

NC Solid Waste Section Guidelines for Alternate Source Demonstration Submittals for Solid Waste Management Facilities

STATE OF NORTH CAROLINA
DEPARTMENT OF ENVIRONMENTAL QUALITY DIVISION OF WASTE MANAGEMENT
SOLID WASTE SECTION

The intent of this Alternate Source Demonstration (ASD) submission guideline for all solid waste management facilities is to determine if exceedances are due to the solid waste management facility or to off-site conditions or to background constituents by:

- Assisting the regulated community with a preparation of a technically complete demonstration;
- Providing the minimum requirements for the technical content of a demonstration; and
- Reducing the need for subsequent modification(s).

Purpose of the ASD

The purpose of groundwater sampling is to determine if landfill activities affect groundwater quality and whether assessment and/or corrective action should be initiated. Monitoring data collected over the past decades has demonstrated that the volume of waste received per day does not necessarily correlate to the type of constituents detected in groundwater. Regardless of daily disposal rates, the waste types have historically been causing consistent threats to groundwater. It is important to note that groundwater standards may change over time as more information becomes available on the toxicological effects of various elements and compounds.

It is also important to consider contaminant processes when interpreting landfill groundwater quality data. Some constituents detected in groundwater may not be present in the landfill waste, and instead they may be present in groundwater because of chemical changes brought about by the presence of the landfill itself. For example, elevated metals can result from leaching of those metals from a landfill, however, the elevated metals may result from changes in groundwater pH and the effect this has upon the solubility of these metals. Similarly, vinyl chloride may originate from waste and be detected because it has not biodegraded, or it may be the end product of the biodegradation of other volatile organic compounds released from the landfill. Therefore, if any of these constituents are detected, more than one possible explanation of the source must be considered.

Background concentrations may periodically be updated throughout the active life and closure of the landfill because aquifer conditions may change over time. Evaluation of the background monitoring well, including installation of additional background monitoring wells may also be useful throughout the life and post closure care of the facility. The greater the number of background monitoring wells that exist at a facility, the more accurate a background standard can be calculated for the facility. In some cases, a moving window approach may be applicable with the most recent 8-10 sampling events used as the background. If there are no clear trends, then the newer data can be pooled with the older background data. Also, increasing trends in background do not necessarily suggest an off-site source of contamination. For example, background monitoring wells can be impacted by landfill gas which follows the path of least resistance and does not necessarily travel downgradient.

Key Points Regarding an ASD

- The ASD is a technical demonstration that requires conclusions that are supported by site specific facts and site specific analytical data;

- The ASD should not contain assumptions or hypothetical conclusions;
- The ASD must be conclusive, not just probable or possible;
- The ASD requires field evidence; and
- If the cause of the suspect groundwater sampling exceedance(s) is concluded to be an alternate source, it must be:
 - An identified source other than the landfill and/or
 - On-site variability, and/or
 - An error during sampling or analysis.

Lines of Evidence

The *EPA Solid Waste Disposal Facility Criteria Technical Manual* dated November 1993 defines the lines of evidence an owner/operator should pursue for an ASD:

1. An alternate source exists;
2. A hydraulic connection exists between the alternate source and the well with the increase;
3. Constituent(s) (or precursor constituents) are present at the alternative source or along the flow path from the alternate source prior to possible release from the unit;
4. The relative concentration and distribution of constituents in the zone of the contamination are more strongly linked to the alternative source than to the unit when fate and transport characteristics of the constituents are considered;
5. The concentration observed in groundwater could not have resulted from the unit given the waste constituents and concentrations in the unit leachate and wastes, and site hydrogeologic conditions; and
6. The data supporting conclusions regarding the alternative source are historically consistent with hydrogeologic conditions and findings of the monitoring program.

At the minimum, the NC Solid Waste Section will require a complete technical ASD to address the first three lines of evidence (1-3). If the first three items are not met, the ASD is considered incomplete. The NC Solid Waste Section will either require additional information or disapprove the ASD. The landfill will then be required to initiate Assessment Monitoring if the landfill is a .1600 MSWLF in accordance with 15A NCAC 13B .1634 or a .0544 CDLF in accordance with 15A NCAC 13B .0545. All other landfills such as unlined and closed MSWLFs, CDLFs, and Industrial Landfills will be required to conduct additional assessment activities in accordance with 15A NCAC 13B .0503, 15A NCAC 2L, and the landfill's closure letter and/or closure permit.

The last three lines of evidence (4-6) may also be used to support the first three lines of evidence.

Fluctuations in inorganic constituent concentrations due to seasonal, temporal or spatial variability, effects of groundwater monitoring well installation, and sampling induced biases makes absolute determination of landfill impacts difficult based on statistical evaluation alone. Even with adequate background sample size and confirmation resampling, the potential for false positives is great given the number of samples collected and potential sources of error. Thus, field investigations with multiple lines of evidence are a requirement in an ASD. The installation of additional background monitoring wells may also be required.

The acceptance of ASDs are well-specific, constituent-specific, and concentration-specific. If the concentration of a constituent that was covered by an ASD increases, the previously accepted demonstration may no longer be satisfactory and assessment monitoring and assessment activities may be triggered unless a new demonstration is accepted. In addition, if concentration data from the downgradient samples are higher than the background sample(s), a contribution from the waste mass cannot be ruled out, and ASD acceptance cannot be issued without further supporting information.

Definitions

- *Background* refers to concentrations of chemicals at locations that are unaffected by any current or past site activities involving the management, handling, treatment, storage or disposal of solid waste. Background includes concentrations of both anthropogenic and naturally occurring chemicals:
 - 1) *Anthropogenic* – natural and human-made substances present in the environment as a result of human activities (not specifically related to the waste disposal site in question); and,
 - 2) *Naturally occurring* – substances present in their unaltered form or altered solely through naturally occurring processes or phenomena, in a location where they are naturally found.
- *Upgradient* refers to areas and locations that are topographically and/or hydraulically upgradient of the waste disposal.

Soil Sampling

Metals concentrations within soil near the ground surface may be different from those present in the underlying aquifer as a result of the addition of material to the soil by atmospheric fallout, animals, and anthropomorphic activities. However, these additional metals should not impact the groundwater monitoring system at the landfill. As a result, the detection of a metal found within surficial on-site soils cannot be interpreted as an alternate source for the same metal being detected and exceeding in downgradient and side gradient monitoring wells unless vertical transport of the metal is technically demonstrated.

Discrete subsurface soil samples should be collected above the water table from multiple depth intervals and at locations not influenced by the landfill. Surficial soil samples and composite soil samples will not be accepted. To withstand technical and regulatory scrutiny, natural background data should be collected within a geologic unit and soil type like that found in the contaminated area, from a comparable soil profile depth, hydraulically upgradient, outside the influence of site activities or other contaminant sources, and close to the site. Anthropogenic background data should represent a larger area and be collected from locations on all sides of the site outside the source area and/or other contaminant source influences. After any obvious outliers are removed from the background data sets, the upper end of the range of concentrations can be used to establish background concentrations. Leachability testing should also be used.

Non-detect sample results with a method detection limit above the North Carolina Protection of Groundwater Preliminary Soil Remediation Goal (PSRG) will be excluded from the background soil dataset.

Groundwater Sampling

At a minimum, background data should be collected from a hydraulically upgradient location or locations in immediate proximity to the site and within the same groundwater horizon (depth/zone). The number of background monitoring wells and samples will be driven in part by the size, geology, hydrogeology, the requirements of statistical methods, and/or other goals of the site assessment. If turbidity appears to be a problem, sampling methodology and monitoring well redevelopment should be addressed.

Baseline Sampling

Groundwater samples collected from both the background and downgradient monitoring wells prior to waste disposal may be useful in establishing background water quality at a landfill. The baseline sampling may also be useful to account for both seasonal and spatial variability in groundwater quality.

Statistical Analysis of Background

A constituent exceedance in a background monitoring well may indicate a change in the naturally occurring groundwater conditions. It is necessary to gather enough sample results from more than one background monitoring well to perform standard statistical analysis that provides an accurate estimate of those naturally occurring levels. Groundwater samples reported with estimated concentrations (J values) shall be treated as valid measurements for statistical purposes. All statistical analyses should be consistent with the *EPA Statistical Groundwater Monitoring Data at RCRA Facilities Unified Guidance* dated March 2009.

Statistical background levels should be calculated using monitoring data where the turbidity values are less than 10 Nephelometric Turbidity Units (NTUs). Turbidity measurements must be submitted along with the sample data to demonstrate whether suspended sediments are playing a role. Statistical background concentrations should be calculated using analytical data from a minimum of 10 groundwater samples with turbidity values less than 10 NTUs. If there is an insufficient number of previous background samples with turbidity values less than 10 NTUs or no field notes to verify the turbidity values, a temporary groundwater monitoring schedule should be established to collect the required minimum number of samples from the background well within a two-year period, and turbidity values should be recorded and submitted to the NC Solid Waste Section during the temporary monitoring period.

Outliers are values that are not representative of the population from which they were sampled and whose presence can significantly alter statistical results. Data sets should initially be screened for potential outliers visually using box-and-whisker and Q-Q plots. Following the visual assessment of data for potential outliers, data sets should be screened for outliers quantitatively. Dixon's or Rosner's Outlier tests are identified in the Unified Guidance (USEPA 2009) and should be utilized. Dixon's Outlier Test is suitable for data sets containing less than 25 samples, whereas Rosner's test is applicable for data sets containing greater than 25 samples. Both tests assume data are normally distributed.

If statistical outliers have been detected, review the values to determine if they should be removed from the data set or are representative of background and should be retained for statistical analysis. Provide technical reasons why a statistical outlier should be included or excluded from either groundwater background data sets.

Constituents in groundwater at background well locations may experience predictable recurring increases and decreases in concentrations that is termed seasonality. Seasonality within a data set can introduce bias into the calculation of background levels and result in falsely identifying a seasonal effect as potential impacts. Data should be assessed for seasonality once an adequate number of background groundwater samples have been collected.

Calculation of New Background Levels

Regulations regarding NC groundwater quality standards provided in 15A NCAC 02L .0202(b)(3) states that where naturally occurring substances exceed the established standard, the standard shall be the naturally occurring concentration as determined by the Director.

Non-filtered (total) groundwater results will be used to establish the new background levels. Turbid samples will not be accepted to calculate new background levels. Statistical background levels derived from turbid samples may not accurately reflect background conditions.

Groundwater data will not be included in the development of new background levels when the turbidity of the groundwater sample was reported to be greater than 10 nephelometric turbidity units (NTU) or when pH is greater than 8.5.

A new background level that is calculated must be protective of public health and the environment. If the NC Solid Waste Section accepts the new background level, the new level would apply to all monitoring wells within the same groundwater monitoring network including background, downgradient and/or side-gradient wells that monitor for potential releases from the landfill.

If utilizing Upper Tolerance Limits (UTLs) to establish new background levels, please ensure the following:

- UTLs should use a coverage proportion (p) and confidence level ($1 - \alpha$) of 95 percent.
- Record all UTLs under all parametric and non-parametric distribution models. When data sets used for producing UTLs can be fitted to multiple distribution models, a specific hierarchy preference is applied. Calculations of a specific UTL will follow the distribution hierarchy preference normal, gamma, lognormal, and nonparametric.
- The exception to the hierarchy is based on situations where the data set exhibits skewness that is moderate and higher (e.g. standard deviation of logged data is greater than 1) and sample size is small (e.g., $n < 30$). In these situations, the nonparametric UTL is preferred over lognormal UTL. Data set distributions will continue to be evaluated as additional samples are collected, with the understanding that distributions may change over time.

Dissolved Metals vs. Total Metals

Dissolved metals data (filtered) is applicable when it is paired with other forms of geochemical aquifer data and if it can be tied specifically to areas downgradient of the landfill where components may be failing.

Total metals results may be higher than historical dissolved metals results for some landfills. Elevated total metals can result from sources other than landfill waste. For example, groundwater sampling techniques involving removing volumes at high flow rates can stir up metal particulates in monitoring well casings and/or neighboring formations, which in turn, can potentially lead to elevated total metals results. As such, all landfills conducting total metals sampling should move toward low flow sampling techniques.

To recognize trends in metal concentrations it is necessary to sample for both total and dissolved metals for eight consecutive groundwater sampling events to evaluate the relationship between dissolved metals and total metal concentrations.

Natural and Spatial Variability

Solid waste often includes waste materials which contain metals which may impact the groundwater.

A landfill may be the ultimate cause of a metal exceedance by either altering the natural geochemistry of the aquifer which in turn enhances mineral sourced mobility, or by simply releasing the leached metal from waste.

The natural chemical composition of groundwater is controlled primarily by the mineral composition of the geologic unit comprising the aquifer. To reduce the probability of detecting naturally occurring differences in groundwater quality between background and side gradient and downgradient groundwater monitoring well locations, groundwater samples should be collected from the same geologic unit(s) for comparison. Even within a single geologic unit, metals may vary spatially.

Background metals calculated from only one background monitoring well will most likely not be able to address the true range of background metals potentially present. As a result, spatial variability could potentially lead to exceedances in the groundwater monitoring network for the landfill.

Seasonal groundwater fluctuations may also lead to increases in total metals concentrations in groundwater samples due to mobilizing metal containing compounds. These conclusions must be based on a demonstrated correlation between elevated groundwater sampling results and variations in precipitation utilizing groundwater elevation data. Site specific precipitation data should be obtained for this case. If the owner or operator utilizes natural and spatial variability for the ASD, the NC Solid Waste Section will require additional assessment to demonstrate whether the existing groundwater monitoring network can account for the noted variability. If the existing monitoring network cannot account for the variability, the groundwater monitoring network would be considered deficient, and installation of additional background monitoring wells and downgradient monitoring wells may be required.

Surface Water and Sediment Sampling

If surface water assessment is necessary, upstream and downstream surface water and upstream and downstream sediment samples should be collected for on-site sources of contamination to establish natural or anthropogenic background concentrations.

Landfill Gas

Landfill gas is a byproduct of waste decomposition. It is difficult to determine whether volatile organic compounds within groundwater are due to leachate or are due to landfill gas. One approach for evaluating this is to analyze landfill gas for volatile organic compounds, and determine whether these are the same volatile organic compounds that are detected within the groundwater.

Another approach is that these concentrations may be correlated with concentrations of certain dissolved inorganic constituents. Landfill gas can act as an acid or a reducing agent due to its carbon dioxide and methane content, respectively. Through geochemical processes these changes can potentially mobilize inorganic constituents within the vadose zone material. If a correlation exists between volatile organic compounds and concentrations of certain inorganic constituents, but no correlation exists with sodium or chloride, for example, in some instances this may indicate that volatile organic compounds within landfill gas have partitioned into the groundwater. This may produce different concentrations than what one would expect from leachate impacts.

However, because landfill gas is derived from the waste material within the waste mass, the NC Solid Waste Section will not allow landfill gas to be used as an alternate source. Landfill gas will need to be addressed through landfill gas remediation and/or groundwater corrective action.

Leachate

It is recommended that leachate analytical sampling data, leachate constituent concentration trends, and leachate indicator parameters be utilized within the ASD when applicable.

ALTERNATE SOURCE DEMONSTRATION OUTLINE

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- 4.0 Work Plan Description
 - 4.1 Soil Borings / Direct Push Sampling
 - 4.2 Monitoring Well Installation(s)
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