Suggested Observation Well Specifications:
W. Wilcox, MV Commission
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Well locations:
Wells should be placed as close to the identified location as possible and in no case more than 50 feet from the planned placement without approval.

Survey:
All wells will be surveyed for elevation and, where groundwater contour definition is required, horizontal location by a licensed surveyor at ground surface and at the top of the protective casing to the 1929 Vertical Datum.

Well Types:
Single cased wells are the preferred monitoring well. Multiple completion wells may be required where sample collection at discrete levels is necessary.

For shallow water tables at depths less than 25 feet and in unconsolidated geologic materials, small diameter, single-rod driven wells may be used. This technique is sometimes described as "direct push". For deeper well requirements, a cased rod may be used. The diameter for this type well ranges from 0.5 to 1.5 inches inside diameter. These wells should not be used where metals are being monitored as the steel casings may release of chromium and nickel. Drive points are generally acceptable but may be limited to depths less than 50 feet.

In addition, wells may be placed by hollow-stem or solid auger, cable tool or hammer. Depending on the goal of the monitoring and the need for intact sediment samples, hydraulic rotary may be used. Remnant mud left in the hole may affect test results due to organic content or to ionic exchange.

Well Rig Cleaning:
For sites where soil contamination is possible, the rig drilling and sampling equipment should be cleaned between borings to remove surface oil, grease, soil and other potentially contaminating materials using steam if necessary. See WSC #91-310, Section 3.3. See also Richter and Collentine reference.

Grease should not be used on drill stem joints or surfaces where it may come in contact with soil or groundwater. If necessary, use vegetable oil for lubrication of these joints.

Materials:
- Two inch nominal inside diameter **flush-threaded joint PVC** or equivalent for both riser and the screen are the preferred materials. Solvent cement should not be used. Schedule 40 is suggested.
- **Stainless steel** may be used for deep boreholes in excess of 300 feet or where the monitoring goal involves corrosive chemicals.
- **Galvanized pipe with stainless screen** may be used where short-term monitoring will not be affected by corrosion of the pipe.
- All **risers** will extend above the surface for wells in wooded locations to a height of 18 to 24 inches. A **locking casing protector** will cover the well casing and be installed in the top 1 to 2 feet of grout and extend above the PVC riser to protect

the well from vandalism. Where there is risk of vehicle traffic damaging an above-ground riser, the well may be secured with a locking device below grade within a **traffic-rated Christy box**.

- Each **well screen** will have a slot size that is consistent with the sand pack size (either 0.010 or 0.020). The slot should be selected to retain 90% of the aquifer material. The screen slots should be non-plugging design best done as factory slotted.
- While there is no guideline applicable to all sites, in general, well screens will be either 5 feet or 10 feet in **length**. Five-foot length screens are intended to monitor sources that produce contaminants that will remain near the surface of the water table between the source and the monitoring well. Ten-foot screens are intended to monitor either multiple sources at different distances or sources that add contaminants to the groundwater in sufficient volume to create some vertical movement into the aquifer.
- **Sand pack:** Material from the borehole will be placed in the annular space between the borehole space and the screen if the sand is clean and is appropriate for that use. The sand pack will be placed from the bottom of the borehole to approximately 2 feet above the well screen. Where the aquifer material consists of 10% or more clay or where it is uniform fine sand, an **artificial filter pack** is suggested. The filter pack should consist of uniform, non-reactive material such as silica sand. For guidance, see Well Water Journal, June 1988.
- **Bentonite** will be placed above the sand pack and where risk of contaminants moving down the well pipe exists or where the formation sequence includes aquifers separated by a low permeability formation, will be followed by a bentonite cement grout (5 to 7% bentonite) to approximately 1 to 2 feet below grade. The seal will be allowed to set for at least 30 minutes before pouring the cement grout into the hole. The upper two feet to grade will be grouted. The grout at the surface will be sloped away from the well casing. See WSC #91-310.

Well development:

Each well will be developed for at least one hour using a surge technique to ensure that bridging the sand pack is eliminated and that the fines are removed from the well. Use visual inspection of the water pumped to determine if one hour of development is adequate. The pumped water should be clear and free from fines. If available, a turbidity meter should be used to assure that the turbidity is less than 5 nephelometric turbidity units.

Development techniques allowed include over pumping, surging with a surge block, jetting with air or with formation water (or with drinking water quality water) and purging.

Screen depth:

The depth of placement of the screen should be decided based on the distance from the source that is to be monitored and using basic knowledge about the rate of groundwater flow and the annual recharge to the groundwater. Where sources to be monitored are within 200 feet, in general the well screen will be placed so that the midpoint of the screen is located at the expected average water table elevation for the month in which the

well is drilled. This information can be obtained from the MVC water resources department.

Soil borings:

If required, soil borings should be taken with hollow-stem auger, cable tool or drive and wash casing. Hollow stem is suggested where intact soil sampling is necessary.

If hollow-stem auger is used, the stem section shall have an inside diameter to allow placement of a monitoring well if required. The Auger stem shall be advanced to the levels where soil samples are required in a step-by-step fashion to allow collection of soil material. Any washing done will be with drinking water quality to avoid contamination.

The drive and wash technique shall use a metal casing having a nominal inside diameter large enough to allow placement of a monitoring well if required. Casing advance shall be done by use of a 300-pound weight falling about 30 inches with number of blows recorded. When the casing has advanced to the required depth and samples have been collected the casing shall be advanced to the next sampling depth by use of a roller bit with washing apparatus. All washing shall be done with drinking water quality water.

Soil samples shall be collected at 5-foot intervals unless otherwise specified according to ASTM D1586 Standard Penetration using a split spoon sampler. Samples shall be not less than 1 and 3/8 inches in diameter collected by dropping at least a 140-pound weight 30 inches beginning at a depth equal to the bottom of the auger or casing that was just advanced. A record of the number of blows and the weight used to drive the sampler into the soil for each 6 inches of penetration.

The sampler shall be cleaned before each sample is taken. Cleaning will be by rinsing with drinking quality water and with either a phosphate free detergent or methanol if required and finally with distilled or deionized water.

Soil samples shall be placed in 8 ounce or 16 ounce large mouth, moisture-proof, screw-top, clear jars. The jars shall be tightly sealed and properly labeled with site, date, well number, number of blows for each 6-inch penetration and depth of collection.

REFERENCES:

For questions and guidance on installation, developing and sampling from small diameter "push wells" see DEP document WSC #91-310 Standard References for Monitoring Wells, 1999.

Gass, T.E. (1988) Monitoring Well Filter Pack and Screen Slot Selection. WWJ June 1988, pp. 30-32

For single borehole, multi-level wells, see MVC specifications titled " Specifications for Test Borings", dated 1/92.

For well monitoring QA requirements, see MVC Groundwater Monitoring Sampling Protocol.

Richter, H.R. & M.G. Collentine Will My Monitoring Well Survive Down There? Groundwater Monitoring Review pp. 223-227