduct geophysical logs in the pilot hole.

2. Caliper logs will be performed, by the Department's Representative, 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.
3. The contractor will give the Department's Representative 24 hours Notice, prior to having the pilot hole or reamed hole ready for logging.
4. The contractor will be given a copy of all logs performed, by the Department's Representative, immediately after the logging is completed.
5. If a geophysical logging tool is lost and not retrievable, the Contractor may drill out or drill by the tool, if in the Department's Representatives opinion doing so will not materially affect the well. If the contractor is unable to drill out or by pass the tool, he will abandon the hole, in accordance with the regulations of the Maryland Department of the Environment and will redrill to the designated diameter and depth.
6. If the geophysical tool is lost due to contractor negligence or problems with the drilled hole, the contractor will reimburse the Department's Representative for the lost equipment and will perform the necessary abandonment and redrilling at no additional cost to the Department. Any cost for additional geophysical logging required due to the contractors negligence or problems with the drilled hole will be bourn by the contractor.

E. WELL CONSTRUCTION

1. The outer casing will extend to the top of the water bearing aquifer.
2. All surface (starter) casing and outer casings will be grouted in place with a minimum of 2 inches of grout surrounding the casings.
3. Well screens will 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 will be left in place and shall be included in the Lump Sum bid price.
5. Screen slot size, configuration, setting and gravel pack size will be selected by the Contractor and approved by the Department's Representative 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 will 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 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, will be done on an around the clock basis.

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 in 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 Department's Representative with a plummet suspended from a tripod on the drill rig. The plummet will be approximately 1/2-inch smaller in diameter of the well casing being tested. The Contractor shall assist the Department's Representative 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 rds 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 his own expense. Should the Contractor fail to correct the faulty plumbness and/or alignment, the Department's Representative 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, would then be abandoned (as specified) at the Contractor's expense. The Department's Representative may waive the requirements for plumbness and alignment if, in his 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 will be done at the Contractor's expense including the Department'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 Department's Representative.
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 clean water to remove drilling mud and natural clays, prior to and during gravel packing.

F. WELL DEVELOPMENT

1. A method of development will 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 Department's Representative. 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 will be at the Contractor's expense, including the Department's cost for consulting and inspection services.

G. TEST PUMPING

1. When the Contractor, at his own determination, feels he 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 Department's Representative, measure the discharge rate in a manner

satisfactory to the Department's Representative and to 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 Department's Representative, 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 may 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 Department's Representative.
- 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 Department's Representative. The discharge pipe shall be free of valves, changes in pipe diameter or other obstructions for a distance of 24-inch and will be free of any external obstruction except for the discharge pipe itself.
- e. Step Test: An initial pumping test will be conducted in the well at stepped rates as outlined in the technical specifications and in the field by the Department's Representative. 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 Department's Representative.
- 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 Department's Representative, for a period of 24 hours, followed by a recovery test period of 24 hours. The pumping rate for the 24 hour test will 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 must wait 24 hours after shut down to remove his 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 Department's Representative. Measurements of water level during the pumping and recovery period shall be made as follows:

- 0 - 20 ----- every minute
- 20 - 40----- every 2 minutes
- 40 - 100 ----- every 5 minutes
- 100 - 240----- every 10 minutes
- 240 - 1450 ----- every 25 minutes

During testing, the Department's Representative 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 Department's Representative 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 Department's Representative and shall take into account staff scheduling and water sampling. The Department's Representative 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 will be done at the Contractor's expense including the Department'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 Department. The Contractor shall be responsible for correcting, at his 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, will 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 will 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 will 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 Department's Representative 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 Department's Representative, the chlorinated water from the well shall be pumped to a discharge location as approved by the Department's Representative. 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 must meet with 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 Department's Representative will conduct a TV survey of the well to confirm construction details and dimensions. The Contractor will assist the Department's Representative in conducting the survey.
- 2. The Contractor is responsible to take whatever steps are necessary to clear the water in the well so a clear TV picture is obtainable.

K. WELL CAPPING

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

L. WELL ABANDONMENT

If the Contractor deems it necessary, or if instructed by the Department's Representative 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.

02555.04 METHOD OF MEASUREMENT**A. Outer Casing**

Length of outer casing will be measured from grade to total depth below grade.

B. Well Screens and Blank Section

Well screens and blank sections measurements will be made from the bottom of the sump or cellar section to the top of the relief screen. The stainless steel lap pipe above the relieve screen is not included in this measurement.

02555.05 BASIS OF PAYMENT**A. General**

1. Payment will be made at the lump sum and unit prices bid. The bid price shall include and cover furnishing all labor, tools, equipment and materials necessary to complete the work as shown and specified in strict accordance with Contract Document and accepted by the Department's Representative. Any items inferred by, but not included in the Specifications and Contract Documents, necessary to complete the work, will be considered part of the specifications and Contract Documents.
2. The unit price bid for outer casing installed should include drilling, installation, grouting and materials.
3. The unit price bid for Well Screen and Blank sections shall include drilling installation, gravel packing and materials.
4. The unit price bid for additional testing shall include equipment, fuel and manpower to operate the equipment and take required readings.

DAILY DRILLING REPORT
 Unconsolidated Formations

Well Name or Number: _____ Date: _____

Location: _____

Contractor: _____

Contractor's Job No.: _____

Time on-site

County Contract No.: _____

Start: _____ am pm

County Contract No.: _____

Stop: _____ am pm

Description of On-site Work	Crew Hours	Equipment on-site:			
		from	to	dia.	remarks
Mobilization - set up					
Geophysical logging					
Plumbness - Align. testing					
Pilot hole drilling					
Reaming					
Setting casing					
Grouting					
Drilling into aquifer					
Setting screen					
Setting riser pipe					
Gravel packing					
Developing	Type drilling fluid: Cement amount: Screen slot size: Gravel size: Water clarity: Pumping rate(s): SWL: PWL:				
Setting/removing test pump					
Test pumping					
Collecting recovery data					
Breakdown - cleaning up					
Other:					
Name of Driller:		State License No.:			
Names of Helpers:					
Remarks:					
Driller's signature:			Inspector's signature:		

FIGURE 1

WELL SUMMARY

Other I.D.:

Well Name:

Description of reference point:			LOCATION		
Vertical Control Form:		Y	N	Address:	
Depths		Formation Description	Thickness	Town:	
From	To			County:	
				State:	
				Maps completed: Y N	
				CONSTRUCTION PERMIT	
				Permit No.:	
				Issuing Agency:	
				Date:	
				Conditions:	
				OWNER	
				Owner:	
				Contact:	
				Phone No.	
				DRILLING CONTRACTOR	
				Company:	
				Address:	
				Onsite Driller:	
				Rig:	
				Contractor's Form Y N	
				INSPECTOR	
				Company:	
				Inspectors:	
				Inspections Reports Y N	
				MOB/DEMOB	
				Date Started:	
				Date Finished:	
				Days to Complete Work:	
				GEOPHYSICAL LOGGING	
				Contractor:	
				Date(s):	
				Logs:	
				Copies Available: Y N	
				P/A TESTING	
				Date(s):	
				Results:	
				Copies Included: Y N	
				DATES OF TV SURVEYS	
				Pre-work:	
				Borehole:	
				Post-work:	
Name of Aquifer:					
Cuttings Saved: Y N			See Other Side		

FIGURE 2