Chapter II.

PLACEMENT OF DETECTION MONITORING WELLS

The purpose of this chapter is to examine criteria the owner/operator should use in determining the number and location of detection monitoring wells. The actual placement and construction details of the detection monitoring system are based on the hydrogeologic data gathered prior to the system installation. Monitoring systems should not be designed until preliminary test data is available.

Upgradient monitoring wells provide background ground-water quality data. Upgradient wells should be (1) located beyond the upgradient limit of the waste management unit so that they reflect background water quality, (2) screened at the same stratigraphic horizon(s) as the downgradient wells to ensure comparability of data, and (3) of sufficient number to account for natural variations in background ground water quality.

Downgradient wells must be located, screened, and sufficiently numerous to provide a high level of certainty that releases of constituents from the waste management unit(s) to the uppermost aquifer will be immediately detected. Downgradient wells must be located at the edge of the waste management units. Distance between wells is chiefly a function of site geology and the nature of the waste disposed. Although every detection monitoring system must ultimately be judged against site specific conditions, there are a number of well-placement criteria that apply to ensure that detection monitoring systems are adequate. These criteria are discussed on the following pages.

Horizontal Spacing Between Downgradient Monitoring Wells

Downgradient detection monitoring wells must be spaced to assure that contaminant leakage will be immediately detected. Deciding whether monitoring wells are properly spaced requires analysis of site-specific conditions. Table II-1 illustrates several factors that may be used to determine the proper spacing.

Final determination of adequate spacing will often come after discussion with representatives of EPD.

TABLE II-1

FACTORS USED TO ADJUST HORIZONTAL SPACING OF MONITORING WELLS

CLOSER SPACING REQUIRED

- Manages or has managed liquid waste
- Is very small (i.e., the downgradient perimeter of the site is less than 150 feet).
- Has a double liner (and may leak over a relatively small area).
- Has waste incompatible with liner materials.
- Is an old facility, with less certainty on design features and past waste disposal practices.
- Has fill material near the waste management units (where preferential flow might occur).
- Has buried pipes, utility trenches, etc., where a point-source leak might occur.
- Has complicated geology
  - closely spaced fractures
  - faults
  - tight folds
  - solution channels
  - discontinuous structures
- Has heterogenous conditions
  - variable hydraulic conductivity
  - variable lithology
- Is located in or near a recharge zone
- Has a high (steep) or variable hydraulic gradient.

WIDER SPACING ALLOWED

- Has never managed liquid waste.
- Is new, with more certainty on facility design features and planned/current waste disposal practices.
- Uses appropriate and proven geophysical techniques to supplement monitoring wells in the detection monitoring program.
- Has simple geology
  - no fractures
  - no faults
  - no folds
  - no solution channels
  - continuous structures
- Has homogeneous conditions
  - uniform hydraulic conductivity
  - uniform lithology
- Has a low (flat) and constant hydraulic gradient

Depth of Wells/Vertical Sampling Interval(s)

Site specific hydrogeological data generated during the site characterization is also necessary for the identification of the vertical sampling interval(s). Proper selection of the vertical sampling interval provides a third dimension to detection monitoring.

Depth of Wells

Depth of detection monitoring wells should be determined by test drilling. Detection monitoring wells should be no deeper than necessary to monitor the first water-bearing horizon encountered year-round. Information on depth to the uppermost aquifer is often available from EPD. Please call if in doubt. It is important to screen upgradient and downgradient wells at approximately the same geologic horizon to obtain comparable data.

Thickness of the Vertical Sampling Interval(s)

Determination of the appropriate thickness of the vertical sampling interval(s) is an extension of the depth selection. The owner/operator should make the decision on the basis of test borings. Other sources of data could include hydrogeologic publications, and EPD or U.S. Geological Survey (USGS) files.

In most cases, monitor-well screens should be no longer than ten feet. Shorter screens promote better resolution of contaminant concentrations than longer screens. At sites where the vertical sampling interval is greater than ten feet, the owner/operator may wish to install a well cluster at each sampling location. A well cluster is a number of wells grouped closely together but screened at different levels.

It is important to remember that the vertical sampling interval is not necessarily synonymous with aquifer thickness. In other words, the owner/operator may select a vertical sampling interval which represents a fraction of the thickness of the uppermost aquifer. The selection should be made on the basis of test borings and the characteristics of the potential pollutants. A sufficiently detailed test boring program may therefore reduce the need for the owner/operator to install more speculative wells by identifying the depth and thickness of the uppermost aquifer. The owner/operator thus tailors the selection of the vertical sampling interval to site-specific conditions.

There are situations where the owner/operator should have multiple wells at a sampling location and others where typically one well is sufficient. These situations are summarized in Table II-2. Generally, the presence of immiscibles in a thick, complex saturated zone of the uppermost aquifer should prompt the owner/operator to use well clusters. Conversely, single phase contaminated ground water and a thin saturated zone within the uppermost aquifer, or isotropic hydrologic properties reduce the need for multiple wells at each sampling location. Where seasonal fluctuation of the water table occurs and the owner/operator intends to sample for light phase immiscibles floating on the water surface, the owner/operator should always use screens long enough to intercept the water table.

TABLE II-2

FACTORS AFFECTING NUMBER OF WELLS PER LOCATION (CLUSTERS)

One Well Per Sampling Location	More than One Well Per Sampling Location
. No "sinkers" or "floaters (immiscible) liquid phases	. Presence of sinkers or floaters
. Thin flow zone (relative to screen length)	. Heterogeneous uppermost aquifer; complicated geology - multiple, interconnected aquifers - variable lithology - perched water table discontinuous structures
. Homogenous uppermost aquifer; simple geology.	. Discrete fracture zones

When the site hydrogeologic data indicate the presence of different but hydraulically interconnected strata, some of the wells should be screened with the bottom of the screens placed at the interface between the strata. Also, the owner/operator should have delineated through site characterization (e.g. flow net analysis) those flow zones in the aquifer(s) in which there is higher potential for contaminant movement. The owner/operator should install enough wells to ensure continuous screening in these zones. As above, these screens should not be longer than ten feet in flow zones in which a higher potential for contaminant movement exists.

Placement of Upgradient (Background) Monitoring Wells

The owner/operator must install background wells so that the ground-water samples taken from these wells cannot be affected by contaminant discharge from the facility. Usually, this is accomplished by locating the background wells far enough upgradient from waste management units to avoid contamination by the facility.

The minimum number of upgradient wells the owner/operator may install is one. However, a facility that uses only one well for background sampling may not be able to account for spatial variability in water quality. The owner/operator who makes comparisons of background and downgradient monitoring well results with data from only one background well increases the risk of a false indication of contamination.

The owner/operator should also install enough background monitoring wells to allow for depth-discrete comparisons of water quality. This means simply that for downgradient wells completed in a particular geologic formation and at a particular depth, the owner/operator should install corresponding wells at the upgradient sampling locations so that the data can be compared on a depth-discrete basis.

Defining Contamination

Contamination has been defined as the presence of significantly elevated levels of a chemical parameter and/or a significant physical change in water quality caused by the activities of man. To determine if aquifer contamination is taking place, the laboratory results from wells located downgradient of the site must be compared with data from the upgradient wells. Often, contamination is evident simply by inspection of water quality data. For instance, if a downgradient well has a specific conductance that is two or three times the upgradient level, then the site being monitored is probably contributing constituents to the ground water.

In other instances, the answer to the question of contamination may not be as evident. Statistical analysis of trends in chemical data comparing upgradient wells to downgradient is a more definitive approach. For each indicator parameter specified in the design and operation plan, the owner/operator should calculate the arithmetic mean and variance, based on at

least four replicate measurements on each sample, for each well in the detection monitoring system, and compare these results with the initial background arithmetic mean. The comparison must consider individually each of the wells in the monitoring system, and must use the Student's t-test to determine statistically significant increases (or pH decreases) over initial background. An acceptable method is detailed in Appendix I. Further information on Student's t-testing is available in many textbooks on elementary statistics.

A Student's t-test for a downgradient well that shows a significant increase in an indicator parameter (or significant change in pH), signals potential ground-water contamination and is the first indication that a facility may be leaking. If a significant change is detected, the facility moves into ground-water assessment, the second stage of monitoring.

Assessment of Contamination

If, during the detection stage, it is established that potentially harmful constituents are being released to the environment, an assessment of contamination will be required. The objectives of an assessment are to define what contaminants are present in the ground water, and to find out how far they have migrated.

An assessment usually involves the installation of several additional monitoring wells. The assessment wells are usually sampled and tested for specific contaminants known to be present in the wastes, although general indicator parameters may be acceptable in specific instances.

Extensive guidance on assessment is available in the RCRA Ground-Water Monitoring Technical Enforcement Guidance Document, available through Government Printing Offices. Throughout the ground-water monitoring process, facility owners, operators, managers, and elected officials are encouraged to contact the Environmental Protection Division if there are any questions. Often, problems solved at other facilities can provide valuable information which saves time and money.