Establishing a new groundwater-based water supply in New Kent County is a matter which should be approached with as much scientific and engineering forethought as possible. It is anticipated that in most instances a Ground Water Withdrawal Permit will be required prior to County acceptance. For withdrawals which are not reasonably expected to exceed 300,000 gallons per month, certain requirements may be waived by the Director of Public Utilities, or his designee, as appropriate.

1. PRE-CONSTRUCTION REQUIREMENTS
    a. Prior to any site engineering or well construction, the Department shall be notified of the proposed withdrawal and intended ground water use.
    b. It is highly recommended that a hydrogeologic consultant, Certified as a Professional Engineer or Geologist in the Commonwealth of Virginia, and experienced with the technical and regulatory matters of ground water withdrawal in the Virginia Coastal Plain, be employed for oversight of the entire project.
    c. It is also recommended that a Ground Water Withdrawal Permit Pre-Application Conference with DEQ be scheduled prior to any work being performed at the site. The conference should be attended by:
        i. the developer.
        ii. the developer's consultant or engineer.
        iii. a representative of New Kent County's Department of Public Utilities.
    d. A Groundwater Availability Study may be required for review & approval by the Department of Public Utilities to establish the technical framework of the withdrawal.
        i. In general, it is expected that project design shall be oriented towards groundwater withdrawal from either the Middle Potomac or Lower Potomac Aquifer, or both.
        ii. Current scientific publications, existing well data, regulatory requirements and any other pertinent information shall be referenced.
        iii. The study shall outline appropriate measures to be taken to fully & accurately delineate the water need, identify alternate supplies, and asses the quantity & quality of groundwater available. These activities include, but are not limited to:
            1. A description of the proposed water use, including a description of the number and size of proposed units, and volume of water required per unit. Potable and non-potable needs should be differentiated and detailed.
            2. Predictive computer modeling or simulation of aquifer properties and various withdrawal scenarios using the Virginia Coastal Plain Model, and evaluation of the withdrawal against the technical evaluation criteria for DEQ Ground Water Withdrawal Permit issuance.
            3. Documentation of a Ground Water Withdrawal Pre-Application Conference with DEQ.

4. Proposed specifications & details for a hydrogeological investigation at the site, including construction of one or more test wells.

2. TEST WELLS
   a. As noted above, prior to any water system construction, one or more test wells may be required to establish the quantity & quality of groundwater available at the site.
      i. The exact specifications for design, construction, and testing of the test well should be outlined in the approved Groundwater Availability Study.
      ii. The test well shall be constructed, developed and tested in a manner that provides, at a minimum, accurate records of the following:
         1. Driller's log/geologist's log of drill cuttings,
         2. Collection of representative formation samples at 10 foot vertical intervals
         3. Geophysical Logs – to include 16, 64 and single point resistivity, SP and gamma
         4. Sieve analysis of drill cuttings from the proposed source aquifers
         5. An estimate of actual specific capacity, theoretical specific capacity and aquifer storativity and transmissivity (using the $T = Q/264\Delta s$ method), based on 48 hours of uninterrupted constant rate pumping and water level recovery.
         6. At 12 hour intervals during pumping, Water Quality Analyses by a DCLS certified Drinking Water Testing Laboratory for the following (at a minimum): Turbidity, Fluoride, Sodium, Calcium, TDS, Iron, Manganese, Nitrate/Nitrite, Sulfate, VOCs, Total Coliform and Radiologicals.
      iii. Multiple interval, zone or packer testing may be required to delineate the source of known or suspected drinking water contaminants of concern.
      iv. Test wells shall be completely removed and the borehole reamed to the top of the lower most source aquifer. The borehole shall be abandoned with neat cement grout or bentonite slurry, conforming to the grout criteria outlined below. If a test well is to be completed and retained as an observation well, the completed well shall conform to the observation well criteria outlined below.
   b. From the test well data collected, an Addendum to the Groundwater Availability Study may be required to provide the following information:
      i. Presentation & interpretation of data collected.
      ii. Calibration of the model predicted conditions.
      iii. Recommendations on supply well & observation well construction to meet design requirements and flow criteria outlined below, as well as DEQ & VDH regulatory requirements. Technical design criteria of wells & pumps shall focus

on operational efficiency, corrosion resistance, longevity, reliability, ease of maintenance and redundancy of systems.

3. PRODUCTION WELL DESIGN
    a. A VDH-approved Preliminary Engineering Report shall be submitted to the Department of Public Utilities which provides an individual production well design which is capable of producing a flow equivalent to the peak diurnal demand of the entire proposed waterworks.
        i. The well design shall be of sufficient depth and diameter to accommodate a pump capable of producing the flow demand requirement at the design head conditions, and at a pumping water level no greater than 80% of the available drawdown between the pre-pumping static water level and the deepest permissible pump setting.
    b. Prior to moving forward with production well construction, the following items shall be provided to the Department (as applicable):
        i. VDH Well Site Approval Letter.
        ii. Evidence of submittal of a DEQ Groundwater Withdrawal Permit Application and Application Fee.
        iii. A DEQ approved Aquifer Test Plan.
    c. In general, production wells shall be constructed in a location which is free of obstructions and is easily accessible for pump installation & removal. This typically means that the wellhead is *not* located inside the well house or pump house.
    d. Production well screen and gravel pack shall be designed to retain a minimum of 70% of the source aquifer material, while allowing a maximum entrance velocity of 0.01 ft/sec, based on sieve analyses of source aquifer samples from the site.

4. WELL CONSTRUCTION
    a. All wells, regardless of use or purpose (production well or observation well), shall conform to the following criteria for Department acceptance**:**
        i. All wells shall be constructed to a minimum Class I standard.
        ii. All products used in borehole drilling & well construction shall be:
            1. Non-biodegradable.
            2. NSF-approved.
        iii. Only potable water from an approved source shall be used in borehole drilling & well construction.
        iv. All wells shall be constructed concentrically in the borehole using centralizers, and in such a manner that the annular space between the well casing and borehole is completely filled with well gravel or grout.

v. All wells shall be designed & constructed such that the annular space around the well screen does not exceed 2.5 inches.
vi. All wells shall be designed & constructed such that the internal diameter of the well screens is not greater that the internal diameter of the well casing.
vii. All wells shall be constructed by the direct or reverse circulation mud rotary method using a sodium bentonite drilling fluid. Any drilling fluid or additives used shall be:
    1. Baroid IDP or approved equal.
    2. Utilized in accordance with the manufacturers recommendations.
viii. During well construction activities, geophysical logs, driller's logs and formation samples (as described in Test Wells above) shall be generated from a borehole which is representative of the site.

b. For boreholes 12-inch diameter or greater, a pilot hole shall be required.
c. Borehole drilling shall proceed in such a manner as to:
    i. Prevent contamination of the subsurface.
    ii. Produce a well bore that is straight, plumb, and free of deviation.
    iii. Completely circulate formation material from the borehole.
    iv. Prevent drift, washout or collapse of the borehole.
    v. Minimize formation damage and drilling fluid penetration into the source aquifer.
    vi. Expedite well completion & initial development.
d. The well driller shall maintain at the site and make available for review a daily record of drilling activities to include:
    i. Crew on site.
    ii. Make & model of drilling equipment in use.
    iii. Drill bit information, including bit type, size and any stabilizing and/or weighting tools in use.
    iv. Description of all formations encountered, including voids, caverns, cavities, water producing zones, etc.
    v. Number of feet drilled.
    vi. Number of hours on-site.
    vii. Hours drilling.
    viii. Hours shut down and cause.
    ix. Drilling fluid properties (viscosity, pH, weight, water loss).
    x. Volume of drilling fluid and/or additives used.
e. Surface or pit casing shall be employed to prevent cave-in or washout at the surface.
f. For production wells, an external monitoring tube with a minimum internal diameter of 1-inch shall be attached directly above the well screen and shall be:
    i. 304 or 316 stainless steel pipe, threaded and coupled.

ii. Banded or strapped to the well casing.
iii. Sufficiently plumb to provide an accurate water level reading.
iv. Hydraulically connected to the well so as to adequately respond to & reflect water level changes.
v. Be useable for water level measurements or transducer installation following completion of site construction.

g. Observation wells shall have a minimum internal casing diameter of 4.0 inches.
h. Well casing & screen assemblies shall be:
   i. Installed under tension, to a depth that is at least five feet shallower than the bottom of the borehole.
   ii. Of sufficient hoop & tensile strength to be installed to the prescribed depth without stretching, separating or collapsing.
   iii. New, of perfectly straight length & perfectly round diameter, without seams.
   iv. Constructed of 100% corrosion resistant materials (PVC and/or stainless steel).
   v. Casing & screen shall be measured in the field to the nearest 0.01 ft, and each piece shall be marked with the measurement prior to inspection.
   vi. For production wells, well screens shall be rod-based, continuous slot, wire-wrapped 304 or 316 stainless steel, Johnson Screen Vee-Wire or approved equivalent, with factory-installed weld rings at each end.
   vii. Steel materials shall be plain-end, beveled, and welded in accordance with ASTM A 139.
   viii. PVC products shall be SDR 17 Certainteed Certa-lok Well Casing or Screen, or approved equivalent.
   ix. Solvent-weld PVC shall *not* be used.
   x. Fitted with a rounded or pointed end cap.
   xi. Outfitted with dielectric couplings, in instances where carbon steel casing has been approved.
i. All wells shall be constructed to prevent leakance between aquifers within the well bore.
   i. Boreholes shall not penetrate the confining layer below the source aquifer.
   ii. Gravel pack & grout shall be discretely and precisely placed using tremie pipe and/or circulatory methods to prevent voids, bridging and/or collapse.
   iii. Gravel pack shall extend from the bottom of the borehole to an elevation that does not exceed the top of the source aquifer and conform to the following:
      1. US Silica Fil-Pro or approved equivalent, delivered in factory packaging.
      2. Sand of at least 95 percent silica in composition.
      3. a uniformity coefficient of 2.5 or less.

4. hard, well-rounded, graded, water-worn material washed clean of silt, dirt, and foreign matter (crushed gravel, angular particles, or other non-specified material will not be accepted).
5. Handled and stored in a manner to prevent contamination or the introduction of foreign material.

iv. Grout shall extend from the top of the source aquifer/top of gravel pack to ground level and conform to the following:

1. Type I Portland neat cement mixture consisting of no more than 6 gallons of water per 94 lb. bag of cement and not exceeding 15.6 lb/gal, OR
2. Bariod IDP Benseal, or approved equivalent bentonite grout slurry, mixed and applied in accordance with the manufacturer's recommendations.
3. Free of deleterious materials such as sand, gravel or fly ash.

j. All wells shall be developed thoroughly using a combination of airlift, jetting, swabbing and/or pumping. Any development chemicals (dispersants, etc.) shall be NSF approved and utilized in accordance with the manufacturer's recommendations.

i. Production well development shall not be considered complete until all drilling mud & formation material has been cleared from the well screen and bottom of the well, as confirmed by a color video survey. The video survey shall:

1. Verify depth setting of screens and condition of well materials.
2. Provide continuous on-screen depth display from ground surface (ground surface = 0) to the nearest 0.10 ft.
3. Provide rotating & side views.
4. Provide a complete account of the well's condition from ground surface to the bottom of the well.

ii. Production wells shall be developed and subsequently tested to produce a turbidity of 1 NTU or less, and a well efficiency of 80% or greater, based on a 24 to 48 hour constant rate & recovery test at the designed well production rate. The efficiency shall be calculated based on the $T=264Q/\Delta s$ method.

iii. Observation wells shall be developed until they produce a well efficiency of 70% or greater, and a turbidity of 3 NTU or less.

iv. Production wells shall be developed until they produce water of a turbidity of

k. Following construction & final development, all wells shall be thoroughly disinfected by flushing & swabbing or injecting a pre-mixed sodium hypochlorite solution of 50 ppm chlorine directly into the well casing and screen. Disinfectant shall be:

i. NSF-approved.

ii. Introduced in a manner which thoroughly disinfects the screened zones and source aquifer.

iii. Introduced in a concentration & manner which does not promote the formation of disinfection byproducts.
iv. Introduced in a concentration & manner which does not promote corrosion of the well casing or screen.
v. Purged from the well by airlift or pumping after a 24 to 36 hour contact period.

l. Following construction of a production well, a test pump shall be installed and the well shall be pumped continuously at a constant rate equivalent to the designed yield capacity and tested for the following:
   i. 48 hour drawdown & recovery.
   ii. Transmissivity, Specific capacity & well efficiency (using the $T = Q/264\Delta s$ method).
   iii. Sand content (using a Rossum Sand Tester).
   iv. Drinking water parameters in accordance with VDH requirements to include analysis of Cyanide, Total Coliform, Metals, Inorganics, Radiologicals, VOCs, & Nitrate/Nitrite by a DCLS-certified Drinking Water Laboratory.

m. Pump test water shall be conducted from the site to a suitable drainage area in manner which:
   i. Prevents ponding at the site and recharge of the source or observed aquifers.
   ii. Prevents washouts, erosion or ponding on or off-site.

n. Following construction, completed wells must be sufficiently plumb, straight & free of excessive bends or deviations.
   i. Completed production wells shall:
      1. Be tested for and conform to the criteria for plumbness & alignment in accordance with AWWA A-100.
      2. Allow installation of the test pump & specified well pump assembly without obstruction or drag.

5. WELLHEAD SURFACE COMPLETION

a. Surface completion of the wellhead, whether permanent or temporary, shall be performed immediately after construction and testing, to prevent tampering, entrance of contaminants or surface drainage into the well.
   i. The annular space of the finished well shall be completely grouted to ground surface.
   ii. The finished well shall be clearly labeled with the corresponding DEQ Well ID#.
   iii. Prior to acceptance by the Department of Public Utilities, the finished well shall be permanently completed with the following:
      1. For observation wells:

a. Well casing extended to 2.5 feet above grade.
b. A reinforced concrete apron, extending a minimum of 18 inches in all directions, with a minimum thickness of 6 inches.
c. An outer steel protective casing, with hinged or removable locking cap, to 3.0 feet above grade.

iv. For production wells:
1. A Baker Monitor pitless adapter, to include:
a. minimum internal opening no less than the minimum internal screen diameter,
b. a steel flanged outlet pipe connection, equivalent in diameter to the well pump discharge pipe diameter.
2. A wire reinforced concrete apron with a minimum compressive strength of 6000 psi, a minimum thickness of 8 inches, and extending a minimum of 3 feet from the pitless adapter in all directions.
3. A threaded cap or plug for the external monitoring tube.

6. WELL PUMP ASSEMBLY & INSTALLATION
a. The specified well pump shall be capable of producing a quantity of water equal to the peak diurnal flow demand of the waterworks, at system design head conditions and at a pumping water level less than 80% of the allowable drawdown. The well pump shall produce the specified flow and pressure based at optimal efficiency, based on the pump curve provided by the manufacturer.
b. Pump & motor assemblies shall be sized to produce the specified flow with head losses no more than 5 feet per hundred feet of pipe at the specified flow.
c. Submerged components of the well & pump assembly shall be thoroughly rinsed with a 50 ppm sodium hypochlorite solution immediately prior to installation.
d. Well pump & motor assemblies shall be easily installed without obstruction or drag, and without the need for weighting or forcing the assembly into the well.
e. No well pump intake shall be installed deeper than the top of the uppermost source aquifer or the maximum allowable pump setting, as dictated by DEQ.

7. SUBMERSIBLE WELL PUMPS
a. Submersible well pumps shall be specified for applications of approximately 1,250 gpm or less, and requiring a pump of 175 horsepower or less.
b. Submersible well pumps shall be ITT Goulds VIS series (deep submersible) or approved equal coupled to a Franklin Electric three-phase, 3450 RPM, 60 Hz, encapsulated (wet wound) standard submersible motor.

c. Submersible pump cable shall be:
    i. New, UL listed, 3-strand wire with ground.
    ii. Sized to limit the voltage drop no more than 5%.
    iii. Water & moisture resistant double PVC jacket, flat submersible pump wire.
    iv. A continuous length in good condition, without splices, nicks or repairs.
    v. Spliced to the well pump motor using NSF approved materials.
    vi. of a gauge consistent with the motor manufacturer's recommendation.
    vii. Securely tethered to the well pump riser pipe at a maximum of 10 foot intervals using 10 mil waterproof PVC tape, to prevent sagging, dragging, snagging or chaffing, and secured with non-conductive bands or clamps for wire of #2 gauge or larger.
d. Submersible well pump riser pipe shall be Certainteed Certa-lok PVC or approved equal, and shall be:
    i. In new condition.
    ii. Of an external diameter which allows installation of the well pump assembly without obstruction or drag.
    iii. Fitted with in-line brass check valves every 200 linear feet.
    iv. Fitted with SCH 40 stainless steel nipples wherever threaded connections are required.

8. VERTICAL TURBINE WELL PUMPS
    a. Vertical turbine well pumps shall be specified for all pumping applications requiring approximately 1,250 gpm or greater, and/or 200 horsepower or greater.
    b. Vertical turbine well pumps shall be ITT Goulds VIT-FF series (vertical turbine) or approved equivalent.
    c. Vertical line shaft shall be:
        a. ASTM A108 Grade C1045 steel.
        b. Furnished in interchangeable pieces no greater than 10 feet in length.
        c. Coupled with machined steel couplings with left-hand thread.
        d. Fitted with a 304 stainless steel sleeve journals at each bearing location.
        e. Line shaft bearings shall be fluted rubber retained in an ASTM B584 silicon bronze spider by a shoulder on each end of the bearing.
        f. Vertical turbine column pipe shall be:
            i. Furnished in sections not exceeding 10 feet in length.
            ii. Connected by threaded sleeve couplings.
            iii. ASTM A53 grade B threaded steel pipe, SCH 30 weight or greater.
            iv. Threaded each end 8 threads per inch, 3/16" taper per foot.
            v. Faced parallel to butt up against the specified centering spiders to form accurate alignment.

g. Discharge head shall be:
    i. Water lubricated.
    ii. High profile type to allow shaft coupled above stuffing box,
    iii. High grade cast iron ASTM A48 Class 30, or fabricated steel,
    iv. Fitted with a flanged discharge pipe to match Class 125 (cast iron) or Class 150 (steel) pipe.

h. Vertical motors shall be US Motors WP I, Vertical AC, high thrust, or approved equal, and shall have:
    i. Three-phase, 60 Hz design.
    ii. Vertical hollow shaft.
    iii. Non-reverse ratcheting design.
    iv. High thrust base.
    v. Weather protected enclosure.
    vi. Class F insulation.
    vii. Class B rise at Full Load (sine wave power).
    viii. Inverter duty rating, for operation with a Variable Frequency Drive.

i. All well pumps & motors shall be operated & controlled by a Variable Frequency Drive (VFD), with appropriate overload protection, in accordance with the pump. motor & drive manufacturer's recommendations.

j. All VFD's shall have:
    i. Continuous rated amps equal or greater to the motor's nameplate maximum amps, RPM, voltage, current and slip without having to utilize the service factor of the motor.
    ii. Output filter as necessary.
    iii. Output waveform capable of handling maximum motor cable distance of up to 1,000 feet (unshielded) without tripping or derating.
    iv. User selected programmable ramp up and ramp down features.
    v. Features to detect phase loss and phase imbalance on the incoming power.
    vi. Capability of operating at ambient temperatures of 0°F to 125°F.
    vii. Properly cooled and ventilated in accordance with the manufacturer's recommendation.

9. FINAL ACCEPTANCE

a. Prior to acceptance by the Department, all finished wells (pumping or observation) & pumping assemblies shall be:
    i. Readily accessible for service & maintenance by an all-weather access road, as prescribed in Volume I, Section 5.
    ii. In conformance with VDH and DEQ regulations & permitting requirements.

iii. Accompanied by a completed Water Well Completion Report (VA Form GW-2), well construction schematic, pump installation record and pump curve.
iv. Fully developed and free from drilling mud, silt, sand, formation material, debris, obstructions or any other deleterious material.
v. Straight, plumb & free of deviations or bends.
vi. Pumping wells shall be proven capable of producing:
    1. The required flow at system design head conditions.
    2. Potable water of a quality which conforms to the Safe Drinking Water Act's Secondary & Primary Maximum Contaminant Levels for drinking water.
    3. Raw & finished water in a quantity equal to the peak diurnal flow demand of the waterworks, at less than 80% of the allowable drawdown.
    4. Accurate water level readings following permanent pump installation via above-grade access for water level probe or pressure transducer.

b. A groundwater-based water system will not be accepted for ownership or operation by the Department of Public Utilities until the following permits have been issued in the name of New Kent County (as applicable):
    i. Department of Environmental Quality (DEQ) Ground Water Withdrawal Permit.
    ii. Virginia Department of Health (VDH) Waterworks Operation Permit.

--END OF SECTION--