Montana Tier 1 Risk-Based Corrective Action Guidance for Petroleum Releases

Montana Department of Environmental Quality

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Definitions and Acronyms

ARM - Administrative Rules of Montana.

BTEX - Benzene, toluene, ethylbenzene, and xylenes

Carcinogen - A compound that the EPA has determined causes cancer based on the weight of peer-reviewed scientific evidence. Some carcinogens may also have non-carcinogenic effects.

Chemicals of concern (COCs) - Specific petroleum compounds that are identified for evaluation in a RBCA evaluation or a risk assessment.

Circular DEQ-7 - The Montana Numerical Water Quality Standards, applicable to state surface water and groundwater, adopted by rule and published by DEQ.

Closure of a petroleum release (or closure review) - A process used to determine a release can be categorized as "resolved." Administrative Rules of Montana 17.56.607 discusses requirements for releases from petroleum storage tanks (PSTs).

COC - See chemicals of concern.

Commercial/industrial property - Property used as a place of business with employees present regularly on a typical five days on, two days off schedule with no one living on the property.

Corrective action - Actions at a petroleum release that may include, but are not limited to, investigation, site assessment, emergency response, abatement, underground storage tank removal, cleanup, operation and maintenance of equipment, monitoring, reclamation, and termination of the corrective action. Also known as remedial action.

DEQ - The Montana Department of Environmental Quality.

DEQ-7 - See Circular DEQ-7.

Dibromoethane, 1,2 (also known as Ethylene dibromide - EDB) - gasoline additive that was used until the late 1980s when leaded gasoline was phased out. 1,2 dibromoethane also was widely used as an agricultural fumigant until it was banned in 1983. EDB may still be found in some leaded aviation gasoline.

DCA 1,2 - See dichloroethane, 1,2

Dichloroethane, 1,2 (1,2 DCA) - leaded gasoline additive that was used until the late 1980s when leaded gasoline was phased out. 1,2 DCA is still used as an industrial solvent and it may still be found in some leaded aviation gasoline.

Diesel range organics (DRO) - Non-target compounds found in diesel. DRO is also the analytical method used to determine the concentrations of these non-target compounds (DEQ has replaced the DRO analysis with EPH).

DRO - See diesel range organics.

EDB - See ethylene dibromide or 1,2 dibromoethane

EPA - The United States Environmental Protection Agency.

EPH - See extractable petroleum hydrocarbons.

Ethylene dibromide (EDB) - see Dibromoethane, 1,2

Excavation/construction scenario - An exposure scenario based on the limited exposure of individuals to subsurface soils during an excavation to install piping, utilities, other underground features, shrubs, or trees.

Exposure - The contact of a receptor with a COC.

Exposure pathway - The route a chemical or physical agent takes from a source to an exposed receptor. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals of concern at or originating from a release. Each exposure pathway includes a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium (e.g., air) or media (in cases of transfer between media) will also be included.
Examples of complete exposure pathways include:

- Inhalation of vapors from impacted soils by a person on site.
- Impacted soils leaching into potable groundwater and being used by a nearby resident for drinking and bathing.
- Inhalation of vapors by a neighbor resulting from the migration of free product.
- Impacted groundwater discharging to wetlands or other surface water bodies.

Extractable petroleum hydrocarbons (EPH) - A group of petroleum hydrocarbons that includes the non-target petroleum fractions typically found in diesel and other heavier petroleum products. EPH is also the analytical method developed by the Massachusetts Department of Environmental Protection to determine the fractional composition of these non-target compounds.

Free (phase) product - Petroleum product floating on the groundwater or surface water, occupying soil pore space, or on the ground surface. Also, petroleum products or other substances present as non-aqueous phase liquids.

Gasoline range organics (GRO) - Non-target compounds found in gasoline. GRO is also the analytical method used to determine the concentrations of these non-target compounds (DEQ has replaced the GRO analysis with VPH).

GRO - See gasoline range organics.

Hazard index (HI) - The sum of more than one hazard quotient for multiple substances and/or multiple exposure pathways.

Hazard quotient - The ratio of a single substance exposure level over a specified time period to a reference dose for that substance derived from a similar exposure period.

Impacted groundwater - Groundwater containing contaminants in concentrations that approach or exceed DEQ-7 human health standards, narrative standards, or RBSLs for non-target compounds.

Lead scavengers - compounds such as 1,2 DCA and EDB added to leaded gasoline to help volatilize or scavenge tetraethyl lead so it would not accumulate in the engine.

MBTEXN - Methyl tertiary-butyl ether, benzene, toluene, ethylbenzene, xylenes, and naphthalene.

MCA - Montana Code Annotated.

Methyl tertiary-butyl ether (MTBE) - A synthetic chemical added to most commercial gasolines as an anti-knock additive or oxygenate.

MNA - See monitored natural attenuation.

Monitored natural attenuation (MNA) - A scientific protocol for documenting monitoring requirements necessary to verify that natural processes are attenuating the transport of petroleum hydrocarbons in the environment.

MTBE - See methyl tertiary-butyl ether.

Non-carcinogen - A compound that the EPA has determined to have toxic effects, but has not determined to be a carcinogen. Some carcinogens may also have non-carcinogenic effects.

Oxygenate - a compound that is added to gasoline to reduce carbon monoxide emissions during the combustion of the fuel.

PAHs - See polycyclic aromatic hydrocarbons.

Petroleum product - Gasoline, crude oil (except for crude oil at production facilities subject to regulation under Title 82 MCA), fuel oil, diesel oil or fuel, lubricating oil, oil sludge or refuse, and any other petroleum-related product or waste or fraction of the product or waste that is liquid at standard conditions of temperature and pressure (60 degrees F and 14.7 pounds per square inch absolute) (§75-10-701, MCA).

Petroleum release - A release of petroleum product into the environment, with "release" defined below (§75-10-701, MCA).

Petroleum storage tank (PST) - a tank that contains or contained petroleum or petroleum products and that is: an underground storage tank (UST); a storage tank that is situated in an underground area, such as a basement, cellar, mine, drift, shaft, or tunnel; an aboveground storage tank (AST) with a capacity less than 30,000 gallons; including aboveground or underground pipes associated with these tanks. The definition of PST excludes pipelines regulated by the Natural Gas Pipeline Safety Act of 1968 (49 U.S.C. 1671, et seq.), the Hazardous Liquid Pipeline Safety Act of 1979 (49 U.S.C. 2001, et seq.), and comparable state laws, if the facility is intrastate.

Polycyclic aromatic hydrocarbons (PAHs) - A group of petroleum hydrocarbons that includes several semivolatile compounds typically found in petroleum products, especially petroleum products that are heavier than diesel. (Also referred to as polynuclear aromatic hydrocarbons or PNAs.)

RBCA - See risk-based corrective action.

RBSL - See risk-based screening level.

Reasonably anticipated future uses - Reasonably anticipated future uses as defined in §75-10-701(18), MCA, means likely future land or resource uses that take into consideration:

- local land and resource use regulations, ordinances, restrictions, or covenants;
- historical and anticipated uses of the facility;
- patterns of development in the immediate area; and
- relevant indications of anticipated land use from the owner of the facility and local planning officials.

Receptor - Any person, plant, or animal that is or could potentially be adversely affected by a petroleum release.

Release - Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of a hazardous or deleterious substance directly into the environment (including the abandonment or discarding of barrels, containers, and other closed receptacles containing any hazardous or deleterious substance), but excludes releases confined to the indoor workplace environment, the use of pesticides

as defined in §80-8-102(30), MCA, when they are applied in accordance with approved federal and state labels, and the use of commercial fertilizers, as defined in §80-10-101(2), MCA, when applied as part of accepted agricultural practice (§75-10-701, MCA).

Residential property - Any property used as a place of residence. Residential properties also used for businesses are considered residential. Residential properties that include other uses not defined here are evaluated on a case-by-case basis.

Resolved petroleum release - A classification indicating no further corrective action is required to address a petroleum release because all remediation requirements for the release have been completed. Administrative Rules of Montana 17.56.607 discusses requirements for releases from petroleum storage tanks (PSTs).

Responsible party (RP) - An owner, operator, generator, transporter, or other person responsible for cleanup of a petroleum release.

Risk-based corrective action (RBCA) - A decision-making process based on the protection of public health, safety and welfare, and the environment, which results in the consistent assessment, remediation and/or closure of petroleum releases.

Risk-based screening level (RBSL) - A chemical concentration considered acceptable for a given exposure scenario based on estimated risk to potential receptors.

RP - See responsible party.

Screening levels - See risk-based screening level.

Tier 1 - The simplest level of RBCA for petroleum releases in Montana. In Tier 1 RBCA, petroleum contaminant levels are compared to pre-determined RBSLs for COCs to determine whether additional investigation and/or cleanup is necessary. It involves situations where the petroleum contaminant is confined to soil and/or is present in the groundwater in concentrations below DEQ-7 human health standards or groundwater RBSLs. Activities that may be conducted to achieve Tier 1 RBSLs include limited over-excavation or some other remedial procedure. Deeper vertical sampling (soil borings or test pits) may produce less contaminated samples that can also be utilized in the Tier 1 process. The Tier 1 process may not be applicable to sites where site-specific cleanup levels have already been chosen or will be identified through a permit or order.

Vapor Intrusion (VI) - Vapor intrusion is the migration of volatile chemicals from the subsurface into overlying or subterranean structures. Volatile chemicals in buried wastes and/or contaminated groundwater can emit vapors that may migrate through subsurface soils and into air spaces of overlying structures. In some cases, the vapors may accumulate in dwellings or occupied buildings to levels that may pose near-term safety hazards, acute health effects or aesthetic problems. In most cases, however, the chemical concentrations are low, or depending on site-specific conditions, vapors may not be present at detectable concentrations.

Volatile petroleum hydrocarbons (VPH) - A group of petroleum hydrocarbons that includes the non-target petroleum fractions typically found in gasoline and other lighter petroleum products. VPH is also the analytical method developed by the Massachusetts Department of Environmental Protection to determine the fractional composition of these non-target compounds.

VPH - See volatile petroleum hydrocarbons.

Montana Tier 1 Risk-Based Corrective Action Guidance for Petroleum Releases
Executive Summary of 2009 Changes

It is the Montana Department of Environmental Quality's (DEQ's) policy to conduct periodic reviews of its Montana Tier 1 Risk-Based Corrective Action Guidance for Petroleum Releases to determine if changes to methods and toxicity information warrant updating the guidance. In 2008, the U.S. Environmental Protection Agency (EPA) released its Regional Screening Levels tables (EPA, September 2008) that represent a consensus throughout the EPA regions regarding toxicity data and methods for calculating screening levels based upon protection of human health. These tables are updated periodically by the EPA and the current version is dated April 2009; however, none of the information upon which DEQ relied changed between 2008 and 2009. In January 2009, EPA released its Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment (EPA, January 2009). DEQ has determined that it is appropriate to change its risk-based screening levels to more closely follow the EPA's approach. The following lists changes made to the October 22, 2007 version of the Montana Tier 1 Risk-Based Corrective Action Guidance for Petroleum Releases.

- Because of the variability of human olfactory senses as well as the variability in the composition of petroleum products, DEQ has determined that definitive and quantitative guidelines and standards on when a petroleum odor constitutes a nuisance condition and significant risk to public welfare are generally not appropriate. Therefore, DEQ removed the beneficial use risk-based screening levels (RBSLs) for soils and has replaced them with text regarding a qualitative evaluation. Taste and odor thresholds for drinking water are more quantifiable, therefore, DEQ has retained beneficial use RBSLs for groundwater.
- DEQ updated the ethylbenzene and MTBE toxicity data to that presented in EPA, September 2008.
- DEQ changed the method for evaluating inhalation exposure to the current EPA approach presented in Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment (EPA, January 2009). The approach involves the use of reference concentrations (RfCs) and inhalation unit risks (IURs) in the equations without adjusting for body weight and inhalation rate.
- DEQ updated the particulate emission factor to that used in the EPA Regional Screening Levels User's Guide and Tables (EPA, September 2008).
- DEQ added inhalation exposure to the polynuclear aromatic hydrocarbon (PAH) exposures using the IURs provided in EPA, September 2008.
- DEQ evaluated naphthalene using both the noncarcinogenic toxicity data and the carcinogenic IUR provided in EPA, September 2008 and chose the most conservative of the two concentrations for each scenario.
- DEQ changed the PAH calculation to the mutagenic mode of action method based upon current EPA guidance and included in the EPA, September 2008 documents.
- DEQ removed any inhalation route calculations made by extrapolating oral toxicity based upon the EPA, January 2009 guidance.

- DEQ increased the commercial skin adherence factor to that provided in EPA, September 2008.
- DEQ changed the volatilization factors for the target analytes to those included in EPA, September 2008.
- DEQ removed dermal exposure for volatile contaminants per EPA, September 2008.
- DEQ removed the saturation concentrations from the Master Table because petroleum compounds are mixtures and these concentrations are not necessarily indicative of free product, therefore, DEQ did not ever use these concentrations for decision-making.
- DEQ determined that it is still appropriate to use a 75-year lifetime for carcinogenicity, instead of changing to 70 years to be consistent with EPA, September 2008, because the slope factors and IURs for the target analytes are not adjusted for a 70-year lifetime and the EPA 1997 Exposure Factors Handbook indicates that 75 years is appropriate.
- DEQ recalculated soil leaching RBSLs for petroleum fractions based upon new groundwater RBSLs.
- DEQ added screening levels for Resource Conservation and Recovery Act (RCRA) metals.
- DEQ updated and revised language throughout the text of the document to make it more understandable.

One final thing to note regarding the 2009 changes to the Montana Tier 1 Risk-Based Corrective Action Guidance for Petroleum Releases is that the RBSLs for soil and water are not designed to be protective of the vapor intrusion (VI) pathway. If volatile compounds are present in the vicinity of inhabitable structures, then the VI pathway should be evaluated either qualitatively or quantitatively. The DEQ is developing VI guidance for Montana, but until that guidance document is completed, currently available VI guidance documents should be used to assess and evaluate VI risks. Additional information is provided in the text.

Corrections Made to Original Text

Four sections in this version contain minor edits from the original September 2009 version of RBCA. These edits are not substantive and update language that did not accurately explain the change made in replacing the numerical ceiling concentrations for total gasoline range and diesel range fractions in soil with narrative conditions that affect beneficial use. These edits made to pages 10, 14, 15, and 16 are discussed in detail on DEQ's Internet web page.

TIER 1
RISK-BASED CORRECTIVE ACTION
EVALUATION PROCESS

Overview of Risk-Based Corrective Action

This document describes the Montana Department of Environmental Quality's (DEQ) Tier 1 risk-based corrective action (RBCA) evaluation process. It provides a description of the concepts and terms that must be understood to use RBCA for petroleum releases in Montana, and is not intended to address other chemical (non-petroleum) releases. This document is applicable to all petroleum releases addressed by DEQ's LUST Brownfields Section, Petroleum Technical Section, Site Response Section, and Enforcement Division and those petroleum releases addressed by DEQ's Remediation Division under the Water Quality Act. In addition, this guidance may be used as a screening tool for DEQ's state and federal Superfund sites and it may be possible to apply Tier 1 to new releases at hazardous waste sites that are covered by existing permits or orders. For hydrocarbon compounds not specifically addressed in this document, a site-specific approach may be developed in consultation with DEQ. The appropriate regulating agency or Bureau should be contacted to determine whether Tier 1 is appropriate.

RBCA Focuses on Risk Evaluation

The goal of RBCA is to identify risks to public health, safety and welfare, and to the environment so they can be reduced. RBCA uses environmental risk analysis, which incorporates elements of toxicology, hydrogeology, chemistry, and engineering to assess the existing and potential risks from a petroleum release. This information is used to develop contaminant concentration levels determined to be acceptable in the State of Montana. The risk-based screening levels (RBSLs) developed within RBCA can be used as cleanup levels at all sites in Montana without the need to perform site-specific leaching models or risk analysis for each release and exposure scenario.

DEQ's Tier 1 site evaluation process consists of assessing site conditions and maximum contaminant concentrations, and choosing the appropriate Tier 1 RBSLs to determine whether further remedial action is needed to close the release. Tier 1 RBSLs denote contaminant concentrations that represent acceptable risks to human health and the environment. When petroleum contamination at concentrations exceeding RBSLs is not present then the release can be considered for closure without the need to perform site-specific risk analysis.

Chemicals of Concern

Typical petroleum products such as fuels and lubricants contain a large number of chemical constituents that may be harmful to the public health, safety and welfare, and to the environment. Risk analysis focuses on the presence of chemicals of concern (COCs) at contaminated sites or facilities. DEQ has identified several common petroleum constituents as COCs generally applicable to petroleum releases. This list includes methyl tertiary-butyl ether (MTBE),

benzene, toluene, ethylbenzene, xylenes, naphthalene, lead scavengers (1,2 DCA and EDB), oxygenates, volatile petroleum hydrocarbons (VPH)[1], extractable petroleum hydrocarbons (EPH)[1], and polycyclic aromatic hydrocarbons (PAHs). Soil and water samples from petroleum release sites are analyzed for these COCs during a Tier 1 evaluation. Other COCs may be included based on site-specific activities. Any additional COCs will be identified by the appropriate regulating agency or Bureau and evaluated outside the Tier 1 process.

Exposure Pathways

COCs affect receptors via exposure pathways. A complete exposure pathway includes a contaminant source, an exposure route, and an exposure point. Sources of petroleum contamination include above ground storage tanks (ASTs) and underground storage tanks (USTs), piping, and surface spills, including spills from trucks or other transport containers. Petroleum-contaminated soil, such as that remaining beneath a UST or pipe, can also be a contaminant source that contributes to an on-going release to adjacent soil and groundwater. An exposure route can be any avenue COCs might follow from petroleum sources to receptors. Contaminants can spread through the soil, surface water, groundwater, and air, and can accumulate in vegetation, animals, and other organisms. COCs are spread by many processes, including gravity, advection, dispersion, diffusion and volatilization. Exposure pathways can include natural or man-made processes and media, and can be direct or indirect. Human receptors are typically exposed to COCs at exposure points through ingestion, inhalation, or direct (dermal) contact.

An example of a common exposure pathway is gasoline releasing from a leaking UST, flowing downward through the soil under gravity until it reaches the water table, and then flowing with the groundwater until it reaches a water well, where the water is extracted and used for drinking. This is just one example.

Remedial Actions Under RBCA

The nature and extent of contamination at petroleum releases are generally characterized through remedial investigations. During these investigations, responsible parties (RPs) and their consultants identify which contaminants are present at a release, and determine their concentrations, and horizontal and vertical distribution. Other site conditions, such as geology, hydrogeology (including determination of site-specific depth to groundwater), local land use, and potential receptors are also documented. This information is evaluated to determine RBCA target cleanup levels for each release (described in more detail below). These target cleanup levels are set to ensure that any COC concentrations that might remain will not pose unacceptable risks to public health, safety and welfare, and the environment.

1. "VPH" and "EPH" are also the names of analytical methods developed by the Massachusetts Department of Environmental Protection to determine the concentrations of these non-target compounds. These methods break total petroleum hydrocarbons (TPH) into "fractions" that can be used in risk calculations. DEQ uses these methods in place of GRO (gasoline range organics) and DRO (diesel range organics) analytical methods.

RBCA cleanup goals can be met by removing contaminated material from the release until COC concentrations meet Tier 1 RBSLs. However, Tier 1 cleanup levels may also be reached by using combinations of other methods that reduce the potential for exposure. Acceptable methods might include *in situ* treatment technologies, source control or treatment, engineered controls that reduce or restrict migration, or enhancement technologies that promote biodegradation.

Removing or reducing contamination to levels below the RBSLs does not always ensure that contamination has not already leached or migrated downward to the water table. The RBSLs listed in this document, among other purposes, are intended to identify conservative threshold conditions where contamination may leach to groundwater. If soil contamination concentrations are reduced below RBSLs, then leaching should not occur in the future. However, if contamination exceeded RBSLs in the past, then the leaching process may have already taken place. This has been particularly evidenced in porous soils and at locations where releases have been present for long periods of time. Therefore, achieving RBSLs does not preclude the need to investigate groundwater to determine whether it has already been contaminated. In some cases contamination may have leached downward and formed a smear zone of contamination within the soil between the seasonal high and low water levels of an aquifer. These smear zones then act as a secondary source of groundwater contamination. In determining whether a groundwater investigation is necessary many factors including the volume and age of the release, permeability of the soil, the depth to groundwater, maximum soil contaminant concentrations originally present, and estimated mass of contamination removed or destroyed, as well as other site-specific parameters, must be evaluated.

Tier 1 Data Collection and Evaluation

The RBCA process is broken into tiers or stages. The lowest level of complexity of RBCA is Tier 1 and the subject of this document. Tier 1 is appropriate for initial evaluation of contaminated soil or simple releases that can be cleaned up easily with minimal information. In the Tier 1 process, RPs or their consultants follow guidelines to complete forms such as the 24-Hour Release Report and 30-Day Release Report that provide DEQ with the information necessary to determine what corrective action is necessary, and whether a release can be evaluated for closure without further action.

More complicated releases require more extensive investigation, data collection, and analysis to fully assess the risk and address the contamination. Under Montana's RBCA program, these will typically include releases where surface water or groundwater are contaminated at concentrations above groundwater RBSLs (including DEQ-7 human health standards), or releases with extensive soil contamination that cannot practically be dealt with under Tier 1. An example of the latter situation would be a release with gasoline-contaminated soil, where a threat exists for vapor migration into nearby structures or dwellings. RBCA Tiers 2 and 3 are generally intended for use at more complex releases to develop site-specific cleanup goals. DEQ has not yet developed Tiers 2 or 3. In addition, Tier 1 may not be appropriate for releases where site-specific cleanup levels have been established under the authority of a permit or order. The

appropriate regulating agency or Bureau must be consulted to determine whether Tier 1 may be applied at these releases.

Documenting Site Conditions

For releases associated with USTs and petroleum storage tanks (PSTs), site conditions are documented on the 24-Hour Release Report and 30-Day Release Report forms published by DEQ. Blank copies of these reports have been included in Appendix A as examples of the type of information DEQ will require. DEQ staff complete the 24-Hour Release Report form over the telephone when an RP or other party reports the discovery of a release. The 30-Day Release Report form, provided by DEQ after a release is reported, is completed by the RP within 30 days of the release notification. The DEQ Enforcement Division uses a Complaint/Spill Report to document initial information about a release (see Appendix B). This form is typically completed by DEQ staff. Other regulating agencies or Bureaus have their own reporting requirements. For releases that are not associated with PSTs or USTs, the appropriate regulating agency or Bureau should be contacted to determine reporting requirements.

DEQ uses the information and laboratory analytical data provided by the RP to determine whether a release qualifies for closure under Tier 1. Some site conditions, such as when petroleum contaminants are present in the groundwater at concentrations exceeding DEQ-7 human health standards or groundwater RBSLs, when petroleum vapors are detected in basements, or when a petroleum plume is moving off site, automatically disqualify a release from closure under Tier 1. In such cases, DEQ will require that more information be gathered to develop release cleanup and management strategies, and target cleanup levels. Such releases generally require more comprehensive investigations to determine the complete extent and magnitude of the contamination.

Soil Sampling Requirements

An adequate number of soil samples must be collected from any area of confirmed or suspected contamination. For RBCA analysis, soil samples must be collected from worst-case areas, such as beneath leaking USTs and PSTs, surface spills or other likely sources of petroleum contamination. The appropriate regulating agency or Bureau should be contacted to determine the appropriate sampling requirements for the site. Although decisions should be made on a site-specific basis, Appendix F provides guidance on the general sampling requirements of the DEQ Hazardous Waste Site Cleanup Bureau. Samples associated with UST and PST sites must be submitted to DEQ-approved laboratories for analysis according to the laboratory methodologies specified in Table A (see page 5). The EPH and VPH analytical methods, developed by the Massachusetts Department of Environmental Protection, will be used for all RBCA Tier 1 evaluations in Montana. Soil sample locations and other pertinent site history data must be recorded and submitted to DEQ. All analytical results and associated laboratory documentation including chromatograms, quality control/quality assurance data and chain of custody forms must be submitted to DEQ as part of the standard reporting process for any phase of site assessment or remediation.

Table A outlines the analytical methods DEQ requires for individual petroleum products in soil. VPH analysis is required for petroleum products that typically contain light range hydrocarbons to determine the concentrations of MTBE, BTEX, naphthalene (MBTEXN) and light end aliphatic and aromatic hydrocarbon fractions in the soil. EPH analysis is required in conjunction with VPH for most of the petroleum product types excluding gasoline and aviation gas and mineral/dielectric oils. DEQ uses a two-step screening technique to evaluate soils at sites where the EPH analysis is required to reduce the analytical costs for the EPH analysis. The first step in the screening technique is similar to the diesel range organics (DRO) analysis and generates a total extractable hydrocarbon (TEH) concentration. If the initial screening result is 200 parts per million (ppm) or less, no additional EPH analysis is required. However, if the TEH concentration is greater than 200 ppm then the EPH fractionation step is required. PAH analysis will be required on a site-specific basis if heavy hydrocarbons, refinery wastes or unknown oils/sources are present.

Table A- Testing Procedures for Soils

Petroleum Product	VPH	**EPH Screen**	**EPH Fractionation**	**EPH for PAHs**	**RCRA Metals**	**EPA Method 8260B**	**Oxygenates & Lead Scavengers**
Gasoline/Aviation Gasoline	R						SS
Diesel (#1 & #2)	R	R	X				
#1 - #2 Heating Oils	R	R	X				
#3 - #6 Fuel Oils		R	X	SS			
Used/Waste Oil	R	R	X	SS	R	R	SS
Kerosene, Jet Fuel (Jet-A, JP-4, JP-5, JP-8, etc.)	R	R	X				
Mineral/Dielectric Oils		R	X				
Heavier Wastes		R	X	SS			
Crude Oil	R	R	X	SS			
Unknown Oils/Sources	R	R	X	SS	R	R	SS

R- required analysis
X - analysis to be run if the EPH screen concentration is >200 ppm TEH
SS- Site specific determination.

Groundwater Sampling Requirements

At some sites it may be necessary to investigate groundwater quality to verify that contaminant concentrations are below RBSLs and DEQ-7 human health standards. Groundwater samples must also be collected from worst-case areas. Appendix F provides guidance on the general sampling requirements of the DEQ Hazardous Waste Site Cleanup Bureau. MBTEXN and other lighter range hydrocarbons are commonly detected at gasoline and diesel release sites at concentrations that exceed human health standards. The VPH Method includes MBTEXN

compounds but the EPH Method does not. MBTEXN compounds are often present in the heavier petroleum products and may represent significant health risks when present in the environment. Consequently, VPH analysis is required in addition to the EPH Method at all diesel #1, diesel #2, kerosene, jet fuel, and waste oil release sites to determine MBTEXN concentrations. Table B outlines the analytical methods DEQ requires for individual petroleum products in groundwater.

Table B - Testing Procedures for Groundwater

Petroleum Product	VPH	EPH Screen	EPH Fractionation	EPA Method 8270C for PAHs	EPA Method 8260B	Oxygenates & Lead Scavengers
Gasoline/Aviation Gasoline	R					SS
Diesel (#1 & #2)	R	R	SS	SS		
#1 - #2 Heating Oils	R	R	SS	SS		
#3 - #6 Fuel Oils		R	SS	SS		
Used/Waste Oil	R	R	SS	SS	R	SS
Kerosene, Jet Fuels (Jet-A, JP-4, JP-5, JP-8, etc.)	R	R	SS	SS		
Mineral/Dielectric Oils		R	SS	SS		
Heavier Wastes		R	SS	SS		
Crude Oil	R	R	SS	SS		
Unknown Oils/Sources	R	R	SS	SS	R	SS

R - required analysis
SS – Site-Specific determination.
EPH fractionation may be required if the EPH screen concentration is >1000 ppb TEH.

To reduce analytical costs, DEQ uses the EPH screening technique. The EPH screen approach is similar to that described above for soils and generates a TEH concentration. If the initial screening result is 1000 parts per billion (ppb) TEH or less, EPH fractionation is not required. VPH analysis is also required initially for some contaminants. If the TEH concentration exceeds 1000 ppb, fractionation may be required. More than one sampling event may be required to verify this. PAH analysis using EPA Method 8270 will be required for refinery wastes and other heavy hydrocarbons regardless of the screening concentration.

At targeted sites, including facilities that have used or currently use aviation fuel and facilities that may have had releases of leaded gasoline, the DEQ has initiated sampling for the lead scavengers 1,2 DCA (1,2 dichloroethane) and EDB (also known as 1,2 dibromoethane). Lead scavengers were added to leaded gasoline worldwide, from the 1920's through the 1980's to reduce engine fouling caused by the tetra ethyl lead that was added to gasoline as an anti-

knocking compound. Lead scavengers may still be present in off-road fuels such as racing gasoline and leaded aviation gasoline.

EPH Screen vs TEH

The initial groundwater samples must be submitted for the EPH screen and fractionation analysis if the EPH screen concentration is greater than 1000 ppb to establish a means of comparing the EPH screen concentration and the post-fractionation TEH concentration. There can be significant differences between the EPH screen and the post- fractionation TEH concentration for the same sample because they are derived by two distinct analytical methods. The EPH screen method is very similar to the former diesel range organic (DRO) method whereas the EPH fractionation step is an additional step in the Massachusetts Method that is not included in a DRO analysis.

The EPH Screen concentration is a summation of all of the compounds that are extracted from the sample and show up on the chromatogram regardless of elution time. These compounds may include naturally occurring organics, intermediate metabolites (hydrocarbon breakdown products) and petroleum hydrocarbons.

The post-fractionation TEH concentration is a summation of the compounds that show up on the chromatograms after the sample has been run through a silica gel cartridge and rinsed with hexane and methylene chloride. The silica gel removes polar petroleum hydrocarbons such as intermediate metabolites and naturally occurring organics so the compounds that pass through the cartridge should be the regulated petroleum hydrocarbons.

The difference between the EPH screen and post- fractionation TEH concentration may have little bearing on a site until the contamination is at a concentration where the site may be considered for closure. For example, a worst-case monitoring well yields an EPH screen concentration of 1500 ppb, (exceeding the beneficial use criteria of 1000 ppb), and a post-fractionation TEH concentration of 600 ppb. Can this site be considered for closure? Yes, if there are no fraction RBSL or DEQ-7 exceedances, and the contamination will not affect current or potential beneficial use of the groundwater. The DEQ will regulate the post-fractionation TEH concentration because it applies to regulated compounds (aliphatic and aromatic fractions) but will also take into account the EPH screen concentration to ensure that current and future beneficial use of groundwater at the site and adjacent properties is protected.

VPH/EPH Sampling Protocol

A number of questions should be addressed when collecting soil and groundwater samples for analysis including: holding time, preservation method, and what type of and how many sample containers to use for collecting Volatile Petroleum Hydrocarbons (VPH) or Extractable Petroleum Hydrocarbons (EPH) samples. Table C contains some useful information to assist in planning and conducting soil and water sampling.

Table C – VPH/EPH Sampling and Preservation Protocol

Parameter	Analytical Method	Sample Container/ Preservation	Holding Time
		Soil Samples	
VPH	Massachusetts Method VPH	for samples not methanol preserved 1 – 4 oz. glass jar, cool to 4° C, or preweighed jar or vials **with methanol** plus 1 – 4 oz. glass jar without methanol for moisture analysis, cool to 4° C	7 days to lab preservation and extraction 28 days from extraction
EPH Screen	Massachusetts Method EPH	1 – 4 oz. glass jar, cool to 4° C	7 days to lab preservation/extraction
EPH Fractionation with or without PAH's	Massachusetts Method EPH	1 – 4 oz. glass jar, cool to 4° C	7 days to lab preservation/extraction
Volatiles Organics	EPA Method 8260B	1 – 4 oz. glass jar, cool to 4 °C	14 days to extraction
RCRA Metals	Method SW 3050A	50 gram plastic or glass jar, no preservation	6 months
Oxygenates	EPA Method 8260B	125 ml glass jar, cool to 4° C	14 days to extraction
Lead Scavengers EDB 1,2 DCA	EPA Method 8011 EPA Method 8260B	125 ml glass jar, cool to 4° C	14 days to extraction
		Aqueous Samples	
VPH	Massachusetts Method VPH	3 – 40 ml. vials, acidify with HCl to pH <2 , cool to 4° C	14 days to analysis
EPH Screen	Massachusetts Method EPH	2 – 1 liter amber glass bottles, acidify with H_2SO_4 to pH <2, cool to 4° C	14 days to extraction
EPH	Massachusetts Method EPH	2 – 1 liter amber glass bottles, acidify with H_2SO_4 or HCl, cool to 4° C	14 days to extraction
Volatile Organics	EPA Method 524.2	3 – 40 ml vials, acidify with HCl to pH <2, cool to 4° C. Remove chlorine with Ascorbic Acid.	14 days to analysis
Volatile Organics	EPA Method 8260B	2 – 40 ml vials, acidify with HCl to pH <2, cool to 4° C	14 days to analysis
PAHs (Semivolatile Organics)	EPA Method 8270C	2- 1liter amber glass bottles, **do not acidify**, cool to 4° C. Remove chlorine with ~4 drops of 10% Sodium Thiosulfate ($Na_2S_2O_3$)	7 days to extraction
Lead Scavengers EDB 1,2 DCA	EPA Method 8011 EPA Method 8260B	3 – 40 ml vials, acidify with HCl to pH <2, cool to 4° C. Remove chlorine with ~4 drops of 10% Sodium Thiosulfate ($Na_2S_2O_3$)	14 days to analysis
Oxygenates	EPA Method 8260B	2 – 40 ml. Vials, acidify with HCl to pH < 2, or raise pH to >11 with trisodium phosphate (TSP) for ethers and alcohols, cool to 4° C	14 days to analysis

Soil Sample Collection and Preservation

The sampling protocols for VPH and EPH vary in a few respects from GRO/DRO sampling previously required by DEQ. They are as follows:

There are two DEQ approved methods for collecting soil samples for VPH analysis: with methanol preservation and without methanol preservation. The DEQ is not routinely requiring that soil samples for RBCA analysis be methanol-preserved in the field at this time but may be required on a site specific basis. The VPH Method includes field methanol preservation. This requires a total of three containers for each sample: two 40-ml glass vials containing preweighed amounts of methanol and one four-ounce jar for a moisture analysis. For samples that are not methanol preserved in the field, to ensure that significant loss of volatiles does not occur, the samples must be placed on ice immediately upon collection and methanol preserved by a laboratory within seven (7) days of sampling.

Soil samples collected for EPH analysis must be placed on ice immediately upon collection to ensure that significant loss of contaminants does not occur; the samples must be placed on ice immediately upon collection and methanol preserved and extracted by a laboratory within seven (7) days of sampling.

Laboratory Moisture Data Reporting for Soil Samples

All soil data must be reported on a dry-weight basis. Moisture percentage must also be determined and reported on the laboratory data reports.

Aqueous Sample Preservation

The VPH Method recommends the use of three (3) 40 milliliter (ml) vials. The samples are to be preserved by adding hydrochloric acid (HCl) and reducing the pH to 2 or less, and placed on ice immediately. Chilled, preserved samples must be analyzed by a laboratory within 14 days of sampling.

The EPH Method recommends 5 milliliters of 1:1 HCl, or suitable acid, as a preservative. Sulfuric acid (H_2SO_4) is a suitable acid. EPH samples must also be placed on ice immediately after sampling and preservation. The samples must be extracted by a laboratory within 14 days.

Trisodium Phosphate (TSP) is used as an alternative to acid preservation for fuel oxygenates. It prevents the biological degradation of the target analytes and does not cause hydrolysis of ethers to alcohols.

At sites where drinking water supplies, either water supply lines or domestic or public water supply wells, are threatened by petroleum contamination, the DEQ may require a volatile organic compound (VOC) analysis by EPA Method 524.2 of the water inside the well or pipelines. HCl is used as a preservative. If the water system is chlorinated, ascorbic acid needs to be added to prevent the formation of chlorination by-products. If the supply is not chlorinated then just HCl is used for preserving the sample.

Odors as a Significant Risk to Public Welfare/Nuisance Condition

Previous versions of Montana Tier 1 Risk-Based Corrective Action Guidance for Petroleum Releases included numerical ceiling concentrations for total gasoline range and diesel range fractions in soil to protect public welfare. This version addresses public welfare and nuisance condition based on site-specific considerations rather than a numerical concentration for soil. Numerical ceiling concentrations are still included for total purgeable hydrocarbons (TPH) and total extractable hydrocarbons (TEH) in groundwater, as depicted in footnotes for Table 3.

The existence of a nuisance condition shall be considered in a characterization of risks to public welfare. Given the low odor recognition thresholds of many petroleum constituents (and breakdown products), the presence of odors at petroleum-contaminated sites can constitute a nuisance condition.

Because of the variability of human olfactory senses as well as the variability in the composition of petroleum products, definitive and quantitative guidelines and standards on when a petroleum odor constitutes a nuisance condition and significant risk to public welfare are generally not appropriate. In the context of petroleum-contaminated sites; however, the following rules of thumb are suggested for when an odor condition would generally NOT be considered a nuisance condition:

1) Odors observed in the subsurface during excavation or boring advancement would generally not be considered a nuisance condition, as long as such odors are not detectable in ambient or indoor air, and as long as there are no plans to excavate or disturb such areas.

2) Odors observed in the breathing zone of the ambient air, or indoor air of an impacted structure, would generally not be considered a nuisance condition, if such odors do not persist for more than 3 months.

3) Odors observed in the breathing zone of the ambient air would generally not be considered a nuisance condition if they are discernable less than 10 days a year.

4) Odors observed in the ambient air or indoor air of an impacted structure would generally not be considered a nuisance condition if the occupants of such a structure do not believe such odors significantly affect or degrade their quality of life.

Many compounds may pose an unacceptable inhalation health risk at concentrations below levels that can be detected by odors. The presence of odors within structures should always be evaluated for vapor intrusion risks as discussed in the Vapor Intrusion to Indoor Air section of this document.

Vapor Intrusion to Indoor Air

Vapor intrusion (VI) sampling is an assessment as to whether or not the vapor intrusion exposure pathway is complete and, if so, whether it poses an unacceptable risk to human health. A complete pathway means that humans are exposed to vapors originating from site contamination: either from volatilation from impacted soil, impacted groundwater, or both. **The RBSLs for soil and water are not designed to be protective of the vapor intrusion (VI) pathway. If volatile compounds are present in the vicinity of inhabitable structures, then the VI pathway should be evaluated either qualitatively or quantitatively.** The DEQ is developing VI guidance for Montana, but until that guidance document is completed currently available VI guidance documents should be used to assess and evaluate VI risks. The DEQ will approve specific evaluation procedures on a site-by-site basis. The EPA has recommended using the vapor intrusion guidance developed by the Interstate Technology & Regulatory Council (ITRC). The ITRC Vapor Intrusion Team—composed of representatives from 19 state environmental agencies, 12 environmental companies, and 4 federal agencies (including EPA)—developed an ITRC Technical and Regulatory Guidance document, *Vapor Intrusion Pathway: A Practical Guide* (VI-1, 2007), and a companion document, *Vapor Intrusion Pathway: Investigative Approaches for Typical Scenarios* (VI-1A, 2007). The states of New York, New Jersey, Massachusetts, and California also have vapor intrusion guidance that contains useful information.

Using Tier 1 Look-Up Tables

The Tier 1 Evaluation

The Tier 1 RBSL lookup tables contain target cleanup levels for surface soil, subsurface soil, and groundwater (see Tables 1, 2, and 3, respectively). These tables are arranged in categories that reflect different site conditions. To determine the appropriate RBSLs, the RP (or their consultant) and DEQ staff match the values in the categories of the tables that correspond with the conditions present at the site.

For the purposes of Tier 1 evaluation, contaminated soil is classified either as "surface soil" lying two feet or less below the ground surface, or as "subsurface soil," buried more than two feet below ground surface. Tier 1 RBSLs for contaminated soil are divided into three categories depending on the distance to groundwater beneath that contaminated soil: 1) soil less than ten feet above groundwater, 2) soil between ten and twenty feet above groundwater, and 3) soil greater than twenty feet above groundwater. The distance to water is determined using the depth to the water table measured from the location where the soil sample is taken to the highest level seasonal conditions in a well screened in the uppermost zone of saturation within 500 feet of the release. Nearby water supply wells may not be appropriate in some case to determine the depth to the uppermost saturated zone (first water) as they may be completed in a deeper zone. If the soil sample is collected below an UST at a depth of 10 feet below ground surface, and the water table is 25 feet below the ground surface, the depth to the groundwater is 15 feet. In

determining which Tier 1 table is appropriate for your situation you must know three depths: 1) the depth the sample was taken below the ground surface, 2) the depth the water table is below the ground surface and 3) known distance to groundwater below contaminated soil (which is calculated by subtracting 1 from 2). When contamination is present both at both surface and subsurface depths, samples must be collected from highest concentration in each depth zone and compared to the appropriate Tier-1 tables.

DEQ and the RP must also consider the current and reasonably anticipated future use of sites with contaminated surface soil. The site may be designated commercial or residential by taking into account past, current, and potential future uses of the site, zoning, and other relevant factors. Residential sites are those where someone resides or may reside in the future at the site and commercial sites are those without residents used only for commercial/industrial purposes. This determination is only relevant for petroleum-contaminated surface soil. When site conditions are not well defined, DEQ uses the most conservative soil RBSLs, corresponding to the shallowest depth to groundwater below contaminated soil with residential use.

If RCRA metals are analyzed, concentrations must be compared to the following screening levels.

Table D – RCRA Metals Screening Levels

Metal	Screening Level	units
Arsenic	40 [a]	mg/kg
Barium	820 [b]	mg/kg
Cadmium	3.8 [b]	mg/kg
Chromium	280[c]	mg/kg
Lead	400[c]	mg/kg
Elemental Mercury	1.0 [b]	mg/kg
Selenium	2.6 [b]	mg/kg
Silver	8.9 [d]	mg/kg

a: Based on Montana DEQ Remediation Division Action Level for Arsenic in Surface Soil (April 2005).
b: Based on the EPA 2008 maximum contaminant level-based protection of groundwater soil screening level (multiplied by 10).
c: Based on the EPA Regional Screening Level for residential soil (EPA, April 2009).
d: Based on the following formula:
(DEQ-7 human health standard)/(tapwater screening level) * (Risk-based soil screening level) * 10

If these screening levels are exceeded, further evaluation is required. DEQ should be contacted to determine what evaluation is appropriate.

Under Petroleum Storage Tank rules, ARM 17.56.506, a release is confirmed when any soil sample collected from a site is measured at levels exceeding levels published in Table 1 of this document. **It is important to note that this law also requires persons conducting subsurface investigations, as well as many other parties, to report the release to DEQ. Failure to report a confirmed release in the specified time period may result in enforcement actions against persons failing to report.**

To be considered for closure under Tier 1, soil and groundwater samples from a site must not contain COC concentrations that exceed the appropriate Tier 1 RBSLs. DEQ issues a "No Further Corrective Action Letter" when Tier 1 RBSLs and closure criteria are satisfied and it is clear from other information that no further cleanup action is necessary.

Should COC concentrations exceed the values in the appropriate Tier 1 RBSL Lookup Table(s), the release is not ready to be resolved under the Tier 1 process. However, it may be possible to remediate a release to Tier 1 RBSLs by removing more contaminated material (e.g., through further excavation or *in situ* remedial techniques), then resampling and following the Tier 1 evaluation process again. Releases that cannot be resolved under the Tier 1 evaluation process, including those with COCs in groundwater above the DEQ-7 human health standards or Tier 1 RBSLs (Table 3), will require further remedial action before they can be resolved.

Summary of Tier 1 Procedures

Procedures for evaluating a release using RBCA Tier 1 are summarized as follows:

- Based on field screening results, initiate site assessment and appropriate interim corrective action (including soil removal or free product abatement activities in the source area).
- Determine if a petroleum release is confirmed.[2] At UST and PST sites petroleum releases are confirmed when pre- or post excavation soil analytical results exceed the RBSLs in the first numeric column of the Tier 1 Surface Soil RBSL Table (Table 1).
- Upon receipt of confirmation of a petroleum release, the RP , and certain other parties, must notify the appropriate DEQ Bureau of the release within the time specified in law. If the release is from a UST or an PST use the information in the 24-hour Release Report (see Appendix A). Timeframe and reporting requirements for releases from USTs and PSTs is described in ARM 17.56.501 through 506.
- Based on the sample depth and distance to groundwater, find the appropriate RBSL value in the Tier 1 tables.
    - If the post-excavation sample depth is two feet or less, the sample represents surface soil and the Tier 1 Surface Soil RBSLs (Table 1) apply.
    - When samples represents surface soil, the appropriate land use must be determined.
    - If anyone lives at the site or may live at the site in the future, residential RBSLs apply to surface soil.
    - If the site is used as a place of business with employees present regularly and no one lives at the site, commercial RBSLs apply to surface soil.
    - If the post-excavation sample depth is greater than two feet, the sample represents subsurface soil and the Tier 1 Subsurface Soil RBSLs (Table 2) apply.
    - For both types of soil, if groundwater at the site is less than ten feet below the sample location, the first set of RBSLs apply (left hand column(s)).

2. Different program regulations may have different reporting requirements. In addition to RBSL exceedances, Montana Petroleum Storage Tank (PST) regulations also require reporting of all PST-related releases of 25 gallons or greater or any size UST-related release that is not remediated within 24 hours. (ARM 17.56.505).

    - For both types of soil, if groundwater at the site is between ten and twenty feet below the sample location, the second set of RBSLs apply (middle column(s)).
    - For both types of soil, if groundwater at the site is greater than twenty feet below the sample location, the third set of RBSLs apply (right hand column(s)).
- If worst-case soil sampling results are less than the appropriate RBSL value, the release may be evaluated for closure.
- If necessary and appropriate, conduct additional remediation or investigation.
- Following removal of additional soil or *in situ* remediation, compare soil confirmation sampling results with RBSLs on the Tier 1 Tables.
- If worst-case soil sampling results are less than the appropriate RBSL value, the release may be evaluated for closure.
- At any point in the process, if groundwater sampling results or site conditions indicate that groundwater is impacted, compare the site data to the Tier 1 groundwater RBSLs (Table 3) to evaluate groundwater sampling results. More than one sampling event may be required for a complete evaluation.
- If groundwater sampling results exceed the Tier 1 groundwater RBSLs (Table 3) the release cannot be resolved under the Tier 1 RBCA process, and a groundwater investigation must be completed.
- Within 30 days of a release from a UST or PST, the RP must submit a completed 30-Day Release Report form (Appendix A) to the DEQ Remediation Division. Other agencies or Bureaus may have other reporting requirements.
- If soil sampling results exceed RBSLs, complete initial site assessment and corrective action based on site conditions and according to a DEQ-approved corrective action plan.

Figure 1 on page 17 is a flowchart showing the RBCA Tier 1 process for a typical UST site addressed by the DEQ Petroleum Technical Section.

Development of Tier 1 Lookup Tables

DEQ calculated Tier 1 RBSLs for exposure pathways commonly associated with petroleum releases. RBSLs for surface soil were calculated for the soil leaching to groundwater pathway, and for the direct-contact pathway assuming residential and commercial land use. RBSLs for subsurface soil were calculated for the soil leaching to groundwater pathway, and for the direct contact pathway to account for exposure of receptors during any excavation/construction at a site. For each of the three distance to groundwater categories in Tables 1 and 2, the RBSLs DEQ published reflect the lowest COC concentration calculated for either of the two Tier 1 exposure scenarios (i.e., for the soil leaching to groundwater pathway or through direct contact). Appendix C is a comprehensive soil RBSL table presenting the RBSLs calculated for both direct contact and leaching to groundwater.

Tier 1 RBSLs for groundwater in Table 3 consist of DEQ-7 human health standards for the individual (target) COCs. For the non-target petroleum fractions, direct contact RBSLs were calculated using the fraction-surrogate approach and compared to beneficial use criteria, and the lowest target value for each fraction was used in Table 3.

Derivation of RBSLs

Tier 1 RBSLs were calculated using chemical fate and transport models, exposure models, and data characterizing the mobility, toxicity, and aesthetics of petroleum compounds. The contaminant transport models simulate chemical movement from a release source to underlying groundwater, and incorporate conservative assumptions regarding soil type, the rate of water infiltration, and the behavior of the COCs. Contaminant transport modeling results were used to calculate soil target levels protective of groundwater RBSLs (including DEQ-7 human health standards). Exposure modeling was performed to characterize potential risk from direct contact with contaminated soil, including ingestion, inhalation, and dermal contact exposure routes, and contact with groundwater, including ingestion and inhalation.

Refined petroleum products are typically mixtures of organic chemicals, many of which do not have DEQ-7 human health standards. The Groundwater RBSL Table (Table 3) includes DEQ-7 human health standards for target COCs for which standards were available.

RBSLs for the non-target ranges of petroleum hydrocarbons were developed using a fraction-surrogate approach because DEQ-7 human health standards were not available. These petroleum constituents are divided into fractions (e.g., C5-C8 aliphatics) based on chemical behavior and toxicity. RBSLs were calculated using a chemical representative ("surrogate") for each fraction. Groundwater RBSLs were developed for each petroleum fraction based on the toxicity and aesthetic qualities of each surrogate chemical. Toxicity values were combined with exposure parameters used to estimate ingestion and inhalation exposure to the COCs in groundwater to develop RBSLs based solely on risk to human health. These parameters were similar to those used to develop DEQ-7 human health standards. Information about taste and odor thresholds for these COCs in groundwater was obtained from other states and used to develop RBSLs based on protection of the beneficial use of the groundwater. DEQ also considered the lowest reasonably achievable practical quantitation limit in setting RBSLs for the petroleum fractions.

Soil RBSLs were calculated for each petroleum fraction using the chemical fate and transport model used for the target compounds. These soil RBSLs are designed to be protective of groundwater below releases, so that contaminants leaching from contaminated soil will not cause groundwater to exceed groundwater RBSLs.

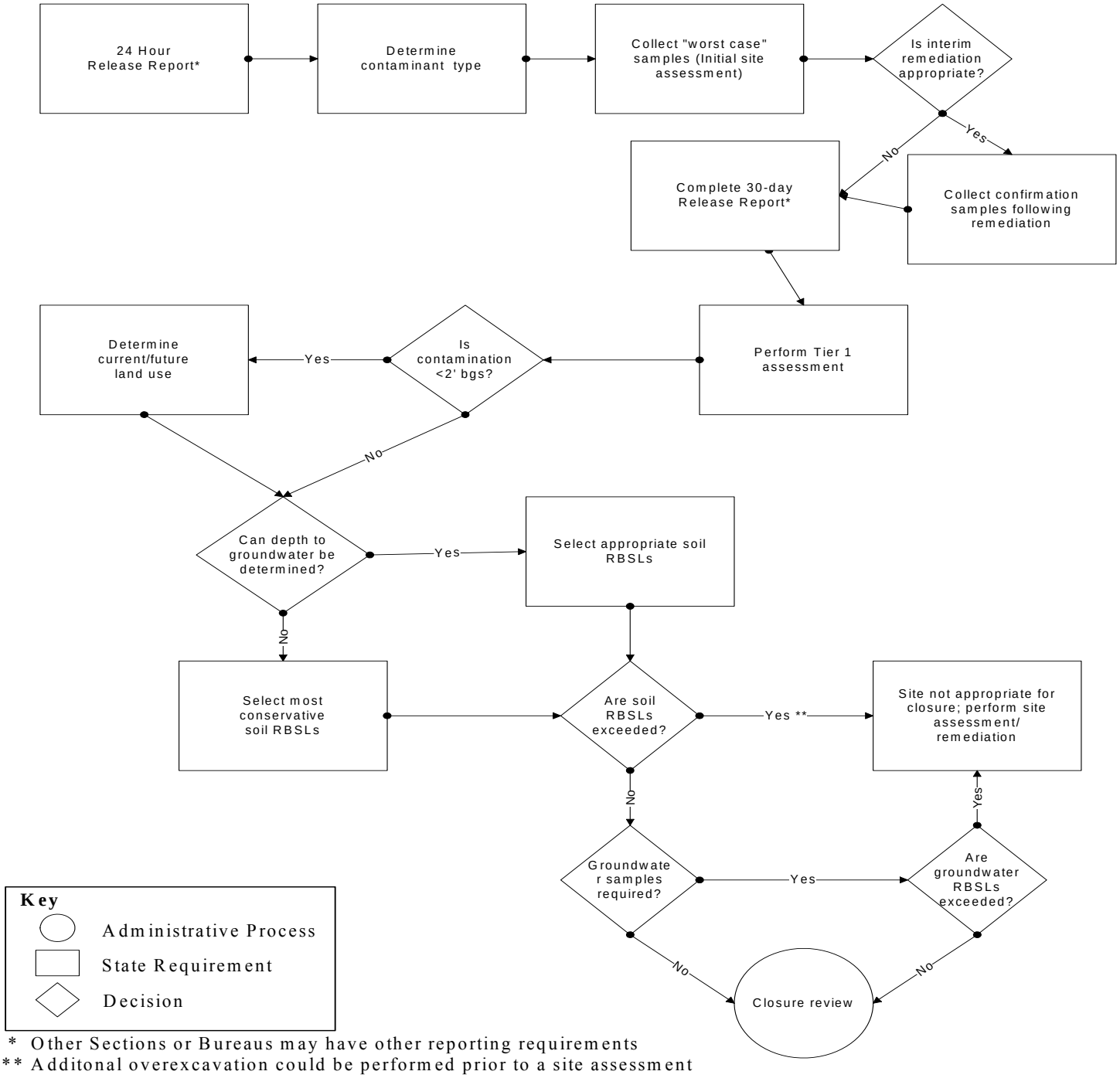
Conservative, generic estimates of physical, chemical, and exposure parameters were used to develop the Tier 1 RBSLs. These generic estimates produce RBSLs with built-in safety margins, to compensate for the limited site-specific information typically available at Tier 1. The conservative Tier 1 RBSLs were created using several generic "worst-case" assumptions for model parameters.

Models Used to Generate Tier 1 RBSLs

DEQ staff calculated Tier 1 RBSLs for the soil leaching to groundwater pathway using the "VS2DT Solute Transport in Variably Saturated Porous Media" model (United States Geological

Survey), combined with the "Hydrologic Evaluation of Landfill Performance" (HELP) model, which was used to estimate water infiltration rates. Direct contact RBSLs were calculated using equations developed by the United States Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection. The specific assumptions used in DEQ's Tier 1 soil leaching to groundwater models are discussed in Appendix D. The assumptions used in the direct contact modeling, including those associated with the fraction-surrogate approach, are discussed in Appendix E. Since Tier 1 RBSLs are intended for use at a variety of releases throughout the state, the assumptions of Tier 1 provide for a wide margin of safety, and are therefore conservative.

Figure 1 --- RBCA Tier 1 Decision Tree



* Other Sections or Bureaus may have other reporting requirements
** Additonal overexcavation could be performed prior to a site assessment

Appendix A

Tier 1 RBCA

24-HOUR AND 30-DAY UST RELEASE REPORTS

Appendix B

Tier 1 RBCA

ENFORCEMENT DIVISION COMPLAINT/SPILL REPORT

Appendix C

Tier 1 RBCA

MASTER TABLE OF POTENTIAL TIER 1 VALUES

Appendix D

Tier 1 RBCA

VADOSE ZONE MODELING TECHNICAL SUPPORT DOCUMENT

Appendix E

Tier 1 RBCA

DIRECT CONTACT
TECHNICAL SUPPORT DOCUMENT

Appendix F

Tier 1 RBCA

TECHNICAL MEMORANDUM: APPLICATION OF THE MASSACHUSETTS METHOD IN FACILITY CHARACTERIZATION