

TITLE: **Post-Remedy Verification Ground Water Monitoring for VAP Projects**

DATE EFFECTIVE: September 2014

HISTORY: New to the technical guidance compendium.

KEYWORDS: Ground water, remedial activities, remedy, operation and maintenance plan, monitoring, applicable standards, voluntary action.

BACKGROUND: Ground water monitoring is typically conducted at several points in the remedial process for various purposes, site characterization, implementation of the remedy, and post-remedy verification to name a few. *Verification monitoring* is distinguished from other types of monitoring as described below:

Site Characterization Monitoring. Site characterization monitoring can range from very limited to extensive number of ground water monitoring locations and cover a period of months to many years. The general purpose of site characterization monitoring is to determine hydrogeologic characteristics at the site, and to determine the concentrations of contaminants of concern (COCs) and, if necessary, determine the nature and extent of contamination. It may also be conducted to determine a variety of other factors deemed necessary at a particular site. This is typically done prior to the remedy evaluation and determination. If characterization monitoring data exist, they may be useful for providing a gauge by which the effectiveness of the selected remedial efforts can be assessed.

Implementation of the Remedy and Achievement of Applicable Standards Demonstration. During the remediation phase, contamination in ground water is either actively or passively being reduced. During this phase, ground water needs to be monitored to assess the effectiveness of the remedy. This phase could require many years of ground water monitoring, and will continue until the remedy has achieved the standards required at the compliance point.

Post-Remedy Verification Monitoring. Verification monitoring is conducted to establish that the property/facility/site has met applicable ground water standards at the compliance point after a remedy has initially achieved those standards. This monitoring is typically designed to look for rebound after remedy shut down and to establish

that long term trends of the COC will not result in a future exceedance of applicable standards.

In the VAP, if a remedy for ground water has been initiated but applicable standards have not been met or verified at the time the covenant not to sue (CNS) is requested, then an operation and maintenance (O&M) plan is needed. The time frame for cleanup should be specified in the plan. Once applicable standards are achieved, verification monitoring should commence in accordance with this guidance. Generally, remedial activities must achieve applicable standards within five years, inclusive of verification monitoring, or such other time frame agreed to by the director in accordance with an O&M agreement.

RULE/

AUTHORITY:

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QUESTION:

How much verification ground water monitoring should be conducted after a required remedy has achieved ground water standards to ensure that further implementation of remedial activities is unnecessary under the Voluntary Action Program (VAP)?

ANSWER:

Once it is established that a remedy has achieved applicable standards, verification monitoring is required to ensure that further implementation of remedial activities is unnecessary for the property/site to remain in compliance with the applicable standards. At a minimum, the following provides guidance on conducting verification monitoring. Additional guidance can be found in U.S. EPA 2014, *Recommended Approach for Evaluating Completion of Groundwater Restoration Remedial Actions at Groundwater Monitoring Wells*.

1. At VAP properties, verification monitoring should be conducted for a minimum of eight consecutive sampling events collected quarterly over a period of two years.
2. Post-remedy verification monitoring should not start until it has been established that all standards have been met at all the wells at the compliance point. (Starts no sooner than one quarter after ground water results are at/below the applicable standard.)
3. The direct or indirect influence of the remedy needs to be assessed prior to starting the recommended minimum eight consecutive sampling events.

Example 1 Fluid Injection: If fluids are injected to promote degradation, the minimum eight consecutive sampling events should not begin until proxy data (e.g., injectate concentrations, redox parameters, daughter product concentrations, etc.) demonstrate that the injected fluids are no longer affecting ground water quality. If the volunteer is injecting a biological amendment (e.g., molasses) to promote reducing conditions in the saturated zone, it is recommended that pre-treatment background samples be collected for the following redox parameters: total organic carbon, dissolved oxygen, oxidation-reduction potential, nitrate/nitrite, manganese, iron and sulfate, and that these redox parameters be used as proxies to demonstrate that the injected fluids are no longer affecting ground water quality, as appropriate.

Example 2 Pump and Treat: The minimum eight consecutive quarters of verification monitoring should not begin until pumping has stopped and the ground water elevation levels have returned to pre-pumping conditions.

Example 3 Monitored Natural Attenuation: Verification monitoring should start after the property-specific evaluation and monitoring have met their performance objectives. (U.S. EPA guidance, Wilson, 2011 and Ohio EPA 2001).

4. Verification monitoring should include COCs plus any daughter COCs and by-products created or mobilized directly or indirectly from the remedy.
5. Verification Monitoring Data Analysis: Comparison to standard and statistical trend analysis

Step 1 Comparison to Standard: Compare all post-remedial sample results to the applicable standard.

- If all eight consecutive results for each well for each COC are below the applicable standard, compliance with the applicable standard has been demonstrated.
- If any sample result exceeds the standard¹, compare the 95 percent upper confidence limit (95 percent UCL) on the mean

¹ If a monitoring result indicates an exceedance, the volunteer or owner/operator may automatically retest the specific well(s) for the particular parameter(s) that indicated an exceedance. Unless both the original result and the retest indicate an exceedance, the sample result will not be treated as an exceedance. If the resample does not exceed its particular limit, that resample result may be used in statistics in place of the original result. The resample must be taken prior to the next scheduled sampling event such that it will provide an independent sample result. (Federal Register (Vol 47, No. 143, page 32303) and OSWER Directive 9481.1985(01b)).

(or median or upper percentile, as appropriate) of the post-remedial samples to the applicable standard. If the 95 percent UCL does not exceed the applicable standard and the last sample result does not exceed the applicable standard then compliance with the applicable standard has been demonstrated.

- If the 95 percent UCL exceeds the standard OR the last sample result exceeds the applicable standard, then compliance with the applicable standard has NOT been demonstrated. The remedy verification process would continue, or additional remedial actions may be required. If the project is trying to achieve applicable standards in the VAP during O&M, then the CNS is out of compliance with applicable standards if remedy verification has not occurred within the required two year timeframe. In these instances the volunteer would be obligated to bring the property back into compliance using the opportunity to cure approach followed by a compliance schedule agreement if a cure has not been achieved. Otherwise, the CNS is subject to revocation.

Step 2 Statistical Test: Once the remediation standards are met, trend analysis techniques, such as the Mann-Kendal test, should be used to establish that COC concentrations are statistically decreasing or stable at an appropriate alpha level and database size. (See U.S. EPA, March 2009 for guidance on statistical analysis). The trend test may not be used in place of meeting the remediation standards. The trend test should demonstrate that there is not a statistically significant increasing trend for any COC for any well in the post-remedial data. The following minimum conditions should be applied in the statistical trend analysis:

- Minimum of eight consecutive, statistically independent, post-remedial sample results including the last result (same data set as comparison to standard).
- Minimum of two years sampling period.
- Type I error rate of no less than five percent on upper tail.
- If a trend analysis conducted consistent with the above parameters shows no statistically significant increasing trend or shows a decreasing trend, then post-verification monitoring has been achieved and the monitoring may cease. If a statistically

significant increasing trend is detected in the trend test for any COC at any well, then compliance with the applicable standard has NOT been demonstrated. The remedy verification process would continue, or additional remedial actions may be required. If the project is trying to achieve applicable standards in the VAP during O&M, then the CNS is out of compliance with applicable standards if remedy verification has not occurred within the required two year timeframe. In these instances the volunteer or property owner would be afforded an opportunity to cure in which to bring the property back into compliance with applicable standards. Otherwise, the CNS is subject to revocation.

REFERENCES: U.S.EPA, March 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance. Environmental Protection Agency. Office of Resource, Conservation, and Recovery.

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U.S. EPA 2014. Recommended Approach for Evaluating Completion of Groundwater Restoration Remedial Actions at Groundwater Monitoring Wells. OSWER 9283.1-44. August 2014
<http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/GWcompletion-recommendedapproach-final-8.4.2014.pdf>

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