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Standard Guide for Corrective Action for Petroleum Releases[1]

This standard is issued under the fixed designation E 1599; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers corrective action for petroleum releases. It describes the approach for assessment and remediation of releases to protect human health, safety, and the environment. It is intended to complement but not supersede federal, state, and local regulations, as well as complement other recommended practices on this subject (for example, NFPA 329 and API 1628).

1.2 The approach described in this guide is not the only way that a corrective action could be conducted, but experience has shown that following these guidelines will help ensure cost effective and timely remediation.

1.3 This guide is not intended to address field and site specific contractor health and safety issues. For guidance concerning contractor health and safety issues appropriate OSHA and other industry standards should be consulted. This guide does not address specific details of sample preparation or preservation or sampling quality assurance/quality control practices. For guidance concerning sampling practices see Appendix X1.

1.4 As shown in Fig. 1, assessment and remedial activities occur at many points in the corrective action process. Each round of assessment and remediation may result in additional steps until the corrective action goal has been achieved. The precise sequence and timing of these activities will depend on the site and the techniques that are used. However, the assessment and remedial activities shown in Fig. 1 may be conducted concurrently.

1.5 Once sufficient information has been gathered, remedial action can begin prior to defining the full extent of contamination. In many cases, an interim remedial action may be appropriate when contaminants are mobile. The ultimate effectiveness and the cost of remediation are often related to the migration of the contamination. Timely action will improve the effectiveness of the remediation and minimize its cost.

1.6 Regulators, consultants, contractors, owners, operators, insurance companies, and the public all need to have good communication throughout the corrective action process. Some of the forms that this communication can take are:

1.6.1 Site visits,
1.6.2 Telephone conversations,
1.6.3 Notification forms,
1.6.4 Progress reports, and
1.6.5 Project plans.

1.7 It is important to note that a report in and of itself is not communication; someone has to read and understand it for there to be communication. Reports must be complete, presenting pertinent information that is necessary to lead to an appropriate corrective action decision.

1.8 Progress reports play a key role in the communication. These reports should be clear and sufficient so that all parties involved in the remediation can understand them.

1.9 This guide is organized as follows: Section 2 lists referenced documents, Section 3 defines terminology used in this guide, Section 5 discusses how indicator compounds can be used in the corrective action process, Section 6 discusses interim remedial actions, Section 7 describes site assessments, Section 8 discusses remedial actions, Section 9 describes operation, maintenance, and monitoring requirements for remedial actions, Section 10 discusses completion of the corrective action process, Section 11 discusses a pre-excavation evaluation (PEE) option that can help identify and plan for contaminated materials that may be encountered during construction activities at UST sites, Section 12 discusses assessments associated with tank removal or abandonment, Sections 11 and 12 are specific to underground storage tank (UST) system closures. When a release is discovered and confirmed to have been caused by other means, the activities or portions of the activities described in Sections 11 and 12 may not be needed. Finally, Appendix X1 identifies additional documents related to assessment and remediation activities.

1.10 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are for information only.

1.11 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *EPA Standards:*
SW 846, USEPA Recommended Analytical Procedures,

[1] This guide is under the jurisdiction of ASTM Committee E50 on Environmental Assessment and is the direct responsibility of Subcommittee E50.04 on Performance Standards Related to Environmental Regulatory Programs.
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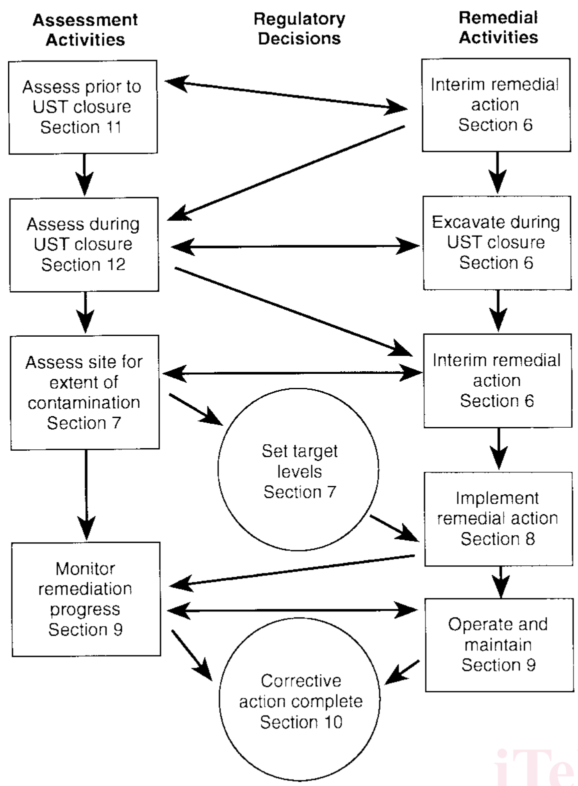

FIG. 1 Corrective Action Activities

Test Methods for Evaluating Solid Waste—Physical/Chemical Methods[2]

USEPA Publication No. USGPO 055-000-00368-8, Field Measurement Technics: Dependable Data When You Need It[2]

2.2 *API Standards:*

RP 1628, A Guide to the Assessment and Remediation of Underground Petroleum Releases[3]

RP 1629, A Guide for Assessing and Remediating Petroleum Hydrocarbons in Soil[3]

2.3 *NFPA Standard:*

NFPA 329, Leakage and Repair Safeguards for Flammable and Combustible Liquids[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *corrective action*—actions taken to identify and clean up a release of petroleum. These activities include site assessment, interim remedial action, remedial action, operation and maintenance of equipment, monitoring of progress, and termination of the remedial action.

3.1.2 *corrective action goal*—the corrective action goal is to reduce levels of contamination to protect human health, safety, and the environment.

3.1.3 *natural cycle*—normally one annual fluctuation of the ground water levels. This time may differ depending on site specific and climatic conditions.

3.1.4 *pre-excavation evaluation (PEE)*—an assessment of the potential for contamination and its relative extent prior to an excavation at an UST site. A typical PEE could include the sampling of soil and ground water in the area of the UST excavation and the product dispensers.

3.1.5 *petroleum*—including crude oil or any fraction thereof that is liquid at standard conditions of temperature and pressure (60°F (16°C) and 14.7 psia (101.3 kPa)). The term includes petroleum-based substances comprised of a complex blend of hydrocarbons derived from crude oil through processes of separation, conversion, upgrading, and finishing, such as motor fuels, jet oils, lubricants, petroleum solvents, and used oils.

3.1.6 *receptors*—persons, structures, utilities, surface waters, and water supply wells that are or may be adversely affected by a release.

3.1.7 *regulatory agency*—USEPA or the designated state and local agencies responsible for carrying out the UST or other corrective action program.

3.1.8 *release*—a discharge of petroleum to the environment.

3.1.9 *remediation/remedial action*—activities conducted to protect human health, safety, and the environment. These activities include evaluating risk, making no further action determinations, monitoring, and designing and operating cleanup equipment.

3.1.10 *site assessment*—an evaluation of subsurface geology, hydrology, and surface characteristics to determine if a release has occurred, the levels of contamination, and the extent of contaminant migration. The site assessment generates information to support remedial action decisions.

3.1.11 *source area*—the source area is defined as either the location of liquid hydrocarbons or the location of highest soil and ground water contamination levels.

3.1.12 *UST closure*—the removal from the ground or decommissioning in place of an UST system, including the evaluation of the surrounding soil to determine if a release has occurred.

3.1.13 *UST system*—a storage tank and underground piping connected to the tank, that has at least 10 % of its volume below the ground.

4. Significance and Use

4.1 The purpose of this guide is to provide a logical, timely, economical framework and general sequence for site assessment and remediation activities for petroleum releases that contaminate the subsurface. However, this guide does not recommend particular techniques. Where state and local regulations exist, the intent is to provide a model to enable streamlining of the regulatory processes and to allow the corrective action to proceed in an effective manner. The corrective action goal is to reduce levels of contamination to protect human health, safety, and the environment, and to demonstrate that the impacts of the contamination have been addressed.

NOTE 1—Activities described in this guide should be conducted by a person familiar with assessment and remediation techniques.

[2] Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

[3] Available from American Petroleum Institute, 1801 K Street N.W., Washington, DC 20226.

[4] Available from National Fire Protection Assoc., Batterymarch Park, Quincy, MA 02269.

5. Corrective Action Indicators

5.1 *Selection and Use of Indicator Compounds*:

5.1.1 Indicator compounds for sampling and analysis are easy to select when the released product is known. If, however, the type of product is unknown or more than one type of hydrocarbon product is suspected to have been released, the initial sampling and analysis should include indicator compounds for all suspected products. Once the compounds of concern have been identified, then further analysis can be limited to the identified compounds. When gasoline is the suspected release, benzene, toluene, ethylbenzene, and xylenes (BTEX) may be indicator compounds of concern. Other possible indicator compounds may be methyl tertiary butyl ether (MTBE) and tertiary butyl alcohol (TBA). When diesel, other distillates, or an unknown mixture of petroleum products is the suspected released hydrocarbon, indicator compounds may include naphthalenes and other semi-volatiles.

5.1.2 Indicator compounds in ground water and soil can be used to confirm the extent of contamination, defining the remedial action target levels discussed in 8.5, monitoring progress of the remedial action, and identifying the termination point of the remedial action.

5.2 *Field Screening Indicators*—Field screening techniques may be a cost-effective and timely assessment methodology. Field screening utilized during the assessment process may use one or more of a wide variety of qualitative or quantitative measurement techniques. The screening process includes defining the likely sources of contamination, the possible direction of contamination movement, and the likely extent of contamination. Some examples of field screening indicators are dissolved oxygen anomalies (O_2), carbon dioxide anomalies (CO_2), and volatile organics. For further information on field measurement techniques see USEPA Publication No. 055-000-00368-8.

5.3 *Indicator Compound Analysis*—The analysis of specific indicator compounds can occur in both soil and ground water. In general, analysis in soil should be limited to those compounds that are adversely affecting or are expected to adversely affect the ground water or other receptors. Unless specifically outlined by the regulatory agency, when investigating a petroleum release, the following analytical methodologies in Table 1 are commonly used and are recommended. Other methodologies or protocols that provide comparable results may be used.

6. Interim Remedial Action

6.1 *Introduction*:

6.1.1 The primary goals of interim remedial action are to mitigate fire and safety hazards and to prevent further migration of hydrocarbons in their vapor, dissolved, or liquid phase. Interim remedial action is most effective when the regulatory agency limits its oversight to being notified of the activities taken. From initial assessment through actual remediation, interim remedial action may be warranted or desired. Situations that warrant interim remedial action include the following:

6.1.1.1 Hydrocarbon vapors in occupied buildings or subsurface structures,

6.1.1.2 Dissolved hydrocarbons in drinking water wells,

6.1.1.3 Liquid hydrocarbons floating on ground water, and

6.1.1.4 Hydrocarbons apparently confined to the soils immediately adjacent to a recent release.

6.1.1.5 In addition, interim remedial action should be used in situations where it will be timely and cost effective and will not adversely affect the final remedial action plan.

6.1.2 *General Methods*—The following methods are the most common alternatives used in handling hydrocarbon-contaminated soils. Other methods may be locally competitive in both cost effectiveness and environmental compatibility. The methods may be used alone or together. (**Warning**—See Note 2.)

6.1.2.1 Liquid hydrocarbon recovery can be accomplished either by control of the ground water (ground water depression through pumping) or by passive recovery methods not requiring ground water pumping.

NOTE 2—**Warning:** Pumping ground water, pumping free product from the ground water, or sparging air into the ground water should only be used when sufficient understanding of the hydrogeologic impact of a method has been acquired or in an emergency situation. If done improperly, the plume may spread into previously uncontaminated areas.

6.1.2.2 Hydrocarbon vapor abatement can be accomplished through vapor extraction or limited source excavation.

6.1.2.3 Dissolved hydrocarbon recovery can be accomplished through ground water pump-and-treat methods or air sparging.

7. Site Assessment

7.1 *Introduction*:

7.1.1 The goals of site assessment are to determine the

TABLE 1 Recommended Analytical Methodologies

	Soil	Water
Gasoline	volatile organic aromatics using SW846 Method 8020	volatile organic aromatics using SW846 Method 8020 modified to detect MTBE and TBA
Middle distillates (for example, No. 2 fuel oil, JP4, diesel)	volatile organic aromatics using SW846 Method 8020	volatile organic aromatics using SW846 Method 8020
	poly-nuclear aromatics (PNAs) using SW846 8100 (Naphthalenes)	poly-nuclear aromatics (PNAs) using SW846 8100 (Naphthalenes)
Heavier fuel oils and lubricating oil or unknown (for example, motor oil, used oil, No. 6 oil)	volatile organic aromatics using SW846 Method 8240	volatile organic aromatics using SW846 Method 8240
	semi-volatile organics using SW846 Method 8270	semi-volatile organics using SW846 Method 8270

source of the contamination, the extent of contamination, and the potential impact of the contamination on human health, safety, and the environment. The data collected during site assessment become the base for determining the need for remedial action and for evaluating remedial-action alternatives. Consequently, the site assessment should be designed to collect data on the extent and movement of the contamination, and the impact to structures and utilities which will assist in the selection of remedial alternatives.

7.1.2 The site assessment should begin as soon as practical after a release has been confirmed. Site-assessment activities can and should coincide with any initial abatement or interim free-product removal activities.

7.1.3 Regardless of the approach and methods used, site assessment should include all of the following components:

7.1.3.1 Initial site evaluation,

7.1.3.2 On-site delineation, and

7.1.3.3 Off-site delineation.

7.1.4 A variety of technologies and methods can be used to conduct a site assessment. The use of some technologies or methodologies may be limited by the geology of the site, the hydrology of the site, surface and subsurface structures, the availability of remediation equipment, characteristics of the substance released, and requirements of the regulatory agency. Ground water monitoring wells may need to be installed. The discussion here is limited to a general approach rather than to specific technologies or methodologies.

7.2 *Initial Site Evaluation*—Prior to drilling or other subsurface site assessment activities, a review of the local and regional geologic and hydrogeologic characteristics and a survey and identification of potential receptors should be conducted. Information collected during this phase will be used to direct subsurface investigation activities and to identify potential initial abatement activities.

7.2.1 The following activities should be performed during the initial site evaluation:

7.2.1.1 Review local and regional geology and hydrogeology through the use of USGS maps, local well logs, environmental agency information, and the like,

7.2.1.2 Estimate the depth to ground water,

7.2.1.3 Identify subsurface structures that may promote contaminant transport (for example, water, sewer, and utility lines),

7.2.1.4 Identify and locate private and public water supply wells within a minimum of a 0.5-mile (0.8-km) radius of the site,

7.2.1.5 Identify surface waters and streams within a minimum of a 0.5-mile (0.8-km) radius of the site,

7.2.1.6 Identify surrounding land use, and

7.2.1.7 Identify other potential contaminant sources.

7.2.2 A suitable base map and surrounding land-use map should be developed summarizing the results of the initial site evaluation. The base map should include the property lines of the site, all structures and underground utilities on the site, and all known underground storage tanks, related piping, and UST excavations. The surrounding land-use map should include the property lines of the site, streets, alleys, utilities, neighboring structures (including structures across the streets from the site), and water supply wells within 0.5 miles (0.8 km) of the site. The base map is also used for summarizing future site assessment data.

7.3 *On-Site Delineation*—Utilizing the results from the initial site evaluation, a subsurface investigation should be initiated to determine site-specific geologic and hydrogeologic characteristics and to identify the extent of contamination on the release site (within the property boundaries). The first objective of the on-site delineation is to identify the source area(s) of the contamination. The second objective is to identify the extent of the contamination in the release site and determine if off-site migration has occurred.

7.3.1 Subsurface investigation activities should begin in the area of the release or in the area of the underground storage tanks and piping. Subsurface investigation activities should be expanded from these areas until the source area has been identified. After the source area(s) has been identified, the vertical and horizontal extent of contamination should be investigated. Variations in contamination levels below and above the water table as well as across the site are important to quantifying the release, its mobility, and potential remedial action alternatives. In addition, the depth to ground water, the soil characteristics, the hydraulic gradient, and the thickness of liquid hydrocarbon should be determined as part of the subsurface investigation. Based on these data, a determination of contaminant migration can be made and further investigative activities can be conducted to determine the extent of contamination within the property boundaries of the release site. Investigative activities for the on-site delineation should continue until the full extent of contaminant migration has been determined or until the investigation reaches the release site property lines.

7.3.2 If after the completion of the on-site delineation, there are data sufficient to design and implement a remedial action, an on-site delineation report describing the on-site activity should be prepared and submitted to the regulatory agency. Utilizing the data collected during the on-site delineation phase, this report should include at the minimum the following:

7.3.2.1 Data collected during the initial site evaluation,

7.3.2.2 Logs of any installed boring(s) or other subsurface investigation and schematics of any installed monitoring well(s) with ground water levels indicated showing screened intervals and the geologic unit where the screen intercepts,

7.3.2.3 Depth-to-fluid, depth-to-water, top-of-casing elevation, water table elevations, and product thickness measurements summarized in tabular and map form,

7.3.2.4 Water table elevations in map form and analytical results tabulated on a site map,

7.3.2.5 Analytical results presented in tabular form,

7.3.2.6 Laboratory reports including chain of custody forms, quality assurance/quality control (QA/QC) procedures, data and chromatograph results, and

7.3.2.7 A conceptual design of the remedial action approach.

7.4 *Off-Site Delineation*—If the extent of contamination extends beyond the property boundaries of the site on which the release is located, investigative activities on neighboring properties may be necessary. Off-site work will require negotiation and may require execution of off-site access agreements that may be difficult to obtain and time-consuming to complete. As a result, it is difficult to anticipate the time required to complete off-site delineation. However, if access is not obtained within a reasonable period of time (for example, 90 days), the regulatory agency should be notified and its assistance solicited.

7.4.1 Off-site investigative activities are a continuation of the activities conducted on-site; they should continue until the extent of contaminant migration has been determined. It is important to recognize that definition of full extent of contamination may not be possible because of structures, access problems, or insufficient data. Assessment activities should continue until enough data have been accumulated to determine the need for remediation, the design of the remedial action, and the method for monitoring its progress and measuring success.

7.4.2 During the preparation of the on-site delineation report, any suspected off-site contamination should be explored. Once the off-site delineation has been completed, a supplemental off-site delineation report may be prepared and submitted to the regulatory agency for approval. The supplemental off-site delineation report should contain the remaining data to complete the requirements of the site assessment report.

7.5 *Sampling/Analysis*—Indicator compounds should be analyzed as noted in Section 5. Every effort should be made to achieve the method detection limits for analysis of compounds in soil and ground water. The initial analytical results may be used to modify subsequent soil and ground water sampling and analysis. If initial testing does not reveal the presence of an indicator compound or it has been determined that its presence is the result of background concentrations, then subsequent testing for those compounds is not required.

7.6 *Site Assessment Methodologies*:

7.6.1 There are a number of methodologies that can be used to conduct site assessment activities. Application of these methods varies according to the site being assessed. For further information see API RP 1628 and API RP 1629. These methods include the following:

7.6.1.1 Soil borings,

7.6.1.2 Direct push technologies (for example, cone penetrometers, formation water sampling devices),

7.6.1.3 Geophysical surveys,

7.6.1.4 Soil gas surveys,

7.6.1.5 Ground penetrating radar,

7.6.1.6 Trenching or test pits,

7.6.1.7 Monitoring wells, and

7.6.1.8 Aerial photographic analysis.

7.7 *Reports*:

7.7.1 *Site Assessment Report*—If an on-site delineation report had not been submitted, then after completion of the site assessment activities a site assessment report should be prepared and submitted to the regulatory agency. The site assessment report should at a minimum include the following:

7.7.1.1 Data collected during the initial site evaluation,

7.7.1.2 Map of facility indicating boring and well locations, structures, property lines, tanks, piping, pump islands, roads, adjacent and neighboring property owners, and other significant features,

7.7.1.3 Logs of any borings or other subsurface investigation and schematics of any installed monitoring well with ground water levels indicated and results of field screening of soils,

7.7.1.4 Depth-to-fluid, depth-to-water, top-of-casing elevations, water table elevations, and product thickness measurements in tabular form,

7.7.1.5 Water table elevations in map form and analytical results tabulated on a site map,

7.7.1.6 Analytical results,

7.7.1.7 Chain of custody forms, and

7.7.1.8 Recommendations for any further actions.

7.7.2 *Progress Reports*—A progress report should be prepared and submitted on a quarterly basis or other interval specified by the regulatory agency. The initial progress report should include the results of the initial site evaluation and any interim remedial action activities. Subsequent progress reports should include at a minimum the following:

7.7.2.1 A base map of the site indicating the location of structures, boring or other subsurface investigations and well locations, property lines, and UST systems and excavations,

7.7.2.2 A surrounding-use map indicating the location of roads, adjacent and neighboring property owners, and other significant features,

7.7.2.3 Logs of borings or any subsurface investigation and schematics of any monitoring well installed since the last report,

7.7.2.4 Results of laboratory analysis received since the last report and data (in tabular or graphic form) from previous sampling events,

7.7.2.5 Depth-to-fluid, depth-to-water, top-of-casing elevations, water table elevations, and product thickness measurements for each well,

7.7.2.6 Water table elevations in map form and analytical results in tabular form on a site map,

7.7.2.7 A brief description of further proposed activities, and

7.7.2.8 Description of any interim remedial action.

8. Remedial Action

8.1 *Remedial Action Determination*:

8.1.1 Prior to the development of a remedial action approach, a determination of the need and extent for remedial action must be made. The need for remedial action will be determined subsequent to an evaluation of the contaminant levels, exposure pathways, contaminant source(s), and potential receptors for contaminants in both the soil and the ground water. The evaluation must address the types of hydrocarbon contamination (for example, vapor, dissolved, floating liquid, or residuals bound in the soils). The following three possible courses of action can result from this evaluation:

8.1.1.1 No further action,

8.1.1.2 Passive remediation (monitoring only), or

8.1.1.3 Active remediation.

8.1.2 The course of action taken will depend upon the site-specific risks to human health and the environment associated with the contaminant levels identified during the site assessment. Remedial action should be a performance-based activity that is focused on target levels, methods of measuring progress, and completion. The following discussions contain general criteria for determining when each course of action would be appropriate. These criteria may not be appropriate for all circumstances. Site-specific circumstances may warrant selecting an option not indicated by these criteria.

8.2 *No Further Action*—The no-further-action course of action could be appropriate when the levels of contaminants identified at the site pose no threat to human health and the environment. Examples of when no further action may be appropriate include the following:

8.2.1 Floating liquid hydrocarbon is not present,

8.2.2 Drinking water supplies are not adversely affected and not likely to be adversely affected,

8.2.3 Underground structures or utilities are not adversely affected and not likely to be adversely affected by vapors,

8.2.4 Surface waters are not adversely affected and not likely to be adversely affected,

8.2.5 Useable portions of USEPA or state-designated sole source aquifers are not adversely affected and not likely to be adversely affected,

8.2.6 The aquifer is unusuable for drinking water,

8.2.7 The contaminants are immobile, or otherwise separated from potential receptors,

8.2.8 State standards for soil or ground water quality are not exceeded, or

8.2.9 Other areas of local environmental concern are not adversely affected and not likely to be adversely affected.

8.3 *Passive Remediation (Monitoring Only)*:

8.3.1 Passive remediation or a monitoring-only action could be appropriate when the levels of contaminants resulting from a site pose a minimal risk to human health, safety, and the environment. Examples of when passive remediation may be appropriate include the following:

8.3.1.1 An exposure evaluation determines the potential for the impacts from the contaminants to be low,

8.3.1.2 Migration is minimal (for example, concentrations of contaminants at the perimeter of the plume are stable or decreasing), or

8.3.1.3 The source of ground water contamination has been eliminated.

8.3.2 If passive remediation is selected, then a monitoring plan should be developed. The goal of the monitoring is to determine if contaminant concentrations are stable or decreasing. The monitoring plan should include the following information:

8.3.2.1 Where ground water is adversely affected, a minimum of three monitoring points is recommended; one downgradient from the area of contamination, one in the area of highest contamination, and one up-gradient from the area of contamination. Additional monitoring points may be necessary based on site-specific conditions (for example, multiple-contaminant plumes, multiple aquifers, or multiple sources) and to monitor ground water flow direction.

8.3.2.2 The monitoring period should usually be a minimum of one year or other reasonable period of time depending on site-specific conditions. Data evaluation should emphasize identification of significant increases in contaminant concentrations at the monitoring points. If monitoring results are erratic or increasing, the period should be extended or active remediation begun.

8.3.2.3 Monitoring points should be sampled for identified indicator compounds on a regular basis agreed upon with the regulatory agency.

8.4 *Active Remediation*—Active remediation should be proposed when concentrations of contaminants identified at the site pose a potential risk to human health, safety, and the environment. Active remediation could be implemented when no further action and passive remediation courses of action are not appropriate.

8.5 *Target Levels*:

8.5.1 Once a remedial action has been determined to be necessary, the objective or target level for that action must be defined. The target level must be either an achievable numeric value or other performance criteria that protect human health, safety, and the environment. For passive remediation, the target level will typically be a performance-based criteria (for example, monitoring of selected wells for increases in contaminant levels). For active remediation, specific levels are usually chosen as both design criteria and goals for remediation. Termination of the remedial activity may occur at levels other than the target levels as discussed in Section 10. Target levels could also include the following:

8.5.1.1 Numeric values based on an evaluation of the risk of the contaminant levels at the site,

8.5.1.2 EPA maximum contaminant levels (MCL) when drinking water supplies are adversely affected or other health-based levels, such as recommended allowable limits (RAL) outlined by the regulatory agency when private drinking water wells are adversely affected, or

8.5.1.3 Minimization or elimination of exposure to potential receptors.

8.5.2 *Contaminated Media*—There are four types of hydrocarbon contamination (vapor, dissolved, floating liquid, and residuals bound in the soil) that need to be addressed when determining target levels and identifying remedial alternatives. In many cases, the impact of one type of contamination on another may be the driving force in determining the need for remediation. For example, contamination in soil may only be significant when it migrates to ground water; the contamination in soil itself may not pose a risk. In other cases, the potential for dermal contact or breathing vapors resulting from the contamination in soil may warrant remedial action of the soil.

8.6 *Technology Selection*:

8.6.1 The technology selection should be based upon the type of contamination to be addressed, the target levels to be achieved, site-specific conditions, and regulatory requirements. In most cases, more than one technology may be required to address the various media and achieve the defined target levels. Technology selection should include the following:

8.6.1.1 An evaluation of the effectiveness of the technologies in achieving the target levels,

8.6.1.2 An evaluation of the ability of the technologies to address the four types of hydrocarbon contamination discussed in 8.5.2,