9 Special Considerations for Managing TPH-Contaminated Sites

This section provides insights and recommendations when evidence of contamination and exposure exists due to the following circumstances:

- Existing or potential emergency conditions or worker exposure to TPH
- Sites that require updated TPH analysis and characterization (e.g., “no further action” with or without conditions)

This section will point regulators, consultants, and contractors to some of the special considerations common to petroleum hydrocarbon sites when workers are potentially exposed to residual TPH and metabolite compounds that were previously unknown or incompletely assessed.

Some sites may have severe TPH contamination that warrants emergency response actions. More often, workers encounter old contamination at historic petroleum storage sites during utility corridor work or property redevelopment. Many petroleum cleanup sites that were assessed and closed early in the history of state regulatory programs may have used older, less accurate analytical methods. In some cases, TPH contamination associated with these sites requires additional assessment. This section will discuss decision points encountered when managing sites with residual TPH and metabolites.

Sites that exhibit TPH impacts in previously undetected areas or routes of exposure may lead to a re-evaluation of the conceptual site model (CSM) and consideration for an incomplete CSM. Practitioners may then choose to use updated TPH analytical data to update the CSM and better inform decision making at the site to limit exposure pathways for workers and determine if additional assessment and subsequent remediation is necessary.

9.1 Special Factors

Not all risk associated with TPH contamination at petroleum-contaminated sites is based on health risks associated with exposure to the contaminated media. Special circumstances usually arise when there is new evidence of contamination and exposure that are realized due to the following:

- Redevelopment or subsurface utility work that involves disturbance of known or newly discovered, petroleum-contaminated soil or groundwater, resulting in emergency conditions or worker exposure
- Open or closed sites (e.g., “no further action” with or without conditions) that require updated TPH analysis and characterization
- Open or closed sites that exhibit TPH impacts in previously undetected areas or routes of exposure, leading to consideration of an incomplete CSM

9.2 Emergency Conditions

An emergency represents a direct and immediate threat to receptors. Emergencies can arise due to a variety of reasons, including:

- Newly exposed or detected contaminated soil or water in utility lines
- Land use changes in which previously incomplete exposure pathways are now complete
- New or ongoing releases that cause exposure
- Newly exposed gas from soil/groundwater contamination (e.g., methane) can lead to explosion or flashback concerns due to mixing with oxygen in the right proportion, especially within enclosed utility corridors. Methane is odorless and represents a significant concern as an asphyxiant if it replaces oxygen at less than 16%.

Emergencies are usually indicated by reports of odors, disagreeable taste of water, visible signs of petroleum contamination, or fire and explosions due to the presence of flammable petroleum hydrocarbons (PHCs) and non-PHC fuel additives, vapors, or methane (see TPH Fundamentals). Under OSHA 29 CFR 1910, such conditions require immediate abatement and mitigation and first responders should be notified immediately of an emergency.

9.3 Worker Exposure and Safety

Potential environmental concerns encountered by worker populations during emergency response, site redevelopment, or maintenance activities may include short-term exposure to vapors; off-site migration of stormwater runoff; off-site migration of vapors, soil, or groundwater; on-site or off-site storage, treatment, and/or disposal of excavated soil; re-infiltration or treatment of groundwater during dewatering activities; and cleaning fouled construction equipment. Worker safety requirements are specified in OSHA 29 CFR 1910.

Elevated levels of methane in subsurface soils can pose potential intrusion and explosion hazards to overlying buildings, especially if the methane is under pressure or being pulled into the building by advective flow. Methane can also pose potential hazards at construction sites that involve excavation or boring into heavily contaminated soils or for utility workers in underground vaults and corridors that require periodic maintenance and repair. Residual TPH in utility corridors represents an enclosed or confined space hazard and warrants special consideration for concentration of methane gas. For more information on methane hazards refer to HIDOH (2016), ASTM (2016), and CAEPA-DTSC (2005, 2012a).

A written plan should be developed that addresses all potential worker exposure pathways of TPH for the applicable media (soil, surface water, vapors, groundwater, and free product/sheen). This plan should also consider the overall CSM for the release site and exposure to construction and nonconstruction personnel. The person responsible for developing such a plan should review all available data collected at the site and develop action levels (e.g., lower explosive limits) for stop-work and recommend personal protective equipment protocols during construction. Several states publish screening levels for soil, water, and air to alert workers to potential short-term risks associated with petroleum exposure encountered in worker exposure scenarios.

9.4 Managing Open and Reopened TPH-Contaminated Sites

This section describes the unique regulatory challenges posed by two types of sites: open sites and reopened closed TPH-contaminated sites. Each may require special consideration when the parameters of exposure change over time or with the noticeable presence of residual TPH (often in the form of petroleum odors and sheens) or metabolites. These sites include those that are open and in long-term monitoring and sites that were closed in the past and reopened due to changing site and land use conditions. Both types of sites are usually cases where remediation to approved levels of all residual TPH constituents or fractions is not practicable.

For closed sites that are reopened, most regulatory programs have specific petroleum release closure provisions (see States Survey) and recognize some form of “re-opener” clause that allows a regulatory program to consider new information obtained months or years after a site is closed. This type of re-evaluation also pertains to open sites that are in long-term monitoring or remediation and when site conditions change.

9.4.1 Historical Site Data

Historical site data should be compared to new data to determine if new detections represent a new release or the discovery of previously undetected contamination. Discovery of TPH contamination or metabolites or complete exposure pathways can result from the following activities:

- Environmental samples collected during environmental investigative activities for real-estate transfer, redevelopment, land use changes, brownfields, and Leaking Underground Storage Tank Trust assessment activities.
- Analysis of TPH fractions not previously evaluated is now required or laboratory methods have been updated according to local regulatory requirements. If TPH fraction concentrations are required, regulatory agencies may permit estimations of fraction concentrations from historic data using techniques described in TPH Fundamentals (see Section 4.2.2). If estimations are not permitted, any new data collected should include analysis of TPH fraction concentrations. A reduced sampling frequency for obtaining new data is allowed by some regulatory programs.
- Visible or olfactory detection of contaminated soil, LNAPL sheen, or water is discovered during demolition, construction, or dewatering activities or severe weather events (e.g., due to migration of fuel beneath buildings or through utility corridors or fuel oil spills from storage tanks in basements).
- Observation of previously undetected hydrocarbons due to changes in groundwater elevation.
- Construction of buildings over contaminated areas, resulting in risk of exposure of building occupants to vapor intrusion from subsurface residual contamination.

- Construction of utility corridors through contaminated areas, resulting in transmission of liquid- or vapor-phase contamination to receptors through the backfill material for the utility, unsealed utility joints, and permeation of the utility line.

9.4.2 Open or Reopened Sites

Open or reopened sites that detect previously undetected or unknown contamination or detect ongoing releases during routine monitoring or investigation may require evaluation of TPH and its fractions when a level of exposure cannot be accurately determined.

TPH data may be old and predate current practices for evaluating TPH or evaluation of metabolites. If existing TPH data are deemed not useful because the analytical methods are no longer used or approved ("old data"), or the degree of weathering and compositional changes is such that a level of exposure cannot be determined, regulatory programs may require collection of new TPH data for fractionation. When collecting new data for TPH analysis from identified media of concern, it is imperative that currently approved methods for the applicable petroleum product type are used (i.e., based on the type of release—gasoline, jet fuel, etc.). The cost of TPH fraction analysis is generally higher than analysis of whole TPH analytical methods, but the benefit of fractionation can be significant because the degree of uncertainty and potential need for cleanup costs are greatly reduced.

9.5 Estimating TPH Fractions

In the absence of TPH fractionation data, some programs may permit the estimation of TPH fractions and calculation of risk-based screening levels (RBSLs) and site-specific target levels (SSTLs) from those estimations based on the accuracy of petroleum product identification and knowledge of any TPH compositional changes due to weathering or other physical processes. Examples of carbon range-weighted screening levels for TPH are included in the Case Studies.

Some methods for estimating TPH fraction concentrations are described below:

- Using the information shown in TPH Fundamentals, Human Health Risk, Risk Calculators, and Case Studies, one may be able to estimate the percentage of each TPH fraction for the specific type of petroleum present (e.g., gasoline or diesel). Multiply the estimated percentage of each fraction by the concentration of whole TPH to derive an estimated concentration of each fraction.
- Calculate RBSLs and SSTLs (see Electronic TPH Risk Calculators) for each fraction by using the applicable physical, chemical, and toxicity properties.
- Calculate RBSLs and SSTLs (see Electronic TPH Risk Calculators) for each fraction using the most toxic fraction estimated to be present of the TPH fractions for the site-specific product type.

9.6 Managing the Presence of TPH Breakdown Products/Metabolites

Metabolites are common at TPH-contaminated sites, particularly where remediation includes the use of accelerated bioremediation techniques. Such cases may cause concern for adverse impacts to groundwater, surface water, nonhuman receptors, and soil quality. As with any other contaminant of concern, metabolites can be managed by knowing the extent and degree of the contamination and site-specific exposures.

This ongoing research suggests that metabolite human toxicity may be low relative to that of petroleum chemicals in TPH (see TPH Fundamentals), (see Human Health Risk), (see Ecological Risk Assessment). However, the presence of metabolites may cause the following concerns:

- Visual and olfactory evidence that causes nuisance and adverse aesthetic impacts.
- Ecological impacts to surface water, plants, and wildlife caused by factors such as toxicity and increased biological oxygen demand.
- Hindrance of land use caused by alteration of soil properties, such as hydraulic conductivity, soil plasticity, field capacity, and ability of soil to retain moisture and nutrients (Adams 2008), which may impact agricultural land use.

9.7 Remedial Action and Institutional Controls

9.7.1 Remedial Action

Selecting a remedial strategy is site-specific and compound-specific. As part of an effective risk management strategy for TPH sites, remedies can be evaluated and selected from the vast toolbox of available remediation technologies. Guidance documents for remedial strategies are numerous and include USEPA (1997b) and ITRC (2009b), and ITRC LNAPL Guidance (2018). These guides highlight basic remedy selection principles that apply to contaminated sites, including TPH, and provide the following key elements of selecting a remedial strategy:

- Identify TPH concerns and set TPH remedial objectives to eliminate exposure
- Set TPH remediation goals for each TPH remedial objective
- Set performance metrics for the TPH remediation goals

9.7.2 Institutional Controls

Institutional controls (ICs) (ITRC 2016b) may be limited to land and/or groundwater use restrictions. However, given the diverse chemical properties and physical characteristics of TPH, it is often necessary that ICs include additional provisions to address unacceptable risk or to alert individuals to potential health and safety, nuisance, or disposal concerns, even where potential risks are acceptable.

For TPH-contaminated sites, it can be beneficial or deemed necessary to include controls to help ensure that future health and safety, soil reuse, nuisance (odors), or disposal concerns are identified. Many regulatory programs have implemented IC tools for the long-term management of residual contamination. A management plan to deal with residual soil and groundwater contamination is typical and used in several states. IC tools help minimize unforeseen costs and delays associated with future maintenance and redevelopment work at sites with residual contamination. The use of ICs to provide long-term management and control of contaminant exposure at impacted sites has been addressed in previous ITRC guidance documents (ITRC 2008a, 2016a). In some federal and state jurisdictions a site-specific risk assessment may adequately address any cumulative long-term risk from the presence of TPH compounds. This may preclude the need for an IC or other long-term management strategy.

9.8 Common Mistakes and Lessons Learned

A number of common mistakes are often made when assessing TPH contamination, which can create challenges and problems for determining environmental impacts, risk to receptors, and necessary remediation. These include the following deficiencies:

- Insufficiently detailed conceptual site models (CSMs), such as lack of definition of extent and degree of all mobile and residual LNAPL contaminant sources (ITRC LNAPL Guidance (2018), incomplete characterization of complete or potentially complete exposure pathways, and improper characterization of human and nonhuman receptors
- Limited analysis and/or misidentification of TPH by measuring only specific chemicals (e.g., BTEX and PAHs) to represent risk
- Lack of extractable TPH analysis without silica gel cleanup in the media of concern to adequately determine presence of polar metabolites, their impact on human and other environmental receptors, and assessment of TPH natural degradation (see Silica Gel Cleanup Fact Sheet).
- Baseline noise in gas chromatography (GC) readings below 100 ug/L TPH
- Applying screening levels to discrete soil samples (ITRC 2012) when site-specific contaminant concentrations are more appropriate (see Risk Calculators)
- Inadequate stakeholder engagement in redevelopment and infrastructure, such as utility projects
- Failure to evaluate TPH chromatograms to validate findings and look for potential interferences
- Failure to look for alternate TPH sources (naturally occurring or otherwise)
- Insufficient knowledge about what is in the petroleum mixture when developing site investigation work plans or in designing remedial systems