

Guidelines – For Groundwater Monitoring Wells Installation

Issued by: Inspection Department – Operations Section

1.0 Information to be included in a Groundwater Monitoring Plan

1.1 Siting

The client must supply information in the groundwater monitoring plan regarding the proposed zone(s) to be monitored. This information shall include the name of the zone chosen, the depth of the zone, lithology, hydraulic parameters (permeability, porosity, etc.) if known, the thickness of the zone, and information regarding the sources of data used in estimating the geologic conditions and geologic and engineering parameters provided. This information should be accompanied by a stratigraphic column of the well site which clearly delineates the proposed monitoring zone, the injection zone, all zones between the injection and monitored zones including their porosities and permeability, injection interval containment interval, and lowest Underground Source of Drinking Water (USDW) (if present). A map should also be included showing the proposed monitoring well site in relation to the injection well(s). In choosing a zone to monitor and the surface location of the monitoring well, the following criteria should be utilized.

- a. The well(s) should be completed in the first porous, permeable interval that lies above the maximum modeled extent of the vertical migration of the waste. In addition, a porous, permeable interval at a shallower depth below the lowest USDW may also be monitored. The number of intervals to be monitored at each site will be determined based upon examination of site specific data.
- b. The ideal monitored interval should extend throughout the area of review, have adequate permeability, and be relatively thin. A thin zone is preferred because waste migration will cause a greater pressure change in a thin zone than in a thick zone. In addition, if the groundwater flow direction in the monitored zone is uncertain, a thin zone can be pumped, causing a larger cone of depression than would form in a thick zone, until the flow direction within the cone of depression will cause any waste within the cone to flow towards the monitoring well, whereas in a thick monitored zone, this pumping would be infeasible.
- c. If present, a monitoring interval should be chosen that has permeability less than that of the injection interval so that if there is leakage into the monitored zone, the pressure change will be maximized in the monitored zone.
- d. The monitoring well(s) should be sited as close to the injection well as possible without risk of damage to the injection well(s) during construction, unless, upon examination of site specific information, it is determined that more information may be gained by placing the monitoring well further from the injection well.



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1.2 Construction

The operator must submit, as part of the groundwater monitoring plan, a proposal outlining the construction of the monitoring well(s). The proposal shall include: the drilling and cementing procedures to be followed during well construction, a list of all logs to be run during drilling and completion of the well, the size, amount, and grade of all casings and tubing to be used in the well, the types and amounts of cement calculated to be used on each casing string, a description of any proposed well completion procedures, a plugging and abandonment plan, and proof of financial resources to plug and abandon the monitoring well. The operator shall also submit a diagram showing the proposed well construction along with the site geology. This diagram can be included on the stratigraphic column showing the monitoring zone described above. The plan must be approved by EHS prior to construction. The acceptability of the construction plan will be evaluated based on the following criteria:

- a. The monitoring well(s) shall be constructed to prevent the movement of fluids into or between USDWs for the expected life of the well(s) by cementing all casings from the base of the casing to the ground surface.
- b. Monitoring should take place through tubing with a packer set within the casing as close to the base of the long string as practicable. An alternative system which provides equivalent mechanical integrity protection and equivalent quality assurance for fluid sampling may be approved by EHS.
- c. A complete list of all proposed logs and tests must be approved by the Authority prior to construction. The Director may require additional logs and tests to gather information regarding USDWs (if present) and the properties of the injection and confining zones. Such logs and tests may include drill stem tests, pumping tests, formation cores and fluid analyses. (A descriptive report interpreting the results of such logs and tests shall be prepared by knowledgeable geologists and/or engineers and submitted to EHS upon completion of the logs or tests.)

2.0 Groundwater Monitoring Well Installation Guidelines

- 2.1 Groundwater Monitoring boreholes are drilled to a depth of 3-6 m (depending on local area) beneath existing ground level using boring rig. The boreholes (see diagram on next page) can be advanced through soil deposits using a casing vertically down and by removing soil inside to form a 150 mm (6 inches) diameter hole.
- 2.2 Prior to commencing each borehole a services inspection pit should be hand dug to a depth of 1.0 m.
- 2.3 Careful attention should be paid during boring to the existence of groundwater while inserting casing.
- 2.4 The well should consist of a 5.0 m long section of 100 mm diameter PVC well screen, having a nominal slot width of 1.0 mm and surrounded by washed fine gravel.



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- 2.5 Above the screen plain casing be used to extend the well to ground level. The gravel pack is continued up to the top of the screen section and then a seal of cement/bentonite grout be placed to within 0.75 m of the ground surface followed by fine sand to 0.5 m below ground level. Concrete can be then placed around the pipe from 0.5 m below ground level to just above the surface.
- 2.6 The installation is completed by closing the PVC with a screw on top cap to about existing ground level. The installation be then encased in concrete and fitted with a lockable steel protection cover for height of about 0.3m above ground level (see Figure 20.1).
- 2.7 Ensure that perforated portion of pipe is always immersed in groundwater considering groundwater level decrease during summer.
- 2.8 Safety barriers/bollards should ideally be put around the well with a warning sign.
- 3.0 Operating Requirements for Groundwater Monitoring Wells
- 3.1 Mechanical Integrity
- a. The monitoring well(s) must have and maintain mechanical integrity so determined by tests in the United States Environmental Protection Agency Regional Guidance #5 – Determination of Mechanical Integrity of Injection Wells (http://www.epa.gov/region5/water/uic/r5guid/r5_05.htm).
 - b. A demonstration of the mechanical integrity of the casing, tubing, and packer shall be made upon completion of the wells and once every twelfth month thereafter, or, if an alternative system is used, upon completion of the well and prior to each sampling event. A demonstration that there is no significant fluid movement through vertical channels adjacent to the well bore shall be made by use of a radioactive tracer survey, cement bond logs, and/or other approved logs upon completion of the well. Mechanical integrity shall also be demonstrated any time the tubing is removed from the well, the packer is reset, or loss of mechanical integrity becomes suspected during operation. Mechanical integrity demonstrations must be witnessed by an authorized representative of the Authority.
- 3.2 Operations
- a. If the well is completed with tubing and packer, the annulus between the tubing and the long string casing shall be filled with a fluid approved by the Authority. A positive pressure shall be maintained on the annulus at all times.
 - b. The client shall submit monthly reports presenting the monitoring well annulus pressure, the monitored zone formation pressure and injection pressure on a single graph.



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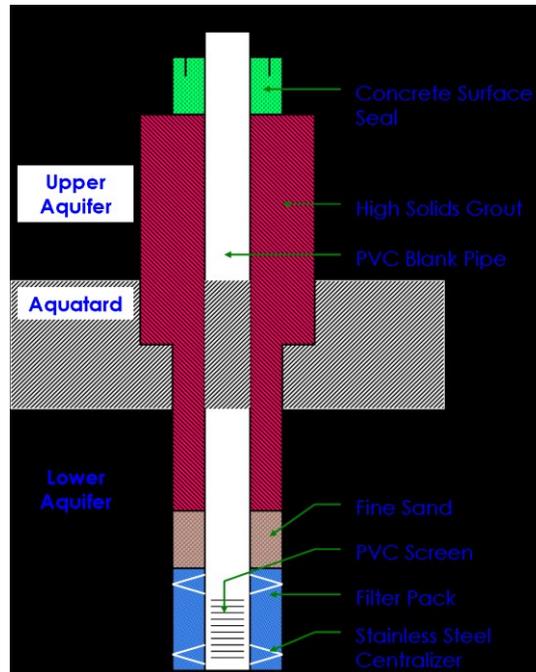
3.3 Monitoring

- a. A fluid sample from the monitored zone shall be taken upon completion of the well. The sample shall be taken after the zone has been produced by pumping, swabbing, or other production means to eliminate contaminants introduced during drilling. The means of assuring this goal is to produce the zone until indicators such as conductivity, pH and chloride content have stabilized. If no trace of the injection fluid constituents or any degradation product thereof is found in the sample, the sample results will be used as a baseline for that monitored interval.
- b. Samples of the monitored zone fluid shall be taken monthly during the first quarter of the new monitoring program and quarterly thereafter. Prior to collecting the fluid sample, the well shall be pumped for a predetermined period of time to sample contamination that may have occurred as a result of leakage along the outside of the injection well. The rate and length of time that the well will be pumped shall be determined based on the pumping capacity of the well, monitored zone thickness, porosity, permeability, and the well location with respect to the injection well, and approved by the Director prior to implementation.
- c. The formation pressure of the monitored zone shall be determined by either recording the fluid level in the well weekly or recorded continuously using a down hole pressure measuring device. The barometric pressure must be recorded every time the fluid level in the well is measured.
- d. The fluid produced by pumping the monitoring well during sampling procedures may be disposed of into the injection well if the injection permit has been modified to allow the disposal of the brine. Alternative disposal methods may be used upon approval by the Director.
- e. Sampling frequencies and procedures may be changed by the Director if an anomaly in the monitoring well data is detected.
- f. If warranted, the monitoring well may serve as a pressure observation well during a transient well test conducted for the waste disposal well.



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4.0 Groundwater Monitoring Well / Borehole Diagram



5.0 Plugging and Abandonment

- 5.1 The Client shall submit a plugging and abandonment plan for the monitoring well(s). The plugging and abandonment plan must be approved by the Authority prior to construction of the well(s).
- 5.2 Operation of the monitoring well(s) may be required after the cessation of injection operations in accordance with any permitted post closure conditions that may be in effect at that time.
- 5.3 The Client shall maintain financial and environmental responsibilities and resources to close, plug and abandon the monitoring well(s).