

Perimeter Air Monitoring Technical Guidance

FOR SITES UNDERGOING REMEDIATION

Contaminated Site Remediation & Redevelopment

New Jersey Department of Environmental Protection



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1. Intended Use of Guidance Document

This guidance is designed to help the person responsible for conducting the remediation to comply with the New Jersey Department of Environmental Protection (Department) requirements established by the Technical Requirements for Site Remediation (Technical Requirements), N.J.A.C. 7:26E-5.5(b)7, dated May 2012. This guidance will be used by many different people involved in the remediation of a contaminated site; such as Licensed Site Remediation Professionals (LSRP), Non-LSRP environmental consultants and other environmental professionals. Therefore, the generic term “investigator” will be used to refer to any person that uses this guidance to remediate a contaminated site on behalf of a remediating party, including the remediating party itself.

The procedures for a person to vary from the technical requirements in regulation are outlined in the Technical Requirements at N.J.A.C. 7:26E-1.7. Variances from a technical requirement or departure from guidance must be documented and adequately supported with data or other information. In applying technical guidance, the Department recognizes that professional judgment may result in a range of interpretations on the application of the guidance to site conditions. This guidance supersedes previous Department draft guidance issued on this topic, therefore decisions may differ from those made previously on a site-specific basis. Technical guidance may be used immediately upon issuance. However, the Department recognizes the challenge of using newly issued technical guidance when a remediation affected by the guidance may have already been conducted or is currently in progress. To provide for the reasonable implementation of new technical guidance, the Department will allow a 6-month “phase-in” period between the date the technical guidance is issued final (or the revision date) and the time it should be used.

This guidance was prepared with stakeholder input. The following individuals were on the committee that prepared this document:

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Certain elements of this guidance were also reviewed by the Department’s Science Advisory Board (SAB) in 2013. At the request of Former Commissioner Bob Martin, the SAB was charged with the task of providing recommendations on a series of questions dealing with Perimeter Air Monitoring (PAM) at hazardous sites undergoing remediation. Many of the SAB recommendations were taken into consideration in the development of this guidance. A copy of the SAB report may be found at <https://dep.nj.gov/sab/>.

Use of commercial or copyrighted names in this guidance document does not constitute endorsement of that product by the Department.

2. Purpose

PAM consists of tools, processes, and actions that measure and evaluate a site undergoing remediation for emissions of contaminants to the ambient air that may impact off-site human receptors. The collection and evaluation of real-time and analytical air data will aid the investigator in determining if off-site receptor exposures are maintained at levels protective of human health. PAM will also provide the opportunity for the investigator to proactively reduce potential impacts to human health before they occur.

The purpose of this document is to provide guidance on:

- When to conduct PAM;
- How to plan and execute PAM that generates quality data; and
- How to evaluate data generated from PAM and determine whether actions are needed to protect off-site receptors from the transport of contaminants released by remediation activities.

Another purpose of the PAM process is to document, through real-time and analytical data collection, that the remedial activities are meeting project and regulatory requirements. Uses of this documentation include:

- To inform stakeholders and the community of monitoring results where appropriate, the Administrative Requirements for the Remediation of Contaminated Sites (ARRCS) at N.J.A.C. 7:26C-1.7;
- To document the effectiveness of emission controls; and
- To record any actions taken to reduce emissions associated with remedial activities.

The preference in this guidance document is to utilize technologies that will generate real-time monitoring results to control adverse off-site exposures by managing site activities. Laboratory analysis will be used to corroborate the effectiveness of real-time monitoring, evaluate exposure to contaminants when appropriate detection levels cannot be achieved by real-time instruments, and to identify specific contaminants of concern.

Investigators who do not have expertise in the design and operation of PAM programs are advised to consult with a qualified professional. LSRPs are reminded that:

An LSRP shall not provide professional services outside his or her areas of professional competence, unless the LSRP has relied upon the technical assistance of another professional whom the LSRP has reasonably determined to be qualified by education, training, and experience.
See N.J.S.A. 58:10C-16(c).

This level of care is required in the rules of professional conduct issued by the Site Remediation Professionals Licensing Board. See N.J.A.C. 7:26I-6.3(e).

Any variations to the PAM program design and implementation procedures must conform to the overall Technical Requirements at N.J.A.C. 7:26E-1.1(a). As such, there is an expectation that the investigator will design and implement a PAM program which is protective of human health.

3. Document Overview

3.1. Organization

This document contains guidance for those who are remediating sites under the Department's

Contaminated Site Remediation and Redevelopment (CSRR) program and are required to monitor and prevent unacceptable exposure from the inhalation of airborne contaminants by off-site receptors in accordance with the Technical Requirements, N.J.A.C. 7:26E-5.5(b)7. Use of this guidance is restricted to implementation of remedial actions. This document provides guidance on:

1. Sites where PAM implementation is applicable;
2. The seven steps used to develop a comprehensive PAM plan;
3. Quality assurance considerations as they relate to the development and implementation of a PAM plan; and,
4. Additional considerations that may be factored in when developing and implementing a PAM plan.

4. Applicability

In accordance with N.J.A.C. 7:26E-5.5(b)7, the person responsible for conducting the remediation shall include in each remedial action workplan for each area of concern, a perimeter air monitoring and action plan to be implemented during a remedial action, if applicable, designed to monitor and control off-site excursion of dust, vapor, and odors.

A PAM plan is required at contaminated sites where remediation activities have the potential to generate air emissions for a project duration exceeding 20 working days¹ within a 30-day period, and where off-site receptors² may be impacted by emissions-generating activities. In situations where emissions-generating activities will be completed in 20 working days or less, a PAM plan will generally not be required. However, if the site is under Department oversight and/or the Department is involved in the review of remediation documents, the Department reserves the right at its own discretion to require a PAM plan at a site. In addition, an LSRP may implement a PAM plan at their discretion for sites that will be completed in less than 20 working days. Potential reasons for requiring a PAM plan for projects less than 20 working days may include contaminant-specific concerns, the presence of sensitive receptors, community concerns, the presence of free product, or the established historical need for monitoring.

Remedial strategies that result in soil disturbance or other contaminant emissions-generating activities will trigger a potential need for PAM. Such activities may include, but are not limited to excavation, grading, filling, compaction, dewatering, trenching, and handling of contaminants or treatment of contaminated media.

This guidance is intended to protect off-site receptors, and is not intended for remedial worker protection³, which should be covered by a separate health and safety plan. However, some of the data collected and its subsequent evaluation may prove useful to those who have the responsibility of protecting the health and safety of workers on the site.

It is assumed that sites where PAM plans are to be deployed have undergone critical review of all remedial options, and that the most appropriate remedial action strategy and technologies have been chosen. This critical review includes an assessment of emission potential as a factor in the selection of the remedial

¹ A working day is any day in which potential air emissions may be generated due to remedial activities occurring at a site.

² Off-site receptors can include sensitive receptors, such as residences, schools, child care centers, and nursing homes; or other receptors, such as commercial and industrial establishments.

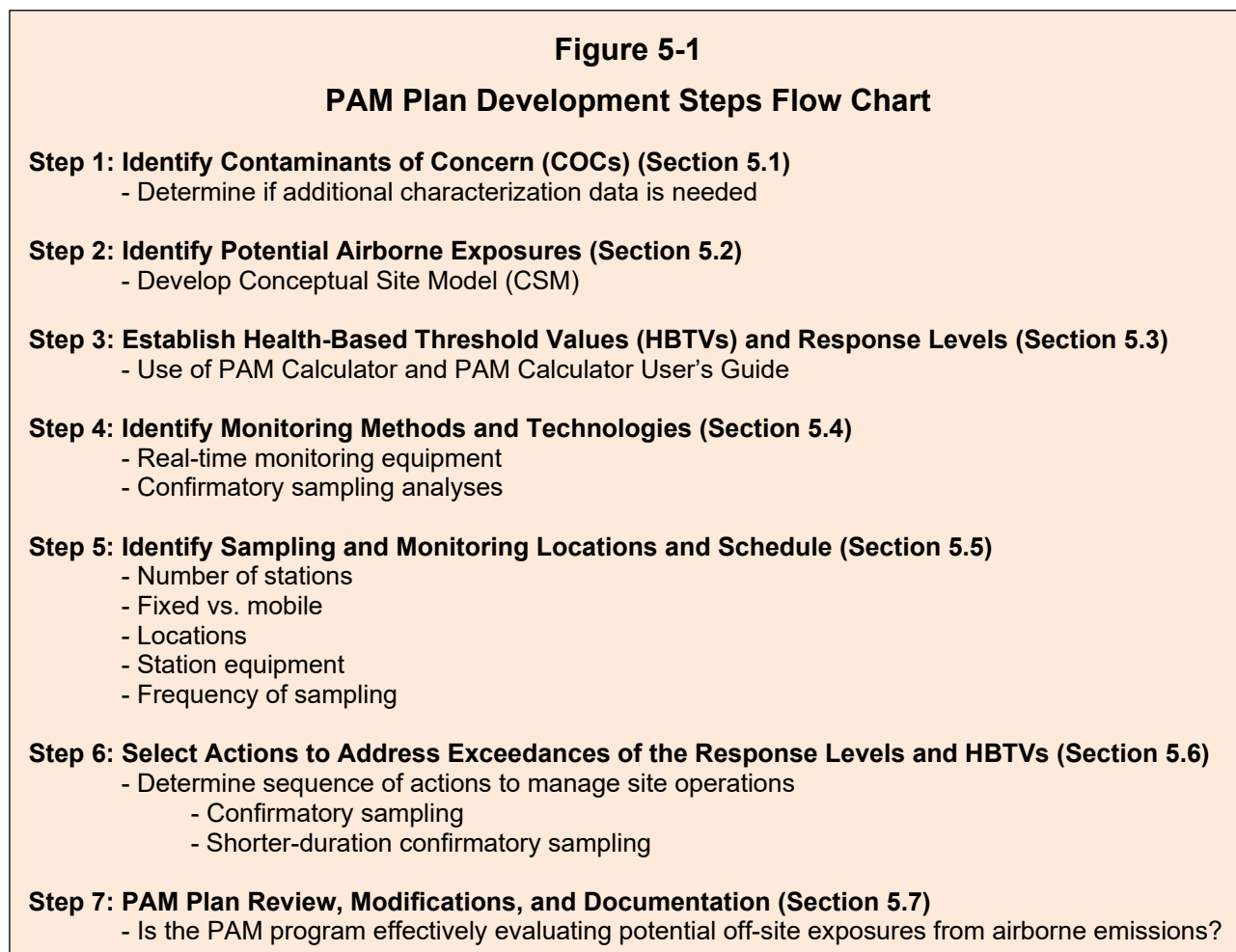
³ Although worker protection should be covered under the health and safety plan, on-site personnel not related to remediation should be taken into consideration when establishing monitoring locations.

action. In all cases, however, the implementation plan for the selected remedial action must be designed to minimize air emissions using best management practices such as dust suppression, odor and vapor control, the use of an enclosure, and other work practices. This should include emission controls for hours when active remediation is not taking place. See Section 7.6 for additional information on best management practices.

This guidance is an effort to cover critical aspects of the design and operation of a PAM plan. Not all sections will be applicable to every site, but the PAM documentation and reporting should take special care to note any elements that are not applicable and provide justification. Because of its intensive nature, it is strongly recommended that a full-time perimeter air monitoring technician be designated to carry out all aspects of the PAM plan at the site.

5. Perimeter Air Monitoring Plan Development

This section outlines the basic process for developing and conducting a PAM plan in seven steps. This section discusses types of contaminants, monitoring requirements, health-based threshold values, quality assurance/quality control (QA/QC) requirements and documentation. Figure 5-1 provides a flow chart illustrating the PAM plan development steps as an iterative process involving multiple decisions. Additionally, a Case Study, included as Appendix F, details how these steps are applied to a real-world remediation scenario.



5.1. Step 1 – Identify Contaminants of Concern (COCs)

It is assumed that sufficient information will have been collected regarding the characterization of contaminants and contaminant concentrations in environmental media at the site to develop a list of potential COCs.

In accordance with N.J.A.C. 7:26E-5.5(b)7, the PAM plan is typically designed to monitor and control off-site exposure to one or more compound types, including: vapors (volatile organic compounds [VOCs] and semi-volatile organic compounds [SVOCs]), gases, particulates (particles that are 10 micrometers in diameter or less [PM₁₀]), other compounds which don't fit in these classifications (e.g. mercury vapor, metal fumes), and odor-causing compounds.

If the material being remediated has an odor but no adequate toxicity criteria exist, then odor and its control should be addressed separately in the PAM plan from monitoring for hazard or risk-based chemicals in accordance with guidance from the NJDEP Air Quality Program (see Section 7.4 Air Permit Requirements).

Predicting exposure from inhalation requires estimating the potential concentrations of contaminants in the air resulting from the remedial action and the timeframe over which exposure occurs. Determining and ranking the COCs subject to the PAM plan is based on many factors including but not limited to:

- The remedial actions to be implemented and form of the associated emissions (gases, vapors and/or particulates);
- Duration of the remedial action;
- Concentrations of contaminants detected in media (e.g., soil, sediment, water);
- Detection frequency in media above NJDEP standards and criteria;
- Predicted maximum potential air emission rates associated with remedy (vapors or particulates);
- Relative toxicity based on most dominant emission (vapors or particulates) and the inhalation route of exposure;
- Consideration of acute toxicity or short-term exposure to emissions (e.g., irritants or asphyxiants) as well as chronic or long-term exposure to concentrations resulting from emissions; and
- Exceedances of PM₁₀ National Ambient Air Quality Standard (NAAQS) and nuisance odors.

5.2. Step 2 – Identify Potential Airborne Exposures

A CSM should be developed to support the understanding of how site COCs identified in Step 1 may impact receptors during remedial action. A CSM is a dynamic and iterative tool designed to evaluate the various work activities being performed and their potential to create airborne emissions. It also identifies the relevant transport mechanisms and exposure pathways as they relate to off-site receptors. The CSM should include source materials, emission generating activities, fate and transport, and exposure pathways to identified receptors. The CSM should be updated as new data and information become available so work practices may be improved to better protect identified receptors. Lastly, the CSM may act as an effective tool when communicating with stakeholders and the community.

The major components of the CSM should include the identification of:

- Source material and emission generating activities;
- Route of exposure (ambient air or dust-borne) relevant to the perimeter receptors;
- Transport mechanism (gases, vapors and/or particulate emission);
- Exposure pathways (inhalation of ambient air or dust);
- Background or ambient concentration considerations;
- Potential receptors of concern (residential, nonresidential, and sensitive populations);
- Site-specific COCs

Technical guidance on the development of CSMs can be found at <https://www.state.nj.us/dep/srp/guidance/>.

5.3. Step 3 – Establish Health-Based Threshold Values (HBTVs) and Response Levels

A primary objective of PAM is to determine if airborne emissions generated during remedial activities are in excess of health-based criteria established for COCs identified on-site. Health-based criteria for PAM, more commonly referred to as HBTVs, are derived using the health-based targets set forth in the New Jersey Brownfield Act (N.J.S.A. 58:10B-12.d). This statute mandates that the Department develop remediation standards based on (a) an additional cancer risk of one in one million and (b) a hazard quotient of one (1) for noncarcinogens.

In addition to using the health-based targets discussed above, the HBTV is calculated using the inhalation toxicity factors in Appendix B, Section 2.0 of this guidance, as well as the exposure frequency (total number of days), and exposure time (hours per day) estimated for the duration of the project.

5.3.1. Calculating a HBTV

To streamline the calculation process and aid the investigator in determining the site-specific HBTVs for COC(s) identified in Step 1, a PAM Calculator and PAM Calculator User's Guide have been developed and can be accessed by going to CSRR's technical guidance library website at <https://www.nj.gov/dep/srp/guidance/> and selecting the link for PAM. The PAM Calculator User's Guide, found in the PAM Calculator, includes step by step directions to follow when using the calculator and background information on the derivation of HBTVs. More details on calculator inputs, the HBTV equations, variable descriptions, and inhalation toxicity values employed can be found in Appendix B. Please note that the Department's PAM Calculator pertains only to PAM plans with remediation activities of 1 year (225 working days in a 365-day period) or less because noncancer toxicity values are used in the calculation of the HBTVs. Since cancer risk is based on long term, chronic exposures, a cancer toxicity factor is only used when a noncancer value is not available. For remediation activities estimated to last beyond a 12-month period, consult the Department for appropriate guidance on calculating HBTVs. The PAM Calculator will not allow users to enter more than 225 days for the exposure frequency. The CSRR contacts for questions on PAM can be found at https://www.nj.gov/dep/srp/srra/srra_contacts.htm.

The HBTV, in the case of the PAM Calculator, is a time-weighted average (TWA) that is dictated by user input. The TWA, which is typically 8-12 hours, is selected by the user depending on the predicted length of a typical workday during remediation efforts. Further, the project duration

ranging from 20 to 225 working days is selected based on an estimated project schedule. Thus, the HBTV is the most conservative TWA for the selected contaminant given the workday duration and project length. Should the HBTV be exceeded over the course of the workday during remediation efforts, additional actions should be taken to address airborne emissions associated with remediation (See Section 5.6).

For cases where an area of concern or site COC is identified and not listed in the PAM Calculator, consult the Department to determine if appropriate inhalation toxicity information is available and an HBTV can be calculated for the COC in question.

5.3.2. Determining Most Restrictive HBTVs for a Site with Multiple COCs

Since in most cases multiple COCs exist at the site, the PAM plan should target the most stringent of the site-specific HBTVs to be protective of the off-site receptors; however, other contaminants present should also be taken into account. By focusing monitoring on the most stringent HBTV, it can be assumed that if that HBTV is not exceeded, the conditions are protective for other COCs having similar physical/chemical properties.

For example, if a recent gasoline release is the subject of remedial action, the most stringent HBTVs for the VOCs benzene, toluene, ethyl benzene and xylenes (BTEX) should be identified as the target for monitoring in the PAM plan. In this case, benzene followed by ethylbenzene have the most stringent HBTVs; and the selected monitoring methodology must be capable of confirming that the two VOCs are below the site-specific HBTVs for the protection of off-site receptors. Monitoring based on benzene and ethylbenzene HBTVs would also be protective of exposures to toluene and xylenes in this example. Analytical confirmatory sampling should include all potential COCs at the site.

All chemical-specific concentration data collected via laboratory analysis should be compared to the contaminant HBTV. Real-time monitoring data produced from instrumentation capable of direct measurement of COCs (e.g., field GC) should also be compared to the HBTV. In many circumstances, real time monitoring for the COCs may not be possible. In those cases, an alternate real-time monitoring methodology may be employed utilizing a surrogate (e.g., using PM₁₀ to monitor arsenic).

For example, if the COCs are bound to soil, PM₁₀ can be used as a surrogate to evaluate airborne COC concentrations. For those cases where direct measurement of COCs is not feasible in the field and alternate real time monitoring instrumentation is employed using a surrogate (e.g., PM₁₀, total volatile organic compounds [TVOC]), a response level must also be calculated for each of the site COCs using the Department's PAM Calculator. The response level is based on the HBTV and is also a time-weighted value that is dictated by the same user input as the HBTV. However, the response level incorporates a more realistic contaminant concentration to be encountered in soil for particulates (e.g., 95% upper confidence limit (UCL) of the mean) and volatiles (percentage of an individual volatile in total volatiles measured). Thus, the response level value is less restrictive than the HBTV which allows for more flexibility during remediation activities while being protective of receptor health. See Section 5 of the PAM Calculator User's Guide for more detailed information on the development of real time response levels.

5.3.3. Calculating a Response Level

The calculated response levels are based on the HBTVs but are adjusted based on soil contaminant

concentration to account for the capabilities of the selected monitoring instrumentation, as well as the frequency and time of exposure for the receptor. For TVOC contaminants being monitored in real-time using a real-time screening instrument (e.g., photoionization detector [PID], flame ionization detector [FID]), the percentage of the individual volatile in the contaminated medium may be used in the development of a response level. For particulates, response levels can be established by using an estimate of the soil contaminant concentrations (e.g., 95% UCL).

The Department's SAB recommends that PM₁₀ concentrations at a remediation site should not exceed the 24-hour USEPA PM₁₀ NAAQS of 150 µg/m³ regardless of workday duration. If the calculated response level for the COC(s) is greater (less stringent) than the PM₁₀ NAAQS, then the PM₁₀ NAAQS should serve as the PAM plan goal. By determining which is the most stringent of the resultant COCs dust concentration or the USEPA NAAQS for PM₁₀ of 150 µg/m³, the dust concentration can be monitored in real time to manage off-site exposures to both COCs and PM₁₀. The PAM Calculator is programmed to default to the PM₁₀ NAAQS if the COC-specific response level is greater.

Laboratory analysis should confirm the assumptions for the use of the response level (i.e., a time-weighted air sample should be taken and analyzed for the specific COCs). See Section 5 of the PAM Calculator User's Guide in the PAM Calculator for additional information regarding development of response levels for TVOCs and PM₁₀.

5.3.4. Use of the Developed Response Levels

While the response level is derived using the HBTV input values, which are based on an 8- to 12-hour workday, the response level is calculated using site-specific soil data. The response level may be used as a shorter-duration TWA (e.g., 5-min, 15-min) to act as a maximum value for real-time monitoring. For additional details on the derivation and use of response levels, please refer to Section 7 of the PAM Calculator User's Guide found in the PAM Calculator. The application of the shorter duration TWA gives the users the opportunity to mitigate the work methods that are causing real-time exceedances without approaching or exceeding the established HBTVs. If the shorter-duration TWA is exceeded multiple times throughout the day, it is possible that the HBTV could be exceeded, and the emission control methods may not be protective of receptor health. In this case, and as detailed in this guidance, work should be stopped, and work practices and emission control methods reevaluated.

5.4. Step 4 – Identify Monitoring Methods and Technologies

On a conceptual level, the PAM plan design begins by identifying the monitoring program strategy, followed by selecting the air sampling methods and technologies to be employed. The data quality and quantity requirements discussed in Section 6 should be satisfied throughout the project employing an iterative process to determine the type of data to be collected and the methods and technologies to be used. The process of selecting effective monitoring strategies, methods, and technologies for assessing whether an HBTV-based response level is exceeded can be challenging due to the spatial variability of site emissions over the course of most remedial actions together with inherent meteorological variability (e.g., wind direction).

5.4.1. Identify Monitoring Strategy

The monitoring strategy includes the selection of the type, quantity, and quality of measurements to be made, consistent with established data quality objectives (DQOs) (see Section 6.1 and

Appendix E) and based on temporal and spatial considerations. The PAM plan should include the design and implementation of an air monitoring strategy that meets the objective of protecting human health, based on the established HBTVs (Step 3).

Specific PAM objectives include:

- To provide real-time air monitoring and meteorological data that can be used to assist project personnel in controlling and reducing emissions to prevent adverse offsite exposures to the public;
- To corroborate that real-time data and associated response levels are adequate in meeting HBTVs based on comparison to analytical data (e.g., via laboratory analysis of air samples); and,
- To document that the PAM program is working as designed and is protecting the public through collection of sufficient data (i.e., via air monitoring and/or sampling and laboratory analysis).

Typically, PAM programs use a combination of real-time monitoring instruments and periodic confirmation using on-site sample collection to be analyzed at an off-site laboratory. The selection of the appropriate type of air monitoring methods and strategies is dependent on several factors, including:

- The type of remedial technologies selected;
- The source-receptor relationship (distance, direction and aerial extent of contamination from each identified source to the potentially affected community);
- The list of COCs identified in Step 1;
- The HBTVs developed in Step 3; and
- The real-time technology that would allow assessment of air concentrations for these COCs and document HBTV exceedances.

5.4.2. Select Air Monitoring Methods and Technologies

An effective PAM plan is founded on the establishment of DQOs (see Section 6.1 and Appendix E) required to demonstrate off-site receptor protection. For most PAM programs, a combination of some type of real-time COC measurement technology or surrogate (e.g., TVOC and PM₁₀ to represent COC concentrations) together with periodic confirmatory sample collection and laboratory analysis will be employed.

5.4.2.1. Real-Time Monitoring

The purpose of real-time monitoring is to assess airborne concentrations that otherwise have the potential to migrate off-site undetected and which might result in unacceptable human health exposure (i.e., an HBTV exceedance).

Common types of real-time monitoring methods include, but are not limited to:

- **Handheld real-time monitoring:** These are real-time instruments used by site personnel to conduct air monitoring at the perimeter of a work zone, at the perimeter of the site, and other locations to demonstrate in real-time that contaminant plumes are not migrating off site undetected. Descriptions of recognized real-time technologies

(e.g., PID, FID, particulate monitors) are provided in Appendix C. Typically, handheld monitors are used to supplement mobile or stationary real-time monitoring stations and not used as the primary means of perimeter air monitoring on these sites.

- **Stationary or mobile real-time monitoring:** These are monitoring stations that can be placed in semi-permanent locations to cover appropriate sensitive receptors, or mobile stations that can be moved periodically depending on the location of the work zone and wind direction. Stationary and mobile stations can be placed at the perimeter of the work zone or the perimeter of the site to assess real-time contaminant concentrations. PIDs, FIDs, particulate monitors, chemical specific monitors, and wind speed and direction (WSD) monitors are typically integrated into these stations.
- **Meteorological Monitoring:** These stations provide data accessible in real-time and are recommended to document atmospheric transport conditions. Such data is typically used for documenting upwind and downwind locations relative to the identified emission source(s), and to support determination of downwind sensitive receptor measurement locations. Meteorological data can also be used to assess, through dispersion modeling relationships, plume dilution between the source and the sensitive receptor location. Minimum recommended measurement parameters include wind direction and wind speed to determine air flow across a site.

It is currently common practice and recommended that all real-time measurement instrumentation used should be equipped with data logging capabilities. The equipment may be linked to a central network for real-time data transfer via wireless or wired connections.

For real-time monitoring, specific QA/QC procedures exist to ensure that the data meet the DQOs as outlined in Appendix E. Like all QA/QC procedures, they should be detailed in the PAM plan and include: operational frequency; manufacturer, or other certified instrument calibration certificates; zero and daily calibrations; bump testing; co-located monitoring; validation (sampling and laboratory analysis); and data integrity (See Section 6 for further details).

5.4.2.2. Confirmatory Sampling

As part of the PAM plan, systematic quality control procedures must be implemented to confirm that the real-time monitoring program is functioning as designed. The verification of the underlying assumptions, on which the real-time monitoring program is based, requires analytical measurements (e.g., TO-15 for volatiles) of specific COCs. Such targeted analytical air sampling should demonstrate and document that the real-time air monitoring program is effectively keeping the contaminant air concentrations below HBTVs for the workday. Because of the need to send samples to an off-site laboratory, results for analytical measurements will not be available in real-time.

The PAM plan should identify the type and frequency of the confirmatory analytical sampling based on project-specific parameters. With the use of analytical sampling, modification of work practices will be delayed while samples are being analyzed. In general, confirmatory analytical samples should be collected at the commencement of emission generating activities and preferably during hot-spot disturbance to confirm protectiveness of real-time monitoring and underlying assumptions. In addition, confirmatory sampling should occur periodically (e.g., once per week) over the course of remediation, when there are changes in operations or

conditions, and/or if there are multiple real-time exceedances.

Numerous validated and/or approved air sampling and monitoring methods are available to collect confirmatory data. Nationally recognized methods available for analyzing contaminant concentrations in air include those published by the USEPA, the National Institute for Occupation Safety and Health (NIOSH), and the Occupational Safety and Health Administration (OSHA). Additional methods may be developed and/or approved by various agencies such as NJDEP, USEPA, OSHA, NIOSH and other state and federal agencies (e.g., California Air Resources Board). NJDEP-certified methods should be used, when available. Although not a comprehensive list, some of the more commonly used analytical methods are provided in Appendix D. A more complete list of available certified methods and laboratories can also be found by visiting NJDEP's DataMiner website at <https://www13.state.nj.us/DataMiner/Search/SearchByCategory?isExternal=y&getCategory=y&catName=Certified+Laboratories>.

The measurement strategy and analytical methodology selected must have sensitivities sufficient to accurately measure air concentrations below the calculated HBTV. One methodology may be chosen over another based on laboratory method detection limits, ease of sampling methodology, or cost. Additionally, in accordance with the Technical Requirements, N.J.A.C. 7:26E, an air method should be used by an analytical laboratory that is certified for that method. Specifically, laboratories submitting analytical data to the State of New Jersey must hold current certification where applicable under the Regulations Governing the Certification of Laboratories and Environmental Measurements, N.J.A.C. 7:18, and/or voluntary certification under the National Environmental Laboratory Accreditation Program (NELAP). The Department's Office of Quality Assurance (OQA) currently provides laboratory certification for air analytical methods and individual parameters and is a recognized accreditation body in the NELAP program. For questions related to laboratory certification and the application process for obtaining laboratory certification, visit the Department's OQA websites: (<https://www.nj.gov/dep/enforcement/oqa/labcert.html>) and OQA staff directory (<https://www.nj.gov/dep/enforcement/oqa/contacts.html>).

As per the Technical Requirements at N.J.A.C 7:26E-2.1, the certification status of the laboratory must be determined prior to submitting air samples to a laboratory for analysis. It is recognized that there will be situations where a certified method is not available for the site-specific analyte(s) of concern. Options do exist under N.J.A.C 7:18 whereby a request can be made to OQA to make certification available. If the method is to be used for a prolonged period and not short-term, then OQA should be requested to provide certification for the method. However, if it is determined that the method needs to be used immediately, or if the method is to be used short-term only, or if it is determined that the time required to provide certification will significantly impact the remediation time frames/goals at a site, then the proposed method without certification may be used. However, in such instances, documentation must be provided to the program for approval prior to its use. This documentation is to include the method number/description, the laboratory's standard operating procedure, a demonstration of performance via the analysis of samples and fortifications, any performance evaluation sample results, and a demonstration of analytical sensitivity. Additional assistance may be requested from the Department's Office of Data Quality. Contacts from the Office of Data Quality for questions related to analytical methods and data validation can be found at https://www.nj.gov/dep/srp/srra/srra_contacts.htm.

5.4.2.2.1. Confirmatory Sampling Considerations

As discussed above, confirmatory sampling is performed to assess if HBTVs were not exceeded for the duration of remedial action and to assess if the established surrogate, real-time response levels were appropriate. Analytical results from confirmatory sampling should be compared directly to the HBTVs calculated for each site-specific COC. It is recommended that initial confirmatory samples be collected for the first three or more consecutive days at the commencement of intrusive activities and periodically (e.g., once per week) afterward to evaluate worksite conditions. Confirmatory sampling is also recommended after a significant change in work, operational conditions, or during hot spot remediation. Confirmatory samples should be collected for the duration of the workday. The workday/sample collection durations should not exceed the exposure time input values used in HBTV calculations. Additionally, confirmatory samples should be collected at the predicted predominant downwind location or monitoring station. An upwind sample should also be collected to assess potential upwind, off-site contaminants.

The confirmatory sampling technique(s) should address each COC and provide the results in a form suitable for comparison to their associated HBTVs. When sampling and analysis is performed, the turnaround time should be expedited if data is needed for risk management decisions. Once the results are received, an evaluation can be made to determine if the response level is appropriate and protective of public health as represented by the HBTVs. In general, when evaluating analytical data for COCs collected using different sampling methods, investigators should be cognizant of comparing similar concentration units (e.g., $\mu\text{g}/\text{m}^3$ versus ppb) and verify that the selected method will report results below the calculated HBTV.

Analytical data can be used to determine if a reduced confirmatory sampling frequency is appropriate; however, no adjustments to the sampling frequency should be made before laboratory results are evaluated. If sampling results from the first three days of active remediation indicate that contaminant concentrations are below their respective HBTVs, the confirmatory sampling frequency may be reduced (e.g., reducing the 8-hr sample collection from once per day to once per week). Regardless of when or how frequent sampling is performed, the strategy should always be to sample or monitor during periods when remediation work is occurring in close proximity to community receptors and when there is the greatest potential for emissions (e.g., during remediation of hot spots). For additional information regarding confirmatory sampling for mercury, polychlorinated biphenyls (PCBs), and naphthalene, see Section 7.1.

5.5. Step 5 – Identify Sampling and Monitoring Locations and Schedule

After the monitoring strategy has been developed and the measurement approaches have been identified, the remaining details of the PAM plan must be decided. These details include but are not limited to: the locations where air monitoring and sampling will occur; the frequency of monitoring and sample collection; how data will be collected and stored; and whether additional specialized monitoring (e.g., radiation) will be necessary.

5.5.1. Air Sampling and Monitoring Locations

To assess the potential exposure to off-site receptors, monitoring stations should be placed at the receptor, or at the on-site locations between the active work site and any identified off-site

receptors. Priority should be given to the targeted remedial areas where highest contaminant concentrations are predicted and the area closest to most vulnerable potential receptors (e.g., schools or residences). Historical wind data can be used to assist with the determination of locations for the equipment. Additionally, handheld monitors positioned between the contaminated work area and sensitive receptor(s) may be used for screening purposes, supplementing the air monitoring station, but not used on their own to meet the air monitoring requirements of this guidance document.

5.5.2. Fixed vs. Mobile Air Sampling and Monitoring Locations

In most cases, fixed air monitoring stations are acceptable to use as long as stations can be located between the source and the receptor or at the receptor itself. In situations where the location of the active work area changes as work progresses, the utilization of mobile stations may be more appropriate. Locations of fixed stations should be initially documented on a site plan. The site plan should be updated if fixed locations are ever adjusted.

When using mobile stations, at least one station should be placed upwind of the work zone and one station placed downwind of the work zone, based on predicted prevailing wind direction. The intent should be to compare downwind and upwind concentrations of COCs to determine what contributions work zone activities are having on ambient air, if any. The locations of the stations (fixed and mobile) should be documented on a site plan. A good practice when wind direction is variable is to add wind speed and direction instruments to these stations to identify, in real-time, results that are upwind and downwind of active site activities.

5.5.3. Frequency of Monitoring and Air Sample Collection at Each Location

Air monitoring stations may collect data continuously with real-time results. It is recommended that continuous real-time monitoring be employed throughout the duration of the workday when remediation activities are occurring to properly assess if response levels are exceeded. For hours when active remediation is not taking place, best management practices should also be employed to control dust and vapor emissions (see Section 7.6). Laboratory analytical samples should also be collected at the commencement of representative emissions generating activities (e.g., for the first three consecutive days or more) and periodically (e.g., at least once a week) over the course of the remediation to confirm contaminant concentrations are below their respective HBTVs and real-time monitoring is functioning as designed. These confirmatory samples should be collected continuously throughout the duration of the workday. The type and frequency of monitoring and sampling is dependent on the project-specific data needs of the PAM plan and may be modified after specific data has been collected.

5.5.4. Air Monitoring and Sampling Station Specifications

A wide variety of air monitoring and sampling procedures and configurations are available for each monitoring station. Dependent upon the type of monitoring required at the site and selection of real-time and/or laboratory analytical sampling technologies, a systematic design of methods and techniques is assembled. A wireless communication network for real-time monitors is common practice and can be included to provide data remotely to personnel on and off the site. Remotely transmitted real-time data is especially useful in alerting personnel when response levels are exceeded but no personnel are in the immediate vicinity of the alarm condition.

5.5.5. Ancillary Meteorological Data

It is critical to measure site WSD as discussed in Section 5.4.2.1. Monitoring of other meteorological parameters, such as precipitation, relative humidity, temperature, and air pressure, is recommended to identify conditions that can affect emission rates, air contaminant transport, and instrument functionality. Meteorological data can be collected using a wide variety of instruments ranging from hand-held instruments to full meteorological stations on-site. Additionally, meteorological data from local publicly available weather stations may provide useful information. Local publicly available weather station data should not be the sole source of meteorological data for a PAM plan as wind directions, wind speeds, etc. may not accurately represent site-specific conditions. It should be noted that if the observed meteorology is characterized by variable and light wind conditions, especially during times when remedial action activities have the greatest potential for generation air emissions, it may be difficult to determine the direction of migrating plumes. Thus, the Department recommends implementing a site-specific WSD measurement tool.

5.5.6. Additional Monitoring Procedures for Odors and Radiation

Additional monitoring may be necessary to address community concerns (e.g., odors or radiation).⁴ If concerns exist on how to control or prevent odors at a site, the Department's Air Enforcement Program should be contacted. Contact information for the Regional Air Enforcement offices can be found in Section 7.4. If radiation is a concern at a site, the Radiological and Environmental Assessment Section Supervisor of the Bureau of Environmental Radiation at 609-984-5400 can serve as a resource to determine monitoring options.

5.5.7. Background Sampling

Prior to the commencement of remediation efforts, it is beneficial to run the PAM stations and collect samples to establish baseline conditions for site related COCs that are common air contaminants, including particulate matter. This will inform the investigator conducting the monitoring of typical site conditions before remediation begins. Should background measurements or air emissions attributable to off-site sources indicate concentrations near or above applicable HBTVs, the Department should be contacted for consultation.

During background sampling, PAM stations should be operated during the anticipated normal workday conditions (e.g., Monday-Friday between 7AM and 3PM for an 8-hour workday) in order to accurately represent the proposed remediation project schedule. It is advantageous to place one real-time monitor upwind and one real-time monitor downwind of the proposed remediation area. Another option is to place WSD monitors on these stations to identify, in real-time, upwind and downwind locations. Should the predicted prevailing wind change day to day, moving the downwind monitoring station to reflect the change is encouraged. The real-time monitoring equipment and data transfer equipment proposed in the PAM plan should be utilized during background monitoring to assess its usability.

Background sampling may also be conducted using confirmatory sampling and analysis to gauge the background presence and concentrations of constituents. It is likewise advantageous to collect

⁴ While the presence of odors may not indicate an exceedance of the HBTV, exceeding odor thresholds can cause community concern. Contact the NJDEP Air Program for questions or concerns regarding odors.

background confirmatory samples during the predicated normal workday conditions at the upwind and downwind locations, as mentioned above. Background monitoring and sampling should be conducted continuously for the duration of the proposed workday.

Documentation of potential background sources of vapors and particulates that may contribute to elevated on-site COC or PM₁₀ concentrations should be collected throughout the sampling periods. Wind direction, speed, and other weather conditions should also be recorded. Background monitoring and sampling data should be submitted with the final PAM report if background concentrations of COCs and/or PM₁₀ demonstrate that keeping site-related emissions below calculated HBTVs and response levels presented difficulties.

5.6. Step 6 – Select Actions to Address Exceedances of the Response Levels and HBTVs

Early identification of COC concentrations nearing HBTVs can aid in preventing exceedances of the HBTVs for the protection of off-site receptors. To ensure that elevated air concentrations associated with remedial activities are addressed in a timely manner, the investigator is advised to develop response levels that can be used as the basis for taking a specific type of corrective action (for further details on the development of response levels, see Step 3, Section 5.3.3). Response levels are developed for use with a real-time screening instrument (e.g., PID) at the perimeter of the work zone or site and can be used throughout daily work activities to determine if operations are proceeding safely.

Response levels are shorter in duration, thus higher in concentration than HBTVs. The higher-concentration response levels provide an avenue for investigators to monitor COCs at the perimeter in real-time and allow for corrective measures to be implemented before daily HBTVs are exceeded. In the event that real-time instrumentation is not available for critical contaminants, HBTVs will be used as response levels and laboratory analysis will be needed for monitoring purposes. Additionally, if chemical-specific real-time monitors are selected for use, HBTVs should be used as the monitoring criteria.

Response levels should be designated for each type of real-time monitoring instrument as a TWA so site personnel can assess the potential source of the emissions and address the situation before an HBTV exceedance occurs. 15-minute TWAs are typically used for shorter-duration response levels (see Section 5.6.1) but may be modified on a case-by-case basis. The response levels derived in the calculator should be used as the shorter-term TWA, with exceedances addressed as detailed in the steps below. The site-specific actions to be taken if response levels are exceeded must be clearly detailed in the PAM plan before work begins.

5.6.1. Actions to Address Exceedances of the Real-Time Response Level

Real-time screening instruments, as part of a PAM plan, provide immediate data to evaluate potential air exposure attributable to emissions generated from remedial activities. The goal is to provide data that can elicit action on the part of site personnel to take steps to control or mitigate site activities as needed. Specific steps for how to respond to real-time exceedances are discussed below. These steps have been designed so that air concentrations above the response level associated with remedial activity at a site can be addressed within an hour or less. This is predicated on the assumption that reducing dust and vapor/gas contaminant levels to below the designated real-time HBTV-based response levels over a 1-hour averaging period will be protective based on a typical workday (e.g., 8 to 12 hours).

The following is a suggested sequence of actions that can be used to manage site operations with the goal of not exceeding the HBTV over the full workday.

1. If an exceedance of the response level (e.g., 15-minute TWA) is observed at the perimeter, the instrumentation should be checked to ensure it is functioning correctly and possible sources of emissions should be identified based on station location and current wind direction.
 - a. If the instrumentation is malfunctioning, it should be repaired or replaced immediately.
 - b. If an external emission source (e.g., street sweeper, idling vehicle) is the cause of the exceedance, the source should be documented, and steps taken to remedy the situation if possible.
 - c. If the remediation activities are the cause of the exceedance, then vapor and/or dust corrective actions should be initiated. These actions may include the application of water or foam, tarping, adjusting the remedial area, or reducing the rate of activities resulting in vapor and/or particulate generation.
2. If the exceedance of the real-time response level at the perimeter continues into the next 15-minute monitoring interval (total of 30 minutes) and is the result of an emissions-generating remediation activity, vapor and/or dust control corrective actions should be implemented. These actions may include the application of water or foam, tarping, adjusting the remedial area, or reducing the rate of activities resulting in vapor and/or particulate generation.
3. If the exceedance of the real-time response level at the perimeter continues into the third 15-minute monitoring interval (total of 45 minutes), continue implementing engineering controls and modify remedial operations to reduce vapor and/or particulate generating activities. Confirmatory samples (e.g., one-hour confirmatory sample) should also be collected at this time, specific for the exceedance and associated COC.
4. If the exceedance of the real-time response level at the perimeter persists into a fourth 15-minute monitoring interval (total of 60 minutes), is attributable to the same cause, and is due to emissions-generating remedial activity, continue implementing engineering controls and stop all activity that has the potential to generate vapors or particulates. Operations may be restarted once the issue is believed to be resolved. If upon re-start an exceedance occurs and is believed to be a continuation of the same problem, operations should be shut down once again. If repeated restarts are not effective, then alternative methods of emission control (e.g., changing foam mixture, tarping, enclosure with emission controls) should be considered.

The above steps may be modified based on the proximity of receptors, type of contaminants, and other considerations.

In addition to an exceedance of a 15-minute TWA, when instrument readings increase unexpectedly or significantly in a period of less than 15 minutes (i.e., spike in air concentrations of COCs), indicating a sudden increasing trend in real-time concentrations at the perimeter, the cause of the increase should be investigated and documented, and instrumentation should be inspected to ensure it is operating properly. Determination of whether the cause of the exceedance will result in a long-term concern (greater than 15 minutes) should be initiated.

Best management dust and vapor control procedures must be instituted at all remediation sites (see Section 7.6). Examples of best management controls include water and foam spray, physical barriers, and/or chemical barriers. Both instantaneous and sustained emissions of visible dust

should be reasonably prevented at all times to ensure receptor and worker safety. If on-site generated visible dust is observed leaving the site from active remediation work areas, either dust controls should be implemented or work causing the visible dust should be stopped. If the use of controls is the selected option and visible dust is still present within the next 15 minutes, all work should cease, and work practices should be modified.

The actions taken to address exceedances should be described in detail in the PAM report. When these exceedances can be documented as not being related to site operations, the source or reason for the exceedance should be recorded and detailed in the PAM report. If the exceedance is caused by off-site sources, NJDEP Enforcement should be notified, at 1-877-WARN DEP.

5.6.2. Actions to Address Exceedances of the HBTVs for Laboratory Analysis

In the event that real-time instrumentation is not available, and/or no surrogate can be established for a particular contaminant or is impracticable to use at a site, daily air samples should be collected over the duration of normal working hours for analysis at an off-site laboratory. HBTVs will be used as the response level; however, the response to an exceedance will not be immediate. Therefore, laboratory analyses should be expedited for a 24-hour turnaround time. No confirmatory sampling will be required for these contaminants as the analytical sampling and confirmatory sampling would be a duplicate effort.

Analytical results will not be received until at least 24 hours after the sample is received at the laboratory, assuming expedited turnaround. This could result in an exceedance not being reported until two (2) working days after the occurrence. In the event of exceedances, work practices should be modified as appropriate to reduce further emissions at the site. Dependent on the type of exceedance (vapor or dust), suppression activities should be implemented, or work conditions modified. In the event exceedances repeatedly occur after emission suppression measures or work modification has been implemented, work activities should cease until additional engineering controls (e.g., change in foam mixture, installing sprung structure) can be implemented or work modifications have been made. Suppression methods include, but are not limited to, vapor foam, water misting, and tarping.

5.6.3. Optional Sampling Approach to Address Site-Related Response Level Exceedances

One approach to determine whether exceedances of the calculated response level(s) are nearing the established HBTVs for contaminant(s) is to collect short-term exceedance confirmatory samples. Should a response level (e.g., 5-min, 15-min TWA) be exceeded during daily remediation activities, an optional confirmatory sample may be collected for a 1-hour duration at the location of the exceedance as soon after the exceedance alarm as feasible. If using this approach, the sampling technique(s) should be COC specific to address the type of exceedance sustained and provide the results in a form suitable for comparison to their associated HBTVs (e.g., a shorter-term sample analyzed via the TO-15 method for volatiles exceedances). Depending on flow rates, a 1-hour sample typically collects sufficient volume to reach detection limits lower than the established HBTVs. When sampling and analysis is performed, it is recommended that the turnaround time be expedited to allow for observation of relative COC concentrations in a timely manner.

A 1-hour sample will dilute the concentration of an instantaneous exceedance and may not be directly correlated to the HBTV, however, the speciation of contaminants in the analytical data may help to conclude whether the perimeter response level exceedance was caused by the original

constituents of concern used to calculate the site-specific HBTVs or from another source. The analytical results from the 1-hour confirmatory sample may also be used to ease community concerns in the event that perimeter air monitoring data is provided directly to the public or if there is a health concern.

It should be noted that an optional 1-hour confirmatory sample for response level exceedances does not replace the need to collect routine confirmatory samples over the duration of a workday to ensure the effectiveness of HBTVs, as detailed in Section 5.4.2.2. It may be used, however, to determine whether work modifications should be implemented or if there are remedial options that may be more protective of receptors.

5.6.4. Exceedances Caused by Conditions Not Related to Remedial Activities

Exceedances caused by activities not directly resulting from the remedial activity will occasionally occur. When these exceedances occur and can be documented as not being related to on-site activities, the reason for the exceedance should be recorded and site activities may continue. Appropriate action should be taken to eliminate the cause of the exceedance when possible (e.g., having an idling vehicle moved away from the vicinity of the monitoring station). In the event the exceedance is caused by monitoring equipment malfunction, the equipment should be immediately re-set, repaired, or replaced as appropriate. If the same types of exceedances occur repeatedly, corrective actions should be taken (e.g., posting “no parking” signs, adjusting the location of monitoring stations, changing work practices, relocating equipment, where feasible). If the exceedance is caused by an off-site source, NJDEP Enforcement should be notified, at 1-877-WARN DEP the first time this occurs. Subsequent occurrences from the same source need not be reported. For record keeping purposes, the real-time exceedance and an explanation of any action taken should be documented in the final report to NJDEP.

5.7. Step 7 – PAM Plan Review, Modifications, and Documentation

A critical component of the PAM plan is to establish procedures that, once implemented, will ensure the program’s ongoing effectiveness. The PAM plan design and scope should be continually re-evaluated during the remedial process as new contaminant information becomes available, with plan modifications implemented as warranted. Depending on the outcome of such re-evaluation, any expansion or reduction in the PAM plan scope must be accurately and thoroughly documented. Most modifications will not require rewriting the entire document.

5.7.1. PAM Plan Review and Modifications

It is important to review confirmatory air sampling and real-time air monitoring data results as they are received to determine whether response levels are effective in keeping air concentrations of COCs below their respective HBTVs. Validation of the underlying assumptions upon which the real-time monitoring program is based (e.g., percent contaminant mass in the PM₁₀ measured concentration, or percent volatile COC in the total VOC measurement) generally requires review of analytical measurements for each COC (for analytical methods, refer to Appendix D).

Data generated at the commencement of remediation can be used to justify modifications to the PAM plan. Most importantly, monitoring methods and technologies must be modified if measurement DQOs are not being achieved (i.e., the data quality is found to be insufficient to demonstrate response level compliance). Other necessary modifications may include the type or frequency of air monitoring, the number of air contaminants monitored, changes in the initial

response level (higher or lower), changes in designated locations of air monitoring equipment and stations, or the number of monitoring stations required to meet PAM plan objectives and protect human health.

Modification to the PAM plan may also be necessary should the following occur:

- Substantive changes in remedial process;
- Changes in duration of operation;
- Receipt of new data on the nature and extent of contamination; or
- New source of potential emissions unrelated to the site.

5.7.2. Documentation of PAM plan Modifications

Any modifications made to the PAM plan should be documented, along with the supporting information and air monitoring data used to justify the modification(s). Regardless of the cause for the modifications, documentation should be sufficient to support independent verification as to why changes were warranted.

Most modifications made to a PAM plan can be documented in a final PAM report and do not require development of a revised PAM plan. Modifications that fall into this category include, but are not limited to:

- Revision of the response level based on analytical data;
- Adjusting the number or locations of monitors;
- Sampling frequency; or
- Air monitoring methods utilized.

Under certain site-specific circumstances, modifications may be significant enough that the PAM plan must be revised to properly document and implement the proposed changes. Modifications that fall into this category typically have cascading effects that require substantial changes to other aspects of the PAM plan as well. Examples include:

- Adjustments to the number of contaminants monitored;
- Adjustments to the HBTV based on the duration of the remedial activities;
- A change to the type(s) of remedial activities; or
- Discovery of previously unidentified contaminants.

5.7.3. Documentation Requirements for PAM Report

At the conclusion of remedial activities, a PAM report should be provided as part of the Remedial Action Report (RAR) and should satisfy the regulatory requirements and timeframe specified in the Technical Requirements at N.J.A.C. 7:26E-5.7 and 5.8. The PAM report should contain the following elements:

- Contaminants monitored;
- Contaminant HBTVs, response levels, and their basis;
- A site map showing actual monitoring locations and receptors, including modified locations;

- Details of any modifications made to the PAM plan during implementation, and supporting documentation to justify the modifications;
- All exceedances encountered with appropriate explanation of how they were resolved;
- Daily data evaluation, including results from upwind stations, and overall results summaries. Problems encountered should also be noted;
- All data deliverables, including data logging files from the meteorological and monitoring stations, and daily wind roses;
- All results and QA/QC documentation for confirmatory laboratory analysis;
- All equipment calibration records and certification sheets; and,
- All sample or measurement traceability documentation (e.g., chain-of-custody records, sample or measurement location maps/drawings, and any other records/notes pertinent to the assessment of measurement quality).

5.7.4. Other Documentation Requirements

In accordance with ARRCS at N.J.A.C. 7:26C-1.7, public outreach to the surrounding community may be necessary due to site-specific circumstances, if there is substantial public interest, or to comply with the public participation requirements applicable to sites subject to the Comprehensive Environmental Response, Compensation and Liability Act and the National Contingency Plan regulations. Types of outreach include, but are not limited to, holding a public meeting, sharing PAM data on a public project website, and sending information via mail to nearby residents. The best method and frequency for distributing information to the surrounding community will be a site-specific decision, based on the scope of the remediation and interests of the community.

The investigator should also keep apprised of local and county requirements, as some municipalities and/or counties may have their own permitting and documentation requirements. The PAM plan should be in compliance with state regulations as well as local and county requirements.

6. Quality Assurance Considerations

Quality assurance (QA) refers to a total integrated program, which when properly applied, will assure the reliability of measurement data by integrating planning, assessment, and quality improvement activities to meet end user needs. The objective of PAM is to collect ambient air data of a quality and type sufficient to conclusively demonstrate that off-site community exposure is maintained below site-specific HBTVs.

The quality assurance aspects of the PAM plan should include components found in the *Quality Assurance Project Plan Technical Guidance*

(https://www.state.nj.us/dep/srp/guidance/srra/quality_assurance_project_plan_guidance.pdf) as appropriate to the goals of the PAM plan to demonstrate that PAM data is technically sound. The quality assurance aspects of the PAM plan should, at a minimum, include identification and specification of DQOs against which all data collected should be vetted prior to its use.

6.1. Data Quality Objectives

As stated previously, it is essential that implementation of the PAM plan results in the collection of data of sufficient type, quality, and quantity to demonstrate the protection of human health. The

approach for verifying data quality should conform with the data quality framework found in the *Quality Assurance Project Plan Technical Guidance* (QA/QC Guidance). This document sets forth the NJDEP recommendation on the importance of Data Quality Indicators (DQIs) for the establishment of associated DQOs in the data quality framework.

DQOs are developed for each DQI by the investigator to ensure that the quality and quantity of data and information is sufficient to meet the goals of the PAM plan and support defensible conclusions relating to the protection of human health and welfare. It is the DQOs that provide the basis for the selection of measurement technologies and methods appropriate for each COC such that the measurement data generated is of a quality sufficient to demonstrate HBTv compliance.

For PAM plans, the DQIs for which DQOs should be developed include:

- **Accuracy:** the degree of agreement of a measured value with a known value.
- **Precision:** the measure of agreement among repeated measurements under identical or substantially similar conditions.
- **Representativeness:** the degree to which the measurements made, or physical samples collected appropriately represent the condition being measured.
- **Completeness:** a measure of the amount of valid data that must be collected from a measurement system.
- **Comparability:** a qualitative term that expresses the measure of confidence that one data set can be compared to another and be combined to support the decisions to be made.
- **Sensitivity:** the minimum concentration or attribute that can be measured by a method (method detection limit), by an instrument (instrument detection limit), or by a laboratory (quantitation limit).

Especially as it pertains to precision, accuracy, and sensitivity DQOs, it is recommended that the PAM plan provide a side-by-side presentation of each with the selected technology or method precision, accuracy, and sensitivity specifications, to demonstrate clearly how each will be achieved.

Finally, in the PAM planning process, a principal challenge is selecting measurement technologies which can adequately address the representativeness (a qualitative DQO). On small spatial scales, contaminant concentrations in ambient air will vary greatly in both time and space due to the heterogeneous nature of most waste sites (USEPA 2001). The challenge therefore is to collect measurement data which are representative of (or traceable to) the true community exposure condition, both in time and space. Properly addressing this quality attribute is essential in order to conclusively demonstrate that community exposures are being maintained at levels in compliance with the HBTv(s). Sample DQO checklists are provided in Appendix E.

If there is a laboratory data quality concern for an analytical method being considered, technical oversight guidance for verifying DQO achievement is provided in NJDEP documents including the *Quality Assurance Project Plan Technical Guidance* and *Data Quality Assessment and Data Usability Technical Guidance*.

6.2. Real-time Monitoring Equipment Quality Assurance:

In accordance with the Department QA/QC Guidance, the PAM plan is prepared following the development of the CSM. To ensure that the real-time monitoring methods selected produce data that meets the DQOs and complies with the requisite specifications developed in the PAM plan, the

following includes some of the specific QC procedures that should be addressed.

- **Factory Calibration** – Instrument calibration that would be conducted off-site either by the instrument manufacturer or a certified provider. Follow the manufacturer specifications for the correct calibration frequency for each instrument. A calibration document illustrating the precision and accuracy measured during the calibration process should be provided after calibration is complete.
- **Field Validation/Calibration** – This can be performed on a daily or as-needed basis to confirm that the precision and accuracy of instruments in the field are functioning in the same manner as they did when they were last factory calibrated. Several common types of field validation exist:
 - **Zero Calibration** – Zero calibration options exist for particulate and vapor meters and should be conducted in accordance with manufacturer’s specifications. Zero calibration is the process by which a real-time monitor draws ambient air to calibrate the equipment with ambient conditions. The PAM plan should detail what technologies are used and specify the frequency when such field validation must occur.
 - **Bump Testing** – The application of a test gas to a vapor or gas meter to assess its immediate response to a pre-determined concentration of a contaminant. Test gas is often provided by and can be requested from the manufacturer in order to conduct in-field bump testing. In using a pre-designated concentration of gas, it can be determined whether the monitoring equipment is detecting concentrations within an acceptable range of error. Following manufacturer instructions, a monitor is introduced to a test gas at its sampling port and the reading on the meter is recorded and compared to the concentration of gas indicated on the test gas bottle. If the instantaneous reading on the meter falls outside the specified range of acceptable readings, the meter should be recalibrated in-field (see below). Bump test readings should be recorded to determine if the unit is subject to drifting over time. The PAM plan should detail what technologies are used and specify the frequency when such field validation must occur.
 - **In-Field Calibration** – The process by which real-time monitors are recalibrated using a manufacturer-provided test gas in the event the monitor has been subject to drifting or is malfunctioning and producing unreliable readings. Following manufacturer instructions, the monitor is connected to the test gas container that holds a pre-designated concentration of gas. The monitor then draws the test gas over a pre-determined duration and is recalibrated to the test gas concentration. This process should reestablish monitoring within the acceptable range of error. The PAM plan should detail what technologies exist and specify the frequency when such field validation must occur.
- **Instrument Inspection** – Some devices are capable of measuring multiple parameters simultaneously (e.g., A DustTrak DRX will measure particles 2.5 micrometers or less in diameter (PM_{2.5}), PM₁₀, & PM_{Total}), while others can only measure one parameter at a time (e.g., A DustTrak II will measure a single particulate matter size depending on the impactor head that is attached). Devices should be inspected to make sure they are all measuring the same parameters as their counterparts, as these devices may have multiple setup options.
- **Sampling Location** – The positions around the perimeter of the site where the monitoring instruments are located should ideally be in an area that places them between the work area

and sensitive receptors (e.g., housing & schools). These locations should also have the instruments oriented to have at least one location upwind of the site work and at least one location downwind of the site work. While certain locations are ideal, they may not be feasible due to other factors that may cause interferences with the instruments' readings (e.g., exhaust/ventilation ports from adjacent buildings or sprinkler systems). The PAM plan should outline the monitoring locations. Adjustments can be made to the selected monitoring locations to account for changing site conditions and should be documented in the report.

- **Co-Located Monitoring** – When using real-time instruments, it is common to occasionally co-locate another real-time instrument adjacent to the primary instrument to determine if the data from the primary meets appropriate correlation coefficients. The PAM plan should outline the type and frequency of co-located monitoring proposed.
- **Validation** – Laboratory analytical samples should be taken periodically (e.g., once per week) and when real-time results exceed certain thresholds. Periodic analytical sampling may also be used in conjunction with real-time instruments to test device accuracy. The frequency and type of analytical sampling should be outlined in the PAM plan.
- **Data Integrity** – When instrument readings are processed by an air monitoring system to calculate averages or statistical reports, a means to determine that these calculations are both accurate and precise must be in place. Instrument manufacturers often provide such documentation for the firmware that is processing collected air monitoring data. If there are other software programs collecting and processing real-time data, then a means to test the accuracy and precision of these calculations should be outlined in the PAM plan.
- **Data Retention & Reporting** – The purpose of real-time monitoring is to provide immediate readings of site conditions based on measurement parameters required by the PAM plan. The raw data collected by the instruments should be saved and stored in accordance with N.J.A.C. 7:26I-6.27 should the data need to be accessed again for any recalculations, reporting, or legal purposes.
- **Operational Hours/Power Requirements** – Depending on the contaminants of concern and the methods being utilized to remediate the site (e.g., in-situ stabilization (ISS)), monitoring may only need to be conducted during working hours or may need to run 24/7. The timeframe for which real-time monitoring should occur should be outlined by the PAM plan and will help to determine the power requirements necessary for the instruments.

6.3. Laboratory Sample Collection and Analysis

As discussed in Section 5.4.2.2 above, sample collection for off-site laboratory analysis is typically performed for confirmatory purposes (e.g., confirming COC identification, verifying response level effectiveness). For sample collection, to ensure the usability of the sample analysis results, QC procedures detailed in the PAM plan should address the following:

- Instrument (pump/regulator) calibration for sampling flow rates
- Proper sampling method and media
- Sample collection QC – Trip blanks, field blanks, duplicates
- Sample collection QC – Sampling media sealed/undamaged prior to use and labeled properly
- Chain of Custody procedures for handling and shipping samples

Collecting air samples for off-site analysis at an analytical laboratory requires QA/QC of the sampling

process and handling as well as the analysis of the sample. These would include instrument calibration, sample collection QA (trip blanks, other blanks), chain of custody procedures, and QA/QC procedures used by the laboratory to analyze the sample. Details of the QA/QC procedures used in collecting and analyzing the data should be outlined in the PAM plan.

6.4. Laboratory Deliverables

For the reporting of laboratory results, the format for the full and reduced laboratory deliverables is specified in the Technical Requirements at N.J.A.C. 7:26E Appendix A. For the purposes of PAM, the submission of reduced laboratory deliverables is acceptable for all analyses, except for polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans sample analyses in accordance with N.J.A.C. 7:26E-2.1(a)15(i) where full data deliverables are required. Additionally, it is strongly recommended that full data deliverables be submitted for scenarios where sensitive receptors are located directly adjacent to emissions generating activities.

7. Additional Considerations

7.1. Chemical-Specific Analytical Sampling Concerns

Some compounds, for which air monitoring and confirmatory sampling should be performed, can be present in ambient air in both volatile and/or particulate forms. These compounds include mercury, naphthalene, and PCBs. For the purposes of PAM, mercury and naphthalene have been specifically identified to remain consistent with the Vapor Intrusion Technical Guidance, which recognizes these COCs as volatile in certain circumstances due to their unique physical and chemical properties. Further, PCBs were identified based on the recommendations of the SAB, which recognizes them as volatile in certain circumstances. Confirmatory analytical sampling to determine the predominant or most toxic form of these COCs should be conducted at the commencement of remedial activities. Should the investigator decide that initial confirmatory analytical sampling for both forms of any one of these COCs is not necessary, adequate justification should be detailed in the PAM report.

Once the confirmatory results are received for the first three (or more) consecutive days of remedial action, preferably conducted in the area with the highest soil COC concentrations and at the predicted predominant downwind location(s), modification to the confirmatory sampling frequency may be considered. Confirmatory samples should be collected in accordance with Step 4, Section 5.4.2.2.1, above and should be analyzed on an expedited turnaround time so the response level monitoring strategy may be modified, if applicable, as quickly as possible. If confirmatory results show that one form is not present or is negligible, then monitoring for that form may be discontinued.

7.2. Chemical-Specific Real-Time Monitoring Concerns

Real-time monitoring for mercury and naphthalene, in both volatile and particulate form, can be achieved with readily available instrumentation; however, real-time monitoring instrumentation for the PCB-volatile fraction is not practical due to cost and method requirements. Additionally, neither a HBTV nor a response level can be calculated for PCBs in ppbv using the PAM Calculator since Total PCBs are a mixture of PCB congeners whose individual molecular weights differ.

PCBs should be monitored in real time as a particulate with collection of samples for laboratory analysis for the volatile component for the first (3) or more consecutive days of remedial work. Once the laboratory PCB data are received, a decision as to whether sample collection for the PCB-volatile

fraction should be continued can be made and documented. If significant concentrations of PCBs are present in the volatile form, modification to the work practices may be necessary.

7.3. Asbestos in Environmental Media

This section pertains to sites undergoing remediation that have soil contaminated with asbestos or other site-specific concentration determined for remedial actions. When buildings are contaminated with asbestos, remediation of those buildings will be covered under the National Emissions Standard for Hazardous Air Pollutants (NESHAPS) found in 40 CFR Part 61, subpart M.

The PAM program to be implemented during the remediation of a site with soils containing asbestos at concentrations determined for remedial actions must include asbestos monitoring using an acceptable level of less than or equal to 0.01 fibers per cc of air via phase-contrast microscopy analysis. Given that there are currently no real-time monitors specific to asbestos fibers, the asbestos sampling will be done on a daily basis, in addition to particulate monitoring, to demonstrate compliance with the site-specific PM₁₀ action level. While it is anticipated that compliance with the site-specific PM₁₀ action level will most likely be protective for asbestos, the PM₁₀ and asbestos data must be evaluated to ensure that use of the site-specific PM₁₀ level remains protective for asbestos. After a minimum of three days of data are collected for both PM₁₀ and asbestos, it may be possible to use a correlation of the results to discontinue the asbestos monitoring if it can be demonstrated that the PM₁₀ level is protective of the 0.01 fibers per cc of air level. The 0.01 fibers per cc of air level comes from the NJ Uniform Construction Code at N.J.A.C. 5:23-8.21 that is based on the Federal criteria for asbestos abatement in schools found in 40 CFR 763.80, Subpart E. The Agency for Toxic Substances and Disease Registry (ATSDR) has previously concurred with the use of the above asbestos level as a perimeter action level protective of community residents during building demolition. The NJDEP has also used the asbestos level of 0.01 fibers per cc of air in other remediation projects involving asbestos.

Best management practices must be used to minimize the generation and/or dispersion of asbestos containing dust during site activities. This should include, at a minimum, wetting down areas subject to dust generation and adequate vehicle/equipment cleaning to avoid the spread of asbestos beyond the site. See Section 7.6 for additional information on best management practices.

7.4. Air Permit Requirements

Sources of air contaminant emissions or odors at remediation sites may require an Air Pollution Control (APC) permit, pursuant to N.J.A.C. 7:27-8 of the APC Regulations (<https://dep.nj.gov/aqm/rules/rules27/>). In N.J.A.C. 7:27-5.1, “air pollution” is defined as follows:

“The presence in the outdoor atmosphere of one or more air contaminants in such quantities and duration as are, or tend to be, injurious to human health or welfare, animal or plant life or property, or would unreasonably interfere with the enjoyment of life or property throughout the State and in such territories of the State as shall be affected thereby and excludes all aspects of employer-employee relationship as to health and safety hazards.”

A violation of the APC regulations at N.J.A.C. 7:27-5 may occur if odors or visible particulate emissions are detected beyond the boundaries of the site undergoing remediation. On remediation sites where odors or releases of air contaminant emissions are anticipated, the investigator is advised to be proactive and to prevent and/or mitigate air contaminant emissions where possible using best management practices and air pollution control technologies. An APC permit is not required for the movement of contaminated material; however, an APC permit would be required if equipment or

operations at a remediation site were found to belong to one of the significant source categories listed at N.J.A.C. 7:27-8.2(c). The most common examples include, but are not limited to:

- N.J.A.C. 7:27-8.2(c)2 which requires an APC Permit for any source operation or equipment that has the potential to emit any Group 1 or Group 2 TXS (Toxic Substances) (or a combination thereof), listed at N.J.A.C. 7:27-17.3(f), at a rate greater than 0.1 pounds per hour (45.4 grams per hour); or
- N.J.A.C. 7:27-8.2(c)16 which requires an APC Permit for any equipment that is used for treating waste soils or sludges, including municipal solid wastes, industrial solid wastes, or recycled materials, if the influent to the equipment has a solids content of two percent by weight or greater.

If equipment or operations at a site undergoing remediation were found to belong to one of the significant source categories listed in N.J.A.C. 7:27-8.2(c) and did not have an approved APC permit, it would be a violation and could result in work stoppage.

In addition, operations such as in-situ solidification/stabilization, soil vapor extraction, thermal treatment and others may cause emissions of air pollutants that are odorous. For these situations, an Odor Management Plan may be required by NJDEP Air Permitting Program. Such a plan might include the use of engineering controls to reduce odor emissions. In addition to direct controls of emissions, a surveillance plan might be put in place to check that odors are not being detected in neighboring communities or at sensitive receptors.

For further details or questions on APC permit applicability, contact the appropriate NJDEP Air Regional Enforcement Office:

Air Regional Enforcement Office Jurisdictions:

Northern Regional Office

Facilities Located In: Bergen, Essex, Hudson, Hunterdon, Morris, Passaic, Somerset, Sussex, Union, and Warren counties
Tel – 973-656-4444

Central Regional Office

Facilities Located In: Burlington, Mercer, Middlesex, Monmouth, and Ocean counties
Tel – 609-292-3187

Southern Regional Office

Facilities Located In: Atlantic, Camden, Cape May, Cumberland, Gloucester, and Salem counties
Tel – 856-614-3601

For remediations that require an APC permit, applicants should be aware that the APC permit application review time is typically 90 days. In cases where the remediation is set to take place in an environmental justice community (<https://www.state.nj.us/dep/ej/>) additional review time may be required. The same applies to areas where an elevated risk above 10^{-6} (one-in-a-million) for carcinogens, or a hazard index above 1, for non-carcinogens, is determined for an air contaminant in the air permitting risk screening process. To download the NJDEP Division of Air Quality risk screening worksheet, visit <https://www.state.nj.us/dep/aqpp/risk.html> and select the excel file titled *NJDEP Division of Air Quality Risk Screening Worksheet for Long-Term Carcinogenic and Noncarcinogenic Effects and Short-Term Effects*.

7.5. Addressing Hot Spot Scenarios

Hot spots are generally defined by the frequency of detection above the applicable soil standard(s) and the magnitude of the exceedances (e.g., more than 10 times the soil remediation standard or background contaminant levels, in 75% or more of the samples). The greatest potential for causing adverse, short-term contaminant release during remedial actions (on the order of minutes to hours) most often arises from the addition of fixative agents (e.g., cement, fly ash) to immobilize contaminants in highly contaminated soils. Concentrated contaminant plumes can exceed HDTV-based response levels. In some instances, the emissions from this type of remedial action will have resulted in significant community impacts and should be considered when selecting the remedial action.

The exothermic reaction caused by the addition of fixatives may result in the rapid release of most of the volatile and lighter semi-volatile compound mass present (e.g., benzene, naphthalene). Accordingly, this will cause such plumes to be generated from the relatively small area within which the fixative is being mixed with soil. Although less likely, evaporation of high concentrations of hazardous chemicals may also occur during other types of remedial actions or site-disturbance activities, such as excavation.

The potential for unacceptable community exposure is increased under meteorological conditions where plume dispersion is inhibited, such as during temperature inversions. When the remedial action is relatively close to the site boundary, narrow plumes may pass off-site undetected between stationary real-time monitoring stations (often separated by a hundred feet or more). Attempts to properly position a mobile real-time station will generally be problematic and ineffective as well, as it is impractical to identify in advance a precise upwind/downwind orientation, especially during times of low wind speeds (less than about 2 m/s).

Described below is a method for assessing response-level compliance from remedial actions performed on sites having hot spots. Using real-time, hand-held monitoring to assess compliance, this method can be employed whenever hot spots are known (or expected) to exist and will be disturbed as part of the remediation. Accordingly, consistent with guidance set forth in Section 5.6.1, if the below method indicates any exceedance of the real-time action level, the remediation process must be immediately stopped until vapor generating activities are sufficiently reduced via implementation of appropriate engineering controls or modifications to the remedial operations.

Figure 7-1 conceptually depicts the proposed approach. While other approaches may be employed, it is strongly recommended that acceptance of such alternatives be granted by the Department prior to initiation of the remedial action.

Immediately downwind of the remedial action, a rapid survey is performed by an on-site worker using a hand-held instrument over a 15-minute period to obtain a mean concentration, also referred to as a path-averaged concentration. This 15-minute mean concentration is then reworked to yield an adjusted downwind concentration (ADC) which conservatively assumes that all of the site emissions emanate from a single, small hot spot (3-by-3 meters), regardless of how these emissions (or hot-spots) are actually distributed throughout the site.

As an example, the downwind mean concentration is 100 ppb over a measurement path of 60 meters; therefore, given the assumed hot-spot source width of 3 meters, the ADC is 2 ppm (100 ppb x 60m/3m). If the 15-minute response level is 3 ppm, the remedial action may continue. On the other hand, if the response level were 1.5 ppm, the ADC of 2 ppm would be too great to allow continuation

of the remedial action.

The ADC is proportional to the measurement path employed, and the ADC can be proportionally reduced if it can be shown that all potential emissions originating from anywhere on the site are still captured. In this example, if it can be shown that a measurement path of only 30 meters is sufficient (vs. 60 meters), the ADC would be reduced by half (e.g., ADC of 1 ppm), and the 1.5 ppm response level would now be satisfied. It behooves the remedial action team to perform the necessary work upfront, to justify reducing the lateral extent of the potential emitting area, thus allowing for the measurement path to be reduced accordingly.

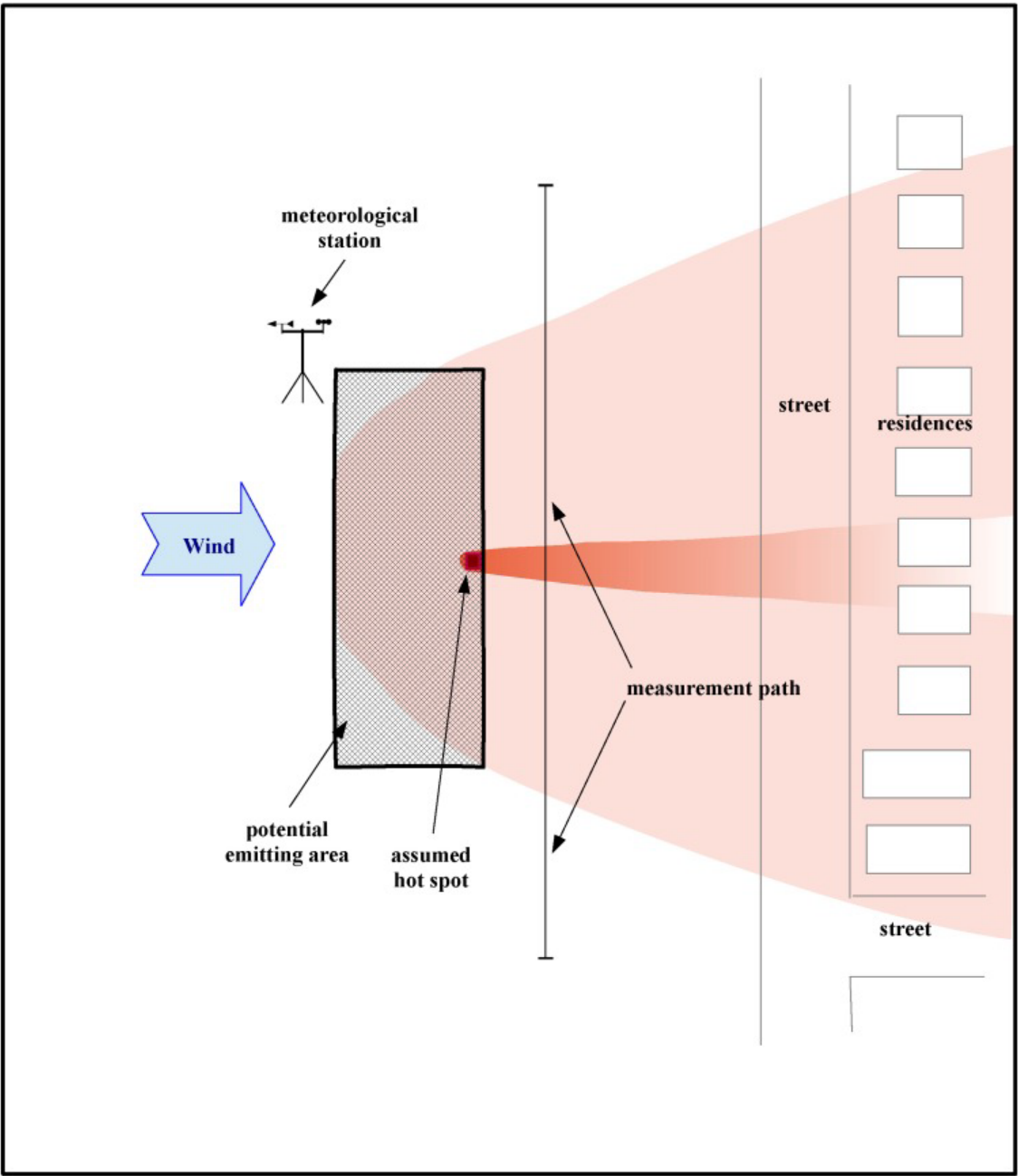
If the width of the emitting area cannot be reduced sufficiently to demonstrate response-level compliance: (a) the remedial action will have to be modified to either reduce the emission rate or implement some type of emissions control; or (b) a further ADC reduction will be needed.

This further reduction involves taking advantage of the fact that the contaminant plume will disperse (both horizontally and vertically) over the time and distance it takes to reach the nearest downwind sensitive receptor (e.g., the nearest resident). The degree of plume dispersion afforded by the distance between the source and the nearest downwind sensitive receptor is referred to as the dilution factor. Multiplying this dilution factor by the ADC yields the maximum exposure to the nearest downwind sensitive receptor, which is then compared to the response level.

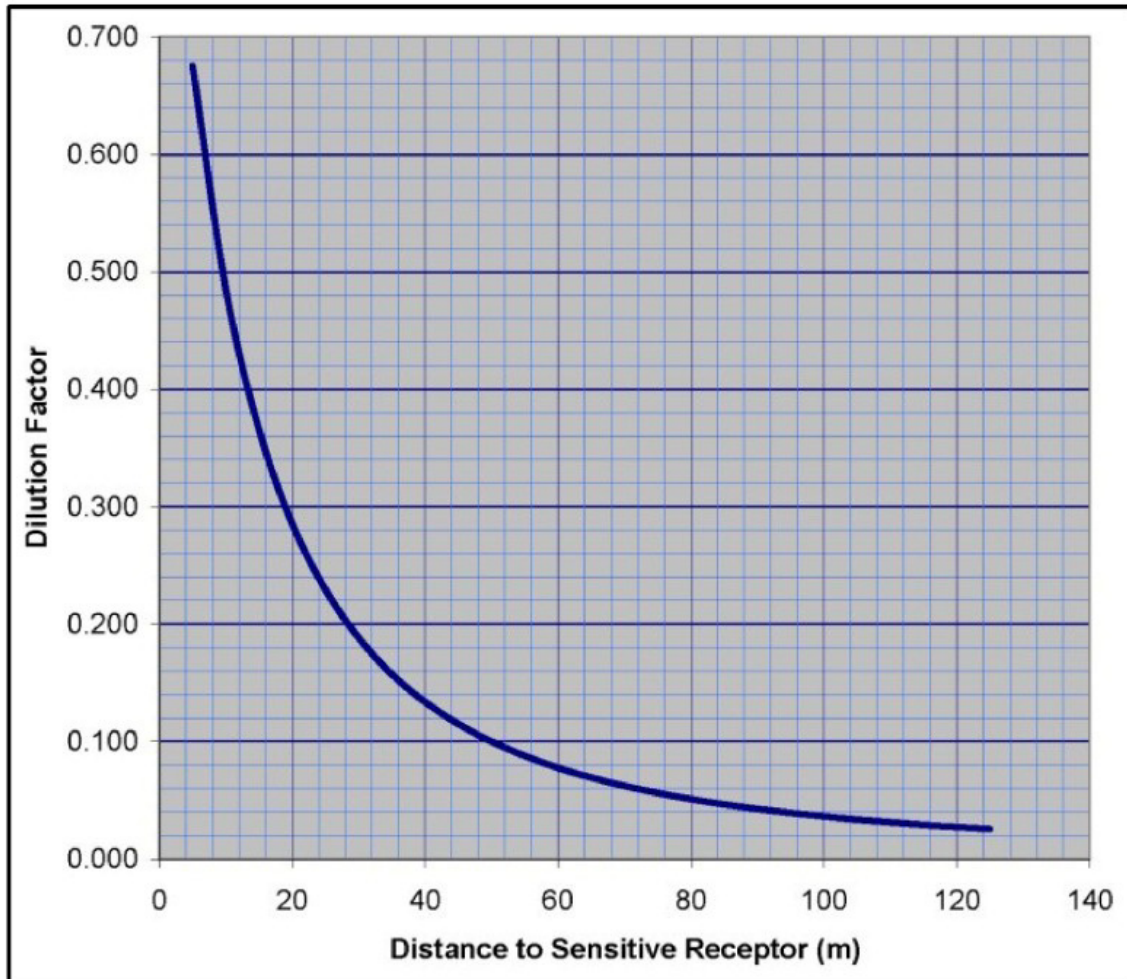
Figure 7-2 depicts a worst-case example of a dispersion modeling-based dilution-factor nomograph, as a function of distance to the nearest downwind sensitive receptor. As can be seen, a 90 percent ADC reduction is obtained for sensitive receptors more than 50 meters downwind.

Alternatively, in part to address the issue of on-site personnel exposure, EPA has developed “standoff” analysis technologies (e.g., EPA Method TO-16), in which all boundaries surrounding a potentially hazardous remedial action can be monitored remotely, in real-time. While not mainstream due largely to cost considerations, the Department will consider investigator proposals of this type in situations where community concern is heightened, especially when the technology can identify and quantify the limiting contaminants in real-time.

**FIGURE 7-1
PREFERRED APPROACH FOR ASSESSING RESPONSE-LEVEL COMPLIANCE
FOR REMEDIAL ACTIONS INVOLVING HOT-SPOTS**



**FIGURE 7-2
EXAMPLE DILUTION-FACTOR NOMOGRAPH**



7.6. Best Management Practices at Contaminated Sites Undergoing Remediation

Dust and vapor emissions must be properly managed at a contaminated site to reduce human exposure, environmental impacts, and comply with regulations. Best management practices for emissions control should be implemented during active remediation, as well as during periods of down time to reduce the potential for air emissions to travel off-site. Best management practices can include wetting active remediation areas with water, minimizing or ceasing activities during periods of high wind, sweeping or wetting paved areas, wetting unpaved areas, application of dust and vapor suppressant materials, and covering stockpiles. During non-working periods, best management practices may include the use of tarps, application of dust and vapor suppression materials, or enclosures to cover stockpiles and/or excavation areas. If there are concerns that best management practices may not be sufficient to control dust or vapor from leaving the site, it is recommended that PAM be implemented during non-working hours as well to ensure that air contaminants are not impacting off-site receptors.

REFERENCES

- NJDEP, 2019. Technical Guidance for Preparation and Submission of a Conceptual Site Model (Version 1.1). https://www.nj.gov/dep/srp/guidance/srra/csm_tech_guidance.pdf
- NJDEP, 2014. Quality Assurance Project Plan Technical Guidance (Version 1.0). https://www.nj.gov/dep/srp/guidance/srra/quality_assurance_project_plan_guidance.pdf
- NJDEP, 2014. Data Quality Assessment and Data Useability Technical Guidance (Version 1.0) https://www.nj.gov/dep/srp/guidance/srra/data_qual_assess_guidance.pdf
- USEPA 2001. Current Perspectives in Site Remediation and Monitoring (EPA-R-01-014), U. S. Environmental Protection Agency, Office of Solid Waste and Environmental Response, Washington, DC, EPA 542/R-01-014, October 2001.

APPENDIX A
PAM PLAN CONTENTS

APPENDIX A

PAM PLAN CONTENTS

A PAM Plan consistent with this guidance document is required prior to initiation of emission-generating activities for remediation activities expected to occur for more than 20 working days. The PAM Plan should contain, at minimum, the information listed below. Department pre-approval of the PAM plan is not required unless the site is in traditional or direct oversight, and in most cases, remediation may commence without Departmental approval.

1. PAM Objective and Remedial Action Description

Provide a context for the PAM program. Most importantly the PAM objective should be clearly stated (e.g., “to collect data of sufficient quality and quantity to demonstrate remedial action related air emissions will not adversely impact off-site human health”).

Remedial action information should include the following:

- Site/Project name;
- Overview of remedial activities which have the potential for generating air emissions;
- Estimated project schedule;
- Site map detailing the locations to be remediated and their proximity to the receptors; and
- Overview of COCs and associated HBTVs.

2. Field Management

Identify responsible personnel, including the individual responsible for ensuring the quality of the PAM data collected and community relations. Information should include the following:

- A project organization chart or list with descriptions of the roles and responsibilities of key personnel.

3. PAM Program Design

Present the program design and strategy for collecting ambient concentration measurements for use in assessing HBTV compliance. Information should include:

- COCs identified, with rationale and documentation supporting their selection or exclusion;
- Compound-specific or surrogate HBTVs and basis for their calculation (provide outputs from NJDEP PAM Calculator). Justification should be detailed regarding surrogate selection;
- Sampling and/or monitoring locations including figures depicting areas relative to the receptors within which ambient concentration measurements will be made. The figure should also include the proposed location of the weather monitoring equipment;
- Calculated real-time monitoring response levels (provide outputs from NJDEP PAM Calculator);
- Real-time monitoring TWA (e.g., 5-minute, 15-minute);

- Real-time monitoring equipment selected to monitor for both volatiles and particulates, where applicable;
- Confirmatory analytical sampling equipment, method(s) and frequency;
- Real-time meteorological equipment; and
- Protocol for reacting to exceedances of instrument Response Levels (see Step 6 of Conceptual Approach).

4. Data Quality Objectives (DQOs)

Describe how the data collected will be of known quality and appropriate for its intended use and of a quality sufficient to be protective of human health.

5. Measurement Technology Selection

Identify and select appropriate measurement technologies and/or methods for which it can be demonstrated that the data generated will be of a quality sufficient to be protective of human health.

6. Standard Operating Procedures (SOPs)

Identify specific SOPs (by reference or attachment) detailing the use of measurement system to be deployed and sample collection activities to be performed.

7. Laboratory Certification

Identify, where applicable, the name of a laboratory certified by the State of New Jersey. If the analytical technique to be employed does not have New Jersey certification, provide other nationally recognized certifications for NJDEP consideration and concurrence (e.g., USEPA, modified OSHA and NIOSH methods, etc.).

8. Identification and Implementation of Corrective Actions

Identify adaptive management techniques so the PAM program keeps up with operational and environmental changes throughout the project and provides protection of offsite receptors.

9. Documentation and Reporting

Identify all documentation and reporting procedures. Some of these may include PAM reports and community relations procedures for providing PAM program results to the public and other stakeholders.

PAM Final Report

A PAM report must be provided following completion of the remedial activities. The report must contain:

- Contaminants monitored;
- HBTVs, Response Levels, and their basis;
- Site map(s) showing actual monitoring locations and receptors, and modified locations if applicable;
- Details of any modifications made to the PAM plan during implementation, and supporting documentation to justify the modifications;
- All exceedances encountered with appropriate explanation of how they were resolved;
- Daily data evaluation, including results from upwind stations, and overall results summaries. Problems identified and actions implemented for their resolution should also be noted;
- All data deliverables, including data logging files from the meteorological and monitoring stations, and daily wind roses (include as appendices);
- All results and QA/QC documentation for confirmatory laboratory analysis;
- All equipment calibration records and certification sheets; and,
- All sample or measurement traceability documentation (e.g., chain-of-custody records, sample or measurement location maps/drawings, and any other records/notes pertinent to the assessment of measurement quality).

APPENDIX B
HBTV EQUATIONS AND INHALATION
TOXICITY FACTORS

APPENDIX B
HBTV EQUATIONS AND INHALATION TOXICITY FACTORS

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- 1.0 HBTV Equations
- 2.0 Inhalation Toxicity Factors
- 3.0 Recommendations for Treatment of Lead for Perimeter Air Monitoring (Equal to or Less Than 1-Year Duration)

1.0 HBTV EQUATIONS

A. Using a Reference Concentration (RfC) to Derive an HBTV

$$HBTV = \frac{RfC * AT}{ET * EF * ED}$$

Where:

RfC = Reference Concentration = Contaminant-specific ($\mu\text{g}/\text{m}^3$)

AT = Averaging Time = 1 year

ET = Exposure Time = Work shift length (hours/24 hours)

EF = Exposure Frequency = Length of actual excavation (days/365 days)

ED = Exposure Duration = 1 year

B. Using an Inhalation Unit Risk (IUR) to Derive an HBTV

If an RfC is not available for a contaminant, but an IUR (for carcinogenicity) is available, the IUR may be used to develop an HBTV.

$$HBTV = \frac{TR * AT}{IUR * ET * EF * ED}$$

Where:

TR = Target Risk = 1×10^{-6}

AT = Averaging Time = 70 years

IUR = Inhalation Unit Risk = Contaminant-specific but in terms of $(\mu\text{g}/\text{m}^3)^{-1}$

ET = Exposure Time = Work shift length (hours/24 hours)

EF = Exposure Frequency = Length of actual excavation (days/365 days)

ED = Exposure Duration = 1 year

2.0 INHALATION TOXICITY FACTORS

Contaminant	CAS No.	PAM Committee Recommendation	Inhalation Toxicity Factor(s)
Acenaphthene	83-32-9	No inhalation-based toxicity factors are available ¹⁸	None
Acetone	67-64-1	No inhalation-based toxicity factors are available	None
Acetophenone	98-86-2	No inhalation-based toxicity factors are available ¹	None
Aldrin	309-00-2	No inhalation-based toxicity factors are available ¹⁷	None
Aluminum	7429-90-5	PPRTV RfC (2006)	5E-03 mg/m ³
Anthracene	120-12-7	No inhalation-based toxicity factors are available ¹⁸	None
Antimony	7440-36-0	ATSDR MRL ¹⁹ (2019)	3E-04 mg/m ³
Arsenic	7440-38-2	IRIS IUR (1998)	4.3E-03 (µg/m ³) ⁻¹
Atrazine	1912-24-9	No inhalation-based toxicity factors are available	None
Barium	7440-39-3	HEAST RfC (1997)	5E-04 mg/m ³
Benzaldehyde	100-52-7	No inhalation-based toxicity factors are available	None
Benzene	71-43-2	IRIS RfC (2003)	3E-02 mg/m ³
Benzo(a)anthracene	56-55-3	IRIS IUR (2017) (benzo(a)pyrene) adjusted for benzo(a)anthracene	6.0E-05 (µg/m ³) ⁻¹
Benzo(a)pyrene	50-32-8	IRIS RfC (2017)	2.0E-06 mg/m ³
Benzo(b)fluoranthene	205-99-2	IRIS IUR (2017) (benzo(a)pyrene) adjusted for benzo(b)fluoranthene	6.0E-05 (µg/m ³) ⁻¹
Benzo(k)fluoranthene	207-08-9	IRIS IUR (2017) (benzo(a)pyrene) adjusted for benzo(k) fluoranthene	6.0E-06 (µg/m ³) ⁻¹
Beryllium	7440-41-7	IRIS RfC (1998)	2E-05 mg/m ³

Contaminant	CAS No.	PAM Committee Recommendation	Inhalation Toxicity Factor(s)
1,1'-Biphenyl	92-52-4	No inhalation-based toxicity factors are available	None
Bis(2-chloroethoxy) methane	111-91-1	No inhalation-based toxicity factors are available	None
Bis(2-chloroethyl) ether	111-44-4	ATSDR Intermediate MRL ² (2017)	1.2 E-01 mg/m ³
Bis(2-ethylhexyl) phthalate	117-81-7	No inhalation-based toxicity factors are available ¹⁷	None
Bromodichloromethane	75-27-4	No inhalation-based toxicity factors are available ¹⁷	None
Bromoform	75-25-2	No inhalation-based toxicity factors are available ¹⁷	None
Bromomethane	74-83-9	IRIS RfC (1992)	5E-03 mg/m ³
2-Butanone (MEK)	78-93-3	IRIS RfC ³ (2003)	5E+00 mg/m ³
Butylbenzylphthalate	85-68-7	No inhalation-based toxicity factors are available	None
Cadmium	7440-43-9	ATSDR MRL ¹⁹ (2013)	1E-05 mg/m ³
Caprolactam	105-60-2	CalEPA RfC (2013)	2.2E-03 mg/m ³
Carbon disulfide	75-15-0	IRIS RfC (1995)	7E-01 mg/m ³
Carbon tetrachloride	56-23-5	IRIS RfC (2010)	1E-01 mg/m ³
Chlordane (alpha plus gamma mixture)	57-74-9	IRIS RfC (1998)	7E-04 mg/m ³
4-Chloroaniline	106-47-8	No inhalation-based toxicity factors are available	None
Chlorobenzene	108-90-7	PPRTV RfC (2006)	5E-02 mg/m ³
Chloroethane	75-00-3	IRIS RfC (1991)	1E+01 mg/m ³
Chloroform	67-66-3	ATSDR MRL ¹⁹ (2013)	9.8E-02 mg/m ³
Chloromethane	74-87-3	IRIS RfC (2001)	9E-02 mg/m ³
2-Chloronaphthalene	91-58-7	No inhalation-based toxicity factors are available	None

Contaminant	CAS No.	PAM Committee Recommendation	Inhalation Toxicity Factor(s)
2-Chlorophenol	95-57-8	No inhalation-based toxicity factors are available ¹⁷	None
Chrysene	218-01-9	IRIS IUR (2017) (benzo(a)pyrene) adjusted for chrysene	6.0E-07 (µg/m ³) ⁻¹
Cobalt	7440-48-4	PPRTV RfC (2008)	6E-06 mg/m ³
Copper	7440-50-8	No inhalation-based toxicity factors are available ⁴	None
Cyanide	57-12-5	IRIS RfC (2010)	8E-04 mg/m ³
Cyclohexane	110-82-7	IRIS RfC (2003)	6E+00 mg/m ³
4,4'-DDD	72-54-8	No inhalation-based toxicity factors are available ¹⁷	None
4,4'-DDE	72-55-9	No inhalation-based toxicity factors are available ¹⁷	None
4,4'-DDT	50-29-3	No inhalation-based toxicity factors are available ¹⁷	None
Dibenz(a,h)anthracene	53-70-3	IRIS IUR (2017) (benzo(a)pyrene) adjusted for dibenzo(a,h)anthracene	6.0E-04(µg/m ³) ⁻¹
Dibromochloromethane	124-48-1	No inhalation-based toxicity factors are available ¹⁷	None
1,2-Dibromo-3-chloropropane	96-12-8	IRIS RfC (1991)	2E-04 mg/m ³
1,2-Dibromoethane	106-93-4	IRIS RfC (2004)	9E-03 mg/m ³
1,2-Dichlorobenzene	95-50-1	HEAST RfC (1997)	2E-01 mg/m ³
1,3-Dichlorobenzene	541-73-1	No inhalation-based toxicity factors are available	None
1,4-Dichlorobenzene	106-46-7	IRIS RfC (1994)	8E-01 mg/m ³
3,3'-Dichlorobenzidine	91-94-1	No inhalation-based toxicity factors are available	None
Dichlorodifluoromethane	75-71-8	No inhalation-based toxicity factors are available ⁵	None

Contaminant	CAS No.	PAM Committee Recommendation	Inhalation Toxicity Factor(s)
1,1-Dichloroethane	75-34-3	No inhalation-based toxicity factors are available ⁶	None
1,2-Dichloroethane	107-06-2	PPRTV RfC (2010)	7E-03 mg/m ³
1,1-Dichloroethene	75-35-4	IRIS RfC (2002)	2E-01 mg/m ³
cis-1,2-Dichloroethene	156-59-2	No inhalation-based toxicity factors are available	None
trans-1,2-Dichloroethene	156-60-5	No inhalation-based toxicity factors are available ⁷	None
2,4-Dichlorophenol	120-83-2	No inhalation-based toxicity factors are available ¹⁷	None
1,2-Dichloropropane	78-87-5	IRIS RfC (1991)	4E-03 mg/m ³
1,3-Dichloropropene (cis and trans)	542-75-6	IRIS RfC (2000)	2E-02 mg/m ³
Dieldrin	60-57-1	No inhalation-based toxicity factors are available	None
Diethylphthalate	84-66-2	No inhalation-based toxicity factors are available ¹⁷	None
2,4-Dimethylphenol	105-67-9	No inhalation-based toxicity factors are available ¹⁷	None
Di-n-butylphthalate	84-74-2	No inhalation-based toxicity factors are available ¹⁷	None
2,4-Dinitrophenol	51-28-5	No inhalation-based toxicity factors are available ¹⁷	None
2,4-Dinitrotoluene /2,6-Dinitrotoluene (mixture)	25321-14-6	No inhalation-based toxicity factors are available ¹⁷	None
Di-n-octylphthalate	117-84-0	No inhalation-based toxicity factors are available ⁸	None
1,4-Dioxane	123-91-1	IRIS RfC (2013)	3E-02 mg/m ³
Endosulfan I and Endosulfan II (alpha and beta)	115-29-7	No inhalation-based toxicity factors are available ¹⁷	None
Endrin	72-20-8	No inhalation-based toxicity factors are available ¹⁷	None

Contaminant	CAS No.	PAM Committee Recommendation	Inhalation Toxicity Factor(s)
Ethylbenzene	100-41-4	IRIS RfC (1991)	1E+00 mg/m ³
Extractable Petroleum Hydrocarbons (EPH) (Category 1)	various	No inhalation-based toxicity factors are available	None
Extractable Petroleum Hydrocarbons (EPH) (category 2)	various	No inhalation-based toxicity factors are available	None
Fluoranthene	206-44-0	No inhalation-based toxicity factors are available ¹⁸	None
Fluorene	86-73-7	No inhalation-based toxicity factors are available ¹⁸	None
alpha-HCH (alpha-BHC)	319-84-6	No inhalation-based toxicity factors are available ¹⁷	None
beta-HCH (beta-BHC)	319-85-7	No inhalation-based toxicity factors are available ¹⁷	None
Heptachlor	76-44-8	No inhalation-based toxicity factors are available ¹⁷	None
Heptachlor epoxide	1024-57-3	No inhalation-based toxicity factors are available ¹⁷	None
Hexachlorobenzene	118-74-1	No inhalation-based toxicity factors are available ¹⁷	None
Hexachloro-1,3-butadiene	87-68-3	No inhalation-based toxicity factors are available ¹⁷	None
Hexachlorocyclopentadiene	77-47-4	IRIS RfC (2001)	2E-04 mg/m ³
Hexachloroethane	67-72-1	IRIS RfC (2011)	3E-02 mg/m ³
n-Hexane	110-54-3	IRIS RfC (2005)	7E-01 mg/m ³
2-Hexanone	591-78-6	IRIS RfC (2009)	3E-02 mg/m ³
Indeno(1,2,3,-cd) pyrene	193-39-5	IRIS IUR (2017) (benzo(a)pyrene) adjusted for indeno(1,2,3,-cd) pyrene.	6.0E-05 (µg/m ³) ⁻¹
Isophorone	78-59-1	CalEPA RfC (2001)	2E-00 mg/m ³
Isopropylbenzene	98-82-8	IRIS RfC (1997)	4E-01 mg/m ³

Contaminant	CAS No.	PAM Committee Recommendation	Inhalation Toxicity Factor(s)
Lead	7439-92-1	Lead NAAQS ⁹ (2008)	0.15 µg/m ³ (use as a 24-hr RfC)
Lindane (gamma-HCH) (gamma-BHC)	58-89-9	No inhalation-based toxicity factors are available ¹⁷	None
Manganese	7439-96-5	IRIS RfC (1993)	5E-05 mg/m ³
Mercury	7439-97-6	IRIS RfC (1995)	3E-04 mg/m ³
Methoxychlor	72-43-5	No inhalation-based toxicity factors are available ¹⁷	None
Methyl acetate	79-20-9	No inhalation-based toxicity factors are available	None
Methylene chloride	75-09-2	IRIS RfC (2011)	6E-01 mg/m ³
2-Methylnaphthalene	91-57-6	No inhalation-based toxicity factors are available ¹⁸	None
4-Methyl-2-pentanone	108-10-1	IRIS RfC (2003)	3E+00 mg/m ³
2-Methylphenol	95-48-7	No inhalation-based toxicity factors are available ¹⁷	None
4-Methylphenol	106-44-5	No inhalation-based toxicity factors are available ¹⁷	None
Methyl tert-butyl ether (MTBE)	1634-04-4	IRIS RfC (1993)	3E+00 mg/m ³
Naphthalene	91-20-3	IRIS RfC (1998)	3E-03 mg/m ³
Nickel	7440-02-0	CalEPA RfC (2012)	1.4E-05 mg/m ³
4-Nitroaniline	100-01-6	PPRTV RfC (2009)	6E-03 mg/m ³
Nitrobenzene	98-95-3	IRIS RfC (2009)	9E-03 mg/m ³
N-Nitroso-di-n-propylamine	621-64-7	No inhalation-based toxicity factors are available ¹⁷	None
N-Nitrosodiphenylamine	86-30-6	No inhalation-based toxicity factors are available ¹⁷	None
2,2'-Oxybis(1-choloropropane)	108-60-1	No inhalation-based toxicity factors are available	None

Contaminant	CAS No.	PAM Committee Recommendation	Inhalation Toxicity Factor(s)
Pentachlorophenol	87-86-5	No inhalation-based toxicity factors are available ¹⁷	None
Phenol	108-95-2	CalEPA RfC (2000)	2E-01 mg/m ³
Polychlorinated biphenyls (PCBs)	1336-36-3	IRIS IUR ¹⁰ (1996)	5.7E-04 (µg/m ³) ⁻¹
Pyrene	129-00-0	No inhalation-based toxicity factors are available ¹⁸	None
Selenium	7782-49-2	No inhalation-based toxicity factors are available	None
Silver	7440-22-4	No inhalation-based toxicity factors are available ¹⁷	None
Styrene	100-42-5	IRIS RfC (1992)	1E+00 mg/m ³
Tertiary butyl alcohol (TBA)	75-65-0	No inhalation-based toxicity factors are available ¹⁷	None
1,2,4,5-Tetrachlorobenzene	95-94-3	No inhalation-based toxicity factors are available	None
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746-01-6	Consult NJDEP	None
1,1,2,2-Tetrachloroethane	79-34-5	No inhalation-based toxicity factors are available ¹⁷	None
Tetrachloroethene (PCE)	127-18-4	IRIS RfC (2012)	4E-02 mg/m ³
2,3,4,6-Tetrachlorophenol	58-90-2	No inhalation-based toxicity factors are available	None
Toluene	108-88-3	IRIS RfC (2005)	5E+00 mg/m ³
Toxaphene	8001-35-2	No inhalation-based toxicity factors are available ¹⁷	None
1,2,4-Trichlorobenzene	120-82-1	PPRTV RfC (2009)	2E-03 mg/m ³
1,1,1-Trichloroethane	71-55-6	IRIS RfC ¹¹ (2007)	5E+00 mg/m ³
1,1,2-Trichloroethane	79-00-5	No inhalation-based toxicity factors are available ¹²	None
Trichloroethene (TCE)	79-01-6	IRIS RfC ¹³ (2011)	2E-3 mg/m ³

Contaminant	CAS No.	PAM Committee Recommendation	Inhalation Toxicity Factor(s)
Trichlorofluoromethane	75-69-4	No inhalation-based toxicity factors are available ¹⁴	None
2,4,5-Trichlorophenol	95-95-4	No inhalation-based toxicity factors are available ¹⁷	None
2,4,6-Trichlorophenol	88-06-2	No inhalation-based toxicity factors are available ¹⁷	None
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	PPRTV RfC (2016)	5E+00 mg/m ³
1,2,4-Trimethylbenzene	95-63-6	IRIS RfC (2016)	6E-02 mg/m ³
Vanadium	7440-62-2	ATSDR MRL ¹⁹ (2012)	1E-04 mg/m ³
Vinyl Chloride	75-01-4	IRIS RfC ¹⁵ (2000)	1E-01 mg/m ³
Xylenes	1330-20-7	IRIS RfC (2003)	1.E-01 mg/m ³
Zinc	7440-66-6	No inhalation-based toxicity factors are available ¹⁶	None

FOOTNOTES:

- 1 A HEAST RfC exists for acetophenone, but a subsequent PPRTV review (2010) questions the use of the HEAST RfC.
- 2 There are no chronic inhalation toxicity values available for bis(2-chloroethyl)ether but a MRL from ATSDR does exist that can be used to assess intermediate (sub-chronic) exposure. The use of this toxicity value is not consistent with the Remediation Standards at N.J.A.C. 7:26D Appendix 11, Table 2. However, since the PAM Technical Guidance applies to projects of one year or less, the use of the ATSDR intermediate MRL is appropriate and can be used as an RfC in the HBTv calculation.
- 3 A NJDWQI RfC exists for 2-butanone, but the IRIS RfC has been determined by the NJDEP to be more appropriate. The existing NJDWQI RfC is based on a route-to-route conversion of a NJDWQI RfD. NJDEP CSRR Program policy does not allow, except where warranted, for the development of HBTvs based on route-to-route conversion of toxicity factors. This policy conforms with USEPA policy concerning route to route conversion of toxicity factors.
- 4 A CalEPA RfC that once existed for copper has been retracted by CalEPA.
- 5 A HEAST RfC and a PPRTV RfC exist for dichlorodifluoromethane. Both RfCs are derived using the same study (Prendergast 1967). The PPRTV RfC is listed as an Appendix value because the Prendergast study was determined to have flaws. As such it is NJDEP CSRR Program policy not to use PPRTV Appendix values to develop HBTvs. As the HEAST RfC was also developed using the Prendergast study, it was recommended not to use this RfC in the development of a HBTv.
- 6 A HEAST RfC exists for 1,1-dichloroethane, but a subsequent PPRTV review (2006) indicated that data were inadequate to derive a chronic exposure RfC for 1,1-dichloroethane.
- 7 A PPRTV RfC exists for trans-1,2-dichloroethene but a subsequent IRIS assessment (2010) stated "the available inhalation data from Freund study are insufficient to support reference value derivation and RfC."
- 8 A 1985 USEPA IUR that once existed for di-n-octylphthalate has been retracted by the USEPA.
- 9 Refer to the *Recommendations for Treatment of Lead for Perimeter Air Monitoring (Equal to or less than 1-year*

duration) in Appendix B. The use of this toxicity value is not consistent with N.J.A.C. 7:26D, Appendix 11, Table 2, but its use has been determined to be appropriate for the purposes of PAM.

- 10 IUR extrapolated from USEPA's IRIS high risk and persistent oral cancer slope factor for PCBs, which is recommended for use when evaluating inhalation of an aerosol or dust contaminated with PCBs. The use of this toxicity value is not consistent with N.J.A.C. 7:26D, Appendix 11, Table 2, but its use has been determined to be appropriate for the purposes of PAM.
- 11 Although an NJDWQI RfC exists for 1,1,1-trichloroethane, the IRIS RfC is recommended to develop a HBTv for PAM.
- 12 Although a PPRTV RfC for 1,1,2-trichloroethane exists, it is listed as an Appendix value. The PPRTV Appendix value is based on a study that was determined by USEPA to have flaws. It is the NJDEP's CSRR Program policy not to use PPRTV Appendix values to develop HBTvs.
- 13 Although the IRIS RfC for trichloroethene is based on a route-to-route conversion of an ingestion study, an in depth USEPA evaluation justifies such a conversion.
- 14 A HEAST RfC exists for trichlorofluoromethane, but a subsequent PPRTV review (2009) indicated that data used to derive the RfC were inadequate.
- 15 Although the IRIS RfC for vinyl chloride is based on a route-to-route conversion of an ingestion study, an in depth USEPA evaluation justifies such a conversion.
- 16 A CalEPA RfC that once existed for zinc has been retracted by CalEPA.
- 17 There is an inhalation toxicity factor available for this contaminant, but it is based on a route-to-route conversion of an oral study. NJDEP CSRR Program policy does not allow, except where warranted, for the development of HBTvs based on route-to-route conversion of toxicity factors.
- 18 The 2008 inhalation toxicity factor was based on an equivalency factor from Nisbet and LaGoy (1992). Nisbet and LaGoy did not conduct administration (not inhalation). The Nisbet and LaGoy study develops TEFs for PAHs compared to B(a)P. The Department did not use this study because it was not derived from an inhalation study.
- 19 ATSDR's MRLs are used as an RfC in the HBTv calculations. Similar to a RfC, a chronic inhalation MRL is a noncancer toxicity value that represents an estimate of daily inhalation exposure to a contaminant that is not expected to result in noncancer health effects during a chronic exposure duration. However, the method for the development of MRL's by ATSDR is different based on the agency's policies.

References *(for table)*

- Nisbet, I.C.T and LaGoy, P.K. (1992). Toxic equivalency factors for polycyclic aromatic hydrocarbons. *Reg. Toxicol. Pharmacol.* 16:290-300
- Prendergast, JA; Jones, RA; Jenkins, LJ; et al. (1967) Effects on experimental animals of long-term inhalation of trichloroethylene, carbon tetrachloride, 1,1,1-trichloroethane, dichlorofluoromethane, and 1,1-dichloroethylene. *Toxicology and Applied Pharmacology* 10(2):270-289.

Acronyms *(for table)*

- ATSDR – Agency for Toxic Substances and Disease Registry
CalEPA – California Environmental Protection Agency
HEAST – Health Effects Assessment Summary Tables
IRIS – Integrated Risk Information System
Lead NAAQS – 2008 National Ambient Air Quality Standard for Lead
MRL – Minimal Risk Level
NJDWQI – New Jersey Drinking Water Quality Institute
PPRTV – Provisional Peer-Reviewed Toxicity Values

3.0 RECOMMENDATIONS FOR THE TREATMENT OF LEAD FOR PERIMETER AIR MONITORING (EQUAL TO OR LESS THAN 1-YEAR DURATION)

Recommended Reference Concentration for Lead

The principal way of measuring exposure to lead is via blood lead levels (PbB) which serves as a marker of the cumulative exposure to lead from multiple media that is relatable to an adverse health effect. Exposure to lead via inhalation may contribute to overall PbB, but other exposure pathways such as ingestion of contaminated dust and soil are more likely to be primary. In 2002, the NJDEP Bureau of Air Quality developed a RfC for lead ($0.1 \mu\text{g}/\text{m}^3$ for 24 hours) that recognized these multiple pathways. In 2008, USEPA used similar considerations to revise the NAAQS for lead ($0.15 \mu\text{g}/\text{m}^3$ 3-month rolling average), using an updated exposure model. This guidance recommends using the NAAQS since it is based on more recent science but revising the averaging time to 24-hours to better reflect the experience during remediation of contaminated sites. An analysis of the protectiveness of using the lead NAAQS as a 24-hour RfC is described below.

Discussion

Unlike other chemicals, standards and guidance for lead are based on a biomarker of exposure (i.e., PbB associated with the sensitive endpoint reduction in IQ). This means there is no RfC for inhalation exposures that would be the relevant route of exposure for the receptors targeted for perimeter air monitoring associated with remedial actions with durations less than one year. NJDEP Bureau of Air Quality Evaluation developed a short-term (24 hour) RfC of $0.1 \mu\text{g}/\text{m}^3$ (NJDEP 2002) that is based on EPA's LEAD5 Model, Version 5 – a precursor to the Integrated Exposure Uptake Biokinetic (IEUBK) model used currently to evaluate multiple sources of lead exposures (diet, air, water, soil and indoor dust) via various routes of exposure including ingestion and inhalation and their impact on PbB in children. The Bureau of Air Quality Evaluation used a 1% increase in incidence of 10 micrograms of lead per deciliter of blood ($\mu\text{g}/\text{dL}$) rather than 5% (see below) to set the short-term RfC at $0.1 \mu\text{g}/\text{m}^3$ for a 24-hour period. The IEUBK default air exposure concentration is also $0.1 \mu\text{g}/\text{m}^3$ which is much higher than ambient levels reported in the New Jersey 2017 Lead Monitoring Report, which indicates the average lead concentration of $0.001\text{-}0.004 \mu\text{g}/\text{m}^3$ – with maximum values less than an order of magnitude higher, $0.01\text{--}0.03 \mu\text{g}/\text{m}^3$ (NJDEP 2018).

USEPA and the Centers for Disease Control and Prevention (CDC) previously determined that childhood PbB at or above $10 \mu\text{g}/\text{dL}$ present risks to children's health. In 2012, CDC's Advisory Committee on Childhood Lead Poisoning Prevention recommended lowering the level that triggers intervention to a childhood PbB based on the 97.5th percentile ($5 \mu\text{g}/\text{dL}$) of the population PbB in children ages one-six (CDC 2012). In May 2021 the $5 \mu\text{g}/\text{dL}$ value was updated to $3.5 \mu\text{g}/\text{dL}$ using more recent data from the National Health and Nutrition Examination Survey (NHANES). There is uncertainty regarding the use of the 3.5 or $5 \mu\text{g}/\text{dL}$ PbB and whether it should actually be lower or higher, and because of this uncertainty, the recommended PbB target may change again in the future. USEPA is also continuing to evaluate the IEUBK model and may propose updates to model variables. In the interim, USEPA's current risk reduction goal for contaminated sites is to limit the probability of a child's PbB exceeding **10 $\mu\text{g}/\text{dL}$ to 5 percent or less after cleanup.**

Rather than using the NJDEP Bureau of Air Quality RfC, the USEPA NAAQS for lead of $0.15 \mu\text{g}/\text{m}^3$ is being used for PAM. Compliance with the NAAQS of $0.15 \mu\text{g}/\text{m}^3$ is based on a rolling 3-month average,

not a daily or 24-hour TWA. The difference in the concentration when using these two different time frames is *de minimus*, but there is a question of how the rolling 3-month average applies to daily perimeter air monitoring, including whether it can serve as a RfC that can be adjusted for the duration of exposure (e.g., 8, 10 or 12 hours over a day).

Recent Evaluation by USEPA

USEPA anticipates that exposure conditions will fluctuate and has determined that intermittent higher levels of lead do not change the biokinetic model as it is based on built in assumptions of sustained chronic exposures that do not allow for a wash out period. Furthermore, the Technical Review Workgroup for lead (<https://www.epa.gov/superfund/lead-superfund-sites-technical-assistance>) recommends average or mean time weighted exposures rather than maximum or statistical derivations of the mean concentrations should be used, which would be consistent with the rolling 3-month average associated with the lead NAAQS (USEPA 2003).

To that point the model is calibrated for chronic and consistent exposures given the toxicokinetics of lead within the body. The “time step” used in the model is a variable that determines what averaging time is used to define average daily intakes of lead. Exposure estimates can be specified for each of the seven years of exposure in the IEUBK model and choosing a time step of one month would result in dividing the lead intake by 12. However, integrating the monthly exposures over a one-year period results in essentially the same lead intake as a one-year time step. Based on the frequently asked questions on IEUBK, USEPA states that “the model predictions of blood lead concentrations for each age group are essentially independent of the choice of the modeling time step” (USEPA 2019).

Taken with the recent reduced ambient lead air concentrations in New Jersey, it can be concluded that any short-term intermittent increases of lead air concentrations over the NAAQS of $0.15 \mu\text{g}/\text{m}^3$, associated with remedial activities, would not result in increases in predicted percentage of PbB above $10 \mu\text{g}/\text{dL}$ in the perimeter receptor.

Conclusion

In summary, it is the PAM Committee’s opinion that the “rolling 3-month average” lead NAAQS of $0.15 \mu\text{g}/\text{m}^3$ can be used as a 24-hour RfC for remediation lasting equal to or less than one year as such is protective of the most sensitive perimeter receptor population. In addition, the model would be insensitive to modulations based on 8-10 hr adjustments to the 24-hour RfC for lead. This is consistent with the findings of the NJDEP Bureau of Air Quality Evaluation in their derivation of a short term RfC of $0.1 \mu\text{g}/\text{m}^3$ (NJDEP 2002).

REFERENCES

- CDC (Centers for Disease Control), 2012. Low Level Lead Exposure Harms Children: A Renewed Call for Primary Prevention, Report of the Advisory Committee on Childhood Lead Poisoning Prevention of the Centers for Disease Control and Prevention.
- NJDEP Bureau of Air Quality Evaluation, 2002. Derivation of Lead Reference Concentration Based on USEPA's LEAD5 Model (Lead Uptake/Biokinetic Model) Version 5.
- NJDEP Bureau of Air Monitoring, 2018. 2017 New Jersey Air Quality Report. http://njaqinow.net/App_Files/2017/2017%20NJ%20Air%20Monitoring%20Report.pdf
- USEPA, 2003. Assessing Intermittent or Variable Exposures at Lead Sites. OSWER 9285.7-76.
- USEPA, 2019. Lead at Superfund Sites: Frequent Questions from Risk Assessors on the Integrated Exposure Uptake Biokinetic (IEUBK) Model. <https://www.epa.gov/superfund/lead-superfund-sites-frequent-questions-risk-assessors-integrated-exposure-uptake#timestep>

APPENDIX C
REAL-TIME MONITORING METHODS

APPENDIX C

REAL-TIME MONITORING METHODS

Real-time monitoring aims to provide screening data to alert stakeholders, on- and off-site, that operations and emission controls at a site are being effective. This real-time information is valuable feedback to allow for on-site personnel to take action if control of potential emissions is not optimized. Additionally, some real-time air monitoring technologies can also provide air sampling data to determine whether potential exposures to specific COCs are below calculated HBTVs and thus protective of human health. It should be noted that real-time air monitoring technology and associated integrated computer networks are continuously and rapidly evolving. Along with these evolving technologies, the role of collecting real-time data also continually evolves.

Below is a discussion of some of the current air monitoring technologies that may be used in implementing PAM plans. This is not an exhaustive list or a list of recommended technologies that should be used on specific projects or in specific situations. This information is best used as a reference when trying to identify appropriate air monitoring technology to meet the goals of the PAM plan.

PHOTO IONIZATION DETECTOR

Typical photoionization detectors measure volatile organic compounds and other gases in concentrations from sub parts per billion to 10,000 parts per million (ppm). The photoionization detector is an efficient and inexpensive detector for many gas and vapor analytes. PIDs produce instantaneous readings, operate continuously, and are commonly used as detectors for gas chromatography or as hand-held portable instruments.

In a photoionization detector, high-energy photons, typically in the vacuum ultraviolet range, break molecules into positively charged ions. As compounds enter the detector, they are bombarded by high-energy ultraviolet (UV) photons and are ionized when they absorb the UV light, resulting in ejection of electrons and the formation of positively charged ions. The ions produce an electric current, which is the signal output of the detector. The greater the concentration of the component, the more ions are produced, and the greater the current. The current is amplified and displayed on an ammeter or digital concentration display. The ions can undergo numerous reactions including reaction with oxygen or water vapor, rearrangement, and fragmentation. A few of them may recapture an electron within the detector to reform their original molecules; however only a small portion of the airborne analytes are ionized to begin with so the practical impact of this (if it occurs) is usually negligible. Thus, PIDs are non-destructive and can be used before other sensors in multiple-detector configurations.

The PID will only respond to components that have ionization energies similar to or lower than the energy of the photons produced by the PID lamp. As stand-alone detectors, PIDs are broad band and not selective, as these may ionize everything with an ionization energy less than or equal to the lamp photon energy. The more common commercial lamps have photons energy upper limits of approximately 8.4 eV, 10.0 eV, 10.6 eV, and 11.7 eV. The major and minor components of clean air all have ionization energies above 12.0 eV and thus do not interfere significantly in the measurement of VOCs, which typically have ionization energies below 12.0 eV.

DUST MONITOR

Dust monitors (sometimes referred to as aerosol monitors) are used for sampling particulate concentrations in ambient air. Most dust monitors are capable of measuring PM₁₀ concentrations, and many can also monitor smaller diameter particulate such as PM_{2.5}. There are a range of methods and instruments available to measure particles in real-time. Available units include those that measure particulate based on the amount of light a particle will absorb, units that measure the amount of laser light scattered by particles, and others that measure the electrical properties of a particle to measure its size and quantity. All methods are capable of measuring PM₁₀ concentrations down to low levels (e.g., 1 µg/m³) and can also measure concentrations several orders of magnitude above the PM₁₀ NAAQS of 150 µg/m³. The most common type of real-time dust monitors in use at remediation sites are light scattering laser photometers, which are capable of measuring both mass concentration and particle size fraction. These instruments are easy to use and program, and are portable.

Many of the dust monitors available today can easily be integrated into a stationary perimeter air monitoring station, which are designed to monitor particulates, VOCs, and meteorological conditions (wind speed and direction) simultaneously at the same point location. Many units are capable of remote data transmission using telemetry and most units have data logging options for data downloading. When provided with a mobile power source, these stations can be easily repositioned as necessary, based on changing upwind/downwind orientations or a shift in remediation activities to another location on the property.

Remediation sites typically require a minimum of two continuous dust monitors (e.g., one upwind and one downwind of work zone) and typically more than two, configured to measure PM₁₀ in real-time. Instruments should be equipped to monitor dust concentrations continuously during work hours and store instantaneous readings (e.g., 1-minute averages) on an internal data logger.

FLAME IONIZATION DETECTOR

The operation of the flame ionization detector is based on the detection of ions formed during combustion of organic compounds in a hydrogen flame. The generation of these ions is proportional to the concentration of organic species in the sample gas stream.

Flame ionization detector measurements are usually reported "as methane", meaning as the quantity of methane which would produce the same response. Hydrocarbons generally have molar response factors that are equal to the number of carbon atoms in their molecule, while oxygenates and other species that contain heteroatoms tend to have a lower response factor. Carbon monoxide and carbon dioxide are not detectable by FID.

Flame ionization measurements are often labelled "total hydrocarbons" or "total hydrocarbon content", although a more accurate name would be "total volatile hydrocarbon content", as hydrocarbons which have condensed out are not detected, even though they are important (e.g., safety when handling compressed oxygen).

HYDROGEN SULFIDE MONITOR

Contaminant-specific hydrogen sulfide (H₂S) monitors, and multi-gas monitors, are real-time monitoring instruments used to measure H₂S gas concentrations in ambient air. Frequently these monitors are used at landfill facilities but may also be necessary during remediation efforts depending on whether H₂S is identified as a contaminant of concern.

H₂S monitors come in both handheld and stationary units and allow for detection limits of H₂S concentrations between 0.05 and 100 parts per billion, depending on monitor selection. Monitors may be used for real-time monitoring of H₂S concentrations and do not require confirmatory sampling to speciate contaminants unlike broad band monitoring units. While multi-gas monitors allow for a higher level of H₂S concentration detection and can analyze and display concentrations of up to 30 gases simultaneously, contaminant-specific handheld monitors tend to have a quicker response to environmental conditions with the same accuracy as laboratory grade stationary monitors. Further, contaminant-specific meters tend to be more sensitive and have a lower detection limit. Handheld monitors are relocated easily and do not require AC power, heating, and air conditioning like their stationary monitoring counterparts.

All handheld units are equipped with screens that display instantaneous H₂S concentrations. Alternatively, many handheld and stationary units are equipped with telemetry capabilities and computer software for remote real-time monitoring which allow for data logging and data transfer.

MERCURY MONITOR

Contaminant-specific elemental mercury (Hg) vapor real-time monitors allow for the real-time measurement of Hg vapor concentrations in ambient air. Depending on ambient temperatures, mercury can exist in the soil as a particulate or vapor. Typically, dust monitoring would provide a surrogate for real-time mercury in particulate form. Mercury monitors use atomic absorption or atomic fluorescence to measure ambient levels of mercury vapor.

Stationary real-time vapor monitors provide real-time, long-term operation and can detect Hg concentrations as low as 0.1 ng/m³ in ambient air detection limits up to 500 µg/m³. A variety of monitors with widely varying detection limits exist. While very low detection limits can be obtained, these meters tend to be more cost prohibitive. Additionally, meters capable of lower detection limits may be more difficult to find as a rental option.

Most stationary Hg vapor monitors require AC power and heating and air conditioning if in an enclosure. Handheld real-time units, which also provide real-time monitoring, may detect Hg vapor concentrations as low as 0.5 ng/m³. Most Hg vapor monitoring units are used to detect elemental mercury, however, there are sampling units available on the market that are able to monitor and speciate Hg particulate, Hg vapor, and reactive gaseous Hg in ambient air simultaneously. Most handheld and stationary real-time mercury vapor monitors have communication capabilities for remote real-time monitoring and data logging and data transfer.

Hg vapor monitoring units allow for in-field zero calibration using a zero-air filter. While units typically do not offer an option for bump testing, most meters have a regeneration function by which the unit is able to cleanse the saturated sensor of contaminants that have accumulated using a closed loop heating cycle. The regeneration feature used to refresh the sensor in the meter can be conducted at a scheduled interval specified by the user.

COLORIMETRIC DETECTOR TUBES

Colorimetric detector tubes are contaminant-specific graduated glass tubes filled with chemical reagents that produce a color change when exposed to the gas or chemical vapor in question. They are used with a hand pump that draws a sample of air into the tube. As the sampled air works its way up through the tube, it reacts with the chemical reagent inside, producing a color change. The length of the color change

is proportional to the concentration of the contaminant being tested. The point where the reaction stops is read off against graduated markings on a tube.

Colorimetric detector tubes allow the investigator to determine in real-time if a particular COC is present in air. This can be especially useful when using non-specific real time monitoring instruments, such as a PID. The other benefit is they are easy to deploy and do not require calibration. Some of the limitations to consider when using colorimetric detector tubes are that they have a limited shelf life, each tube is contaminant-specific, and each tube can only be used once.

FIELD GAS CHROMATOGRAPH/MASS SPECTROMETER

Gas chromatography/mass spectrometry (GC/MS) is an analytical technology that allows reasonably rapid compound specific analysis and quantification.

The continuously operating portable GC technologies may be easier to deploy in the field; however, the investigator should confirm before use that the instrument has sufficient selectivity and sensitivity. The speciated measurement results are available in real-time (typically within about one minute).

The field GC/MS allows the user to conclusively identify and quantify low concentrations of COCs but may be cost prohibitive and more labor intensive. However, a measurement can be provided to the decision-maker within as little as 30 minutes of sample collection.

OPEN-PATH FOURIER-TRANSFORM INFRARED SPECTROSCOPY

Open-path Fourier-transform infrared (OP-FTIR) spectroscopy is able to provide real-time, simultaneous analysis of several dozen gaseous contaminants. The technology is identical in principle to classical laboratory FTIR spectroscopy, except the cell into which a sample would be injected is extended to the open atmosphere. A beam of light is propagated from the transmitter portion of the instrument, where a retroreflector redirects it back upon itself to the receiver portion of the instrument. An interferometer splits the returning beam of radiation into two paths, and then recombines them such that an interference is generated from the phase difference. In each path, the radiation is reflected off of a mirror resulting in an intensity variation which is measured at the detector as a function of the path difference between the mirrors. The result is an interferogram.

Contaminants of concern are identified and quantified using a computer-based spectral search involving sequential, compound-specific analysis and comparison to the system's internal reference (NIST-traceable) spectral library. Any gaseous compound which absorbs in the IR spectrum is a potential candidate for monitoring using this technology. The chosen analytical method will dictate which compounds are reported.

One-way pathlengths are suitable for PAM applications as they can accurately monitor contaminants in real-time up to 100 meters or more from the unit.

Analytical data from a certified lab using a certified method would be required to verify these real-time measurements, even though they are contaminant specific, are accurate.

Path-integrated concentrations are usually reported in units of parts-per-million-meters (ppm-m). It is often desirable to convert path-integrated concentrations (ppm-m) to units of milligrams per cubic meter times meter ($\text{mg}/\text{m}^3 \times \text{m}$, or mg/m^2) to address molecular weight differences in compounds.

The integrated concentration reported is directly proportional to the total pathlength for a given uniform contaminant concentration. On a site from which contaminants are emanating in a plume of narrow width (e.g., 10 meters), the same path-integrated concentration will be reported regardless of pathlength, as long as the narrow plume remains contained within the observing pathlength and there is no upwind (or background) contaminant contribution.

APPENDIX D
ANALYTICAL METHODS

APPENDIX D

ANALYTICAL METHODS

Analytical methods are those methods which can speciate, thus providing a concentration for a specific compound. Most analytical methods require collection of a sample with analysis performed at an off-site laboratory. However, a few mainstream analytical methods can provide speciated results in real-time. Although this list is not exhaustive nor prescribed, some of the more commonly used analytical methods for air include:

- USEPA METHOD TO-4A: Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air Using High Volume Polyurethane Foam (PUF) Sampling Followed by Gas Chromatographic/ Multi-Detector Detection
- USEPA METHOD TO-9A: Determination of Polychlorinated, Polybrominated and Brominated/Chlorinated Dibenzo-P-Dioxins and Dibenzofurans in Ambient Air
- USEPA METHOD TO-13A: Determination of Polycyclic Aromatic Hydrocarbons in Ambient Air Using Gas Chromatography/ Mass Spectrometry (GC/MS)
- USEPA METHOD TO-15: Determination of Volatile Organic Compounds in Air Collected in Specially Prepared Canisters and Analyzed by Gas Chromatography/ Mass Spectrometry (GC/MS)
- USEPA METHOD TO-17: Determination of Volatile Organic Compounds in Ambient Air Using Active Sampling onto Sorbent Tubes
- NIOSH METHOD 7303: Various metals
- USEPA METHOD SW 846: Various metals
- NIOSH METHOD 7300: Various metals
- NIOSH METHOD 6009: Mercury
- OSHA METHOD 215: Hexavalent chromium

APPENDIX E
DATA QUALITY OBJECTIVE CHECKLISTS

APPENDIX E
DATA QUALITY OBJECTIVE CHECKLISTS

Example DQO checklist tables are provided below for common real-time monitoring methods. Analytical sampling methods and associated quality control procedures should be developed in concert with the NJ certified laboratory and detailed in the PAM plan.

Table E-1 DQO Checklist for Common Real-time Monitoring Methods: Preparation for Field Monitoring Tasks

Table E-2 DQO Checklist for Common Real-time Monitoring Methods: Performance of Field Monitoring Tasks

Table E-3 DQO Checklist for Common Analytical Methods for VOCs: Performance of Field Sampling Tasks

Table E-4 DQO Checklist for Analytical Methods TO-4A, TO-9A, and TO-13A for Toxic Organic Compounds: Performance for Field Sampling

Table E-5 DQO Checklist for Common Real-time Monitoring Methods: Meteorological Requirements

TABLE E-1

**DQO CHECKLIST FOR COMMON REAL-TIME MONITORING METHODS:
PREPARATION FOR FIELD MONITORING TASKS**

ITEM	INSTRUMENTS				
	PID	FID	GC/ MS	Dust Meter	Hg-H ₂ S Meter
Precision					
Calibration certification (with manufacturer data)	✓	✓	✓	✓	✓
Correct lamp installation (e.g., 9.8, 10.2, 11.7 eV)	✓				
Lamp-specific response factor data	✓				
CH ₄ based response factors		✓			
Calibration curve based on soil particle size range				✓	
Accuracy					
Calibration certification (with data showing any bias)	✓	✓	✓	✓	✓
Representativeness					
Model/Serial No. associated with calibration certificate	✓	✓	✓	✓	✓
Comparability					
Performance test results between all instruments	✓	✓	✓	✓	✓
Completeness					
(none)					
Sensitivity					
Reporting limit (RL) specification	✓	✓	✓	✓	✓
Calibration certifications (to verify RL)	✓	✓	✓	✓	✓

TABLE E-2

**DQO CHECKLIST FOR COMMON REAL-TIME MONITORING METHODS:
PERFORMANCE OF FIELD MONITORING TASKS**

ITEM	INSTRUMENT				
	PID	FID	GC/ MS	Dust Meter	Hg, H ₂ S Meter
Precision					
Start-up/warm-up records conformant with manufacturer's SOP	✓	✓		✓	✓
Method blank analysis			✓		
Performance of instrument zeroing	✓	✓		✓	✓
Confirm particle size range setting				✓	
Concentration range setting (span setting)	✓				✓
Bump tests (with common gas source) to assess field relative percent difference (RPD) between measurements	✓				
Monitoring data from collocated instruments (time and space)	✓	✓	✓	✓	✓
Effect of interferent (e.g., for PID, fog/rain, high voltage fields)	✓			✓	
Effect of interferent (NH ₃ for H ₂ S; acidic gases for Hg)					✓
Accuracy					
Continuing calibration (as needed, dependent on response factor)			✓		
Accuracy check (e.g., certified gas standards or equivalent)	✓	✓	✓		✓
Representativeness					
Monitoring downwind of highest emitting remedial action locations	✓	✓		✓	✓
Monitoring during high emitting remedial action process	✓	✓		✓	✓
Sample collected downwind of highest emitting remedial action locations			✓		
Sample collected during high emitting remedial action process			✓		
Chain of custody			✓		
Comparability					
Measurement SOP (from different monitoring events)	✓	✓		✓	✓
Instrument Model No. set-up specifications	✓	✓		✓	✓
Occurrence of interfering conditions (e.g., weather)	✓	✓		✓	✓
Instrument RPD between two or more units and/or measurement events	✓	✓			✓

Completeness					
Number of valid measurements compared to the project DQO	✓	✓		✓	✓
Sensitivity					
Evidence of presence of interferences (e.g., humidity)	✓			✓	

TABLE E-3

**DQO CHECKLIST FOR COMMON ANALYTICAL METHODS FOR VOCs:
PERFORMANCE OF FIELD SAMPLING TASKS**

ITEM	Method	
	TO-15	TO-17
Precision		
Collection of a field duplicate (using a sampling pump, split collection line)	✓	✓
Collection of a collocated separate canister grab samples	✓	
Accuracy		
Canister pressure checks within performance criteria	✓	
Use of appropriate sample preservation method specification (e.g., iced)		✓
Presence of interfering compounds for non-remedial action sources	✓	✓
Prompt sample shipment to lab to facilitate analysis within holding time criteria	✓	✓
Representativeness		
Chain of Custody	✓	✓
Sample collection downwind of potential VOC-emitting remedial action efforts	✓	✓
Sample collected during high-emitting remedial action process (e.g., ISS)	✓	✓
Air intake clear of obstructions	✓	✓
Custody documentation indicating pre- and post-sample canister evacuation pressure	✓	✓
Custody documentation associating sample ID with sampling equipment (e.g., pump, regulator)	✓	✓
Comparability		
Sampling SOP (e.g., differences in sample collection equipment and use)	✓	✓
Canister supplier (e.g., are there physical differences in conditioning method)	✓	
Sorbent and tubes (differences in laboratory sample media preparation method)		✓
Completeness		
Number of valid measurements compared to the project DQO	✓	✓
Sensitivity		
Presence of interfering compounds for non-remedial action sources	✓	✓
Compliance with appropriate holding time; sample preservation method (e.g., ice chest)		✓

TABLE E-4

DQO CHECKLIST FOR ANALYTICAL METHODS TO-4A, TO-9A and TO-13A FOR TOXIC ORGANIC COMPOUNDS:

PERFORMANCE OF FIELD SAMPING TASKS

ITEM
Precision and Accuracy
High volume multi-point (4+ pts) calibration curve with records identifying calibrated meters/devices used (documentation from laboratory)
NIST traceable calibration documentation for volume meter, orifice plate, air thermometer, and aneroid barometer (from laboratory)
Flow check at start and end of sample collection with records identifying calibrated meters/devices used
QC samples (e.g., field blank, duplicate sample, trip blank)
Representativeness
High-Volume Sampler siting downwind of PM ₁₀ -generating remedial action locations
Air intake clear of obstructions
Chain of Custody filter ID with corresponding field sample number
Comparability
Sample to sample differences in flow rate
Differences in sample media handling and deployment method
Completeness
None
Sensitivity
Compliance with appropriate holding time; sample preservation method (e.g., ice chest)
Results of sample flow rate calibration (i.e., flow rate accuracy check)
Clean certification (from laboratory) for sample sorbent media and assembly

TABLE E-5

**DQO CHECKLIST FOR COMMON REAL-TIME MONITORING METHODS:
METEOROLOGICAL REQUIREMENTS**

ITEM	Instrument Supplier	Field Investigator
Precision		
Calibration certification (with manufacturer RSD data)	✓	
Evidence of possible wind-flow bias (from nearby obstructions)		✓
Accuracy		
Calibration certification (e.g., review data during low wind speeds)	✓	
Representativeness		
Sensor height and location away from nearby obstructions	✓	✓
Sensor siting spatially reflective of area between source and community		✓
Sensor data coincident with COC measurement data		✓
Sensor siting away from obstructions to wind		✓
Comparability		
Performance test results between sensors	✓	
Monitoring SOP (from different monitoring events)		✓
Measurement differences related to wind-sensor siting differences		✓
On large sites, supplement the primary meteorological station with one or more additional wind sensor sets, as appropriate		✓
Completeness		
Wind sensor data (encompassing all remedial action activities)		✓
Temperature/humidity data (document to support validity of COC data)		✓
Sensitivity		
Calibration certification (e.g., wind speed threshold specification)	✓	

APPENDIX F
CASE STUDY

APPENDIX F

CASE STUDY

Introduction

This Case Study is presented to provide investigators with an example of how to develop a PAM plan at a remediation site. In the case detailed below, a PAM plan is developed for a hypothetical site using the seven steps detailed in the PAM Technical Guidance.

Site Description

This 15-acre Site is in an extensively developed, highly industrialized area of New Jersey that is dominated by national and international trade, transportation, and manufacturing. Historically, the area was developed through the deposition of dredging spoils and importation of fill material to bring the existing tidal swamps up to the current grade. In its history, the property served many purposes including ship building, dry dock and repairs, and other industrial uses. The historic fill placement and past operations have resulted in multiple soil contaminants including VOCs, metals, and PAHs above applicable standards.

The eastern boundary of the proposed remedial work area is a residential housing zone. The other boundaries consist of undeveloped tidal marsh (north), abandoned piers on a navigable tributary (west) and warehouses (south). The wind direction is predominately from the west coming off the waterway but is subject to change based on weather conditions.

Remedial Activities and Duration

Based on the results of the remedial investigation, the selected remedial action for the site is soil excavation and transport for off-site disposal. Work is expected to take place 8 hours per day, 5 days per week for 90 days within a calendar year. To accommodate work delays and provide that the selected HBTVs are protective, this plan will assume that work activities will last 120 days. That way if the operation takes longer than the estimated 90 days, but less than 120 days, there will be no need to recalculate the HBTVs.

As part of the remedial action, vapor and dust emissions will be monitored and controlled to protect the surrounding environment from exposure to potential airborne contaminants during remedial activities. A PAM plan has been prepared to provide a measure of protection for the downwind community (i.e., off-site receptors including residences and businesses, and on-site workers not directly involved with the subject work activities) from potential airborne contaminant releases as a direct result of the remedial activities.

PAM Plan Development

General PAM Plan Application

The site will have a designated individual whose sole function will be to properly and effectively execute the PAM plan. This person will be referred to as the PAM technician and will have an intimate knowledge of the PAM plan developed for the site's remedial activities. The PAM technician will also be well-trained on the use of real-time monitoring equipment and the collection of confirmatory air samples.

The PAM technician will, at minimum, be responsible for:

- Operation of the air monitoring system
- Performing in-field perimeter air monitoring station startup and shutdown
- Documenting daily weather patterns, on-site remedial activities, monitoring start and end times, confirmatory sample collection, shorter-duration confirmatory sample collection, perimeter exceedances and source, corrective actions, and equipment issues
- Performing in-field zeroing and bump testing, and in-field calibration, where necessary, of real-time monitoring equipment
- General monitoring and confirmatory sampling equipment maintenance and trouble shooting
- Ensuring valid equipment calibration status
- Maintaining daily zeroing and calibration logs
- Maintaining manufacturer calibration sheets
- Ensuring all equipment is being used per manufacturers' specifications
- Collection and submission of confirmatory air samples to the NJ-certified laboratory
- Ensuring all samples are sent to the laboratory and analyzed within their respective holding times
- Reporting of confirmatory and shorter-duration sampling results
- Ensuring chain of custodies are accurately and fully completed
- Data downloads from the telemetry system and from meters used in the field

It is anticipated that remediation activities will be conducted from 7:00 am to 3:30 pm each day, with a 30-minute lunch break around noon. The PAM technician will set up and turn on all perimeter air monitoring stations prior to work startup in the morning and will shut down all perimeter air monitoring stations only after all soil disturbing work has been completed for the day; monitoring will not cease during the lunch break.

Step 1: Identify Contaminants of Concern (COCs)

Soil analytical data collected during previous investigations such as the site investigation and remedial investigation were evaluated to develop a list of site-specific COCs to be measured during perimeter air monitoring. Available data were reviewed to identify maximum contaminant concentrations in soil for each contaminant where the data indicates exceedances of the most stringent NJDEP soil remediation standards. Through previous investigations, sufficient data (> 20 samples) were collected at the site to use the statistical mean (95% UCL of the arithmetic mean) of the dataset as input values in the PAM Calculator for the areas being remediated. The database yielded acceptable statistics without identification of outliers and the 95% UCL did not exceed the maximum value which would have necessitated using the maximum concentration as the PAM Calculator input value.

At the site, soil analytical characterization data indicated the presence of VOCs, metals, and PAHs above the most stringent NJDEP soil remediation standards. COCs included in the PAM plan were those that are present in soil at the highest concentrations and/or have the most stringent health criteria. Both relative toxicity and concentration were taken into account when determining COCs. The 95% UCL particulate and VOC contaminant concentrations identified in soil for the site are shown in Tables 1 and 2, respectively. The ProUCL outputs and associated data sets will be included in the appendices of the Final PAM Report.

Table 1 Particulate Contaminants (metals, PAHs) Identified Exceeding Most Stringent NJDEP Soil Remediation Standard	
Contaminants	95% UCL Soil Concentration (mg/kg)
Arsenic	73
Lead	2990
Mercury	24.8
Nickel	295
Benzo(a)anthracene	1190
Benzo(a)pyrene	95
Dibenz(a,h)anthracene	101
Indeno(1,2,3-cd)pyrene	304

Table 2 Volatile Organic Contaminants Identified Exceeding Most Stringent NJDEP Soil Remediation Standard				
Contaminants	95% UCL COC Concentration at Site (mg/kg)	Sample Location	Total VOCs at Site* (mg/kg)	Percent Individual VOC/Total VOCs at Site (%)**
Benzene	3,059	SB-4	53,842	5.68
Toluene	6,604	SB-4	53,842	12.27
Chlorobenzene	1,899	SB-12	53,842	3.53
Vinyl Chloride	1,741	SB-7	53,842	3.23
Trichloroethene	290	SB-12	53,842	0.54
Mercury	24.8	SB-9	53,842	0.046

* Total VOCs at the Site refers to the summation of all concentrations of VOCs detected at the site during all phases of investigation.

** [% of Total Volatiles = (Individual VOC soil concentration (mg/kg)/Total VOCs soil concentration (mg/kg)) X 100]

Step 2 – Identify Potential Airborne Exposures

The primary objective of the PAM plan is to document protection of human health outside of the remediation zone(s) from exposure to metals, PAHs, VOCs, PM₁₀, and other emissions that could potentially be generated during soil disturbing remedial activities. A conceptual site model was developed for the site to assess site conditions, the remedial efforts to be conducted, and whether they would create air emissions that could potentially negatively impact the health of receptors in the surrounding community.

The planned remedial action includes excavation of soils to a depth of approximately eight feet below grade using an excavator and loading of contaminated soils into trucks for off-site disposal. Based on the planned remedial action, the following key areas of understanding were investigated:

1. Physical setting
2. Nature and extent of contamination
3. Work tasks to be performed
4. Fate and transport of contamination
5. Off-site receptors

Table 3
Conceptual Site Model

Item	Discussion
1- Physical Setting	Site is primarily historic backfill deposits and operations' discharges that contain VOCs, PAHs, and metals. Historic fill was estimated to have been placed >50 years ago. Site is located in proximity to residential neighborhood and industrial/commercial areas.
2- Nature and extent of contamination	Site has historical fill over 60% of the site. The fill appears to be relatively homogeneous in that the chemical contaminant concentrations in the sampling data are in close range throughout the known areas with historical fill. The only exceptions are two areas of concern (AOC) with evidence of spills and elevated concentrations of chemicals associated with industrial uses.
3- Work Tasks	Project remediation requires excavation of soils at specific locations throughout the site to remove soil that exceeds most stringent NJDEP soil remediation standards for COCs. Project tasks include site preparation to support the movement of heavy equipment, construction of truck and equipment decontamination areas, excavation of soil, placement of excavated soil directly into dump trucks, and transport of soils offsite.
4- Fate and Transport of Contamination	Considering the age of the spills, data indicates that most volatiles will no longer be present in any significant concentration in shallow (< 4 fbs) soils. There may be higher concentrations of volatiles present in soils being excavated below 4 fbs. It is also anticipated that semi-volatiles and metals will be mixed in with soils and potentially released as particulates once the soil is disturbed.

5- Offsite Receptors	The primary receptor area of concern is the residential neighborhood located to the east of the site. The residential neighborhood is also located in the predominant downwind location of the site. The southern boundary is adjacent to some warehouse buildings and parking lots for workers at these sites. The north boundary is an undeveloped tidal marsh, and the west is waterfront consisting of abandoned piers of a navigable tributary.
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The development of the CSM aided in identifying the following potential chemical exposure pathways:

- Inhalation of airborne organic vapors and contaminated particulates
- Eye and skin contact and absorption due to direct contact with vapors, liquids, and contaminated soils
- Incidental ingestion of contaminated liquids, particulates, and soils

As the PAM plan only addresses the inhalation exposure pathway at the perimeter for receptor protection, the additional chemical exposure pathways are being addressed in the site-specific health and safety plan. Based on the inhalation exposure pathway, monitoring during remedial efforts will focus on addressing volatilization from soils being excavated and particulate emissions from soil excavation, vehicle movement, loading of trucks with contaminated soil, and other soil disturbing activities. Additionally, conditions aiding in the transport mechanisms of airborne contaminants (wind direction, wind speed, etc.) will also be monitored during remedial efforts.

Step 3 – Establish HBTVs and Response Levels

HBTVs were developed using the PAM Calculator for each site COC identified in Step 1. Calculator input values were derived from the estimated duration of the remedial activities (workday duration, working days per week, & number of workdays per calendar year) and soil-specific contaminant toxicity information. If these HBTVs are not exceeded, it can be assumed with relative certainty that site related COCs are not impacting off-site receptors during remediation. Response levels were also developed using these same input values and soil-specific concentration data (discussed in Step 1 and listed in Tables 1 and 2) for use with real-time monitors (e.g., PID) at the perimeter of the remediation area/site for real-time monitoring.

The following HBTVs and response levels were calculated for each contaminant given the exposure time of 8 hours/24-hour day, five working days per week, and exposure frequency of 120 days/365-day year:

Table 4a.

Particulate HBTVs and Response Levels		
Contaminant	HBTV ($\mu\text{g}/\text{m}^3$)	Response Level ($\mu\text{g}/\text{m}^3$)
Arsenic	0.149	150
Lead	0.450	150
Mercury	2.74	150
Nickel	0.128	150
Benzo(a)anthracene	10.6	150
Benzo(a)pyrene	0.0183	150
Dibenz(a,h)anthracene	1.06	150
Indeno(1,2,3-cd)pyrene	10.6	150

Table 4b.

VOC HBTVs and Response Levels		
Contaminant	HBTV (ppbv)	Response Level (ppbv)
Benzene	85.7	1,510
Toluene	12,100	98,700
Chlorobenzene	99.1	808
Vinyl Chloride	357	11,100
Trichloroethylene	3.40	629
Mercury ¹	1.33	1.33

¹ Because real-time monitoring for mercury vapor is accomplished using a mercury-specific meter, the HBTV is used as the response level.

As shown on Table 4a, the HBTV for benzo(a)pyrene is the most stringent for site COCs in particulate phase. Additionally, as shown on Table 4b, the HBTV and response level for trichloroethylene (TCE) is the most stringent for site COCs in volatile phase. Although mercury has a more stringent HBTV and response level than the other volatile COC, due to TVOC real time instrument limitations, mercury vapor will be evaluated separately from the other COCs in the volatile phase using a mercury-specific meter with direct comparison to the HBTV. Thus, if the HBTV and response level for TCE (3.40 ppbv and 629 ppbv, respectively) and the HBTV and response level for benzo(a)pyrene (0.0183 $\mu\text{g}/\text{m}^3$ and 150 $\mu\text{g}/\text{m}^3$, respectively) are not exceeded at the perimeter, it can be reasonably assumed that the HBTVs and response

levels for other site COCs in volatile and particulate forms are also not being exceeded. As mercury is being analyzed separately, it would not be a surrogate for other contaminants. For perimeter air monitoring with real-time monitors (e.g., PID), the response level of 629 ppbv was selected as a surrogate for all VOCs. In the case of particulate monitoring, all response levels defaulted to the NAAQS 24-hour Average for PM₁₀ of 150 µg/m³ (ceiling limit). Thus, for perimeter air monitoring with real-time monitors (e.g., dust monitor), the response level of 150 µg/m³ will be used.

Step 4: Identify the Monitoring Strategy; Select Methods and Technologies

After determining the COCs to be monitored during remedial activities and calculating HBTVs and response levels, real-time monitoring and confirmatory air sampling methods and equipment were selected. Real-time and confirmatory methods and equipment were evaluated to ensure that they were sensitive enough to detect COCs at levels consistent with the calculated HBTVs and response levels. For this site, the use of COC-specific monitors is not appropriate. The site has several VOCs and particulates requiring consistent monitoring, and individual monitors for COCs is not optimal. Instead, surrogates (i.e., TVOCs and PM₁₀) were deemed appropriate for use with real-time monitoring equipment for all COCs except mercury vapor, as detailed in Step 3.

Real-Time Monitoring Methods and Equipment

Volatiles

Due to the number of volatile COCs found at the site, specific monitoring for each COC is impractical. Instead, TVOCs was selected as the surrogate to be used with real-time monitors to reduce the required instrumentation for perimeter air monitoring, though the COCs cannot be speciated with use of a PID. Based on the ionization potential of site related COCs listed in Table 5, a PID with a 10.6 eV lamp will be used for the purposes of real-time monitoring as each of the site related VOCs (except mercury vapor) can be detected. A PID was selected due to its ease of use in the field, data logging capabilities, and ability to be used with a telecommunication system. The PID is sensitive enough to detect the response level of 629 ppbv (the most stringent calculated response level (TCE)) and will be able to accommodate exceedance concentrations at the perimeter of the site. Since the HBTV and response level for TCE were determined to be the most stringent in Step 3, the response level of 629 ppbv will be used as the limit for the shorter-duration TWA. The investigators concluded that a 15-minute TWA response level would be an appropriate shorter-duration TWA. In most cases, it will allow the investigator time to rectify any site related emissions issues causing 15-min TWA exceedances at the perimeter without exceeding the HBTV for TCE for the 8-hr workday. Additionally, it may allow for an instantaneous exceedance to be remedied on its own over the 15-minute duration without the need to cease work and reevaluate.

Table 5

Contaminant	Ionization Potential (eV)	Case Study Response Levels (ppbv)
Benzene	9.25	1,510
Toluene	8.82	98,700
Chlorobenzene	9.07	2,810
Vinyl Chloride	10.00	11,100
Trichloroethene	9.45	629

Particulates

The surrogate selected for particulate COCs was PM₁₀ because there are many particulate bound COCs encountered at the site and monitoring for each COC is also impractical. A dust meter was selected for monitoring PM₁₀ at the perimeter. Like a PID, a dust meter is a real-time monitor that cannot speciate individual COCs. However, there are many different types of dust meters available for use, many of which have the sensitivity to detect PM₁₀ well below the calculated response levels and have data logging capabilities. Since the HBTV and response level for benzo(a)pyrene were determined to be the most stringent in Step 3, the response level of 150 µg/m³ will be used as the limit for the shorter-duration TWA. If the HBTV for benzo(a)pyrene is not exceeded throughout the day, it is highly unlikely that the HBTVs for other particulate bound COCs will be exceeded. Like for volatiles, the investigators deemed the use of the 15-min TWA appropriate for site conditions and constituents. In most cases, it will allow the investigator to rectify any site related emissions issues causing 15-min TWA exceedances at the perimeter without exceeding the HBTVs for the 8-hr workday. Additionally, it may allow for an instantaneous exceedance to be remedied on its own over the 15-minute duration without the need to cease work and reevaluate.

Mercury

While elemental mercury has the potential to vaporize, mercury vapor cannot be detected by real-time equipment used to monitor TVOCs. A mercury-specific real-time handheld monitor will be used by either the site health and safety officer or the PAM technician to continuously detect mercury vapor concentrations in ambient air at the perimeter of the work zone. The work zone may or may not coincide with the perimeter of the site. Because the mercury vapor meter is mercury-specific, the HBTV will be used at the work zone perimeter limit. Additionally, no shorter-duration TWA was established to be used with the mercury meter. Because the monitor will be used to detect concentrations that exceed the HBTV, if any exceedances occur, work should be stopped immediately, and remediation efforts reevaluated.

Additionally, because mercury may be present in both the volatile and particulate fraction, potentially particulate bound mercury will be monitored in real time by the dust meter at the perimeter. Though unable to speciate, the selected response level 150 µg/m³ for the 15-min TWA is restrictive enough to prevent exceedances of the mercury HBTV.

Meteorology

To document the changing meteorological conditions throughout the day, and to correlate possible perimeter exceedances with specific weather events, a primary meteorological monitoring station with data logging and wireless/remote connection capabilities will be employed at the site. The system will employ sensors for measuring, at minimum, WSD, temperature, relative humidity, and precipitation.

The wireless telemetry capability will be configured to enable real-time access to wind direction and speed measurements to support decision making (i.e., typically the data will be accessed via computer in the field operations office trailer). These data will be used to determine the upwind-downwind orientation to support real-time air monitoring decision making for siting of mobile real-time monitoring stations and/or directing use of hand-held monitoring equipment.

However, due to the complexity of the site and planned remediation activities, it was recognized that accurate assessment of wind direction would be difficult because of site topography and physical obstructions (i.e., buildings and large trees). To address this difficulty and to corroborate the upwind to downwind orientation, two additional supplemental meteorological stations configured to measure only

WSD, equipped with wireless telemetry for real-time data access, will be set up on the site perimeter.

Confirmatory Analytical Sampling Methods and Equipment

Confirmatory analytical sampling will be conducted for all site COCs to confirm the protectiveness of the selected real-time monitoring perimeter response levels. The results of confirmatory sampling will be compared directly to the individual COC HBTVs to confirm that HBTVs are not being exceeded at the perimeter. All confirmatory analytical air samples will be collected for the duration of the workday (a minimum of 8 hours) and analyzed at a NJDEP-certified off-site laboratory.

Various methods were screened as possible candidates for confirmatory sampling for each COC. Considerations included whether the method is able to detect multiple site COCs, the method's ease of use in the field, and whether the sensitivity of the method was able to achieve the calculated HBTVs.

Volatiles

The following sampling methods were selected for volatile COCs at the site:

Table 6

Contaminant	Method	Technique	Pump/Flow Rate	Analytical Sensitivity Meets HBTV (Yes/No)
Benzene	TO-15	GC/MS ¹	1-, 8-, or 24-hr	Yes
Toluene	TO-15	GC/MS	1-, 8-, or 24-hr	Yes
Chlorobenzene	TO-15	GC/MS	1-, 8-, or 24-hr	Yes
Trichloroethene	TO-15	GC/MS	1-, 8-, or 24-hr	Yes
Vinyl Chloride	TO-15	GC/MS	1-, 8-, or 24-hr	Yes
Mercury	Mod. NIOSH ² 6009	CVAA ³	0.15-0.25 lpm ⁴	Yes

1. GC/MS – Gas chromatograph mass spectrometer
2. NIOSH – National Institute for Occupational Safety and Health
3. CVAA – Cold vapor atomic absorption
4. LPM – liters per minute

For confirmatory sampling procedures that require the use of a pump with an internal battery (Mod. NIOSH 6009), a spare pump will remain onsite connected to a charging station in case the pump being used to collect the sample dies in the field. Care will be taken to place confirmatory sampling equipment away from emissions generating equipment (e.g., excavator exhaust).

Particulates

The following sampling methods were selected for particulate COCs at the site:

Table 7

Compound	Method	Technique	Pump/Flow Rate	Analytical Sensitivity Meets HBTV (Yes/No)
Arsenic	Mod. NIOSH ¹ 7303	ICP/AES ²	1-4 lpm ³	Yes
Lead	Mod. NIOSH 7303	ICP/AES	1-4 lpm	Yes
Nickel	Mod. NIOSH 7303	ICP/AES	1-4 lpm	Yes
Mercury	Mod. NIOSH 6009	CVAA ⁴	0.15-0.25 lpm	Yes
Benzo(a)anthracene	TO-13A	PUF ⁵ and GC/MS ⁶	8 ft ³ /min (0.225 m ³ /min) ±10%	Yes
Benzo(a)pyrene	TO-13A	PUF and GC/MS	8 ft ³ /min (0.225 m ³ /min) ±10%	Yes
Dibenz(a,h)anthracene	TO-13A	PUF and GC/MS	8 ft ³ /min (0.225 m ³ /min) ±10%	Yes
Indeno(1,2,3-cd)pyrene	TO-13A	PUF and GC/MS	8 ft ³ /min (0.225 m ³ /min) ±10%	Yes

1. NIOSH – National Institute for Occupational Safety and Health
2. ICP/AES – Inductively coupled plasma atomic emission spectroscopy
3. LPM – liters per minute
4. CVAA – Cold vapor atomic absorption
5. PUF – Polyurethane foam
6. GC/MS – Gas chromatograph mass spectrometer

For confirmatory sampling procedures that require the use of a pump with an internal battery (e.g., Mod. NIOSH 7303), a spare pump will remain onsite connected to a charging station in case the pump being used to collect the sample dies in the field. For confirmatory sampling procedures that require an external power source (TO-13A), either an extension cord will be run from an onsite trailer with electrical hookup or a generator with a gas reservoir capable of running for the duration of the workday will be connected. Care will be taken to ensure that the emissions from the generator are not impacting the results of air sample collection.

Speciation of Mercury in Air

While mercury is expected to be particulate bound as no soil data suggests that elemental mercury is present at the site, confirmatory air sampling will be conducted initially to determine which fraction of mercury (particulate, volatile, or both) is present at the site. This will be accomplished using the modified NIOSH Method 6009 with a particulate prefilter. The prefilter will be analyzed for particulate-bound mercury species and the sorbent material will be analyzed for elemental mercury. All samples will be sent to a laboratory on an expedited turnaround time. A discussion of the confirmatory sampling process is detailed in Step 5.

Step 5 – Identify Sampling and Monitoring Locations and Schedule

Real-Time Monitoring Schedule

Due to the nature of the COCs present at the site, perimeter air monitoring activities will be performed during all activities that cause soil disturbance. Air monitoring equipment will be powered on and zeroed prior to the commencement of soil disturbing activities. Additionally, equipment will be bump tested and calibrated in-field at designated frequencies (see General QA/QC Section) prior to the commencement of soil disturbing activities. Soil disturbing activities include, but are not limited to, excavation of impacted soils, loading and offsite transport of impacted soils, site grading, compaction, dewatering, trenching, and the handling or treatment of contaminated media. Should soil disturbing activities cease prior to the end of the workday, real-time monitoring equipment for particulates and volatiles will be powered down at that time. Weather monitoring, however, will continue to operate for the duration of the workday.

Real-Time Monitoring Locations

Based on the residential area to the east of the remediation area, adequate coverage on the eastern boundary will be provided to measure particulate and VOC emissions emanating from the excavation and other active work areas that might migrate to the residential neighborhood. Three stationary air monitoring stations will be located along the eastern perimeter of the work area. It is anticipated that these stations may be moved along the eastern perimeter as the excavation efforts move within the site. Distance between these monitoring stations will be based on prevailing wind directions and anticipated daily worksite activities.

The other boundaries of the excavation work area consist of undeveloped tidal marsh to the north, abandoned piers on a navigable tributary to the west and warehouses to the south. One air monitoring station is planned for the north and west boundaries since there are no receptors of concern along those perimeter locations. There will be two fixed stations located on the southern perimeter to address the warehouses' parking areas.

Real-Time Monitoring Station Setup and Schedule

Each perimeter monitoring station will be equipped with both a dust monitor and a PID that have data logging capabilities. The dust monitor and PID will be connected to a telemetry system that relays real-time concentration information to a server accessible to the on-site personnel through computer or cellphone access. The telemetry system will be configured to have alarm conditions (e.g., exceedance of the 15-min TWA) to alert when remediation activities may be causing off-site emissions. The telemetry system will allow for on-site personnel to react immediately to an alarm condition without the burden of frequently checking the monitoring stations. The telemetry system will also aid in informing the on-site personnel if there is malfunctioning equipment at any of the perimeter air monitoring stations.

All real-time perimeter monitoring equipment will be arranged in an enclosure equipped with a lock to prevent tampering when on-site personnel are not immediately nearby. The enclosure will also act as protection during inclement weather events. The perimeter air monitoring station will be connected to a power source to prevent equipment from powering off throughout the day. Further, a backup dust meter and PID will be kept on-site and remain on chargers throughout the day in the event that the in-use meters malfunction and must be switched out.

A handheld mercury monitor with data logging capabilities will be available on-site to screen soils during the excavation and help determine if there is evidence of any free mercury in the soil. The mercury meter will provide real-time results displayed on its window while in hand, thereby eliminating the need for a telemetry system. Because the mercury monitor is handheld, an external power source is impractical. A backup mercury monitor will remain on a charger throughout the day in the event that the in-use handheld meter runs out of battery during the workday, or if the meter malfunctions and must be switched out. Should confirmatory sampling results demonstrate that mercury is present only in the particulate fraction, the use of the handheld mercury monitor may be discontinued.

A full weather station with specifications detailed in Step 4 will be located in the parking lot of the site. Additionally, two WSD monitors will be affixed to two different monitoring stations, one at the western boundary and one at the southern boundary, to identify when real-time readings are potentially originating from the excavation and loading areas. The full weather station and WSD monitors will be connected to the telemetry system to relay real-time weather information to the server accessible to on-site personnel. The WSD monitor data will be integrated with the data from the full weather station to determine accurate wind flow across the site. The telemetry system will log weather data from the full weather station and WSD monitors while they are in use.

Background Confirmatory Sample Locations and Schedule

Analytical air samples will be collected for three consecutive days prior to the commencement of remedial activities to identify ambient air conditions and potential interfering emission sources not associated with the project, as well as to confirm that instruments are operating effectively. Background air samples will be collected utilizing the same methods chosen for confirmatory air sampling during remediation (see Step 4). The pre-remedial air samples will be collected for the duration of the proposed typical workday (8 hours) at forecasted prevailing upwind and downwind locations for each day. After sample collection, the samples will be sent to a NJDEP-certified off-site laboratory on an expedited turnaround time.

Confirmatory Sample Locations and Schedule During Soil Disturbing Activities

Volatiles and Particulate

At the commencement of remedial activities involving the disturbance of contaminated soils, confirmatory air samples will be collected for all site COCs for three consecutive days at the anticipated prevailing downwind locations. The confirmatory samples will be collected for the duration of the workday. Multiple air samples may be collected at various downwind locations during the day but only one series of samples from one location will be sent for analysis. Samples to be submitted for analysis will be selected at the end of the workday after the prevailing downwind direction has been determined. All samples will be sent to the laboratory on an expedited turnaround time.

Upon receipt of analytical data for the first three consecutive days of remediation, the results will be evaluated to confirm whether air contaminant concentrations are below their respective HBTVs, and to determine whether real-time monitoring surrogates are adequate. Following the evaluation of analytical

results, if the data supports that HBTVs are not being exceeded, confirmatory air sampling will be reduced to a weekly sampling scheme. If the weekly sampling scheme is employed, confirmatory air samples will be collected on a different weekday each week and will be collected for the duration of the workday at the anticipated prevailing downwind location. If the results of analytical sample demonstrate that the HBTVs are being exceeded, the steps outlined in Step 6 of the PAM Calculator User's Guide will be followed and information evaluated to determine where characterization may be insufficient or whether equipment selection, failure, or misuse is the issue.

When a hot spot not previously identified is encountered, the steps outlined above for confirmatory sampling for the first three or more consecutive days will be followed.

Mercury

As discussed in Step 4, mercury is expected to be encountered in the particulate fraction. However, confirmatory air sampling will be conducted to address both fractions of mercury (particulate and volatile). Confirmatory samples will be collected for the first three consecutive days of soil disturbing remediation, as described above. The analytical results from sampling will be compared to the HBTVs developed for mercury. Following the evaluation of analytical results, if the data supports that HBTVs is not being exceeded, confirmatory air sampling will be reduced to a weekly sampling scheme. If the weekly sampling scheme is employed, confirmatory air samples will be collected on a different weekday each week and will be collected for the duration of the workday at the anticipated prevailing downwind location. If the results of analytical sample demonstrate that the HBTVs are being exceeded, the steps outlined in Step 6 of the PAM Calculator User's Guide will be followed and information evaluated to determine where characterization may be insufficient or whether equipment selection, failure, or misuse is the issue. As detailed above, samples will be collected for the duration of the workday at the anticipated prevailing downwind location. All samples will be sent to the off-site laboratory on an expedited turnaround time.

When a hot spot not previously identified is encountered, the steps outlined above for confirmatory sampling for the first three or more consecutive days will be followed.

Shorter-Duration Confirmatory Samples & Colorimetric Gas Tube Samples (Qualitative)

As part of the actions to address exceedances of the perimeter response levels, a shorter-duration confirmatory sample (1-hour) will be collected if the sustained exceedance surpasses 45 minutes in duration. The shorter-duration confirmatory sample will be collected at the perimeter station that is exhibiting the exceedance and will be specific to the volatile or particulate fraction (or both) depending on which real-time monitor is exhibiting the alarm condition. Because the real-time monitors are incapable of speciating contaminants, it is impossible to know which COC, if any, is the cause of the alarm condition. Thus, each confirmatory sampling method for that fraction (e.g., TO-13A, NIOSH method 7303, and NIOSH method 6009 for particulate) will be collected for one hour. The samples will be sent to the laboratory on an expedited turnaround time. The 1-hour sampling results cannot be directly correlated to the established HBTVs. Instead, the analytical results of the 1-hour samples will be reviewed to determine whether any of the site COCs were present during the alarm condition, and whether work practices need to be adjusted to mitigate future perimeter exceedances.

Additionally, because confirmatory samples must be sent to an off-site laboratory and will not provide immediate analytical results, a qualitative test to determine the presence or absence of the driving volatile COC (TCE) will be used when PIDs are denoting exceedances of TVOCs. This will be accomplished using a TCE-specific colorimetric gas tube and manual tube pump. If the colorimetric gas tube indicates

that TCE is present during or after the alarm condition, soil disturbing work will be halted, and work practices will be amended. Colorimetric gas tubes are specific to gases and vapors and are not designed to sample particulate matter. Therefore, they will only be used when there is an alarm condition for TVOCs.

The collection of shorter-duration confirmatory samples will require that some amount of confirmatory sample media (e.g., PUF cartridge and filter) and equipment (e.g., SUMMA canister and 1-hr flow regulator) is stored at the site. Care will be taken to ensure that sample media and equipment is either used or returned to the laboratory before its use-by date has passed.

Step 6 – Select Action to Address Exceedances of Perimeter Response Levels

Should the 15-minute TWA of 629 ppbv for TVOCs or the 15-min TWA of 150 $\mu\text{g}/\text{m}^3$ for PM_{10} be exceeded at any of the perimeter stations during soil disturbance activities, the following response steps will be taken:

1. If an exceedance of the 15-minute TWA is observed at the perimeter, the instrumentation will be checked to ensure it is functioning correctly and possible sources of emissions will be identified based on station location and current wind direction.
 - a. If the instrumentation is malfunctioning, it will be repaired or replaced immediately.
 - b. If an external emission source (e.g., street sweeper, idling vehicle) is the cause of the exceedance, the source will be documented, and steps taken to remedy the situation if possible.
 - c. If the remediation activities are the cause of the exceedance, then corrective actions will be initiated.
2. If the exceedance of the 15-min TWA at the perimeter continues into the next 15-minute monitoring interval (total of 30 minutes) and is the result of an emissions-generating remediation activity, engineering controls such as vapor and/or dust control corrective actions will be implemented. These actions may include the application of water or foam, tarping, adjusting the remedial area, or reducing the rate of activities resulting in vapor and/or particulate generation.
3. If the exceedance of the 15-min TWA at the perimeter continues into the third 15-minute monitoring interval (total of 45 minutes), continued implementation of engineering controls will occur and modification of remedial operations to reduce vapor and/or particulate generating activities will be assessed. A shorter-duration confirmatory air sample (e.g., one-hour confirmatory sample) will also be collected at this time, specific for the exceedance and associated COC, co-located at the station(s) experiencing the exceedance(s). The 1-hour confirmatory sample will be collected using the same methodology for each COC listed in Tables 6 and 7. Shorter-duration confirmatory samples will be sent to the laboratory on an expedited turnaround time. Additionally, at the termination of the 1-hour confirmatory sample collection, a TCE-specific colorimetric gas tube sample will be collected using a manual hand pump if the alarm condition was specific to the PID.
4. If the exceedance of the 15-min TWA at the perimeter persists into a fourth 15-minute monitoring interval (total of 60 minutes), is attributable to the same cause, and is due to emissions-generating remedial activity, continued implementation of engineering controls will occur and stopping of all work activity that has the potential to generate vapors or particulates will also occur. Operations will be restarted once the offending issue is believed to be resolved. If upon re-start an exceedance occurs and is believed to be a continuation of the same problem, operations will be shut down once again. If

repeated restarts are not effective, then alternative methods of emission control (e.g., changing foam mixture, tarping, enclosure with emission controls) will be considered.

At each stage of the exceedance evaluation process, the investigator will document the time, concentration range, duration, and assumed source of the exceedance. Additionally, the investigator will document all corrective actions that were taken to address the exceedance, including the collection of shorter-duration confirmatory air samples. If a shorter-duration confirmatory air sample is collected, it will be submitted to the laboratory for analysis on an expedited turnaround time. Once analytical data is received, it will be reviewed to determine if any of the site COCs were drivers for the exceedance. Documented exceedance information will be included in the final PAM report once site remediation has been completed.

Step 7 – PAM Plan Review, Modifications, and Documentation

Review

Confirmatory sampling analytical data and real-time air monitoring data results will be reviewed as they are received to verify that response levels are effective at keeping air concentrations of COCs below their respective HBTVs. If the review of this data does not support that response levels are protective of HBTVs, modifications to the PAM plan may be made.

Modifications

Any modifications to the original PAM plan will be documented and included in the final PAM report. These may include, but are not limited to:

1. Relocation of perimeter air monitoring stations to better address downwind migration of dust or contaminant plumes
2. Change in real-time monitoring methods
3. Change in confirmatory air sampling methods
4. Change in selected remedial activities
5. Change in work duration (day length or project length)
6. Collection and inclusion of new characterization data

Documentation

At the conclusion of remediation at the site, a final PAM report will be prepared and submitted to the NJDEP as part of the Remedial Action Report. The final PAM report will include, at minimum, the following information:

1. Contaminants monitored
2. Site soil data used to derive HBTVs and response levels (tabulated)
3. Contaminant-specific HBTVs and response levels
4. Site map depicting perimeter air monitoring locations, including modified locations, and receptors
5. Details of any modifications made to the original PAM plan during implementation, and supporting documentation and rationale to justify the modifications
6. Daily data evaluations (e.g., monitoring start and end times, confirmatory and shorter-duration confirmatory sample collection, including start and end times and sample locations, if

applicable, maximum and average response levels at each station, general weather data, changes in work scope or work stoppages, and noted exceedances)

7. All data deliverables (reduced), including data logging files from real-time monitoring equipment and WSD meters
8. QA/QC documentation for real-time monitoring equipment and confirmatory air sample analysis including calibration sheets (e.g., air sampling pump manufacturer's calibration, SUMMA canister and flow regulator laboratory calibration, PID manufacturer's calibration sheets, etc.)
9. Real-time monitoring equipment zeroing, bump testing, and calibration logs
10. Perimeter exceedance logs including corrective actions
11. Community relations procedures, if deemed necessary
12. Any other information recorded following the General QA/QC procedures

Additional information, if deemed appropriate, may be submitted along with the final PAM report.

General QA/QC

Daily Record Keeping

A record of general daily information will be initially kept by the PAM technician in a field logbook and later transcribed to an electronic file. The daily record will include:

1. Date and day of week
2. Weather conditions (AM and PM, or any major changes throughout the day)
3. Real-time monitoring start and end times including temporary shutdowns for inclement weather
4. Soil disturbing work start and end times, including breaks and temporary shutdowns for inclement weather
5. Work activities conducted throughout the day
6. Perimeter exceedance information including fraction type (volatile, particulate, or both), station number or location, maximum and average exceedance concentrations, duration of exceedance, corrective actions(s), and expected cause of the exceedance
7. Confirmatory, shorter-duration confirmatory, duplicate, field/trip blank, and colorimetric gas tube sample collection information including equipment and media serial/ID numbers, start and end times, start and end volumes/pressures, station number or collection location, and associated sample identifiers
8. Laboratory sample pickup (courier) or sample drop-off times and preservation methods
9. Community outreach or community concerns addressed
10. Odor complaints, assessments, and corrective actions

Real-Time Monitoring Equipment and Procedures

Upon the initial receipt of and at the point that any new or replacement real-time monitoring equipment is received, the manufacturer's calibration sheets will be checked to ensure that calibration is not past due on any equipment. All equipment serial numbers and next calibration dates will be written down and posted in the on-site trailer in an easily visible location, so calibration dates are not missed. It is anticipated that real-time monitoring equipment will be sent back to the manufacturer or to the selected equipment

supplier for calibration approximately one month prior to its calibration date. Prior to sending equipment for calibration, replacement equipment will be requested and received from the selected equipment supplier. The return of equipment for calibration and receipt of replacement equipment, and the logging of calibration dates, will be an iterative process. Equipment calibration and QA/QC sheets (if received) will be stored in an on-site file and included in the final PAM report.

Prior to use of real-time monitoring equipment, equipment will be inspected to ensure that the correct filters, lamps, etc. are installed or have been included with the equipment delivery. Additionally, an inspection will be conducted to confirm that all equipment required for the proper use and maintenance of the real-time equipment is included with its delivery.

Before the commencement of daily soil disturbing activities, air monitoring equipment will be powered on (connected to external power source) and zeroed within their perimeter stations. A note of the relative humidity at the time of zeroing will be made in the field logbook. Manufacturer recommendations for using real-time equipment during inclement weather or high humidity situations will be followed. Additionally, the PIDs will be bump tested using the supplied span gas once per week prior to the commencement of daily soil disturbing activities. If the results of bump testing indicate that a PID is outside of its calibration range, the PID will be recalibrated per the manufacturer's instructions.

All equipment selected for air monitoring at that site has data logging capabilities. Equipment will be set at 1-minute logging intervals. Additionally, the telemetry system will be set to 1-minute logging intervals whereby data from the monitoring station equipment will be transmitted to the telemetry system and stored. Telemetry data and equipment logged data will be downloaded at the end of each work, and equipment data will then be erased.

Daily Real-time Equipment Calibration and Record Keeping

Daily equipment calibration logs and record keeping will be completed and kept in an on-site file. These records will be submitted as part of the final PAM report. Daily calibration logs will record the following information:

1. Date, day, weather conditions
2. Daily zero calibration for each instrument (complete/incomplete)
3. Weekly bump testing for applicable instruments (complete/incomplete)
4. Calibration for each instrument, if necessary (date, time, reason)

Additionally, daily record keeping as it relates to equipment QA/QC will include, at minimum, the following information:

1. Instrument malfunctions and corrective actions (Station # or location, equipment serial numbers, type of issue, cause of issue if known, and remedy)
2. Monitoring station instrument changes or replacements (switching out with stored on-site equipment) (Station # or location, serial # of exiting and incoming instrument, time of replacement)
3. Instrument replacements from manufacturer or selected equipment supplier due to calibration or malfunction (Station # or location, serial # of exiting and incoming instrument, time of replacement)

Confirmatory Sampling Equipment and Procedures

Confirmatory sampling equipment requiring calibration prior to use will undergo calibration per the

manufacturer's instructions. It is anticipated that most of the calibration for confirmatory sampling equipment will be conducted by the manufacturer or equipment supplier. Calibration dates and pertinent information regarding the calibration will be logged and kept in an on-site file.

All calibration sheets/information for confirmatory sampling, shorter-duration confirmatory sampling, colorimetric gas tube sampling, duplicate sampling, and field/trip blank sampling equipment and media will be checked upon receipt to ensure that calibration is not past due, and that sample media is used within its applicable use-by date. Equipment calibration and QA/QC sheets will be stored in an on-site file and included in the final PAM report. Serial numbers or identification information for equipment and sampling media, where applicable, will be recorded on the date that they are used both in the daily field log or book and on the chain of custody.

Chains of Custody

Chains of custody will be filled out completely and accurately by the PAM technician for all samples that are being submitted to the laboratory. Care will be taken to note the correct preservation methods and turnaround time on the chain of custody. All sampling equipment and sample media serial numbers, where applicable, will also be recorded on the chain of custody. Further, care will be taken to submit samples to the laboratory within their respective holding times.

Quality Assurance Sample Collection

Collection of duplicate samples, trip/field blanks, and other quality assurance samples will be conducted at rates specified in the NJDEP *Quality Assurance Project Plan Technical Guidance*, April 2014 document and will be documented in the daily field log or book and on the chain of custody. Should this document be revised during remediation, quality assurance samples will be collected at the rates reflected in the updated guidance.

APPENDIX G
GLOSSARY

APPENDIX G

GLOSSARY

Background: The ambient air concentration that is/would be measured if remedial emissions-generating activities were not present.

Bump Testing: A functional test of a gas monitor (e.g., PID, FID) to ensure that the sensors will respond to their target gas and the alarms will function. The test exposes the monitor to a known concentration of gas that exceed the lowest alarm set-point for each sensor. Bump testing can also be employed to identify instrument operation and calibration issues associated with measurement precision and sensitivity.

Chronic: Long duration or frequent occurrence.

Co-located Monitoring: A quality assurance procedure used to assess field precision whereby the use of a second, identical real-time instrument is placed adjacent to the primary instrument to determine if the data from the primary meets appropriate correlation coefficients.

Contaminated site: See N.J.A.C. 7:26E-1.8 (https://dep.nj.gov/wp-content/uploads/rules/rules/njac7_26e.pdf).

Contaminant of Concern (COC): A site-specific compound at a site that is detected in environmental media (soil, ground water, surface water, sediment, air) above its regulatory standards or screening criteria.

Emissions-Generating Activities: Remedial actions at a site that may cause or generate air contaminant emissions.

Health-Based Threshold Value (HBTV): A calculated air concentration that is assumed to be protective of human health for off-site receptors (average concentration over a workday). The HBTV is calculated using selected chemical specific toxicity reference values and site-specific exposure assumptions (e.g., expected duration of the remediation activities, hours worked per day, etc.).

Inhalation Unit Risk (IUR): The upper-bound excess lifetime cancer risk estimated to result from continuous exposure to a chemical at a concentration of 1 microgram per cubic meter ($\mu\text{g}/\text{m}^3$) in air. For example, if a chemical's IUR is $2 \times 10^{-6} / (\mu\text{g}/\text{m}^3)$, then a person exposed daily for a lifetime to 1 μg of the chemical in 1 cubic meter of air would have an increased risk of cancer equal to 2 in a million (as defined in USEPA's IRIS).

Licensed Site Remediation Professional (LSRP): A person defined as such pursuant to ARRCS at N.J.A.C. 7:26C-1.3 (https://dep.nj.gov/wp-content/uploads/rules/rules/njac7_26c.pdf).

Method Detection Limit: See N.J.A.C. 7:26E-1.8 (https://dep.nj.gov/wp-content/uploads/rules/rules/njac7_26e.pdf).

Off-Site Receptors: A person or population located adjacent to or potentially impacted by a contaminated site or area of concern.

Particulate matter: Small particles suspended in the air that can impact the respiratory system. They may be fine liquid or solid particles emitted from a source or formed in the environment, and include dust, smoke, mist, fumes, or smog.

Perimeter: The boundary of a contaminated site or area of concern.

Real-Time Monitor: Equipment that measures the total concentration for groups of contaminants (e.g., total VOCs or particulates) or concentrations for a specific chemical (e.g., mercury) that displays instantaneous concentration readings across the screen of the instrument. For the purposes of PAM, this

equipment is used in addition to the collection of analytical air samples that are submitted to certified laboratories for analysis.

Receptor: See N.J.A.C. 7:26E-1.8 (https://dep.nj.gov/wp-content/uploads/rules/rules/njac7_26e.pdf).

Reference Concentration (RfC): An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. It can be derived from various types of human or animal data, with uncertainty factors generally applied to reflect limitations of the data used (as defined in USEPA's IRIS).

Remedial Action: See N.J.A.C. 7:26E-1.8 (https://dep.nj.gov/wp-content/uploads/rules/rules/njac7_26e.pdf).

Response Level: An HBTV-based timeweighted average screening air concentration monitored in real-time along the site boundary.

Semi-Volatile Organic Compounds (SVOCs): See N.J.A.C. 7:26E-1.8 (https://dep.nj.gov/wp-content/uploads/rules/rules/njac7_26e.pdf).

Sensitive Receptor: Sensitive receptors include, but are not limited to, occupants in hospitals, schools, daycare facilities, elderly housing, and convalescent facilities. These occupants are more susceptible to the adverse effects of exposure to toxic chemicals, pesticides, and other pollutants.

Time Weighted Average (TWA): For the purposes of this document, the average exposure to any hazardous chemical using the baseline of an 8–12-hour workday and 20–225-day total work schedule. In the case of the PAM Calculator, TWAs will be dependent on project-specific input. The TWA may be modified to a shorter time interval of 15 minutes or less for the purposes of real time monitoring. Such a TWA adjustment does not allow for the recalculation of the HBTV or response level and is solely for the purpose of providing a shorter time interval for use with real-time monitoring instrumentation. This time adjustment allows users to address any shorter-term real-time exceedances (e.g., 15 minutes or less) before an HBTV exceedance occurs.

Volatile Organic Compounds (VOCs): See N.J.A.C. 7:26E-1.8 (https://dep.nj.gov/wp-content/uploads/rules/rules/njac7_26e.pdf).

APPENDIX H
ACRONYMS

APPENDIX H

ACRONYMS

AA	Atomic Absorption
ADC	Adjusted Downwind Concentration
AOC	Area of Concern
APC	Air Pollution Control
ARRCS	Administrative Requirements for the Remediation of Contaminated Sites
ATSDR	Agency for Toxic Substances and Disease Registry
BTEX	Benzene, Toluene, Ethyl Benzene and Xylenes
CARB	California Air Resources Board
CalEPA	California Environmental Protection Agency
CDC	Centers for Disease Control
COC	Contaminants of Concern
CSM	Conceptual Site Model
CSRR	Contaminated Site Remediation and Redevelopment
Department	New Jersey Department of Environmental Protection
DQI	Data Quality Indicators
DQO	Data Quality Objective
FAA	Flame Atomic Absorption
FID	Flame Ionization Detector
FTIR	Fourier Transform Infrared
GC	Gas Chromatograph
GFAA	Graphite Furnace Atomic Absorption
HBTV	Health-Based Threshold Value
HEAST	Health Effects Assessment Summary Tables
ICP	Inductively Coupled Plasma
IEUBK	Integrated Exposure Uptake Biokinetic Model for Lead
IR	Infrared
IRIS	Integrated Risk Information System
ISS	In-Situ Stabilization and Solidification
IUR	Inhalation Unit Risk
LSRP	Licensed Site Remediation Professional
MDL	Method Detection Limit
MS	Mass Spectroscopy
NAAQS	National Ambient Air Quality Standard

NELAP	National Environmental Laboratory Accreditation Program
NESHAP	National Emissions Standard for Hazardous Air Pollutants
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NJDEP	New Jersey Department of Environmental Protection
OQA	Office of Quality Assurance
OSHA	Occupational Safety and Health Administration
OP-FTIR	Open-Path Fourier-transform Infrared Spectroscopy
PAH:	Polycyclic Aromatic Hydrocarbon
PAM:	Perimeter Air Monitoring
PbB	Blood Lead Level
PCB	Polychlorinated Biphenyl
PID	Photo Ionization Detector
PM _{2.5}	Particles 2.5 Micrometers or Less in Diameter
PM ₁₀	Particles 10 Micrometers or Less in Diameter
PPRTV	Provisional Peer-Reviewed Toxicity Values
PUF	Polyurethane Foam
QA	Quality Assurance
QC	Quality Control
QAPP	Quality Assurance Project Plan
RAR	Remedial Action Report
RfC	Reference Concentration
RL	Reporting Limit
RPD	Relative Percent Difference
SAB	Science Advisory Board
SOP	Standard Operating Procedure
SPM	Suspended Particulate Matter
SVOC	Semi-Volatile Organic Compound
TVOC	Total Volatile Organic Compounds
TWA	Time Weighted Average
TXS	Toxic Substances
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Agency
UV	Ultraviolet
VOC	Volatile Organic Compound
PHDDs/PHDFs	Polyhalogenated Dibenzo-p-Dioxins and Dibenzofurans

PCDDs/PCDFs	Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans
PBDDs/PBDFs	Polybrominated Dibenzo-p-Dioxins and Dibenzofurans
WSD	Wind Speed and Direction
XRF	X-Ray Fluorescence