TCEQ REGULATORY GUIDANCE
Remediation Division
RG-523/PST-03 • Revised January 2017

Risk-based Corrective Action for LPST Sites

Contents

1.0 Introduction

This document describes the risk-based Corrective Action (RBCA) process to achieve the risk assessment requirements of Title 30 Texas Administrative Code (TAC) Chapter 334 subchapters D, G, and Chapter 26.3572 of the Texas Water Code (TWC), within the TCEQ's Leaking Petroleum Storage Tank (LPST) Program. The RBCA process identifies LPST releases that pose a potential risk to human health and the environment and attempts to focus resources on those that pose the greatest risk. The process begins with a risk-based site assessment, proceeds through a series of screening steps and development of target levels, may be followed by remediation, and ultimately ends with closure of the LPST site.

This document describes the framework of the RBCA process that constitutes Site investigation, Plan A evaluation followed by Exit Criteria and Plan B evaluations to systematically progress the site towards closure. The criteria for the RBCA program are described in 30 TAC Section 334.203. This document applies to releases from leaking underground storage tanks and aboveground storage tanks regulated under the 30 TAC Chapter 334.

1.1 Background

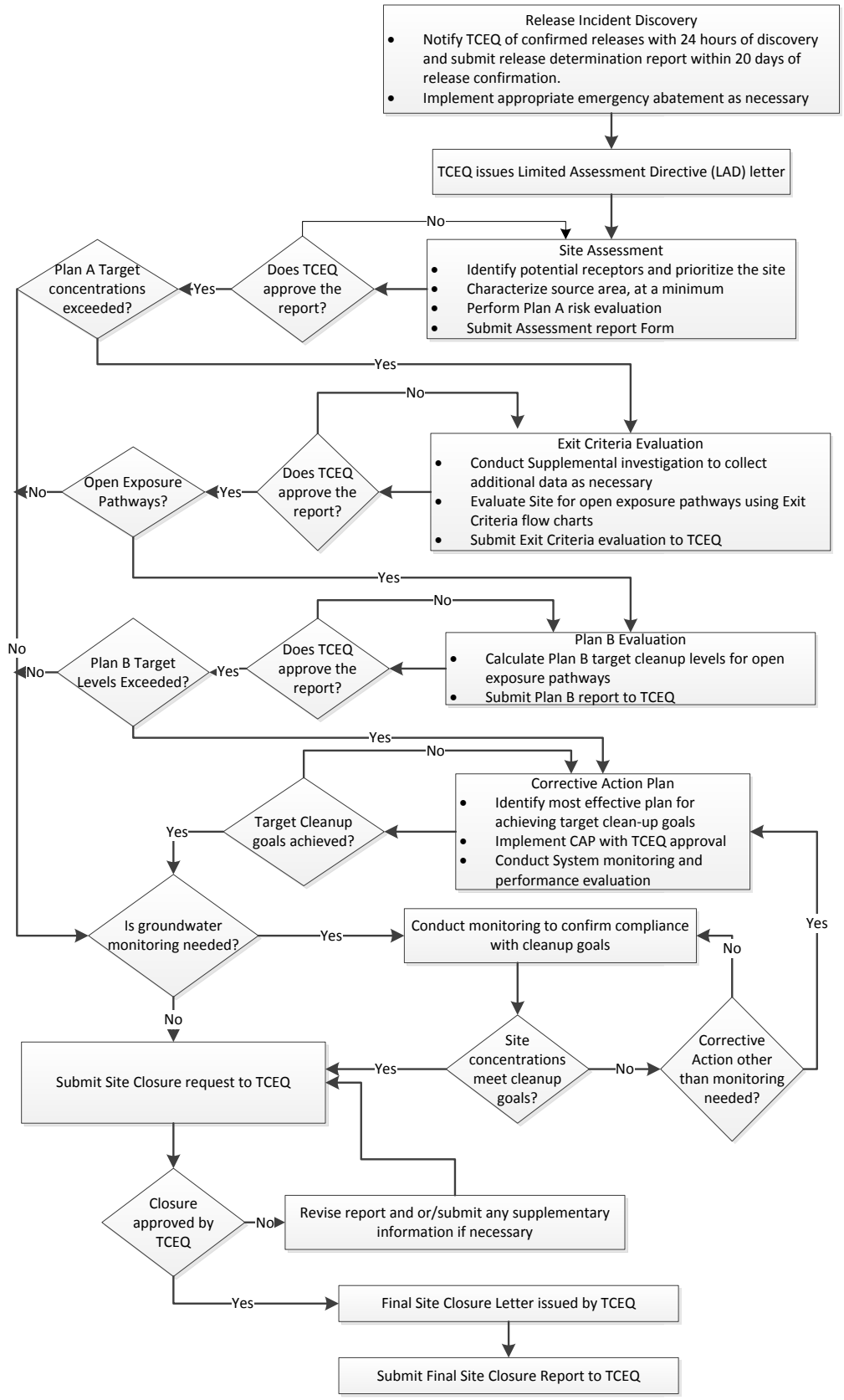
This guidance sets forth a systematic approach to identifying and remediating LPST releases that may pose an unacceptable risk to human health or the environment. Since publication of its original version in 1994, several interoffice memoranda have amended, updated, or further developed the guidance, policies, and procedures. The current revision of this guidance incorporates components of the TCEQ Guidance for risk-based Assessments at LPST Sites in Texas, RG-175 and the following interoffice memoranda:

- "Chapter 334 Closure Criteria for Domestic Irrigation Wells," September 6, 2006.
- "Process for Expedited Closure for Evaluation of Priority 4.1 Petroleum Hydrocarbon LPST Sites," July 17, 2003.
- "Guidance for Leaking Petroleum Storage Tank (LPST) Sites Located on State Designated Major/Minor Aquifers or Local Water Supply," November 1, 1999.
- "Adjustment to March 6, 1997 Protective Concentrations in Groundwater for Construction Worker Exposure to Account for Time-Averaged Exposure," August 12, 1997.
- "Clarifications and Amendments for Implementation of RG-36," March 6, 1997.
- "Guidance for Judging the Adequacy of Contaminant Delineation for Purposes of Determining if Further Corrective Action is Needed," February 10, 1997.
- "Process for Evaluating Petroleum Hydrocarbon LPST Sites Exceeding Target Concentrations," February 10, 1997.

1.2 Overview

The risk-based criteria regulated under 30 TAC 334.203 are similar to ASTM International standard E-1739 Tier 1 and Tier 2 evaluations. Plan A evaluation, like Tier 1, refers to a risk-based analysis performed to develop non site-specific target levels by applying conservative exposure factors to different land/groundwater use scenarios. Plan B evaluates the risk under the same scenarios by applying site-specific data for all complete exposure pathways. An Exit Criteria Evaluation is performed between the Plan A and Plan B evaluations to evaluate and qualitatively eliminate open exposure pathways. Figure 1 provides an overview of the RBCA process and serves as a reference point for the remainder of the document.

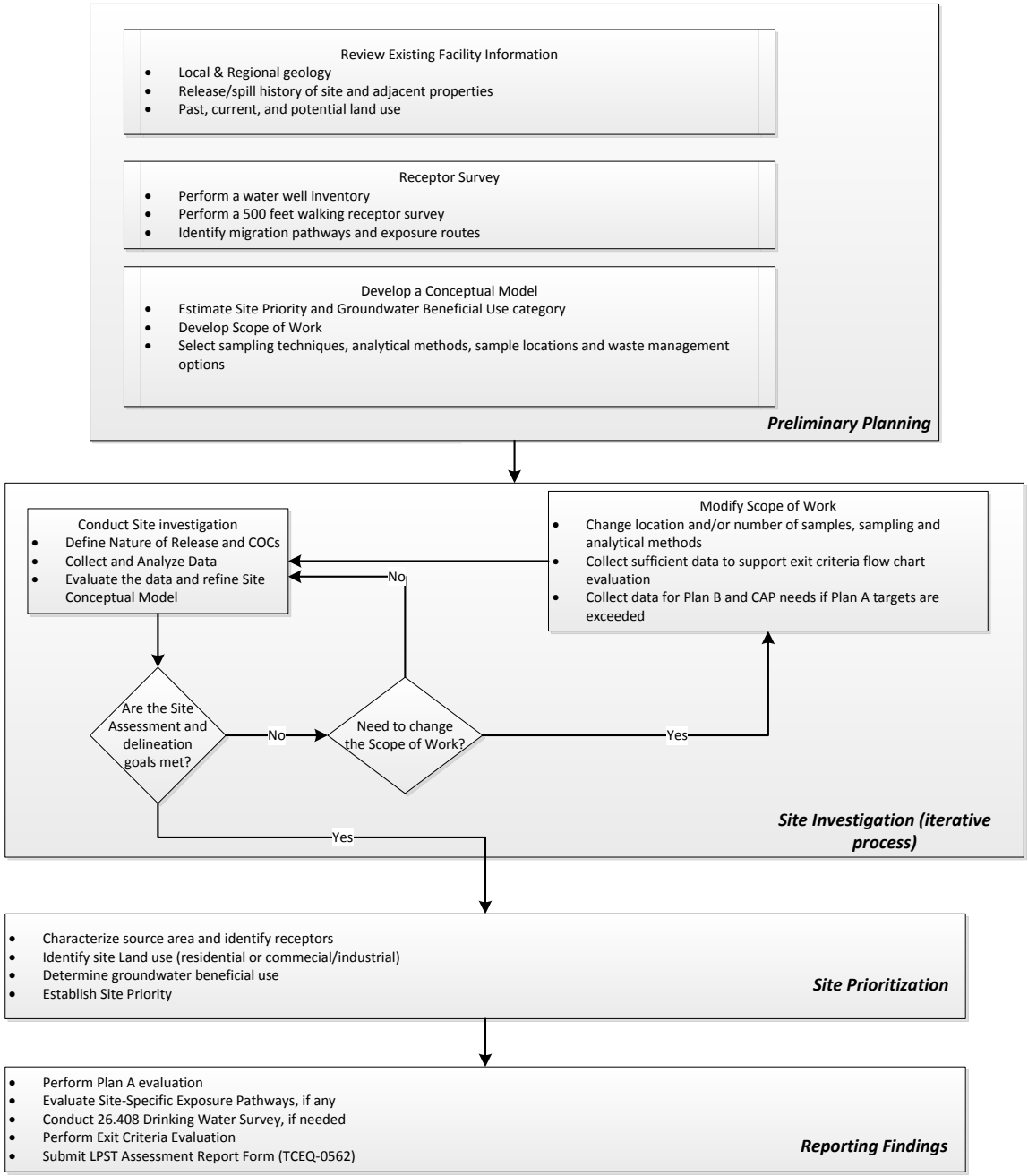
Figure 1. Overview of RBCA Process.



2.0 The Risk-based Site Assessment

A thorough and reliable assessment is essential for risk-based corrective action. A proper site assessment requires evaluation of potential source areas, delineation of the contaminant plume, and determination of chemical of concern (COC) concentrations; as well as identification of receptors, viable exposure pathways, and transport mechanisms. The major components of the risk-based site assessment process are illustrated in Figure 2.

Figure 2: Risk-based Site Assessment Process.



2.1 Preliminary Planning

The success of any site investigation is directly related to the quality of pre-investigation planning. Preliminary planning *must* include a review of existing facility information, performance of a receptor survey, development of a conceptual model, and designing a scope of work. It is essential that all background information be collected and a receptor survey be performed to develop the conceptual model (i.e., understanding of the site) *prior* to the site investigation.

2.1.1 Review Site Information

2.1.1.1 Regional Geology

Review local and regional geologic/hydrogeologic maps and other publications to identify general soil and rock types, regional depth to bedrock, depth to groundwater, aquifer properties, groundwater gradient, and flow direction. Identify the aquifer and/or surface water body which serves as the source of drinking water for the area and facility. Identify and evaluate the use of the affected groundwater zone within 1/2 mile of the LPST site.

2.1.1.2 Land Use

Investigate and describe past, current, and probable future land uses of the site. Identify potential source areas, and migration pathways. Determine past and current uses of adjacent properties to identify other possible sources of contamination. If an off-site receptor is identified, predict probable future land use based on current use and any existing zoning of the adjacent properties. Identify the current predominant land use of the area as either commercial/industrial, or residential.

2.1.1.3 Source History

Locate current and former tank systems, and other potential sources (i.e., releases, spills, and overfill incidents) on- and off-site. Inventory control records and tank tightness tests may provide valuable data in evaluating possible sources. Investigate previous assessment work (e.g., tank removal data, release investigation) and ongoing corrective action activities at the site and adjacent properties.

2.1.2 Perform a Receptor Survey

The identification of potential receptors and exposure pathways is the basis for site prioritization and determination of target cleanup levels. The receptor survey includes a field survey and a water well records inventory. This information should be clearly presented on a vicinity map or an existing aerial photograph of appropriate scale.

2.1.2.1 Water Well Inventory

Perform a records inventory of all water wells located within 1/2 mile of the site. Plot all inventoried wells on a current United States Geological Survey (USGS) topographic map and provide all available information regarding well completion, age, use, and status. Document any ordinances which prevent or influence the future installation of water wells at the site or surrounding area. The location and current use of water wells within 1/2 mile that could potentially be impacted should be physically verified. Drinking Water Surveys performed in accordance with TWC Section 26.408 may be used to complete this portion, but will not substitute for the receptor survey.

2.1.2.2 Field Survey

A door-to-door field survey must be performed within a 500-foot radius of the facility and include the following:

1. Receptor Identification: Locate all registered and unregistered water wells, schools, hospitals, residences, basements, day care centers, nursing homes, businesses, etc. Other sensitive receptors such as surface water bodies, parks, recreational areas,

wildlife sanctuaries, wetlands, and agricultural areas must also be identified in the field survey.

2. Migration Pathway Identification: Identify and indicate the depth of all subsurface utilities and structures that may serve as preferential migration pathways.

Depending on the site specific information and as the site assessment progresses, the TCEQ may require that the field survey extend beyond a 500-foot radius of the facility. If a sensitive receptor is identified, then the potential for impact must be evaluated. Sensitive receptor(s) known or suspected to be impacted require immediate action. This may include initiating abatement measures, providing alternative water supply, and/or sampling threatened water wells.

2.1.3 Develop Site Conceptual Model

The information obtained during the preliminary planning phase, in conjunction with considerations for Plan A and prioritization, is used to develop an initial site conceptual model (CSM). A CSM is a three-dimensional representation of the site conditions. It starts with a basic understanding of the contaminant concentrations and distribution, the factors affecting contaminant transport (including direction and rate), the potential for contaminants to reach a receptor, and iterates around what is known and what needs to be known. A CSM contains sufficient information for the development of current and future exposure scenarios. Therefore, as a part of the conceptual model and essential to the development of a Plan A risk evaluation, consider and incorporate the following into the scope of work for risk-based site investigation:

- Determination of COCs and concentrations in each affected media (i.e., soil, groundwater, vapors, surface water).
- Determination of appropriate beneficial groundwater use category for the site (for sites where groundwater is not encountered, consult regional groundwater information).
- Evaluation of vapors to ensure total contaminant concentration does not exceed 25 percent lower explosive limit (LEL).
- Evaluation of impact to surface water if surface water exists within 1/4 mile of the site.
- Evaluation of nuisance conditions like presence of nonaqueous phase liquid (NAPL), potential for explosive vapors, impact to food source vegetation.
- Periodic evaluation of existing data to establish current site conditions and groundwater plume stability.

2.2 Site Investigation: General Requirements

This section provides guidance for collecting information required to complete Plan A and Plan B evaluations. Such information includes characterization of source area, selection of COCs, development of sampling requirements, and delineation of the contaminant plume.

2.2.1 Nature of the Release and Chemicals of Concern

The contaminants released into the environment are identified based on the nature of the product released and the documented presence of chemical components in various petroleum products. The COCs commonly sampled for petroleum releases are provided in Table 1. Groundwater samples may also be analyzed for inorganic components (e.g., oxygen (O_2), nitrates (NO_3), sulfates (SO_4), etc.) as a screening tool for an indirect measurement of hydrocarbon distribution (i.e., biodegradation indicators) since concentrations of these inorganic compounds are significantly influenced by microbial

activity that metabolizes petroleum hydrocarbons. The TCEQ requires the analysis of all soil, groundwater, and vapor samples be conducted at a National Environmental Laboratory Accreditation Conference (NELAC) certified laboratory.

The physical properties of soil affect the fate and transport of the COC. Consideration should be given to the collection of samples to determine the site soil properties. Unaffected soil samples should be collected from the vadose zone for evaluation of soil bulk density, porosity, water content, fraction organic carbon, and hydraulic conductivity. Appropriate ASTM International standards or other common geotechnical methods may also be used to determine the soil parameters. Default values must be used for determination of Plan A target concentrations when site-specific soil data is not available.

Table 1. Summary of PST Constituents and Analytical Methods [1].

Substance Stored	Constituents	Analytical Methods	Sample Media [2]	Comments
Gasoline, diesel, jet fuels, and Nos. 1, 2, and 4 fuel oils	BTEX & MTBE	8021B or 8260B	Water, Soil [5]	Method 8260B is preferred, over 8021B at identifying COCs.
	TPH	TX1005	Water, Soil [5]	Report the results of the following ranges: nC_6 to nC_{12}, >nC_{12} to nC_{28}, >nC_{28} to nC_{35} or nC_{36}, nC_6 to nC_{35} or nC_{36}
	PAHs (if TPH >nC_{12} detected[3])	8310 or 8270 [4] (if applicable)	Water, Soil [5]	If analytical interference is observed or suspected, sample extract should undergo cleanup; for example, using Method 3611B.
Waste oil or unknown petroleum products	VOCs (including BTEX and MTBE)	8260B	Water, Soil [5]	Include all solvent-type volatile chemicals, BTEX, and MTBE in the initial 8260B analyses. Other methods, such as Methods 8011 or 8021B, can be used during corrective action activities, if desired.
	TPH	TX1005	Water, Soil [5]	Report the results of the following ranges: nC_6 to nC_{12}, >nC_{12} to nC_{28}, >nC_{28} to nC_{35} or nC_{36}, nC_6 to nC_{35} or nC_{36}
	PAHs (if TPH >nC_{12} detected[3])	8310 or 8270 [4] (if applicable)	Water, Soil [5]	If analytical interference is observed or suspected, sample extract should undergo cleanup; for example, using Method 3611B.
	RCRA 8 Metals	6020	Soil	Filtering water samples is only allowed when the turbidity of the sample is greater than 10 nephlometric turbidity units (NTUs).

NOTES

[1] The method quantitation limits (MQLs) for all analyses must be **less than or equal to the action levels**. The MQL for a chemical is the lowest nonzero standard used in the laboratory's initial calibration curve, as described in SW846-8000B.

[2] The water sample protocols summarized in the table assume that the water has no residual free chlorine. For water samples **with** residual chlorine (e.g., collected from a public chlorinated supply), free chlorine must be removed with appropriate addition of $Na_2S_2O_3$.

[3] MQLs for TPH must be less than or equal to 50 mg/kg (soil) or less than or equal to 5 mg/L (water) for each carbon range (e.g., nC6 to nC12, >nC12 to nC28, >nC28 to nC35 or 36). Analytical responses detected above the laboratory's method detection limit (MDL) (i.e., observed above the MDLs and meeting the qualitative identification criteria specified either in the analytical method used or in the laboratory's standard operating procedure) should be reported as detected results. If the response is detected below the MQL but above the MDL, the results should be reported at the concentration estimated by the laboratory and flagged with a qualifier (e.g., "J") to indicate the value reported is an estimate.

[4] Method 8270 using select ion monitoring (SIM) or using a low-level PAH approach is recommended because it minimizes false-positive detections of PAHs. Regardless of the method used, the MQL of the method must be less than or equal to the respective PST Program action level.

[5] EPA SW-846 Method 5035 must be used to collect soil samples for VOC, BTEX, and/or MTBE analysis. Soils samples for TPH and/or PAH analysis can be collected in 4-6 oz. containers (bulk).

2.2.2 Sampling and Data Collection

Samples must be handled properly to avoid cross-contamination and ensure that sample integrity is not compromised.

2.2.2.1 Soil

Determining the nature and extent of a petroleum release generally begins with characterizing soil and rock permeability and conducting soil sampling. Soil samples are collected to establish the full horizontal and vertical extent of the release in the soil.

Samples should be screened for petroleum hydrocarbons in the field using a portable photo-ionization detector (PID), flame-ionization detector (FID), or an ultraviolet fluorescence (UVF) instrument to establish where contamination is present. Continuous sampling of soil cores allows rapid visual observations of soil staining from releases, and technologies such as UVF screening can quickly identify the exact vertical extent of a release in the soil column. Using continuous screening of soils in this way, from the ground surface to the bottom of the borehole, allows a precise understanding of the vertical extent of contamination at each boring. Soil samples are typically collected for analytical purposes from the zone of greatest contamination based on field screening results, immediately above saturated zone, and total depth.

2.2.2.2 Groundwater

Monitoring wells are constructed to establish the horizontal and vertical extent of impact to the groundwater resource. Monitoring wells are typically established around the release to understand the distribution of contaminants in the saturated zone. The number and location of groundwater monitoring wells must be adequate to characterize the nature and extent of contamination. A minimum of three triangulated monitoring wells are necessary to establish the direction of groundwater flow. For sites with complex geologic conditions, man-made disturbances, or underground utilities within the groundwater, more wells will be necessary to fully understand groundwater attributes.

2.3 Considerations for Plan A and Site Prioritization

The information gathered during the site investigation is used to determine the three critical components of a risk-based assessment—contaminant concentration, exposure

route, and exposure point. These components dictate the site prioritization, which in turn directs the remediation standards for the site. Once the site prioritization is completed, the responsible party may choose to use the default target levels (Plan A) set for the established exposure pathways or may choose to derive the site-specific target levels (Plan B).

2.3.2 Land Use

Target levels are based on either residential or commercial-industrial land use. *Residential* generally applies to land used for human habitation but also includes day-care facilities, schools, hospitals, and parks. *Commercial-industrial* generally applies to land not being used for human habitation such as offices, retail businesses, and hotels. More detailed definitions of these terms appear at 30 TAC Section 334.202.

Each COC-affected property must be designated as either residential or commercial-industrial based on current use at the time the assessment is conducted, unless a planned change is known. Vacant property should be considered residential unless the site is clearly located in a commercial-industrial area or is zoned for commercial-industrial use, or there are documented plans to use the property for commercial or industrial purposes (US EPA, 1991a). Rights of way along transportation corridors should be considered commercial-industrial.

2.3.3 Groundwater Categories

Four potential beneficial use categories have been established based on water quality and documented water use. Table 2 presents the criteria for categorizing beneficial use. Each category takes into consideration the identified receptors (water wells, etc.), the current and probable future use conditions, and the quality as measured by the total dissolved solids (TDS) content of the water. The beneficial use categories determine the applicable exposure factors to be used when calculating target concentrations, and in some cases, establish the criteria for plume delineation.

Actual beneficial groundwater use is demonstrated if a well or spring is located within 1/2 mile of the site and produces drinking water from the affected groundwater zone. This includes wells producing from hydrologically connected groundwater zones, wells with unknown completion details (e.g. screened intervals, cementing etc.), and wells where completion details suggest hydraulic communication may occur between the affected groundwater zone and the groundwater unit.

Presume groundwater has a potential beneficial use if one of the following applies:

1. The natural TDS content is less than 10,000 milligrams per liter (mg/L).
2. The natural sustainable yield is at least 150 gallons per day from a 4-inch well, determined by standard industry practices.
3. In the event TDS and yield data are not available, assume the TDS content to be less than 3,000 mg/L and the aquifer to yield usable quantities of water.

Table 2. Categories of Affected Groundwater.

Category I	Category II	Category III	Category IV
One or more affected or threatened drinking-water wells	Affected groundwater zone with TDS < 3,000 mg/L, **and** no drinking-water wells documented within 1/2 mile of the site	Affected groundwater zone with TDS 3,000–10,000 mg/L, **and** no drinking-water wells documented within 1/2 mile of the site	Affected groundwater zone with TDS > 10,000 mg/L
Affected groundwater zone TDS < 3,000 mg/L, and one or more drinking-water wells or water-supply springs located within 1/2 mile of site	TDS 3,000–10,000 mg/L, **and** one or more drinking-water wells are documented within 1/2 mile of the site		Well yield < 150 gpd (i.e., the affected zone is not productive)

2.3.4 Site Prioritization

LPST sites are prioritized as critical (1), high risk (2), moderate risk (3), or low risk (4) (Table 3). **Priority 1** sites considered as critical represent an actual or probable impact to public health and safety. This includes not only those sites where a receptor is impacted but also sites where a receptor is threatened (i.e., will likely be impacted if the contaminant plume migration is not addressed). These cases may require an immediate emergency abatement action or an interim containment measure. **Priority 2** sites may threaten public health and safety. **Priority 3** sites pose minimal risk to no risk to public health and safety, but impact a state-designated major or minor aquifer or surface water. **Priority 4** sites pose no immediate risk to the public or state-designated major or minor aquifers. The TCEQ strives to place regulatory oversight on priority 1 sites first, followed by other priorities in numerical order. Although numerous priority designations may apply for a site based on the threats identified, the lowest priority number (highest risk) of the site is considered as the actual site priority for corrective action purposes.

Table 3. Priority of LPST Sites.

	Priority of LPST Sites
	Priority 1
1.1	Explosive levels or concentrations of vapors that could cause acute health effects are present in a residence or other building. (Ensure the local fire authority or State Fire Marshal and the local TCEQ Regional Office have been notified.)

	Priority of LPST Sites
1.2	An active public water supply well, public water supply line, or public surface water intake is affected or immediately threatened by the release. (Ensure the public authority and the local TCEQ Regional Office have been notified.)
1.3	A sole-source domestic water supply well or line or sole source domestic surface water intake is affected or immediately threatened by the release. (Ensure the well user or surface water user and the local TCEQ Regional Office have been notified.)
1.4	Explosive vapors are present in a subsurface utility system, but no building or residence is affected. (Ensure the utility authority and the local TCEQ Regional Office have been notified.)
1.5	NAPL is present at the ground surface, on surface water bodies, in surface water runoff, or in utilities other than water supply lines. (Ensure the utility authority is notified if utilities are affected. Ensure NAPL is removed as required pursuant to 30 TAC Section 334.79.)
1.6	The Edwards aquifer recharge zone or transition zone is affected. (Ensure the local TCEQ Region Office has been notified.)
1.7	Concentrations of vapors or particulates that could cause acute health effects or safety concerns are present in outdoor air. (Ensure the local TCEQ Regional Office has been notified.)
	Priority 2
2.1	Soils or water contaminated by the release are exposed and unsecured from public access and dwellings, playgrounds, parks, day care centers, schools, or similar use facilities are located within 500 feet of those soils.
2.2	A former vapor impact is associated with the site, or NAPL is present in close proximity to subsurface utilities or other natural or man-made conduit, and there is potential for the accumulation of explosive vapors or vapors that could cause acute effects in a building or other structure.
2.3	A domestic water supply well or line, or a domestic surface water intake, is affected or immediately threatened by the release, but the user has access to another public or private water supply. (Ensure the user and the local TCEQ Regional Office has been notified.)
2.4	A non-public or non-domestic water supply well is affected or immediately threatened. (Ensure the user and the local TCEQ Regional Office have been notified.)

	Priority of LPST Sites
2.5	Groundwater is affected and a public or domestic water supply well is located within 1/4 miles of the UST/AST system or source area. (Select this priority if a well is present, even if the well use is unknown. See table note 1 before responding.)
2.6	Groundwater or storm water runoff is affected and discharges within 500 feet of the known extent of COCs to a surface water body.
2.7	A public or domestic water supply well that produces from a groundwater zone which is not affected or threatened is located within the known extent of COCs. (Select this priority if a well is present, even if the well use is unknown.)
	Priority 3
3.1	Groundwater is affected and a public or domestic water supply well is located between 1/4 and 1/2 mile from the UST/AST system or source area. (Select this priority if a well is present in this interval, even if the well use is unknown. See table note 1 before responding.)
3.2	Groundwater is affected and the affected groundwater zone may discharge between 500 feet and 1/4 mile of the UST/AST or source area to a surface water body.
3.3	Groundwater is affected and a non-public or non-domestic water supply well is located within 1/4 mile of the UST/AST system or source area. (See table note 1 before responding.)
3.4	A non-public or non-domestic water supply well that produces from a groundwater zone which is not affected or threatened is located within the known extent of COCs. (If a well is present, but the use of the well is unknown, select 2.7 instead.)
3.5	A state-designated major or minor aquifer is affected or immediately threatened. (See table note 2 before responding.)
	Priority 4
4.0	Assessment is incomplete.
4.1	COCs detected in groundwater, but no apparent receptors are impacted.
4.2	The vertical extent of contamination has been defined and the assessment results document that COCs are not detected in groundwater.

NOTES

[1] Consider only wells producing from the same interval as the affected groundwater zone at the release site, wells which may provide a cross-contamination pathway, or wells where completion details are unknown.

[2] Refer to Major and Minor Aquifers of Texas Maps prepared by Texas Water Development Board, 2014. Do not consider the low permeability Beaumont clays of the Beaumont Formation for the Gulf Coast aquifer. Do not consider a perched groundwater zone overlaying the principal producing portion of the aquifer unless the two are hydrologically connected.

2.4 Delineation Criteria

Delineation of the contaminate plume may span multiple stages of the RBCA process. Repeat the risk-based screening steps each time additional delineation data is available to possibly screen additional COCs or exposure pathways from further consideration.

2.4.1 Soil Delineation

Apply the following delineation standards to define the plume vertically and laterally.

2.4.1.1 Vertical Delineation

Identify the soil interval where human health–based target concentrations are exceeded and determine if groundwater is threatened or affected. Account for the probable location of the source and the site stratigraphy. For example, a release of fuel to the Ogallala Aquifer tends to migrate vertically with minimal lateral spread (interception of a caliche layer may induce some lateral spread). The affected soils may be missed unless the investigation targets the actual point of release.

Focus delineation at the point of release, or the area of highest soil contamination as documented during tank removal or other soil assessment. Investigations must extend below the depth of the point of release, or below the deepest portion of the tank system when the point of release is unknown.

Vertical delineation must continue to at least 5 feet deeper than the limit of soil contamination (no concentration apparent) as indicated by field observations and field screening, or until the water table is intercepted. Because of fluctuating water tables and the potential for hydrocarbons to be smeared below the water table in the groundwater source area, it may be prudent to collect a soil sample from within the saturated zone.

Vertical delineation in soil should be defined to MQLs. If subsequent laboratory analyses indicate that the vertical extent has not been defined to MQLs, base the need for further delineation on the likelihood of groundwater impact, the sensitivity of the underlying groundwater, and the proximity of groundwater receptors. Consider such factors as the source of the release, depth to groundwater, site geology, permeability of the material, and detected concentration levels, distribution, and trends.

2.4.1.2 Lateral Delineation

Delineate soil to appropriate Plan A target levels (apply the lesser of the health-based or groundwater protective soil target concentrations).

Locate at least one sampling point in the area of probable maximum COC concentrations within the upper 15 feet of soils to determine if residential/commercial health-based, or construction worker default concentrations have been exceeded. Include tank removal samples in the evaluation.

Specifically evaluate other hazards such as impacts to utilities or generation of explosive atmospheres in utilities. Consider the possibility that subsurface conduits (e.g., subsurface utility runs) may be preferential pathways for COC migration. This may be of particular concern where the site soils are clays or other low-permeability material, and the utility fill is of much higher permeability.

2.4.2 Groundwater Delineation

Groundwater delineation requirements are risk-based and depend on the presence of groundwater receptors (e.g., drinking-water wells, irrigation wells, surface waters,

utilities) and the distance to the receptors from the source. Delineation needs also depend on groundwater depth, geologic conditions, and exposure pathways. Thus, receptor survey information, and in particular the Drinking Water Survey, is critical to determining the appropriate delineation requirements. For hazardous-substance releases, delineate the contaminant plume to the applicable Plan A Category I target concentrations. For petroleum releases, follow the criteria defined in Table 4. Consider each scenario when more than one applies. Under all scenarios, document declining concentrations with distance from the source.

These are general criteria for acceptable COC delineation. The potential for existing water wells installed up gradient of or lateral to the source to influence gradients and draw in COCs due to conditions like preferential pathways, excessive pumping, etc., should be considered. Consider also the insights drawn from the Bureau of Economic Geology (BEG) study (Mace, R.E., et al. 1997), the hydrogeologic environment, the location of the source area, COC properties, documented impacts, and other available site-specific information when determining if delineation is adequate. Consult the TCEQ where full delineation is not feasible.

When existing water supply wells or surface waters are within 1/4 mile of the source, delineate to the target concentrations relevant to that particular receptor. A conservative model may be used to estimate COC concentrations at a groundwater receptor more than 1/4 mile from the source; however, if the estimated concentration exceeds the Plan A target concentration, the plume must be delineated.

Consider the current status and use of the water well. If acceptable to the well owner, plug and abandon threatened or impacted water-supply wells in accordance with Texas Water Well Drillers regulations to eliminate the receptor.

If the depth to groundwater is 15 feet or less, delineation to construction-worker target levels is also required.

2.4.2.1 State-designated Major or Minor Aquifers and Local Supply

When a state-designated major or minor aquifer is affected or immediately threatened, or the groundwater is used as a local source of drinking water, the groundwater contaminant plume must be delineated to the appropriate Beneficial Groundwater Use Category in all directions. Exceptions may exist when the affected/threatened aquifer has naturally poor water quality (exceeding drinking water standards). In these scenarios, if there is no documented use, it may only be necessary to demonstrate plume stability and declining concentrations with distance from the source. Any exceptions must be discussed with the TCEQ.

2.4.2.2 No Current or Probable Future Receptors

When no receptors are present within 1/2 mile and the depth to groundwater is greater than 15 feet below ground surface, demonstrate declining concentrations with distance from the source.

2.4.2.3 NAPL

The full extent of the NAPL plume must be defined.

2.4.2.4 Fractured bedrock or Karst Environments

Attempt to define the COC extent to Category I target levels when impacts to karst or fracture-control lithologies occur.

Table 4. Criteria for Delineating COCs in Groundwater.

	Groundwater Scenario	Delineation Extent[1]
1	Existing water-supply or irrigation well within 1/4 mile of source area	Define to Plan A Category I[2] target levels.
2	Existing water-supply or irrigation well beyond 1/4 mile of source area	Use modeling to project concentrations at the well. If modeling results exceed Plan A target levels, delineation to Plan A target levels towards the well is required.
3	Priority 3.5[3] or local supply	Define to appropriate beneficial use Plan A target levels in all directions.
4	Surface water within 1/4 mile of source area	Define to target surface water levels.
5	Groundwater ≤ 15 feet deep	Define to construction-worker target levels.
6	No existing receptors within 1/2 mile	Document declining concentrations with distance from the source area.
7	Fractured bedrock or karst	Focus primarily on protection of receptors (possible monitoring of likely receptors). Define to Plan A Category I target levels in all directions.
8	Other exposure pathways (e.g. explosive concentrations)	When these issues are of concern at sites, then delineation to target levels for these pathways should occur.

NOTES

1 All delineation scenarios require documentation of plume stability and declining concentrations with distance from the source area.

2 Irrigation well targets apply when only irrigation wells exist.

3 Refer to George, Mace, and Petrossian, 2011. Consider the chemical quality of the water for any portion of the aquifer that is designated as a “downdip.”

2.5 Report Findings

A completed Assessment Report Form (TCEQ-0562) with all appropriate attachments must be submitted to the TCEQ as required by TWC 26.3512 and updated as additional information becomes available.

3.0 Plan A Target Levels and Screening

Plan A site-evaluation criteria sets default target levels for affected media for default exposure pathways applicable to all LPST sites, based on the criteria established under 30 TAC 334.203.

Plan A target levels have been developed to expedite the site evaluation process. The target levels as well as all required equations, exposure factors, site parameter values, and COC properties used to calculate them are available on the TCEQ's LPST Web page <www.tceq.texas.gov/goto/LPSTcleanups> under PST Forms and Guidance. For nonstandard COCs, when such information is not available, evaluate case-by-case, as appropriate, using the equations and criteria available on the TCEQ's LPST Web page. For metals, if site-specific background concentrations or established state-wide background concentrations are greater than the calculated value, the background concentrations may be used instead.

3.1 Target Groundwater levels

Target levels should not be set below the federal maximum contaminant level (MCL) for the COC when MCLs exist. The target groundwater levels assume residential ingestion for all groundwater that is an actual or potential drinking water source. If actual beneficial use of the impacted aquifer is documented for a use other than drinking, then case specific exposure may be allowed.

The beneficial groundwater use category (i.e., groundwater category as defined in Table 2) defines the applicable target levels for groundwater ingestion. The Plan A groundwater target levels are the same for residential or commercial-industrial land use. The target groundwater levels for the four groundwater categories are based on the criteria indicated on Table 5. Regardless of beneficial use, removal of NAPL is required to maximum extent practicable, or to the extent where no hazard to the public exist. Utility impacts, explosive vapors, nuisance conditions, contaminant discharge to beneficial-use groundwater, contaminant discharge to surface waters, and plume expansion, if any exist, must be abated and prevented.

Table 5. Applicable Risk and Exposure Criteria for Groundwater Target Levels.

GW Category	Risk (carcinogens)		Hazard Quotient (Non-carcinogens)	Exposure factors[2]			
	Class A & B	Class C		Averaging Time (yr.)		Exposure Duration (yr.)	Daily ingestion rate (liters/day)
				Carcinogens	Non-carcinogens		
Category I[1]	10^{-6}	10^{-5}	1	70	30	30	2
Category II[1]	10^{-5}	10^{-4}	1	70	30	30	2
Category III	10^{-5}	10^{-4}	1	70	9	9	1.4
Category IV [3]	Not Applicable						

NOTES

[1] MCLs as promulgated under Federal Safe Drinking Water Act apply, if less stringent.

[2] Refer to TCEQ's LPST Web page <www.tceq.texas.gov/goto/LPSTcleanups> under PST Forms and Guidance for a detailed list of exposure factors.

[3] Target levels based on documented receptor information (e.g. presence of surface water, water wells etc.).

3.2 Target Soil Concentrations

Compare site soil COC concentrations to the Plan A target soil concentrations to make this evaluation.

3.2.1 Groundwater-Protective Soil Concentrations

Plan A soil-to-groundwater target concentrations have been established to evaluate the potential for groundwater to be impacted by leachate from the affected soil. Groundwater-protective soil concentrations are intended as an initial screen to evaluate the potential to impact groundwater. They should not be used as the driving criteria for corrective action when groundwater is documented to be impacted and there is low probability that the groundwater concentrations will increase (e.g., no new release) or when the impacted soil is unlikely to become a secondary source.

If collecting a groundwater sample is impractical, then further evaluation is warranted. The Synthetic Precipitation Leaching Procedure (SPLP), EPA Method 1312 (US EPA, 1990b), may be used to determine the COC concentrations present in leachate from the soil location or locations with the highest COC concentrations. If measured leachate concentrations are less than 100 times the target groundwater concentration, then the soil COC concentrations are adequately protective of groundwater. A concentration-reduction factor (CRF) of 100 is assumed for the purpose of Plan A. However, if the maximum soil contaminant levels are in direct contact with groundwater or if there is a

direct conduit between the source and groundwater, then a CRF of 1 should be assumed. The minimum detected depth to groundwater should be the basis for this determination.

3.2.2 Residential and Commercial Health-Based Soil Concentrations

For residential and commercial-industrial land uses, health-based target soil concentrations are based on the risk associated with ingestion and inhalation of impacted soil. Target concentrations apply from ground surface to 15 feet below ground surface but do not apply to saturated soils. When on-site commercial-industrial land use is assumed, and COCs extend off-site onto residential property, also set a Point of Exposure (POE) at that closest property line to demonstrate target concentrations for residential use are met off-site. Covering the impacted area with an impermeable surface may be proposed as an exposure control measure in lieu of site cleanup; however, the responsible party must submit to the TCEQ sufficient justification (existence of structures, no anticipated construction, etc.) that impermeable surfaces will be maintained. Target concentrations are based on an individual risk level of 1×10^{-6} for Class A and B carcinogens or, 1×10^{-5} for Class C carcinogens, or a hazard quotient of 1 for non-carcinogens.

3.3 Target Surface Water Concentrations

The potential for impact to surface water must be considered when a surface water body is located within 1/4 mile radius of the contaminant plume. Surface waters are considered receptors only when in hydrologic connection with the affected groundwater zone.

Target surface water concentrations are based on the Texas Surface Water Quality Standards of 30 TAC Chapter 307 and General Regulations Incorporated into Permits of 30 TAC Chapter 319 or, if those values are not available, then on MCLs promulgated under the Safe Drinking Water Act. If MCLs are not available or not appropriate, then the target surface water concentrations are to be based on human ingestion of water and the Category I exposure parameters indicated on Table 5. Texas Surface Water Quality Standards can be obtained from the TCEQ Water Quality Standards Team.

In general, target concentrations must be met at a compliance point (POE) located up gradient prior to the discharge to the surface water body. Surface water dilution should not be considered at the POE unless all of the following criteria are met.

The maximum concentration of any COC at the POE is greater than the Texas Surface Water Quality Standards appropriate for that surface water body.

The receiving body is a tidal water body, estuary, lake, or perennial stream (i.e., it is not an intermittent stream or an intermittent stream with perennial pools).

The listed COCs at the site are not on the latest approved 303(d) list for impaired surface waters. The list is updated periodically and is available at the following website: <www.tceq.texas.gov/waterquality/assessment/305_303.html>.

If the COC concentrations at the POE exceed target surface water standards, TCEQ accepts 15 percent dilution (Dilution Factor of 0.15) for groundwater releases to lakes, perennial streams and rivers, and tidal water bodies. Specific to this pathway, the target levels for the POE then become the target surface water standards appropriate for the surface body divided by the dilution factor.

3.4 Target Ambient Air Concentrations

Evaluate target air concentrations when there is concern of a potential vapor hazard, or known or suspected indoor air exposure to the COCs. Generally, the potential for explosive vapor generation is a more common concern than intrusion of toxic vapors.

COC concentrations in soils and groundwater should not be capable of generating vapors in the pore spaces of the soil, utilities, or in the atmosphere which could cause an explosive environment at any surface or subsurface structure. In instances where there is a reasonable potential for explosive vapors to collect in surface or subsurface structures (e.g., utility vaults, storm sewers, basements, poorly vented surface structures), target soil-air concentrations should be based on 25 percent LEL value for that constituent. Vapor accumulations in excess of 10 percent of the LEL should be vented, monitored, and further assessed for possible remediation. Vapor concentrations must not exceed 25 percent of the LEL. The LEL and upper explosive limit (UEL) for some common compounds are provided in Table 6. Monitoring for explosive atmosphere levels should be performed by a properly trained environmental or fire professional using a properly calibrated and operating explosimeter. If emergency or hazardous situations exist, such as the presence of explosive conditions, immediately contact the local fire authority or State Fire Marshal and notify the local TCEQ Regional Office. Take all actions necessary to prevent such situations from occurring and immediately abate the hazardous conditions.

Table 6. Maximum Allowable Vapor Concentrations.

Compound	LEL %	UEL %	25% LEL Action Levels, %
Gasoline	1.2	7.6	0.30 (3,000 ppm_v)
JP-4	1.3	8.0	0.32 (3,200 ppm_v)
Diesel Fuel	1.3	7.5	0.32 (3,200 ppm_v)
Fuel Oils	0.6	7.5	0.15 (1,500 ppm_v)
Kerosene	0.7	5.0	0.18 (1,800 ppm_v)
Benzene	1.3	7.9	0.32 (3,200 ppm_v)
Ethylbenzene	1.0	6.7	0.25 (2,500 ppm_v)
Toluene	1.2	7.1	0.30 (3,000 ppm_v)
Xylenes	1.0	7.0	0.25 (2,500 ppm_v)
n-hexane	1.2	7.5	0.28 (2,800 ppm_v)

If direct measurement is not feasible and NAPL is not present at the site, use the following equilibrium-partitioning equation to determine the theoretical maximum vapor concentration in the soil (Thomas, 1982). The calculated soil vapor concentrations can be compared to the 25 percent LEL action level in Table 6 to determine if the potential to create vapor levels of concern exists. The default values provided below are conservative. Hence, if calculated concentrations are less than 25 percent of the LEL, then soil concentrations should be adequately protective. Use site-specific data if available.

$$C_a = \frac{C_T H' \beta}{K_d \beta + \Phi_w + \Phi_a H'}, \text{ where}$$

C_T = bulk soil concentration (mg/kg dry weight) (see field sampling data)

C_a = soil vapor concentration (mg/L)

K_d = soil-water partition coefficient ($K_{oc} \times f_{oc}$)

K_{oc} = organic carbon partition coefficient (kg adsorbed chemical/kg soil organic carbon)/ (kg dissolved chemical/L water) (chemical specific)

f_{oc} = soil organic carbon fraction (default: 0.2% or .002)

β = dry-soil bulk density (kg/L) (default: 1.72 kg/L)

Φ = total soil porosity [$\Phi = 1 - \beta/P_b$; P_b = particle density (default particle density = 2.65 kg/L)]

Φ_a = air filled soil porosity ($\Phi - \Phi w$)

Φ_w = water content (cm^3/cm^3) (default: 13% or .13)

H′ = Henry's Law constant (unitless). H′ = H/ (RT) where H = the dimensional form of Henry's Law Constant, atm-m^3/mol; R = universal gas constant, 0.0000821 atm-m^3/mole-^{0}K; T = absolute temperature, 273^{0}K + ^{0}C. **H′=H × 41.57**.

[*Note:* mg/L × (1 × 10^3 L/m^3) = mg/m^3]

Note the following conversion of Threshold Limit Values (TLV) in ppm to mg/m^3 assuming 760 torr barometric pressure at 25^{0}C (77^{0}F), and where 24.45 = molar volume in liters (ACGIH, 1991):

$$\text{TLV (mg/m}^3\text{)} = \frac{\text{(TLV in ppm) (gram molecular weight of substance)}}{24.45}$$

This same conversion, rearranged to solve for ppm, can be used to convert concentrations derived from the previous equation for comparison to concentrations presented in Table 5.

3.5 Nonaqueous Phase Liquid

Removal of NAPL to the maximum extent practicable is required by 30 TAC 334.79. Exceptions may be allowable where no hazard to the public will develop. The TCEQ has established certain criteria for evaluating closure for sites with NAPL remaining in place. However, even in situations when the site fails to meet one or more of the established criteria, the site may still be evaluated for closure if it is adequately documented that the presence of NAPL would not become a secondary source for an existing receptor or

exposure pathway (e.g. construction worker, vapor, groundwater ingestion etc.). These criteria rely a great deal on professional judgment; therefore, maintain close coordination with the TCEQ when evaluating NAPL exposure. In general, consider the following criteria when evaluating closure:

1. The depth to water is greater than 15 feet.
2. No groundwater receptors exist.
3. The NAPL plume is adequately delineated.
4. The NAPL plume is stable.
5. The affected groundwater zone is not a part of fractured bedrock or karst environment.
6. Potential for vapor risk does not exist.
7. There is no ongoing release.
8. Adequate efforts to recover NAPL are documented.

4.0 Site-Specific Exposure Pathways

Plan A screening compares the maximum detected concentrations of each COC to the default Plan A target concentrations. If site COC concentrations exceed target concentrations, then a post–Plan A evaluation is warranted. Post-Plan A evaluation includes exit criteria evaluation before the site proceeds towards development of Plan B Site Specific Target Levels for all open exposure pathways. Exit criteria evaluation described in detail in the later sections, is a mechanism that attempts to qualitatively close pathways by applying modifications to the pathways already evaluated under Plan A (e.g., moving the POE) and using alternate exposure factors and equations to the certain pathways (e.g. future exposure, construction worker), specific to the site. Some of these pathways are described below. Target concentrations, equations, exposure factors, site parameter values, and COC properties for these additional exposure pathways are available for download at the TCEQ's LPST Web page <www.tceq.texas.gov/remediation/pst_rp/downloads.html>.

4.1 Future Potential Groundwater Ingestion

Future use of groundwater is considered likely when the affected groundwater is either a state-designated major or minor aquifer or is used as a local supply. Local use may be considered likely when one or more of the following apply:

1. There is routine use of the affected groundwater zone.
2. No public supply is available.
3. The area is residential, particularly rural.
4. There are no ordinances prohibiting groundwater use.

For sites located over state-designated aquifers, consideration should be given to groundwater quality. If the general groundwater quality of the aquifer is poor or if the affected groundwater is designated as category III/IV beneficial use, then the future use of groundwater from the aquifer is considered unlikely.

Once potential for future groundwater use is established, the future off-site POE is assumed to be at the nearest off-site property line. The TCEQ may consider qualitative elimination of future on-site groundwater exposure if all the following conditions are met; otherwise, an institutional control to eliminate the future on-site use of groundwater may be required:

1. The on-site land use is commercial-industrial.

2. There is a municipal water source available (not sourced from the affected groundwater zone).
3. There is no history of commercial-industrial use of the affected groundwater zone within 1/2 mile of the site.

Target concentrations for future groundwater ingestion are based on alternate risk criteria with an individual risk level of 1×10^{-4} for Class A, B, and C carcinogens, or a hazard quotient of 1 for non-carcinogens. Additionally, cumulative carcinogenic risk and hazard index values should not exceed 1×10^{-4} and 1, respectively. The Most Likely Exposure factors (MLEs) for the appropriate land use are used to calculate the target concentrations. Target concentrations apply throughout the entire extent of the plume if on-site future ingestion cannot be qualitatively eliminated.

4.2 Threatened Irrigation Wells

In this document, *irrigation well* refers to a well used solely for landscape irrigation.

If irrigation wells are screened within or are in hydrological connection with the impacted groundwater zone, then target concentrations must be met before the POE (irrigation well); however, it is not necessary to meet them throughout the dissolved-phase plume.

Evaluation of this pathway includes consideration of incidental groundwater ingestion, dermal contact, and vapor inhalation. Target concentrations are based on an individual risk level of 1×10^{-5} for Class A, B, and C carcinogens, or a hazard quotient of 1 for non-carcinogens. Additionally, cumulative carcinogenic risk and hazard index values should not exceed 1×10^{-4} and 1 respectively.

4.3 Construction Worker Exposure

4.3.1 Soil

Potential construction worker exposure must be considered at depths of 15 feet or less below ground surface (or within the typical construction depth) in areas where construction is likely; however, the pathway does not apply to saturated soils. Subsurface utility areas are the minimum default POEs for the construction-worker exposure pathway. Also, evaluate other areas where subsurface construction activities are planned or are likely to occur, such as transportation rights-of-way, subsurface utility easements, and planned construction areas.

Target concentrations are based on the risk associated with ingestion and inhalation of COCs, as well as dermal contact. When the construction worker is exposed to both the soil and the groundwater pathways, the target concentrations should be based on cumulative risk from the soil and groundwater pathways.

Target concentrations are based on an individual risk level of 1×10^{-6} for Class A and B carcinogens and 1×10^{-5} for Class C carcinogens, or a hazard quotient of 1 for non-carcinogens.

4.3.2 Groundwater

Construction worker exposure to groundwater must be considered when the depth to groundwater is less than 15 feet below ground surface, or within the typical construction depth for the area. Target concentrations are based on time-averaged COC concentrations in the excavation area. This adjustment accounts for the rate of COC volatilization from the excavation being greater than the rate groundwater flow resupplies COCs to the excavation area. The concentration of volatile COCs in the pit water is assumed to decrease over the exposure period. The POE should be assumed to be located at subsurface utility areas as well as transportation rights-of-way, subsurface utility easements, and planned construction areas.

The construction worker exposure pathway assumes combined exposure via inhalation of volatiles from the groundwater and dermal contact with groundwater. When the construction worker is exposed to both the soil and the groundwater pathways, the target concentrations should be based on cumulative risk from the soil and groundwater pathways. Consideration of the inhalation exposure pathway is only necessary for those COCs with a Henry's Law constant greater than 10^{-5} atm-m^3/mole and a molecular weight of less than 200 grams/mole.

Target concentrations are based on an individual risk level of 1×10^{-6} for Class A and B carcinogens or 1×10^{-5} for Class C carcinogens, or a hazard quotient of 1 for COCs that affect the same target organ.

5.0 Exit Criteria Evaluation

Following the Plan A evaluation, the site should be evaluated under the Exit Criteria. The objective of such evaluation is to close lower-risk sites quickly and efficiently (preferably before a Plan B evaluation). The Exit Criteria flowcharts are based on a Bureau of Economic Geology (BEG) study (Mace, et al., 1997) and apply only to releases of petroleum (e.g., gasoline, diesel). Hazardous-substance releases must comply with Plan A or Plan B target concentrations with respect to delineation and remediation standards. In addition, the flowcharts do not address special concerns that may be present at certain sites such as nuisance conditions, utility impacts, etc. Any such concerns must be resolved before evaluating if closure is appropriate under Exit Criteria.

The Exit Criteria evaluation focuses on sites where exposure potential is low, for example, a commercial area with extensive impervious surface cover and a municipal water supply not sourced from the affected groundwater zone. The impacted or threatened groundwater zone at such sites is not typically targeted for groundwater supply. Using the Exit Criteria, these types of sites are often able to close relatively quickly after the risk-based assessment and plume-stability monitoring.

Figures 3, 4, and 5 present the Exit Criteria flowcharts for evaluating when site closure may be appropriate. The Exit Criteria evaluation is an iterative process that should be repeated after each phase of corrective action. When using the flowcharts, the term *site* refers to all properties affected by the release. *Closure* refers to closure of the pathway, not closure of the case. Only when all pathways can be closed is site closure appropriate. A reference to "further corrective action" could be a Plan B evaluation, site cleanup (engineered or natural attenuation), or possible implementation of a control (institutional or engineered).

When NAPL is present and recovery is ongoing, the remaining pathways should continue to be evaluated.

Figure 3. Groundwater Pathways (wells, aquifers, surface water, etc.). See also Figure 4.

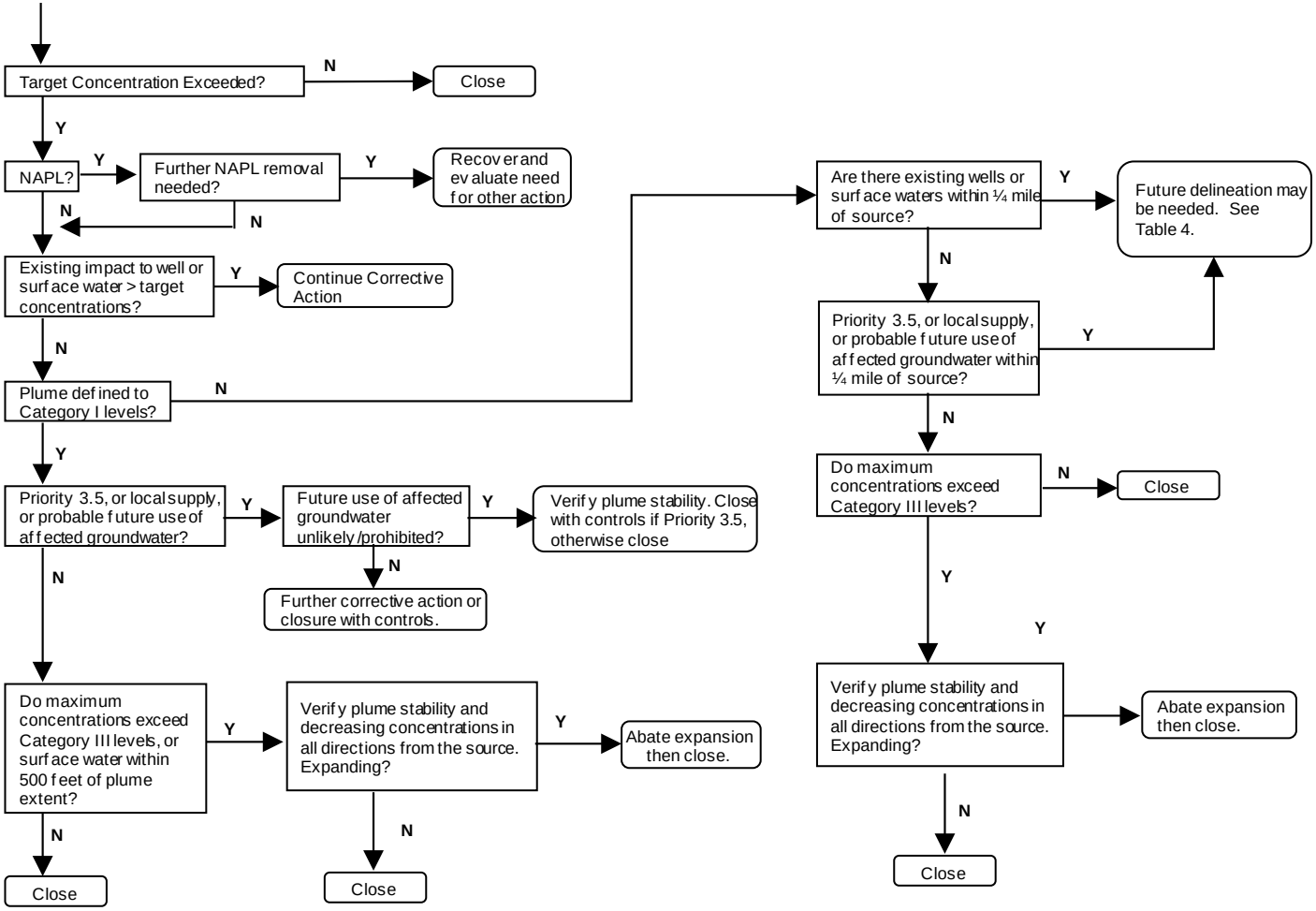


Figure 4. Groundwater Pathways (construction workers). See also Figure 3.

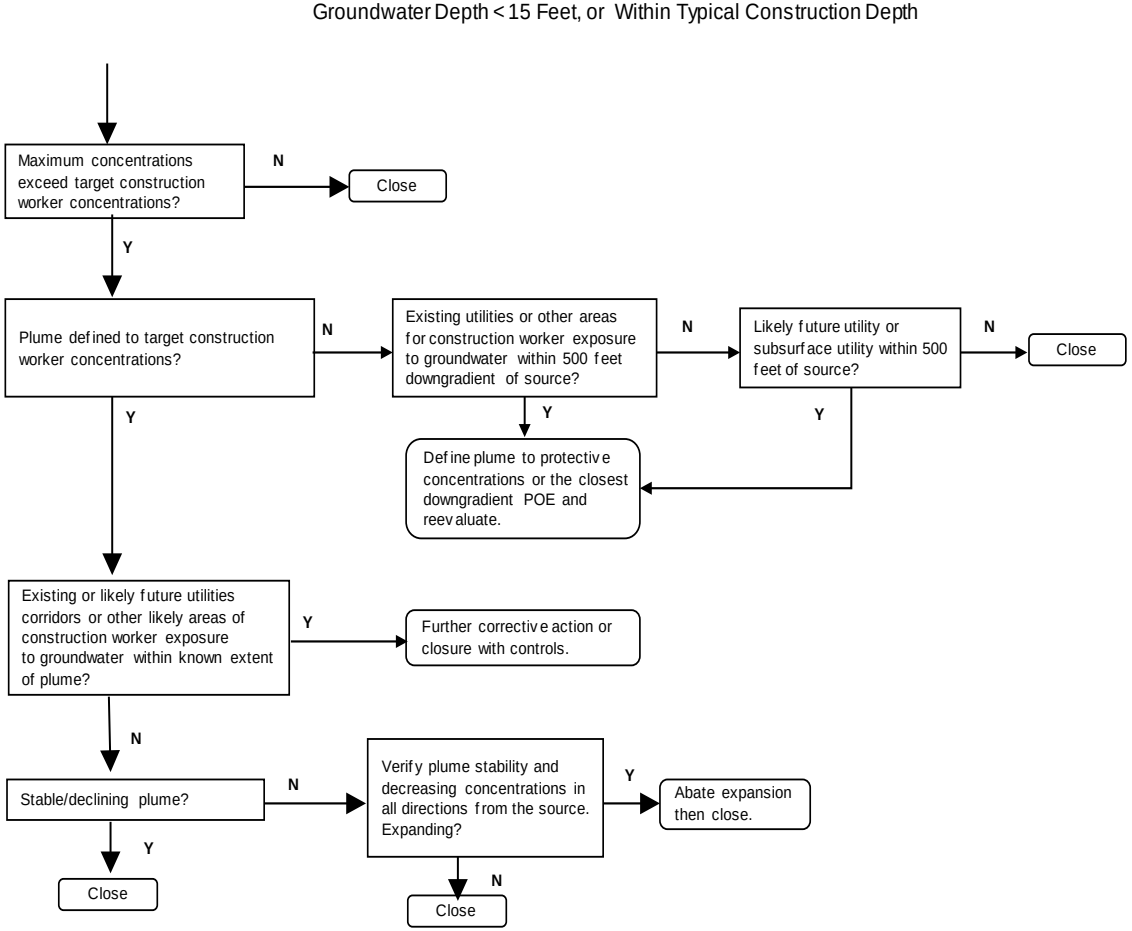
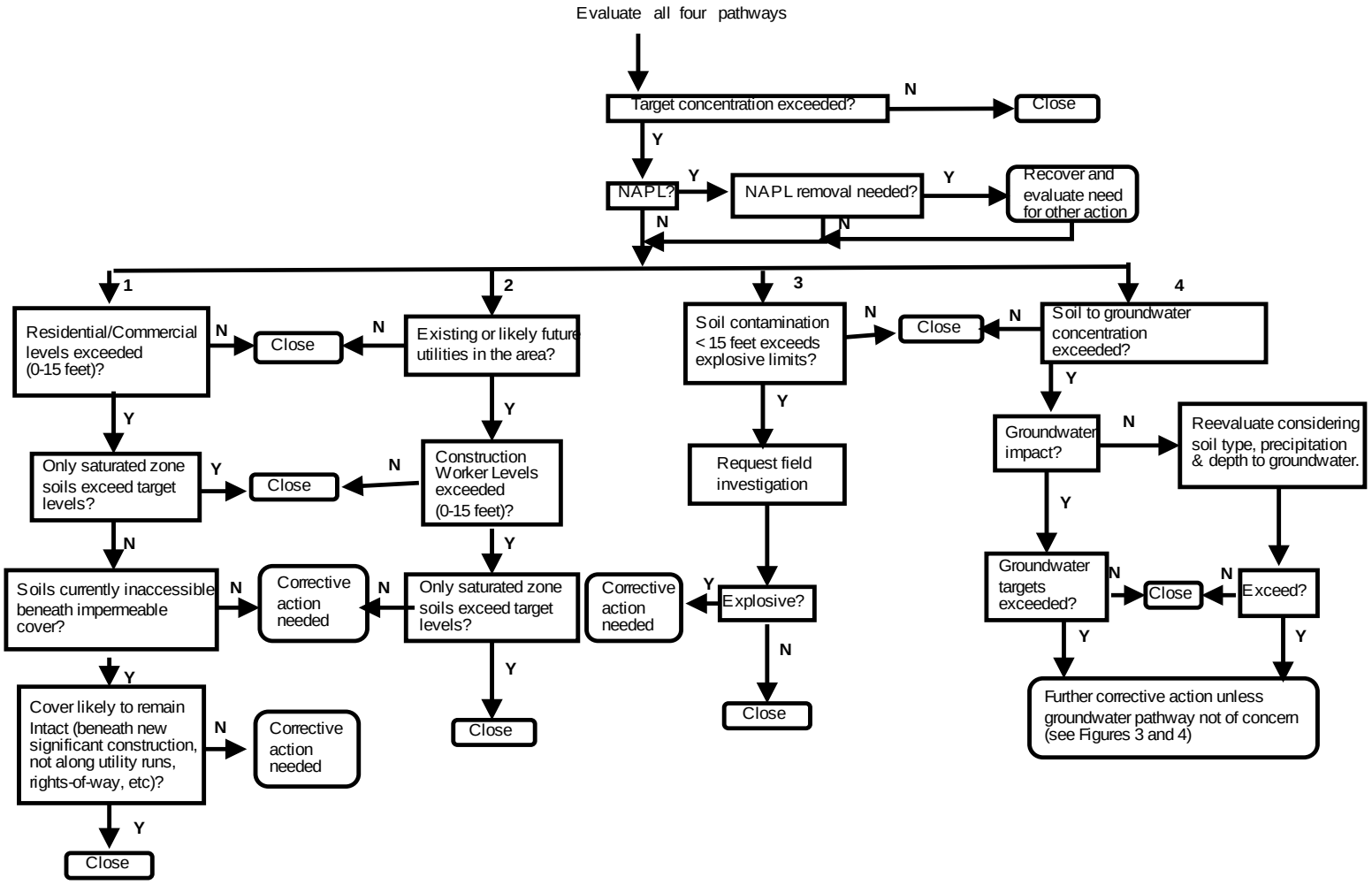


Figure 5. Soil Pathways.



5.1 Closure Following a Single Groundwater Sampling Event

In certain instances, site closure may be appropriate when only a single groundwater sampling event has been conducted. Use criteria presented in Table 7 to determine when this option can be considered.

Table 7. Potential Closure Following a Single Sampling Event.

Impact: Soils Only	Impact: Soils and Groundwater	Target Soil Levels Met[a]	Target Soil Levels Met[a]	Target Groundwater Levels Met[a,c]	Historical Release[d]	No Wells Within	No Surface Waters Within[e]	Municipal Water Supply Available[f]	Priority
		Human Health	Soil to Groundwater[b]						
X		X	X						4.2
X		X			X	500 ft.	500 ft.	X	4.2
	X	X	X	X	X	500 ft.	500 ft.	X	4.1
	X	X	X	X	X	1/4 mile	1/4 mile	X	3.5[g]

NOTES

[a] No NAPL.

[b] Vertical delineation should be complete, appropriate, and demonstrate generally declining concentrations with depth. Additionally soil samples should be representative, and there should be no concerns regarding preferential pathways (e.g., fractured bedrock, karst).

[c] Groundwater must be Category I–III. If Category IV groundwater, and Category III standards exceeded, then additional monitoring or evaluation is warranted to ensure there is no other hazard.

[d] Historical releases generally have static or declining conditions. (Recent releases could be considered if known to be minor)

[e] Groundwater-to-surface water interconnection should be likely.

[f] The municipal supply is not the affected groundwater body.

[g] Or local supply.

5.2 Verifying Plume Stability

Documentation of plume stability and declining concentrations with distance from the source must be completed under all scenarios, except when the site meets closure under single monitoring event as indicated in Table 7. At least four consecutive quarterly groundwater monitoring events are required to sufficiently document subsurface conditions. Consider a groundwater COC plume to be stable or declining if its area is not increasing. This may be demonstrated when the concentrations in perimeter monitoring points are showing a stable or declining trend, recognizing natural variability in field conditions, environmental samples and analysis. Consider stable or declining trends in plume data to support site closure.

6.0 Plan B Target Concentrations and Screening

Conduct a Plan B evaluation if after completing the Plan A and Exit Criteria evaluation, exposure pathways remain open. Plan B is typically focused on a narrower set of COCs and exposure pathways relative to the evaluations conducted under Plan A or the Exit Criteria. Plan B should only be used to evaluate complete or potentially complete exposure pathways.

The Plan B evaluation must consider the fate and transport of the contaminants in soil, air, and water and potential human exposure under current and future conditions. Contaminant fate and transport models should only be used when necessary. Modeling evaluations are not needed to estimate exposure-point concentrations for the direct-contact groundwater pathways when site groundwater monitoring data are adequate to document that the contaminant plume is in a steady or declining state, and the POE is not affected by concentrations that exceed health-protective limits. If the plume is in a steady state or declining, then there is potential for exposure only if there is a current or likely future POE within the limits of the contaminant plume. Points of exposure beyond the limits of steady-state or declining plumes generally should not be considered potential receptors. All modeling conclusions should be substantiated through monitoring data. When modeling outputs and monitoring data conflict, decisions should be based on the monitoring data.

6.1 Site-Specific Target Levels

Under Plan B, site-specific target levels (SSTLs) are set either by moving the POE or by substituting site-specific data for the default soil, groundwater, or source-area parameters assumed in calculating Plan A target concentrations.

Target concentrations for groundwater-ingestion pathways are based on the same individual risk level for carcinogens, and same hazard quotient for non-carcinogens as Plan A. Additionally, the cumulative carcinogenic risk must not exceed 1×10^{-4} for carcinogens and the hazard index must not exceed one for non-carcinogens. Reasonable Maximum Exposure (RME) factors are applicable for current exposure; Most Likely Exposure (MLE) factors are applicable for potential future exposure when calculating the target concentrations.

For soil exposure pathways and other non-ingestion groundwater exposure pathways, substitute one or more of the default soil or groundwater or source-area parameters assumed to calculate Plan A target concentrations with site-specific values and calculate Plan B SSTLs. The SSTLs apply at their respective exposure pathway-specific POEs.

6.2 Exposure Pathways

The applicable exposure pathways and parameters are the same as for Plan A, including the construction-worker and irrigation-well exposure pathways; however, only the COCs and exposure pathways that did not screen out under Plan A or the Exit Criteria should be evaluated under Plan B. Plan B distinguishes between current and potential future exposures when selecting the applicable exposure factors, and applicable risk levels for calculating target groundwater ingestion concentrations.

6.3 Points of Exposure (POE)

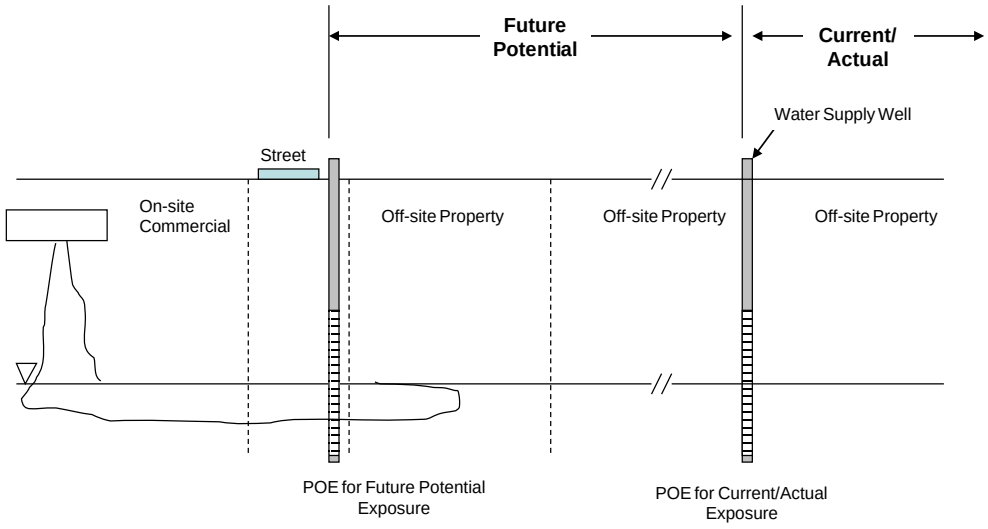
The groundwater ingestion POE under Plan A is considered at every point within the entire extent of COC-affected groundwater. Flexibility is available under Plan B; however, take site factors into consideration to adjust the groundwater-ingestion POE location. For example, karst systems are not likely candidates for alternate

POE locations. Proper selection of groundwater ingestion POEs under Plan B depends on the presence of water-supply wells, the nature of the affected groundwater zone, and land use. Set a POE at each affected or threatened water supply well (for current exposure). If a state-designated major or minor aquifer or local supply is impacted, but there are no current impacted or threatened water-supply wells, set the future potential POE at the nearest downgradient off-site property line, which may be across a street (see Figure 6).

For groundwater discharging to surface water, set the POE at a point up gradient of, but near, the surface water body.

For residential and commercial-industrial soil ingestion, set the POE at the soil COC source area. For exposure due to inhalation of volatile COC emissions from soil, set the POE at the soil COC source area within the upper 2 feet of soil (0–2 feet below grade). When on-site commercial-industrial land use is assumed, and COCs extend off-site onto residential property, also set a POE at the closest property line to demonstrate target concentrations are met off-site. When using physical controls such as impermeable surfaces to prevent exposure to impacted soils, set soil POEs at the limit of the physical control to demonstrate that target concentrations are met beyond the limits of the physical control.

Figure 6. Alternate Points of Groundwater-ingestion Exposure.



6.4 Plan B Screen

Once the Plan B SSTLs have been determined, calculate the cumulative risk and hazard index in order to verify the additive effect of multiple COCs and multiple exposure pathways, even those that were previously closed under Plan A screening or exit criteria evaluation. The cumulative carcinogen risks for each COC and each exposure pathway contributing to exposure of the same individual for the same period should not exceed 1×10^{-4}. The total hazard index for each COC affecting the same target organ for each exposure pathway should not exceed 1. If the established SSTLs are of acceptable risk, compare site concentrations to the Plan B SSTLs. If SSTLs are met, pursue site closure; otherwise, remediate the site to the established SSTLs or implement an institutional control to restrict potential exposure. If site conditions subsequently change and the potential future POE

becomes a current POE, the risk evaluation must be revised appropriately and the need for corrective action re-assessed.

7.0 Institutional Controls

It may be appropriate to place an institutional control on a property to prevent potential future exposure. Land owner approval is needed prior to proposing institutional control. Model institutional control language is provided in 30 TAC Section 334.208. The owner and operator, or the agency, may recommend the specific conditions of the institutional control. In the event the agency and the owner and operator are unable to agree upon a suitable institutional control, then the agency will require target concentrations to be established so as to eliminate a need for an institutional control. TCEQ approval is required before filing the institutional control in the property records. The TCEQ must receive a certified copy of the filed institutional control stamped by the county clerk before granting site closure.

8.0 Glossary

Affected Property: The area defined by the extent of migration of the chemicals of concern.

Attenuation: The reduction in concentrations of chemical(s)s of concern in the environment with distance and time due to processes such as diffusion, dispersion, absorption, chemical degradation, biodegradation etc.

Beneficial Use: The designated use of the groundwater resource in an area defined by virtue of its resources and quality.

Biodegradation: The reduction in total mass and concentration of chemicals of concern due to the biological processes by bacteria in the environment.

Carcinogen: Substances which have been classified for human carcinogenic risk based on the United States Environmental Protection Agency's Weight of Evidence System of Carcinogenicity as one of the following:

(A) Group A--Human Carcinogen

(B) Group B--Probable Human Carcinogen

(C) Group C--Possible Human Carcinogen

Chemicals of Concern: Specific constituent of petroleum that the agency has identified for evaluation due to its toxicological effects.

Commercial/Industrial: Any real property or portion of a property not currently being used for human habitation or for other purposes with a similar potential for human exposure.

Compliance Point: Location(s) selected between the source area(s) and the potential exposure point(s) where concentrations of regulated substances must be at or below the determined target concentrations in media (for example, groundwater, air, soil).

Corrective Action: The sequence of actions that include site assessment, remedial action, and monitoring to get the release incident to closure.

Engineering Controls: Modifications to a site or facility (for example, slurry walls, capping, point of use water treatment) to reduce or eliminate the potential for exposure to a regulated substance.

Exit Criteria: A mechanism that screens incomplete exposure pathways.

Exposure Pathway: The course a regulated substance takes from a source to an exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals at or originating from a leaking storage tank site. Each exposure pathway includes a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport mechanism must also be present.

Facility: The property containing the source of the release of chemicals of concern.

Fate and Transport Models: An estimate of contaminant concentration with time and distance based on a quantitative estimate of chemical mobility and persistence developed using pre-set or site-specific information in conjunction with analysis of transport mechanisms such as advection, dispersion, and diffusion and/or a quantitative estimate of biodegradation processes.

Hazard Index: The sum of two or more hazard quotients for multiple regulated substances and/or multiple exposure pathways which impact the same target organ or act by the same method of toxicity.

Hazard Quotient: The ratio of a single substance exposure level over a specific time period to a reference dose for that substance derived from a similar exposure period.

Institutional Control: Legally binding instruments to control or eliminate an otherwise viable exposure pathway to ensure that exposure to remaining regulated substances is reduced to a human health and environmentally protective level. Institutional controls may include record notice, land use restrictions, land access restrictions and controls, or other legally binding and practically feasible instrument.

Maximum Contaminant Level or MCL: The maximum concentration in water of a regulated substance established by the United States Environmental Protection Agency under Section 141 of the Federal Safe Drinking Water Act.

Most Likely Exposure Factors: Mid-range exposure factors to be used in dose estimation equations in situations when there is a credible chance for future exposure to chemical of concern exists.

Nonaqueous Phase Liquid: Measurable petroleum product that is present in free phase.

Plan A: A risk based analysis to develop non-site specific/default target levels using conservative factors and fate and transport models for various potential exposure pathways.

Plan B: A risk based analysis to develop site specific target levels using site specific factors and conditions for all complete exposure pathways.

Point of Exposure: The point at which an individual or population may come in contact with a chemical of concern originating from a site.

Receptor: Persons, structures, utilities, surface waters, and water supply wells that are or may be adversely affected by a release.

Reasonable Maximum Exposure Factors: Combination of upper-bound and mid-range exposure factors to be used in dose estimation equations to provide a result which represents an exposure scenario that is both protective and reasonable; not the worst case.

Residential: Property used for dwellings such as single family houses and multifamily apartments, children's homes and nursing homes. Because of the similarity of exposure potential and the sensitive nature of the potentially exposed population, day care facilities, educational facilities, hospitals, parks and like facilities shall also be considered "residential."

Remediation: Activities conducted to protect human health, safety, and the environment including evaluating risk, making no-further-action determinations, monitoring institutional controls, engineering controls, and designing and operating cleanup equipment.

Risk Assessment: An analysis of the potential for adverse health effects caused by a chemical of concern from a site and to determine the need for remedial action or the development of target levels where remedial action is required.

Risk Based Corrective Action: A streamlined approach to the corrective action integrating exposure and risk to ensure that appropriate remedies are selected to protect human health and environment.

Site Specific Target Levels: Risk based cleanup levels established for a chemical of concern from Plan B assessment.

Source Area: The location of NAPL or highest soil and groundwater concentrations of the chemical(s) of concern. This includes contaminants that act as a reservoir for migration to groundwater, surface water, air, or as a source for direct exposure.

Subsurface Soils: Unconsolidated soils located within the unsaturated zone at a depth greater than 2 feet below ground level.

Surface Soils: Unconsolidated soils located within the unsaturated zone at a depth 0-2 feet below ground surface.

Target Risk: The level of concern used in exposure equations to calculate an allowable concentration of chemical of concern at the Point of Exposure.

Target Concentrations: Also known as “Target Levels are Site-specific” and “chemical-specific concentration” for affected media (for example, soil, air, groundwater, surface water) that are protective of human health and safety, and the environment

Utilities: Generally includes subsurface pipeline networks for electricity, natural gas, water, telephone and sewage.

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