Region V Guidelines for Class I Well Monitoring Plans

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION V

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Background

The United States Environmental Protection Agency (USEPA) Underground Injection Control (UIC) Section is currently reviewing petitions submitted by operators of Class I hazardous waste injection wells who wish to continue injection operations after the effective ban date without treating the waste. The purpose of the petition, as stated under [Title 40 of the Code of Federal Regulations] (40 CFR) 148.20(d)(2) is to demonstrate with a reasonable degree of certainty that there will be no migration of hazardous materials from the injection zone within 10,000 years.

During our evaluation of these petitions, it has been recognized that although a great deal of effort has gone into writing each petition, due to the geological conditions at some sites, such as the presence of faults, abandoned wells, or uncertainty regarding fractures in, or the physical properties of, the injection or confining zone, groundwater monitoring will provide additional assurance that the injected waste will not migrate from the injection zone. The USEPA regulations at 40 CFR 148.20(d)(2) allow the petition demonstration to include a groundwater monitoring plan to enhance confidence in one or more aspects of the demonstration.

If the agency decides that it is prudent for the petitioner to exercise the option of groundwater monitoring as part of his/her Class I injection operation, this option will be recommended to the petitioner. In that case, an acceptable groundwater monitoring plan should be submitted as a supplement or as part of the petition document before a draft approval is issued by the Agency. The operator may not begin construction of the monitoring well(s) until a complete groundwater monitoring plan has been approved by the USEPA. The following criteria regarding siting, construction, and sampling of the monitoring well(s) are intended to inform Class I operators of the information they must consider when preparing their groundwater monitoring operations. The guidelines have been divided into two parts; Part I describes the type of data that must be submitted to USEPA in the groundwater monitoring plan, and Part II describes the guidelines for operating a groundwater monitoring well(s).

PART I. Information to be Included in a Groundwater Monitoring Plan

A. Siting

The operator 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 permeabilities, injection interval, containment interval, and lowest [Underground Source of Drinking Water] (USDW). 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.

1. 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.
2. The ideal monitored interval should extend throughout the area of review, have adequate permeability, and be relatively thin.[1]
3. If present, a monitoring interval should be chosen that has a 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.
4. 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.

[1] 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.

B. 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 in Part I(A) Siting. The plan must be approved by USEPA prior to construction.[2] The acceptability of the construction plan will be evaluated based on the following criteria:

1. 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.
2. 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 USEPA. Examples of single, dual, and multiple completion monitoring wells using packer and tubing are shown in Attachment A.
3. A complete list of all proposed logs and tests must be approved by the Director prior to construction. The Director may require additional logs and tests to gather information regarding USDWs 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 the Director upon completion of the logs or tests.)

[2] Upon approval by the USEPA, monitoring well(s) may be constructed to monitor multiple zones; new Class I injection wells may be constructed to monitor specified zones through the annulus (An example of a dual injection/monitor well is shown in Attachment B); and proposed injection wells or stratigraphic test wells may be drilled and converted to monitoring wells.

PART II.Operating Requirements For Groundwater Monitoring Wells

A. Mechanical Integrity
   1. The monitoring well(s) must have and maintain mechanical integrity so determined by the tests in 40 CFR 146.8.
   2. 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 wellbore 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 Director.
B. Operations
   1. 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 Director. A positive pressure shall be maintained on the annulus at all times.
   2. The operator shall submit monthly reports presenting the monitoring well annulus pressure, the monitored zone formation pressure and injection pressure on a single graph.
C. Monitoring
   1. 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.

2. 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.[3] The rate and length of time that the well will be pumped shall be determined cased 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.
3. 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 downhole pressure measuring device. The barometric pressure must be recorded every time the fluid level in the well is measured.
4. All fluid sampling procedures and sample analyses shall be conducted according to the waste analysis plan contained in the operator's UIC Class I hazardous waste injection permit. A revised waste analysis plan may have to be submitted by the operator to USEPA to include monitoring well sampling procedures.
5. 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.
6. Sampling frequencies and procedures may be changed by the Director if an anomaly in the monitoring well data is detected.
7. If warranted, the monitoring well may serve as a pressure observation well during a transient well test conducted for the waste disposal well.

[3] The following formula may be used to calculate the necessary volume sufficient to fill a cylinder of the monitored zone rock with a height equal to the thickness of the monitored zone and a radius equal to the distance from the injection well less a factor for the incomplete displacement of native fluid;

$V = S * (F * (h * p * r^2))$ where:

S = Estimate of sweep efficiency

V = Volume to be pumped

F = Porosity

h = Monitor zone thickness (ft.)

r = Distance from injection well to monitoring well (ft.)

D. Plugging and Abandonment
   1. The operator shall submit a plugging and abandonment plan for the monitoring well(s) that is consistent with 40 CFR 146.10. The plugging and abandonment plan must be approved by the Director prior to construction of the well(s).

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.
3. The operator shall maintain financial responsibility and resources to close, plug, and abandon the monitoring well(s) in a manner consistent with 40 CFR 144.52(a)(7) and 40 CFR 144.60 through 144.70.

ATTACHMENT A

Examples of Single, Dual, and Multiple Completion Monitoring Wells

Figures 1 and 2 modified from:

Evaluation of Certain Crucial Issues Regarding
the Use of Hazardous-Waste Injection Wells
for U.S. Environmental Protection Agency

prepared by
Mankin, Charles, Tola Moffett, and Laura Whitaker, 1988

Figure 3 modified from:

Black, W.H., H.R. Smith, and F.D. Patton, 1986. Multiple-Level Ground Water Monitoring With the MP System. in "Proceedings of the NWWA-AGU Conference on Surface and Borehole Geophysical Methods and Groundwater Instrumentation". Denver, CO. 1986, pp. 41 - 61.

Figure 1 - Single Zone Monitoring Well

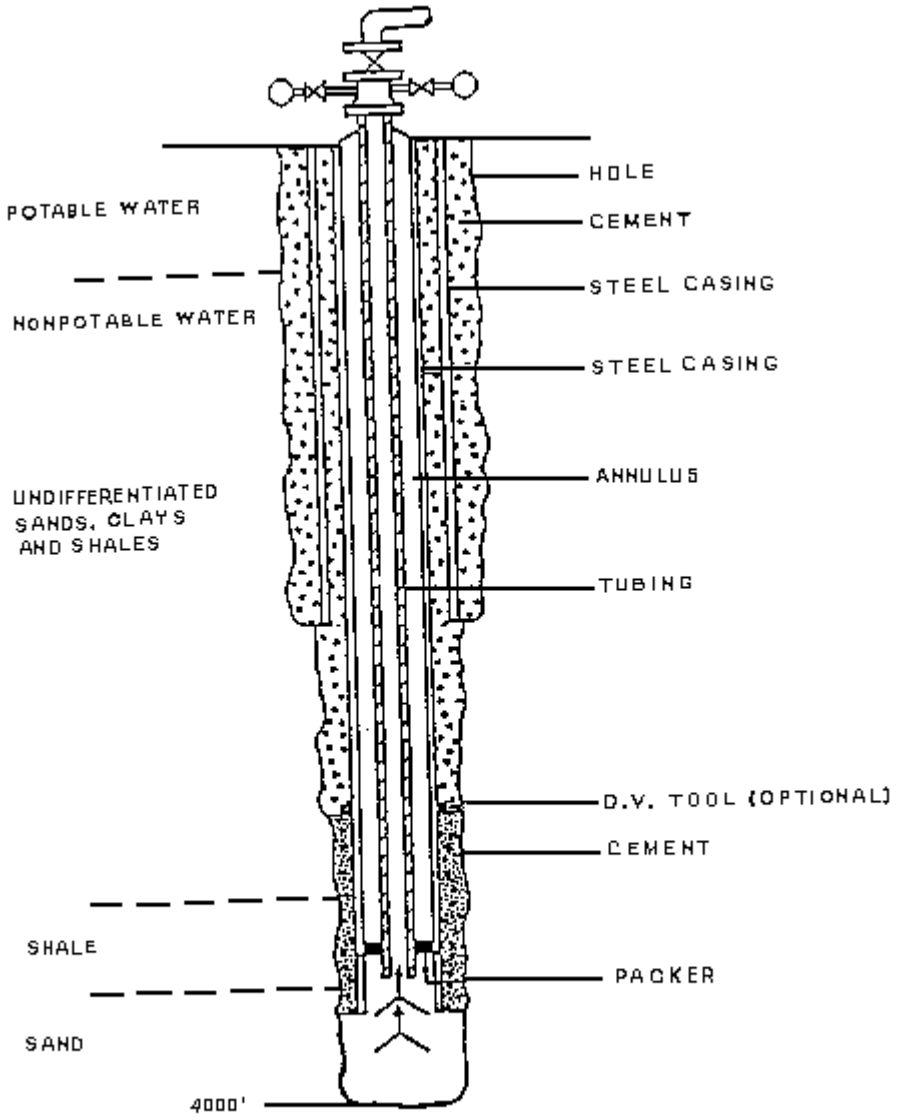


Figure 2 - Dual Zone Monitoring Well

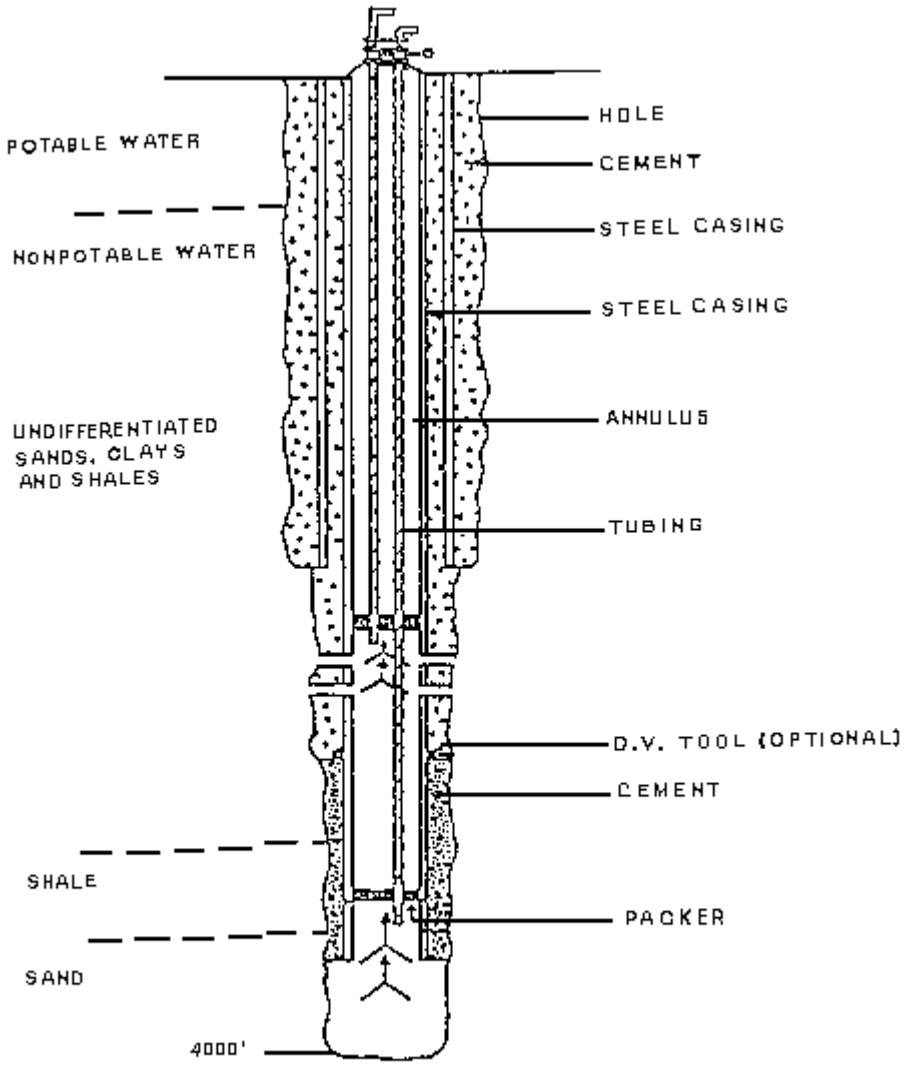
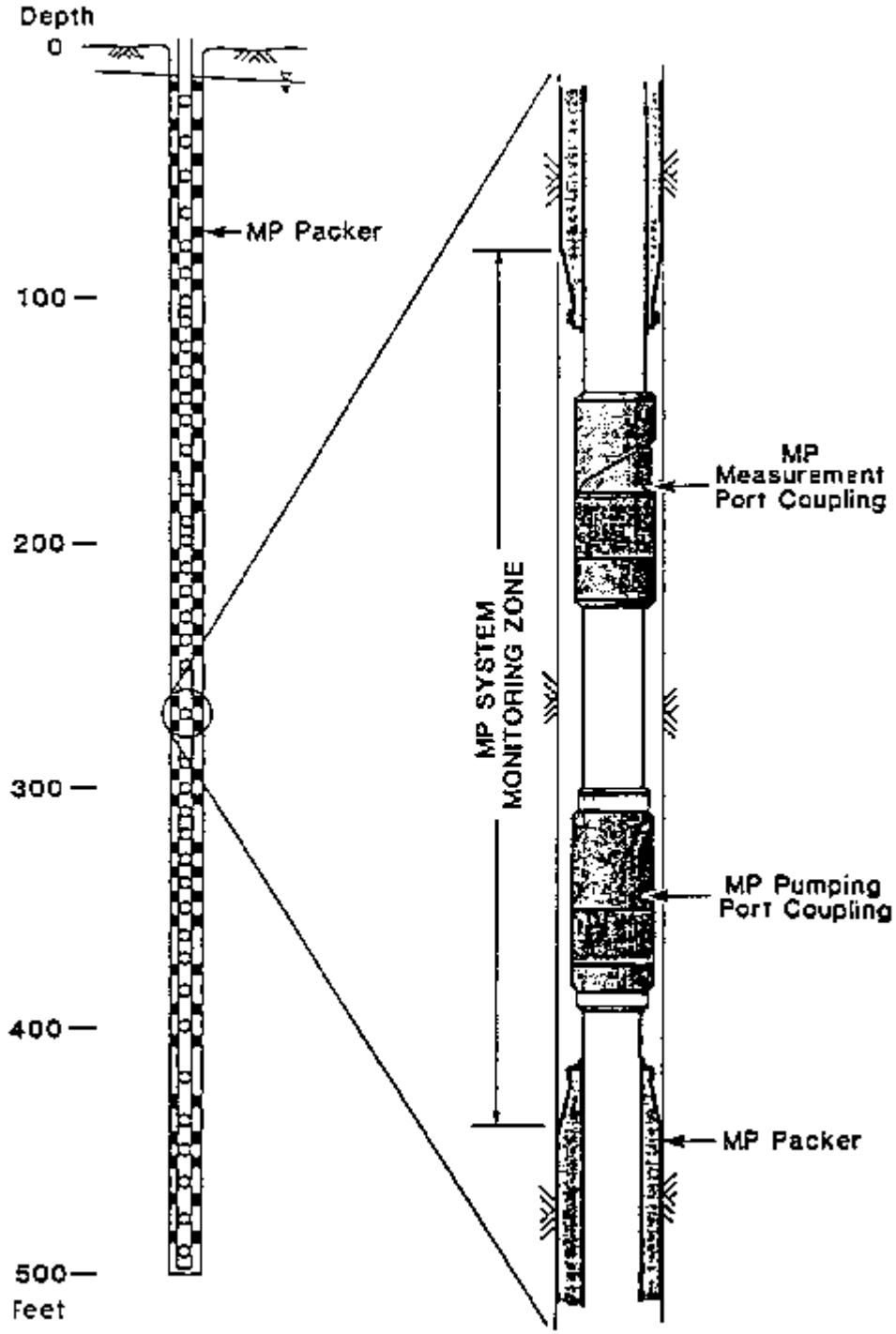


Figure 3 - MP System Installation with Monitoring Zones Isolated by Packers



ATTACHMENT B

Example of a Dual Injection/Monitoring Well

modified from:

Poimboeuf, W.W., personal communication, 1988