Petroleum Mixing Zone Corrective Action Plan
Report Requirements

Montana Department of Environmental Quality
Remediation Division
Petroleum Mixing Zone (PMZ) Corrective Action Plan (CAP) Requirements

A release can be resolved with a PMZ only when all conditions set forth in law and rule have been met. Please refer to Page 1 of this guidance and/or Section H of the checklist (Appendix A) for more information.

Upon file review, a DEQ PM may require a PMZ Corrective Action Plan (CAP) from a requesting O/O (or representative). If appropriate, a CAP is prepared to evaluate whether a release could be resolved with a PMZ. The CAP may be prepared by the O/O and submitted for DEQ approval when all the requirements set forth in §75-11-508, MCA, and administrative rules adopted at ARM 17.56.607 have been met. The DEQ Project Manager (PM) will evaluate whether the release may be resolved with a PMZ.

DEQ will complete an initial technical review of the release documents based on the DEQ Petroleum Release Closure Checklist (Appendix A). If deficiencies are found, DEQ will likely require those to be resolved before continuing the closure with a PMZ process. A submitted CAP that follows this guidance should provide rational as to how and why the release is ready to close with a PMZ. Some additional information may be required so that DEQ can determine if the release is eligible for "resolved with a PMZ" categorization.

Note: Most of the requested information for CAP preparation has already been collected and reported to DEQ through various investigations or clean-up reports. The CAP is intended to summarize work already completed. Whenever possible, the person submitting this CAP should copy applicable sections, information, maps, data tables from previously created documents. In the event that this information is not available, check DEQ's release files and use already produced maps, text, tables, and materials that are part of the public record. Recreation of past data and information can become time and cost intensive; please communicate with the DEQ PM prior to CAP preparation if data are unknown or missing.

Responses to the required sections in the PMZ CAP should be informative and provide DEQ with clear rational to support the closure with a PMZ. If parts of the CAP do not make sense or are not clear, DEQ will return the PMZ CAP to the preparer and ask for further clarification. When DEQ has to ask for further clarification or details, the process is prolonged. DEQ strongly encourages the O/O (and/or representative consultant) to communicate any questions or discrepancies early and before submitting a formal PMZ CAP.

Each petroleum release is unique, so site-specific details apply and will control the applicability of each section presented in this CAP guidance. When in doubt, please contact the DEQ PM to discuss the specifics. The outline of this report format coincides with the established the minimum standards set forth in statute and rule for categorization of a petroleum release as closed with a PMZ under ARM 17.56.607(10). Based on site conditions, DEQ may require additional or different information before categorizing a release as closed with a PMZ.

Further, submittal of a Petroleum Mixing Zone Closure Summary Report may not result in categorization of a release as closed with a PMZ. DEQ will evaluate all submitted information for consistency and compliance with environmental statutes and rules. Upon review, DEQ will communicate with the O/O (or others) as to the categorization of the release, and whether additional information or corrective actions are necessary.

Map Depicting Proposed PMZ

The Corrective Action Plan (CAP) shall include a map depicting the proposed PMZ boundaries and a "buffer zone" boundary extending 500 feet beyond the proposed PMZ boundary. The map shall be drawn to scale and include permanent landmarks that are reasonably expected to remain in place throughout the life of the PMZ, such as roadways, survey markers, historical buildings, and other durable features. The map shall also depict the following graphical information:

a. All tank systems associated with the release (including tanks, piping, fill ports, vent lines, sumps, pumps, and dispensers);
b. The source of the release (if a specific source has not been identified, depict all portions of the tank system(s) that can have reasonably contributed to the release. If the release originated from a surface spill, depict the point(s) where petroleum entered the subsurface as the source area.);

c. Groundwater flow direction(s) (for sites where groundwater flow changes seasonally, depict the swing or range of flow directions);
d. A point measured 500 feet down-gradient from the furthest down-gradient edge of the source for each flow direction depicted;
e. Facility boundaries. ("Facility property" means a single parcel or contiguous parcels on which one or more petroleum storage tanks are or were located, provided that contiguous parcels must be under single ownership at the time the petroleum mixing zone is established.);
f. All other property boundaries where the PMZ is proposed to be established, if applicable, and attach copies of any recorded easements allowing the PMZ to extend off the Facility property;
g. All groundwater supply wells within 500 feet of the proposed PMZ boundary;
h. All surface water bodies within 500 feet of the proposed PMZ boundary;
i. All utilities within 500 feet of the proposed PMZ boundary; and
j. Copies of proposed institutional controls, engineering controls, or physical conditions in place to ensure that identified risks to human health and safety are reduced to acceptable levels, including a map that will be recorded with the proposed institutional control.

Determining the Boundary of the PMZ

The boundary of the proposed PMZ is an inferred line beyond which the concentration of any petroleum constituents in groundwater do not exceed a water quality standard adopted by the Board of Environmental Review pursuant to 75-5-301, MCA. This boundary is determined through documented groundwater quality measurements collected during a remedial investigation or corrective action plan conducted in accordance with ARM 17.56.604.

The PMZ boundary will be established at the location of the monitoring point closest to the contaminant source where water quality standards are met. Extrapolating the location of the PMZ boundary between two monitoring points based on relative concentrations will not generally be approved by DEQ. The PMZ boundary will be established through points where contaminant concentrations are measured at or below water quality standards based on the results of a remedial investigation or corrective action plan conducted in accordance with ARM 17.56.604.

Petroleum Mixing Zone Corrective Action Plan Report

A DEQ-approved PMZ CAP Report is required to establish a PMZ and the following pages contain the minimum requirements for such a report. A PMZ CAP Report will determine the extent and magnitude of contamination that will rely solely on natural attenuation for further remediation and will evaluate the risk this residual contamination poses to human health, safety and the environment. The report will document site conditions and provide a risk evaluation. Not all of the below-listed sections will be required for every release site. When a section is not required, it will be omitted with a brief explanation.

TITLE PAGE
The title page must include the following information:
1. Title of the report ("Petroleum Mixing Zone Closure Summary Report for Release #[insert release number(s)]);
2. Facility Name and DEQ Facility ID Number;
3. Facility Physical Street Address, City, and County;
4. Responsible party's name, mailing address, and phone number;
5. Consultant's name, address, and phone number;
6. Contact person's name, mailing address, and phone number (if different from above); and
7. Date report prepared.

EXECUTIVE SUMMARY
The executive summary should describe the investigation, corrective actions, current site conditions, and rationale for closure with a PMZ. This section should be one page or less in length.

CHRONOLOGY

Include a chronology of events, beginning with the most recent activity, associated with the release assessment, investigation, and remedial activities conducted at the facility. Include the date of actions taken and a brief description of release abatement activities, assessment activities and response actions conducted. Incorporate and describe ownership and operational history of the facility. Provide the names of the all property owners during the time the petroleum storage tanks (PSTs) were located on the facility property; provide the names of all owners and operators of PSTs located on the facility property (if different from the current property owner).

TABLE OF CONTENTS

The table of contents must include the following information:

1. Titles of report sections and page numbers (please use naming/numbering methodology for main sections listed below);
2. Lists of tables and figures; and
3. List of appendices.

SECTION 1: FACILITY INFORMATION

The purpose of this section is to describe the environmental setting, the geology/hydrogeology of the area, general ownership and operational history of the facility, the extent of the release, any offsite properties impacted by the release, and source(s) of the release.

1.1 Physical Location

Identify the name of the facility; provide either the physical street address, or a legal description for the facility property. Provide all names used to identify the facility (if it was identified through time by more than one name). For example: Corner Gas Station (2001), then All-in-1 Fueling Station (2010) .

Describe the topography and surface conditions that might influence distribution of constituents of concern at the facility. Discuss ground slope direction and grade, surface water bodies, and other significant topographic features. Identify whether the site is within the 100-year floodplain.

Provide a to-scale facility site map or maps and descriptions or symbols appropriate to the map/maps and scope showing the following within a 500-foot radius of the site (information may be shown on more than one map for clarity):

1. Adjacent and nearby buildings;
2. Land use of adjacent properties and buildings;
3. Surface conditions (i.e., extent of paved or concrete areas, etc.); and
4. Property lines defining property ownerships and the facility property boundary.

1.2 Site History

The purpose of this section is to describe the site history with regard to PST ownership, PST operation, regulatory compliance, and release identification and remediation. A thorough description of site history will assist with the evaluation of whether or not the site has been adequately assessed.

1.2.1 History of ownership and operation of the facility, going back at least to the date of release confirmation, including the following:

1. The name, current address and telephone number of all current owners and operators;
2. The name, current address, and telephone number (if known) of all past owners and operators;
3. The approximate time period during which each owner owned the facility property and/or the PSTs located on the facility property;
4. A description of the activities conducted at the site during the period each owner owned the facility property or the PSTs located on the Facility property;

5. A general construction history of the site;
6. Former and existing hazardous material/waste storage areas, lagoons, and waste pits; and
7. Waste management history.

1.2.2 History of operation of PSTs at the facility or on the facility property going back at least to the date of release confirmation, including the following (some or all of this information may be presented in tabular form):

1. Dates of installation and removal of all existing and former tank systems located on the site;
2. Volume of tank(s);
3. Tank and piping construction material;
4. Overfill/spill protection and leak detectors;
5. Cathodic protection;
6. Date and description of repairs, replacements, modifications to tanks, piping, and/or ancillary equipment;
7. Condition of tank(s)/piping if removed, location, and size of any perforations; and
8. Map showing current and past tank configuration, piping layout and dispenser location. Distinct symbols should be used and referenced in the legend indicating current, inactive, and closed/removed tank systems or infrastructure.

1.2.3 History of compliance with local, state and federal environmental regulations to assess that all applicable environmental laws associated with the ownership and operation of the facility and with the release have been met:

1. List all environmental permits for the facility;
2. Provide all inspection or monitoring reports associated with each permit;
3. Provide a history of environmental violations, enforcement, and resolution of each violation ; and
4. Describe leak detection methods employed at the facility, including the results of product inventory reconciliation (describe and attach copies of product inventory charts from the time the release was first suspected until the release was abated).

1.2.4 A description of all confirmed and suspected leaks, spills, overfills or other releases from PSTs or any other petroleum sources located on the site. The following information should be included for each occurrence:

1. Date of release and description of how the release was initially suspected;
2. Date and by whom the release was reported to DEQ;
3. Type of product(s) stored on site, and type of product released;
4. Quantity released;
5. Quantity recovered;
6. Known or suspected cause of the release;
7. Description of immediate (within 30 days) cleanup action initiated;
8. Offsite effects;
9. For sites with multiple releases, if a release has been resolved (i.e., DEQ has issued a No Further Corrective Action (NFCA) letter), provide the date the release was resolved and the conditions listed in the NFCA letter (e.g., residual soil contamination, etc.);
10. Provide a map showing the location and extent of the release and a description denoting the area(s) where immediate cleanup action(s) were initiated;
11. For sites with multiple releases, if a release has been resolved include a map showing the extent of residual soil contamination (if applicable).

SECTION 2: EXPOSURE PATHWAYS AND RECEPTOR SURVEY

The purpose of this section is to describe the actions taken to identify the potential receptors in and within 500 feet of the proposed PMZ boundary. The identification of the presence or lack of receptors should be discussed and primary sources

of information should be included in an appendix. Note that the survey radius required by ARM 17.56.607(10)(i) is relative to the proposed PMZ boundary, not the facility property boundary.

2.1 Identification of Potential Receptors

The purpose of this section is to document the results of the 500-foot field receptor survey and the records survey to identify potential human and ecological receptors. The requestor must provide a map identifying and depicting the location of the potential receptors (i.e., water wells, structures, buried utilities, and surface water bodies) and identifying general land uses (i.e., residential, commercial/industrial) within the receptor survey area. The boundary of the 500-foot receptor survey area must be clearly depicted on the map. All potential receptors must be identified. Evaluation of the risk posed to each identified receptor is described in Section 6. The receptor survey must include a discussion of the following:

2.1.1 Drinking water: Identify the source(s) of potable water for each real property within 500 feet of the proposed PMZ boundary and the distance and direction of the water source from the proposed PMZ, and from the source of the petroleum release. The following information should be included for each water source:

Water wells:

1. Owner name;
2. Water use;
3. Groundwater production zone;
4. Well depth and screen interval(s);
5. Typical and maximum pumping rates;
6. Any existing institutional controls (e.g., local ordinances or deed restrictions) that prevent or restrict the installation of water wells; and
7. A copy of the well lithologic logs and/or existing institutional controls should be included in an appendix.

Water mains:

1. Name of the supplier;
2. Construction material; and
3. Water service connection points and current owner of property served by connection.

Surface water bodies serving as a drinking water source:

1. Name of the surface water body;
2. Water supply intake point(s); and
3. Water use(s).

Provide a to-scale map that shows the proposed PMZ boundary; the location of water wells, water mains, and water service connections; surface water bodies; and water supply intake points from the surface water body that are within 500 feet of the proposed PMZ boundary.

2.1.2 Vapors in structures: Identify the real property parcels and all structures including commercial and residential buildings, schools, and utility vaults within the PMZ boundary. The following information should be provided for each indentified structure:

1. Building use (i.e., residential, commercial/industrial, public use) and the type of business currently and historically conducted in the building;
2. Type of structure (e.g., residential duplex, residential single family house, apartment, commercial single business, commercial multiple business, etc.);
3. The number of floors and square footage of each floor;
4. Type of construction (e.g., basement, slab on grade, crawl space, etc.);
5. Foundation construction material;

6. Historical, current, and future use of basement;
7. Frequency of moisture problems and/or flooding in the basement;
8. Description of openings in the basement including but not limited to floor cracks, wall cracks, sump, and floor drain;
9. Description of building occupancy including the number of occupants, and the typical number of days per week, and hours per day the structure is occupied; and
10. Any existing institutional controls (e.g., local ordinances or deed restrictions) that limit or restrict land use within the PMZ boundary.

2.1.3 Direct dermal contact with surface soil (< 2 feet bgs): Describe the condition of soil within the upper 2 feet of the soil column and how those conditions relate to the proposed PMZ. Provide the following information for soil:

1. Uses of property (i.e., residential, commercial/industrial, recreational) in the area(s) where affected surface soil has been documented or may reasonably exist;
2. Surface soil lithology;
3. Description of hydrocarbon impacts to surface soil;
4. Description of hydrocarbon-affected soil that has been left in place;
5. Description of land surface conditions (e.g., concrete, asphalt, landscaped grass, etc.);
6. The presence or absence of burrowing animals that may contact surface soil; and
7. Any existing institutional controls (e.g., local ordinances or deed restrictions) that limit or restrict land use the PMZ boundary.

2.1.4 Buried Utilities: Describe the underground utilities located within or transecting the proposed PMZ. Discuss both open utilities (e.g., water, sewer, etc.) as well as closed utilities (e.g., phone, power, etc.).

2.1.5 Surface Water: Describe the surface water bodies located within the receptor survey area. If not shown in previous maps, provide a to-scale map clearly indicating surface water bodies within 500 feet of the proposed PMZ boundary. Provide the following information:

1. Name the surface water body (i.e., lake, river, pond, wetland);
2. State the distance and direction of any surface water bodies from the proposed PMZ boundary;
3. Describe any storm sewers that pass through or connect to sewers passing through the proposed PMZ. Include a description of construction materials, the surface water body the storm sewer discharges to, and the distance from the PMZ boundary to the discharge point;
4. Describe the topography between the proposed PMZ boundary and the nearest surface water body. Include a description of any conditions that may affect the direction of surface drainage, and the potential for erosion of surface soil to the surface water body; and
5. Describe the hydrogeologic conditions at the site in relation to surface water body(ies) (e.g., downgradient, crossgradient, upgradient, depth of the affected aquifer compared to the depth of the surface water body, groundwater flow direction, groundwater flow velocity, etc.).

2.1.6 Groundwater: Describe the uppermost groundwater bearing unit located within the receptor survey area, and describe any other groundwater bearing units that may have been, or may become affected by the release. Provide the following information for each groundwater bearing unit within the receptor survey area:

1. Describe the lithology from ground surface to the base of the groundwater bearing unit;
2. Describe the uses of the groundwater bearing unit (e.g., undeveloped, not potable due to salinity, not suitable as a water source due to production rate, etc.) If the groundwater within the receptor survey area is a drinking water source that is located within 500 feet of the proposed PMZ boundary, ensure that it is identified in Section 2.1.1 above;
3. Describe the hydraulic gradient and flow direction of the groundwater;

4. Describe the connection of all groundwater bearing units within the receptor survey area to surface water; and
5. If the groundwater bearing unit may be a suitable potable water source but is not currently used as one, describe any existing institutional controls (*e.g.*, local ordinances or deed restrictions) that prevent or restrict the future development of the groundwater bearing unit as a potable water source.

2.2 Exposure Pathway Identification and Evaluation

The purpose of this section is to identify all exposure pathways that may be complete from the contamination source to all potential receptors identified in Section 2.1. Include a sub-section for each identified receptor that discusses the conditions under which human health or ecological exposure pathways are, or may become, complete. Where applicable, include in the discussion for each identified receptor the following potential pathways:

1. Exposure to Surface Soil: Discuss the potential for human health or ecological exposure pathways to be completed through contact with or ingestion of surface soil or plants with root systems in potentially affected surface soil. Discuss the affects of land use (i.e., residential, commercial/industrial, recreational) on the potential completion of the exposure pathway and the potential for constituents of concern to leach from surface soil to groundwater.
2. Exposure to Subsurface Soil: Discuss the potential for human health or ecological exposure pathways to be completed through direct contact, or contact with vapors from subsurface soil. Discuss the potential for constituents of concern to leach from subsurface soil to groundwater, or to migrate through air into habitable structures.
3. Exposure to Groundwater: Discuss the potential for human health or ecological exposure pathways to be completed through the ingestion of groundwater, contact with vapors from groundwater, groundwater seeping into surface water, and groundwater seeping into sediments.
4. Exposure to Surface Water and Sediments: Discuss the potential for human health or ecological exposure pathways to be completed through contact with or the ingestion of surface water and sediments. Discuss how potential surface water use (e.g., recreational boating, recreational fishing, commercial fishing, etc.) may impact the potential completion of the exposure pathway.
5. Evaluate whether vapor intrusion presents a risk to existing or future structures within the PMZ boundary.

SECTION 3: SOIL INVESTIGATION

The purpose of this section is to discuss the results of the surface and subsurface soil assessment, the nature and extent of petroleum hydrocarbon contamination, the constituents of concern (COCs) in soil, and to relate the distribution of COCs in soil to the source(s) of the release and to potential human and ecological receptors. For this discussion, the term soil includes the vadose zone and capillary fringe. This section should discuss the following:

3.1 Describe the soil investigation

1. Describe the investigation methods (test pits, boring and monitor well installation, vapor sampling, heated headspace sampling, and other field screening methods);
2. Provide a rationale for the selection of each sample location (e.g., both boring location and sample interval from within the boring) and how the sampling locations and methods are the most optimal to detect petroleum hydrocarbons and/or COCs in soil;
3. Describe how each sampling location was chosen in relation to available history of the site, current infrastructure, and historical infrastructure;
4. Describe how the layout, infrastructure, and logistics of the release site modified or limited the investigation and how the investigation was designed to compensate for these logistical issues;
5. Describe the handling/disposal of investigation derived waste (e.g., soil cuttings); and
6. Provide an appendix detailing sampling and analysis plans and construction techniques that include the method(s) of sample collection, field screening, calibration of field instruments, sample preservation, and decontamination of non-dedicated sampling equipment.

3.2 Describe soil conditions

1. Describe soil type and characteristics (i.e., grain size, sorting, origin, texture, permeability, plasticity, classification, color, moisture content);
2. Describe soil, unconsolidated material, and bedrock at the facility from ground surface to the base of the groundwater bearing unit;
3. Provide an appendix with boring logs, monitor well logs, and/or test pit logs that includes a description of soil characteristics, field screening results, moisture observations, olfactory observations, blow counts, and other field observations.

3.3 Provide soil analytical results

1. Identify the requested chemical analyses and how the analyses relate to the type of materials, wastes, and products historically located at the facility;
2. Provide soil analytical results in tabular format that includes sample name, boring number, sample date, sample depth, COC name, RBSL, field screening result, and COC concentration reported in dry weight corrected mg/kg. Denote concentrations and/or reporting limits (for non-detected results) that exceed the RBSL;
3. Provide a to-scale map that clearly depicts the distribution of COCs and petroleum hydrocarbons in surface soils (0-2 feet bgs). The map should identify potential source areas; locations of borings and surface soil samples; excavated areas, buildings and other structures (including utilities); the maximum COC concentration detected at each location, including the depth at which the maximum COC was detected at each location; and a clearly labeled isoconcentration contour line representing the RBSL. (Note multiple maps may be required based on the number of COCs that exceed RBSLs.);
4. Provide a to-scale map that clearly depicts the distribution of COCs and petroleum hydrocarbons in subsurface soils (>2 feet bgs). The map should identify potential source areas; locations of borings and surface soil samples; excavated areas; buildings and other structures (including utilities); the maximum COC concentration detected at each location, including the depth at which the maximum COC was detected at each location; and a clearly labeled isoconcentration contour line representing the RBSL. (Note multiple maps may be required based on the number of COCs that exceed RBSLs.);
5. Provide two cross sections, perpendicular to each other, using at least three representative points showing the subsurface stratigraphy, and the extent and magnitude of COCs present in soil prior to corrective action. Cross section location lines should either be depicted on a separate map, or included on an index map. Cross sections should include the following:
    a. Boring or monitor well identification;
    b. Interpolated stratigraphy between each boring/monitor well from the ground surface to the maximum depth assessed;
    c. Groundwater bearing units and aquitards;
    d. Sample locations;
    e. COC concentrations at critical sampling points (*i.e.*, sample points used to demonstrate vertical delineation of COCs in soil);
    f. Distribution of petroleum hydrocarbons;
    g. Monitor well screen intervals;
    h. Potentiometric surface based on static groundwater levels in each monitor well;
    i. Structural features, subsurface conduits, underground utilities, or other migration pathways; and
    j. Excavated areas.
6. Describe the nature and extent of COCs in surface soil and how the distribution of COCs relates to the source area and human and ecological receptors; and
7. Describe the nature and extent of COCs in subsurface soil and how the distribution of COCs relates to the source area and human and ecological receptors.

SECTION 4: GROUNDWATER INVESTIGATION

The purpose of this section is to discuss the results of the groundwater investigation, to describe the nature and extent of petroleum hydrocarbon and COCs in groundwater, and to relate the distribution of COCs in groundwater to the source of the release(s) and to potential human and ecological receptors.

4.1 Describe the groundwater investigation

1. Describe the investigation methods (test pits, boring and monitor well installation, vapor sampling, heated headspace sampling, and other field screening methods);
2. Provide rationale for selecting sample locations (e.g., both boring/well location and screen interval) and how the sampling locations and methods are the most optimal to detect petroleum hydrocarbons and/or COCs in groundwater;
3. Describe how sampling locations were determined in relation to available history of the site, including current infrastructure, and historical infrastructure;
4. Describe how the layout, infrastructure, and logistics modified or limited the investigation and how the investigation compensated for these logistical issues;
5. Describe handling/disposal of investigation derived waste (e.g., purge water, free phase hydrocarbon, etc.); and
6. Provide an appendix detailing sampling and analysis plans and construction techniques that includes the methods of sample collection, field screening (e.g., pH, temperature, specific conductance, oxygen reduction potential, dissolved oxygen, etc.), calibration of field instruments, sample preservation, and decontamination of non-dedicated sampling equipment.

4.2 Describe the General characteristics of aquifers and the unsaturated zone at the facility

1. Describe hydraulic characteristics (e.g., hydraulic conductivity, aquifer thickness, storativity, etc.) of each stratigraphic unit identified in Section 2. If the described hydraulic characteristics are based on site investigation, include supporting data in an appendix. If the described hydraulic characteristics are based on literature research, include references and discuss the applicability of the referenced values to the site;
2. Describe aquifer conditions (e.g., perched, unconfined, confined, etc.) and the connection of the potentially affected transmissive unit to other aquifers, especially its connection to aquifer(s) used for potable water;
3. Provide a table identifying each well in chronological order of installation, that provides the measurement date, the surveyed elevation of the measuring point, the depth or elevation of the top of the screen, the depth to non-aqueous phase liquid (NAPL), the depth to water, the total well depth, water elevations referenced to mean sea level or to a site specific datum that is corrected for the presence of NAPL;
4. Discuss groundwater flow including direction, gradient, rate of flow, and seasonal variations;
5. Provide a potentiometric surface map of the potentially affected aquifer that shows typical groundwater conditions (multiple maps may be necessary to demonstrate significant seasonal variations). Maps should include the corrected groundwater elevation at each well, potentiometric surface contours at a contour interval sufficient to show groundwater flow characteristics, groundwater flow direction line, groundwater flow gradient along the flowline, and a reference to the date the wells were gauged.

4.3 Description of groundwater analytical results

1. Identify the requested chemical analyses and how these analyses relate to the type of materials, wastes, and products historically located at the facility;
2. Present groundwater analytical results in chronological order, in a table that includes sample name, boring/well identification, sample date, COC name, RBSL, field screening results, and COC concentration reported in micrograms per liter (ug/L). Denote concentrations and/or reporting limits (for non-detected results) that exceed the RBSL (Note, multiple tables may be required based on the amount of available data, number of field screening analyses, and types of contamination (*e.g.*, gasoline, diesel, etc.);
3. Present a to-scale map that clearly depicts the distribution of COCs and petroleum hydrocarbons in groundwater. The map should identify potential source areas, locations of monitor wells and other sampling points, excavated areas, buildings and other structures (including utilities), the maximum COC concentration representative of current conditions detected at each location for each analyte that exceeds RBSLs, a clearly labeled isoconcentration contour line representing the RBSL, and where applicable a clearly labeled contour

line of the 1% solubility limit of the COC. (Note multiple maps may be required based on the number of COCs that exceed RBSLs.);

4. Utilize the cross sections created in Section 3 or construct two cross sections perpendicular to each other that use at least three representative points to represent the subsurface stratigraphy and the maximum extent of COCs in groundwater representing current conditions. One cross section should be oriented parallel to the groundwater flow direction and should cross through the potential source area. Cross section location lines should be depicted on a separate map or included on an index map. Cross sections should include the following:
    a. Boring or monitor well identification;
    b. Interpolated stratigraphy between each boring/monitor well from the ground surface to the maximum depth assessed;
    c. Groundwater bearing units and aquitards;
    d. Sample locations;
    e. COC concentrations in groundwater at critical sampling points (*i.e.*, sample points used to determine lateral and if applicable vertical delineation of COCs in groundwater);
    f. Distribution of petroleum hydrocarbons;
    g. Monitor well screen intervals;
    h. Potentiometric surface based on static groundwater level in each monitor well;
    i. Structural features, subsurface conduits, underground utilities, or other migration pathways (*e.g.*, surface water bodies, lithologic preferential pathways, etc.); and
    j. Excavated areas.
5. Present a graphical, to-scale depiction of the concentration of COCs in groundwater over time. The x axis should be in a linear scale representing time and include the dates of sample collection. The y axis should be in linear or log scale representing COC concentrations in ug/L. A graphical representation of COC concentration over time should be provided for at least the source area well for each analyte that exceeds RBSLs. (Note multiple graphs may be required based on the number of COCs that exceed RBSLs.);
6. Describe the nature and extent of COCs in groundwater, how the concentrations have changed over time, how the distribution of COCs relates to the source area and to potential human and ecological receptors, and explain any sampling or analytical anomalies.

SECTION 5: VAPOR INTRUSION INVESTIGATION

The purpose of this section is to describe any results obtained through a vapor study and/or vapor intrusion investigation. This section should provide a description of the sample methods and locations used, the rational for the selected monitoring points and the number of samples collected, and describe results including any mitigation taken.

5.1 Investigation

1. Describe the investigation methods (soil vapor, near-slab, subslab, indoor air, etc; Tedlar bag, summa canister);
2. Provide a rationale for the selection of each sample location and how the sampling locations and methods are the most optimal to detect petroleum hydrocarbons vapors; Describe how each sampling location was chosen in relation to current buildings and the release location; Evaluate past investigations and confirm that work was completed in agreement with the Montana Vapor Intrusion Technical Guidance Document.
3. Describe how the layout, infrastructure, and logistics of the release site limited the investigation and how the investigation was designed to compensate for these logistical issues;

5. 2 Building Details

1. Identify all structures. Describe how each building is constructed – e.g. stick-built on grade with a crawl space and an attached garage.
2. Present a to-scale map showing the structures in relation the petroleum release. Describe the distance of each structure from source of contamination; including lateral and vertical distances from impacted groundwater.

5.3 Describe Vapor Results

1. Identify the requested chemical analyses and how these analyses relate to the type of materials, wastes, and products historically located at the facility; refer to the Montana Vapor Intrusion Technical Guidance Document to confirm that the correct chemical analyses were utilized.
2. Present vapor analytical results in chronological order, in a table that includes sample name and identification, sample date, COC name, RSL, and COC concentration reported in micrograms per cubic meter (ug/m^3). Denote concentrations and/or reporting limits (for non-detected results) that exceed the RSL. (Note, multiple tables may be required based on the amount of available data, number of field screening analyses, and types of contamination (*e.g.*, gasoline, diesel, etc.);
3. Present a to-scale map that clearly depicts the distribution of vapor COCs and petroleum hydrocarbons. The map should identify potential receptors (e.g. structures or utility corridors), sampling points, excavated areas, and the maximum COC concentration representative of current conditions detected at each location for each analyte.

5.4 Describe Mitigation

1. Describe all mitigation efforts and the effectiveness of each. Include data that illustrates post-mitigation impacts. Indicate whether the vapor mitigation system is still active.

SECTION 6: CORRECTIVE ACTION EFFECTIVENESS

The purpose of this section is to describe the corrective actions that have been completed to date. This section should provide a description of confirmation sampling locations, rationale for selecting the locations of confirmation samples, demonstrate that source material has been removed to the maximum extent practicable, demonstrate that no further corrective action is reasonably required at the site, and document the proper disposal, or remediation to concentrations less than applicable RBSLs, of corrective action derived waste.

Provide the following to-scale maps:

1. A map that clearly depicts the distribution of residual COCs in soils. This map should identify potential source areas, locations of borings and soil samples, excavated/treated areas, buildings and other structures (including utilities), the maximum COC concentration (post excavation/treatment) for any analyte detected at a concentration greater than the release assessment level (*i.e.*, Tier 1 Surface Soil RBSL with less than 10 feet to groundwater), and the location and depth at which the analyte was detected. (Note multiple maps may be required based on the number of COCs that exceed the release assessment level);

2. A map that clearly depicts the distribution of COCs in groundwater. The map should identify potential source areas, locations of monitor wells and other sampling points, excavated/treated areas, buildings and other structures (including utilities), the maximum COC concentration (post excavation/treatment) for any analyte detected at a concentration greater than the release assessment level (*i.e.*, Tier 1 Surface Soil RBSLs with less than 10 feet to groundwater), and the location and depth at which the analyte was detected. (Note multiple maps may be required based on the number of COCs that exceed RBSLs.);

3. Provide at least one cross section that transects the source area and clearly depicts the vertical distribution of residual COCs left in soil. (A cross section representing current COC conditions in groundwater requested in Section 4; the requested cross section for soils may need to be a standalone diagram illustrating the relation of the contamination to the soil). This cross section should identify potential source areas, locations of soil samples, excavated/treated areas, subsurface buildings and other structures (including utilities), the maximum COC concentration (post excavation/treatment) for any analyte detected at a concentration greater than the release assessment level (*i.e.*, Tier 1 Surface Soil RBSL with less than 10 feet to groundwater), and the location and depth at which the analyte was detected. (Note multiple maps may be required based on the number of COCs that exceed the release assessment level);

Include a subsection detailing each corrective action technology utilized. For example:

1. For excavation of hydrocarbon impacted soils:
   a. Describe the equipment used, the lateral and vertical extent of excavation, the rationale for ceasing excavation, and the volume removed in cubic yards;
   b. Describe the disposal of excavated soils including location of disposal, volume disposed of, rationale for soil reuse if applicable, volume of soil reused, dates of landfarm operation (if applicable), and date of landfarm closure. Include, in an appendix, a copy of the landfarm closure letter or waste manifests documenting disposal at an appropriate landfill;
   c. Describe the confirmation samples that were collected, how sampling locations and analytical methods were selected, and discuss the results.

2. For in-place soil treatment:
   a. Describe the equipment/technology used, and the lateral and vertical extent of soil treatment,
   b. Provide a map showing the treatment area/points;
   c. Describe how treatment intervals (*e.g.*, lateral distance between injection/vapor extraction points, etc.) and how treatment points were selected;
   d. Provide additional technical discussion as necessary to adequately describe the effectiveness of the soil treatment technology;
   e. Describe dates of soil treatment system operation, any significant modifications/repairs to the system, and explain any periods of system in operation;
   f. Describe the confirmation samples that were collected, how sampling locations and analytical methods were selected, and discuss of the results.

3. For product recovery:
   a. Describe the equipment/technology used for product recovery, and the lateral and vertical extent of product recovery;
   b. Provide a to-scale map showing the recovery area/points;
   c. Describe how recovery intervals (*e.g.*, lateral distance between recovery points, etc.) and recovery points were selected;
   d. Provide other technical discussion as necessary to adequately describe the effectiveness of the product recovery technology;
   e. Describe dates of operation, any significant modifications/repairs to the system, and explain any periods of system in operation;
   f. Describe the method and location of disposal of recovered fluids (*i.e.*, product and groundwater) and the cumulative volume disposed. Include a copy of the waste manifests documenting the proper disposal of product in an appendix ;
   g. Describe the confirmation samples that were collected, how sampling locations, sample timing, and analytical methods were selected and discuss the results.

4. For groundwater removal and treatment:
   a. Describe the equipment/technology used for groundwater removal and treatment, and the lateral and vertical extent of groundwater removal;
   b. Provide a to-scale map showing the groundwater recovery wells, the approximate area of groundwater removal based on the calculated radius of influence, location of treatment infrastructure, and treated water injection/discharge point(s);
   c. Describe how recovery intervals (*e.g.*, lateral distance between recovery wells, etc.) and recovery well locations were selected;
   d. Describe the fate of removed groundwater, including treatment method, pre and post-treatment chemical analyses, any anomalous results from laboratory analyses of groundwater, method and location of discharge of removed and treated groundwater, and the cumulative volume of groundwater removed and treated;
   e. Provide other technical discussion as necessary to adequately describe the effectiveness of the groundwater removal and treatment technology;

f. Describe dates of operation, any significant modifications/repairs to the system, and explain any periods of system in operation;
g. Describe the post-treatment system confirmation samples that were collected, how sampling locations and analytical methods were selected and discuss the results.

SECTION 7: EXPOSURE PATHWAY EVALUATION AND RISK MITIGATION

The purpose of this section is to describe the exposure pathways and risks from petroleum contamination remaining in the environment and to explain how these risks are mitigated by engineering controls, institutional controls, or physical conditions. In this section, discuss how each potential exposure pathway identified in Section 2.2 has been mitigated, limited, or determined to be incomplete so that risk to the receptors identified in Section 2.1 is acceptable. Include the following information:

7. 1 Risk Mitigation

1. Engineered Controls include man made physical features that control migration or exposure pathways. Engineered Controls include groundwater gradient control and vapor control through the use of barriers :

    a. Describe the equipment/technology used as an engineering control, and the lateral and vertical extent of the control;
    b. Provide a map showing the extent of residual contamination in soil and groundwater and the lateral extent of the engineered control;
    c. If applicable, provide a cross section that shows the vertical extent of the engineered control and how it relates to facility stratigraphy. Interpolate stratigraphy between each boring/monitor well and denote groundwater bearing units and aquitards;
    d. Provide other technical discussion as necessary to adequately describe the current and continued effectiveness of the engineered control;
    e. Describe dates of installation, any significant modifications/repairs to the engineered control, inspection/maintenance schedule, and explain how the inspection/maintenance schedule was developed;
    f. Describe the confirmation samples that were collected, how sampling locations and analytical methods were chosen and discuss the results.
    g. Document the designs and installation of the engineered control and provide an inspection and maintenance schedule. Include the following information:
        i. In an appendix (or by reference to previously submitted reports) provide the engineering specification for the constructed engineered control. Provide the “as built” conditions of the control. The submitted engineering specifications and the “as built” report and maps should be signed and sealed by a Professional Engineer;
        ii. The schedule for the inspection and maintenance of the engineered control should describe how inspection and maintenance will be documented and how the results will be reported to DEQ;

2. Institutional Controls include binding legal or administrative measures that eliminate an exposure pathway. Institutional controls may include but are not limited to restrictive covenants, deed restrictions, or easements that eliminate an exposure pathway (such as enacting a restriction on the installation of drinking water wells to eliminate the consumption of contaminated groundwater). The purpose of this section is to provide example or draft institutional control language to DEQ for review and approval in accordance with ARM 17.56.607(10). Following DEQ approval, all institutional controls must be finalized and recorded or otherwise put into effect prior to issuance of the NFCA letter under ARM 17.56.607(11).

    a. Describe the type of institutional control that will be used (*e.g.*, easement, deed restriction, restrictive covenant, etc.);
    b. Describe how the institutional control limits exposure to potentially affected soil, groundwater, and/or vapors;
    c. If the PMZ extends off the property boundary where the release originated, provide a copy of the easement allowing the PMZ to extend onto adjoining property for DEQ approval

d. If the institutional control is via a controlled groundwater area, provide evidence that other suitable sources of water are available, and evidence that steps have been taken to put a controlled groundwater area, as provided for in §85-2-506, MCA, in effect;
e. If the institutional control is via an environmental control easement, provide a copy of the easement for DEQ review and approval;
f. Provide sample language of the notice that will be placed on the deed of all parcels of real property which the PMZ impacts describing the nature and location of the residual contamination remaining in the soil and groundwater and all institutional controls, engineering controls, physical conditions, or other controls or conditions required to maintain the PMZ for DEQ to review and approve [*ARM 17.56.607 (10)(l)*];
g. Provide copies of all proposed institutional controls for DEQ review and approval.

3. Physical Conditions include characteristics of the site that mitigate or eliminate an exposure pathway. An example of a physical condition limiting the consumption of groundwater could include the presence of tight clay soils that do not allow the extraction of groundwater and the presence of a public water supply servicing all area buildings. An example of a physical condition limiting vapor intrusion into buildings could include a thick separation of clean soil between the contamination and the building foundations that has been studied and determined to attenuate the vertical migration of petroleum vapors. Include the following information:

a. Describe the type of physical condition present to mitigate exposure pathways and risks;
b. Describe how the physical conditions limit exposure to potentially affected soil and/or groundwater;
c. Describe how these protective physical conditions will be maintained.

7. 2 Evaluation of Effectiveness of Mitigation of Exposure Pathways (three scenarios)

I. Exposure to Surface Soil:

Discuss how the potential for human or ecological exposure to petroleum-impacted surface soil (<2 feet bgs) has been limited by remediation or by engineering, institutional, physical, or other controls. Refer to maps in Section 5 and/or 6 to illustrate that remediation and/or control measures have effectively limited the exposure pathway.

a. Explain how surface soil has been remediated or surface conditions altered to limit the potential for direct contact (*e.g.*, burrowing, foraging of plants, ingestion of dust, direct skin contact, etc) with affected soil.
b. Explain how surface soil has been remediated or surface conditions altered to limit the potential for COCs to leach from surface soil to groundwater.
c. Explain how surface soil has been remediated or surface conditions altered to limit the potential for COCs to migrate to open utilities (*e.g.*, storm sewer), surface water bodies, or sediments by erosion and transport by wind or water.

II. Exposure to Subsurface Soil:

Discuss how the potential for human or ecological exposure to subsurface soil has been limited by remediation or by engineering, institutional, physical, or other controls. Refer to maps in Sections 5and/or 6 to illustrate that remediation and/or control measures have effectively limited the exposure pathway.

a. Explain how subsurface soil has been remediated, subsurface, or surface conditions altered to limit the potential for petroleum hydrocarbon vapors to emanate from subsurface soil and into structures at concentrations considered hazardous to human health or the environment.
b. Explain how subsurface soil has been remediated, subsurface, or surface conditions altered to limit the potential for COCs to leach from soil to groundwater.

III. Exposure to Groundwater:

Discuss how the potential for human or ecological exposure to groundwater has been limited by remediation or by engineering, institutional, physical, or other controls. Refer to maps in Sections 5 and/or 6 to illustrate that remediation and/or control measures have effectively limited the exposure pathway.

a. Explain how groundwater has been remediated or controlled to limit the potential for petroleum hydrocarbon vapors to emanate from groundwater and into structures at concentrations considered hazardous to human health or the environment.
b. Explain how groundwater has been remediated or controlled to limit the potential for the ingestion of affected groundwater by human or ecological receptors.
c. Explain how groundwater has been remediated or controlled to limit the potential for affected groundwater to seep to surface water or sediments
d. Explain how groundwater has been remediated or controlled to limit the potential for COC migration into and/or along buried utilities.

Following DEQ approval of the language used in the proposed institutional control, a metes and bounds survey of the proposed PMZ (not the property boundary) must be completed by a surveyor licensed by the State of Montana. The proposed institutional control will be published for public review and a minimum of 30 days will be allowed for public comment. Following public comment, DEQ will work with the responsible party to amend the institutional control as necessary to address potential public concerns. The release will not be considered "Resolved with a PMZ" until all applicable institutional controls have been approved and duly recorded with the DEQ and the applicable county registrar of deeds.

Provide a cost estimate for the inspection and maintenance of the engineered control for a 30 year period. Include the details of the cost estimate in an appendix. Upon approval of the PMZ closure with engineered control, financial assurance that the responsible party can maintain the engineered control will be requested and received by DEQ prior to issuance of the NFCA letter.

SECTION 8: NATURAL ATTENUATION EVALUATION

The purpose of this section is to provide guidance that will assistance the owner/operator in demonstrating that natural breakdown or attenuation of residual contamination within the PMZ is occurring as required under §75-11-508, MCA. Natural attenuation is an effective method of petroleum contaminant mass reduction. Provide the following information so that DEQ can assess whether site conditions favor continued natural attenuation:

1. Report aquifer parameters (i.e., hydraulic conductivity, groundwater gradient, and groundwater average linear velocity). If this data has not been previously reported to DEQ, provide supporting field data and calculations in an appendix;
2. Discuss how the lateral distribution of COCs in groundwater indicates that the plume is stable or contracting;
3. Discuss how the temporal variation in COC concentration at the source area well indicates that the plume is stable or contracting;
    a. Demonstrate in graphical form that each COC in groundwater exceeding RBSLs is stable or decreasing;
4. Describe the evaluation of geochemical parameters (i.e., dissolved oxygen, oxygen reduction potential, ferrous iron, nitrates, and sulfate);
    a. If not presented previously in Section 4, present a table in chronological order of geochemical parameters;
    b. Present a to-scale map showing the distribution of dissolved oxygen in relation to the source area and the extent of the dissolved phase plume. If dissolved oxygen is no longer the primary electron receptor additional geochemical parameters may need to be presented to demonstrate that natural attenuation is occurring throughout the extent of the plume.
    c. Discuss how the aquifer parameters will enable the primary electron receptor to be replenished, or recharged, and therefore allow natural attenuation to continue until remedial goals have been met.
5. Discuss how COC concentrations are influenced by groundwater table fluctuations;
    a. Present a graph that relates COC concentrations in groundwater to the groundwater elevation;
    b. Discuss how the observed trends relate to residual soil contamination and how changes in groundwater elevation (seasonal variations or abnormal water levels) will not result in an expanding dissolved phase plume.
6. If the plume is stable (i.e., a continuous source provides contaminate mass at the same rate as mass is removed by degradation), discuss why no additional corrective action should reasonably be required to remove source material.

SECTION 9: SUMMARY AND CONCLUSIONS

The purpose of this section is to discuss the basis supporting a conclusion that the release has met conditions for closure with a PMZ. Briefly discuss how corrective actions and/or institutional controls have or will limit exposure to potential human and environmental receptors. Discuss how the land will be used in the foreseeable future and how changing conditions will be limited or controlled so that a potential exposure pathway will not be complete. Briefly review the evidence that natural attenuation will continue until remedial goals have been met. Predict when remediation by natural attenuation will meet remedial goals and why closure with a PMZ is more advantageous than continued monitoring until remedial goals have been met.