# Groundwater Protection Programs For Petroleum Refining and Storage Facilities: A Guidance Document

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STEP
*Strategies for Today's Environmental Partnership*

**American Petroleum Institute**
1220 L Street, Northwest
Washington, D.C. 20005

## STEP

One of the most significant long-term trends affecting the future vitality of the petroleum industry is the public's concerns about the environment. Recognizing this trend, API member companies have developed a positive, forward looking strategy called STEP: Strategies for Today's Environmental Partnership. This program aims to address public concerns by improving industry's environmental, health and safety performance; documenting performance improvements; and communicating them to the public. The foundation of STEP is the API Environmental Mission and Guiding Environmental Principles. API standards, by promoting the use of sound engineering and operational practices, are an important means of implementing API's STEP program.

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- To recognize and to respond to community concerns about our raw materials, products and operations.
- To operate our plants and facilities, and to handle our raw materials and products in a manner that protects the environment, and the safety and health of our employees and the public.
- To make safety, health and environmental considerations a priority in our planning, and our development of new products and processes.
- To advise promptly appropriate officials, employees, customers and the public of information on significant industry-related safety, health and environmental hazards, and to recommend protective measures.
- To counsel customers, transporters and others in the safe use, transportation and disposal of our raw materials, products and waste materials.
- To economically develop and produce natural resources and to conserve those resources by using energy efficiently.
- To extend knowledge by conducting or supporting research on the safety, health and environmental effects of our raw materials, products, processes and waste materials.
- To commit to reduce overall emissions and waste generation.
- To work with others to resolve problems created by handling and disposal of hazardous substances from our operations.
- To participate with government and others in creating responsible laws, regulations and standards to safeguard the community, workplace and environment.
- To promote these principles and practices by sharing experiences and offering assistance to others who produce, handle, use, transport or dispose of similar raw materials, petroleum products and wastes.

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**Manufacturing, Distribution and Marketing Department**

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# CONTENTS


| | Page |
|---|---|
| SECTION 1—GENERAL | 1 |
| 1.1 Introduction | 1 |
| 1.2 Purpose | 1 |
| 1.3 Scope | 1 |
| 1.4 Referenced Publications | 1 |
| SECTION 2—SITE ASSESSMENT | 2 |
| 2.1 Objectives | 2 |
| 2.2 Components of a Site Assessment | 2 |
| 2.2.1 Facility Description | 2 |
| 2.2.2 History of a Site | 2 |
| 2.2.3 Adjacent Facilities | 2 |
| 2.2.4 Topography | 2 |
| 2.2.5 Substances Present | 2 |
| 2.2.6 Underground Environment | 3 |
| SECTION 3—IMPLEMENTATION: PREVENTION/DETECTION | 3 |
| 3.1 General | 3 |
| 3.2 Design and Construction Measures | 4 |
| 3.2.1 Location | 4 |
| 3.2.2 Design Standards | 4 |
| 3.3 Management Measures and Operating Controls | 4 |
| 3.3.1 Personnel | 4 |
| 3.3.2 Facility Plans | 5 |
| 3.3.3 Inspections and Maintenance | 5 |
| 3.3.4 Housekeeping | 5 |
| 3.3.5 Training | 5 |
| 3.3.6 Recordkeeping | 5 |
| 3.3.7 Public Education and Information | 6 |
| 3.4 Additional Materials | 6 |
| SECTION 4—REMEDIATION/MITIGATION | 6 |
| SECTION 5—REFERENCE MATERIAL | 7 |
| 5.1 Refining | 7 |
| 5.1.1 Pressure Vessels and Tanks and Materials Engineering | 7 |
| 5.1.2 Refinery Environmental Research | 7 |
| 5.2 Marketing Operations | 7 |
| 5.3 Health and Environmental | 7 |
| 5.3.1 Soil and Groundwater Research | 7 |
| 5.3.2 Biodegradation Processes | 8 |
| 5.3.3 Contaminant Fate and Transport | 8 |
| 5.3.4 Exposure/Risk Assessment | 8 |
| 5.3.5 Remedial Technologies | 8 |
| 5.3.6 Site Characterization | 9 |
| 5.3.7 Storage Tank Research | 9 |
| 5.4 Policy Analysis and Strategic Planning | 9 |
| 5.4.1 Research Studies | 9 |
| 5.4.2 Strategies for Today's Environmental Partnership (STEP) | 9 |
| 5.5 Other | 9 |

# Groundwater Protection Programs for Petroleum Refining and Storage Facilities: A Guidance Document

## SECTION 1—GENERAL

### 1.1 Introduction

During the 1980s, public concern about groundwater increased greatly. Research efforts multiplied, comprehensive analyses and plans were created, and governments at the federal, state, and local levels started new programs to protect this valuable national resource.

The petroleum industry has acted positively to address groundwater protection. At the core of the industry's groundwater initiative is the concept of *beneficial use*. This is the principle that all groundwater protection plans should be developed in full consideration of the beneficial use, value, and vulnerability of the groundwater resource, combined with full consideration of the economic and social values and of the practical technological and cost limitations.

In 1992, the American Petroleum Institute adopted, as part of its Strategies for Today's Environmental Partnership or STEP program, a plan to help guide the industry's actions on groundwater. The purpose of this effort was to help "STEP participants" or "API members" perform the following objectives:

a. Assess the potential impacts on groundwater from petroleum industry operations and facilities.
b. Incorporate design and engineering protections into new and renovated facilities.
c. Develop operating and personnel training practices that foster protection of groundwater.
d. Undertake timely response, as appropriate, when contamination is discovered.
e. Conduct research on groundwater protection.
f. Promote mutual understanding among the industry, the public, and the government.

### 1.2 Purpose

The purpose of this document is to provide additional guidance for API members to meet the objectives stated above. These guidelines are intended to help refineries, terminals associated with transportation pipelines, product distribution terminals, and other downstream petroleum storage units develop groundwater protection plans that are tailored to the individual circumstances of particular facilities. They are also intended to help the general public by providing information on what petroleum facilities are doing and how they are planning to enhance groundwater protection.

### 1.3 Scope

This new publication is designed to help petroleum facilities identify the types of issues that may need to be addressed in a groundwater protection plan. This document provides only general guidelines and is not intended as a comprehensive checklist or standard. API recognizes that each facility is unique. Many facilities have groundwater protection and remediation plans that suit their own circumstances but which may not address every issue covered in these guidelines, consequently, a plan may still be appropriate under facility-specific circumstances. For those facilities, this document may serve as a useful tool to review and evaluate their existing plans to ensure their currency. Other facilities may have extensive engineering controls and operating practices already in place. For those, this document may provide a useful framework for integrating existing company practices into a comprehensive site-specific groundwater protection plan.

This document emphasizes the same areas that constitute the cornerstones of the groundwater protection plans implemented by individual API members. Those groundwater protection plans are based on the following elements:

a. *Assessment* of the specific site to identify potential threats to groundwater.
b. *Prevention* of releases from existing facilities.
c. *Detection* of any releases that could occur despite preventive efforts.

### 1.4 Referenced Publications

The following publications are cited in this document:

API

| | |
|---|---|
| Std 653 | *Tank Inspection, Repair, Alteration, Reconstruction* |
| Publ 1628 | *A Guide to the Assessment and Remediation of Underground Petroleum Releases* |
| Publ 1629 | *Guide for Assessing and Remediating Petroleum Hydrocarbons in Soils* |
| Std 2610 | *Design, Construction, Operation, Maintenance, and Inspection of Terminal and Tank Facilities* |
| Publ 4367 | *Groundwater Monitoring and Sample Bias* |
| Publ 4394 | *Detection of Hydrocarbons in Groundwater by Analysis of Shallow Soil Gas/Vapor* |

# SECTION 2—SITE ASSESSMENT

## 2.1 Objectives

The first objective and initial step in developing a groundwater protection plan is to assess the potential impacts on groundwater from industry operations and facilities. Response or prevention measures cannot be adopted in the abstract; they should be guided by an understanding of the potential impact on groundwater from industry operations at a specific site.

The development of a site-specific groundwater protection plan begins with an assessment of the aboveground and belowground characteristics of the facility. The assessment objectives should be the following:

a. To identify the substances present that might adversely affect groundwater quality if released.
b. To assess the physical facilities and operating procedures for the possibility that the identified substances might be released in the future or might have been released in the past.
c. To assess the need to make physical and/or procedural modifications to mitigate risks from contamination if the first and second steps given above indicate the possibility of a significant risk.

## 2.2 Components of a Site Assessment

### 2.2.1 FACILITY DESCRIPTION

A site assessment normally begins with a description of the facility where the groundwater protection plan is being implemented. The facility description can include a description of the following characteristics:

a. A map of the site showing the locations and dimensions of the physical facilities.
b. The physical facilities' construction and operations.
c. The potential for release of specific substances used in the operations.
d. The points of particular vulnerability. (For example, any transfer point, where substances are unloaded or moved from one container or process to another, presents a potential for spills.)
e. Any containers that cannot be readily inspected, such as an underground storage tank.
f. The waste handling facilities.
g. Any storm sewers, ditches, sumps, dry wells, tank water draw facilities and similar locations. These are such familiar sights they can easily be overlooked.

### 2.2.2 HISTORY OF A SITE

An understanding of the site's history may be important to a full site assessment. The facility may have processed or stored substances in the past that are not present today. Similarly, the physical configuration of a plant may have changed over the years. Portions of a site that are grass or blacktop today may have once been the locations of storage tanks, piping, ditches, loading racks, or other operations. Again, the assessor may need to be aware of this history to understand and assess the site.

There are numerous ways to learn about the history of a site. Old building permits and construction plans are useful, as well as old aerial photographs. Other sources are former owners and employees, longtime residents of the area, and the local police and fire departments.

### 2.2.3 ADJACENT FACILITIES

A site assessor may also need to consider the uses of nearby property. The presence of substances at a petroleum facility can be a result of releases that have migrated from a neighboring plant. The opposite may also exist; releases from the site under assessment may have migrated to a nearby site.

### 2.2.4 TOPOGRAPHY

The physical characteristics of the land can be charted to identify drainage patterns that surface contamination may have followed. Topography also provides an initial indication of recharge or discharge zones for groundwater, thus also providing a preliminary idea of groundwater patterns.

### 2.2.5 SUBSTANCES PRESENT

For petroleum facilities, the substances of most obvious concern are the petroleum raw materials and products produced or handled by the facility. However, it cannot be assumed that these are the only substances of concern because other substances may also be present, such as solvents, degreasers, and wastes.

A site assessment can include a broad canvass that identifies all possible substances of concern. One common-sense approach to making this canvass is to examine the material prepared by the facility in response to existing environmental requirements. The following list are some examples of regulatory reporting requirements that can help identify possible substances of concern:

a. Air emissions are subject to numerous reporting and permitting requirements.
b. National Pollution Discharge Elimination System permits cover discharges into water.
c. Recent regulations on stormwater necessitate analysis of water runoff.
d. The generation of hazardous waste requires identification of the wastes involved.

e. Simple storage or use of chemicals triggers regulatory requirements.
f. Under the Occupational Safety and Health Administration's (OSHA) Hazard Communication Rule, Material Safety Data Sheets (MSDS) must be prepared for numerous chemicals present in the workplace.
g. Under the Emergency Planning and Community Right-To-Know Act (EPCRA), local authorities must be informed of the presence of a long list of substances.

Examining this regulatory material should provide an inventory of substances of possible concern that may be present or in use. An assessor may also choose to conduct a walk-through of the facility, with a view toward identifying substances present at a particular facility that are not required to be inventoried under these regulations.

Once the substances of concern have been identified, the assessor may want to confirm that information is readily available on their characteristics, insofar as relevant to their effect on groundwater (solubility, biodegradability, specific gravity, toxicity, mobility, persistence, vapor pressure, sorption, and octanol/water partition coefficient).

### 2.2.6 UNDERGROUND ENVIRONMENT

Once a picture of the aboveground characteristics of the site has been developed, the underground environment may be addressed. The subsurface evaluation can often be conducted by reviewing available documents and data pertaining to the local subsurface. This evaluation need not be a physical evaluation.

If a hydrogeologic study is performed, such a study can address the following elements:

a. Facility description (including location, setting, history, chemicals used, and so forth).
b. Climate.
c. Physiographic setting (including topography, surface water, and so forth).
d. Geology (regional and local).
e. Hydrogeology (groundwater occurrence and flow).
f. Containment evaluation.

Following are some questions about the groundwater that may need to be answered for a subsurface evaluation:

a. How deep is it?
b. What is its direction and rate of flow?
c. Does the area contain special features, such as sewers, old stream beds, or utility conduits that might divert groundwater from its normal flow path or that might expedite its flow?
d. What classification has been given the groundwater by the relevant government agency?
e. What is it used for now, and what might it be used for in the future? (Different standards may apply to water used for drinking, agriculture, and industry.)
f. Are drinking water wells nearby?
g. Are abandoned wells nearby?
h. Where is the recharge zone of the local aquifer? Is the facility located in the recharge zone for a distant aquifer?
i. Does the groundwater connect to surface water, wetlands, or other confined aquifers, and, if so, where?

The geological and hydrogeological analysis can draw from a number of useful sources. The publications of the United States Geological Survey and the United States Soil Conservation Service often provide a good framework for analysis in the form of regional data. However, if more information is needed to create a model of an individual facility, then other potential sources of information should be considered, including state groundwater agencies and local officials. It may also be possible to obtain more detailed information from the records of old geotechnical borings or from people with general experience in the geological characteristics of the area, such as architects, construction contractors, well-drillers, or sanitation engineers.

API has published several recommended practices, standards, and guidance documents that address various issues of site assessment and groundwater monitoring. For example, the API Publications 1628, 1629, 4367, 4394, and several others address significant specific technical issues. A complete list of relevant API works is contained in the last section of this document.

## SECTION 3—IMPLEMENTATION: PREVENTION/DETECTION

### 3.1 General

Preventing releases is superior to detection and remediation after a release, so prevention should have first priority. API's members are devoting efforts to forestalling any releases that would create risks to the groundwater underlying petroleum industry facilities.

Two basic, complementary approaches exist for protecting groundwater at any petroleum industry facility. The first is to build protection into the design and construction of the facilities. The second is to follow management and operating practices designed to prevent releases or designed to provide early detection. Both are important components in a groundwater protection program. For further information see API Standard 2610.

It is also important that the person in charge of designing a groundwater protection program be familiar with the many federal and state programs applicable to specific types of in-

stallations that are often found at a petroleum industry facility. Since 1986, for example, underground storage tanks (USTs) have been extensively regulated by both the Environmental Protection Agency (EPA) and the states. Aboveground storage tanks (ASTs) and other facilities near surface waters are subject to the Oil Pollution Act (OPA) and to the Spill Prevention Control and Countermeasure Program (SPCC) under the Clean Water Act. Numerous other regulatory laws are also relevant, and a thorough knowledge of applicable requirements is important.

## 3.2 Design and Construction Measures

### 3.2.1 LOCATION

One measure to protect groundwater can be taken when a facility is first constructed. The site of the facility as a whole, and, within the facility, the sites of its components, can be selected in a manner that minimizes any harm to groundwater if a release occurs.

Historically, petroleum industry facilities, such as refineries and distribution facilities, have usually been located near surface water, largely because of the importance of water transportation. For the siting of new facilities the extent of the need to be near surface water and the possibility of alternative sites should be considered.

The possibility for improved siting should not be overstated, however. Petroleum facilities must often be located on transportation arteries and must be near the cities and transportation facilities that they service. In most instances, location away from water resources is simply impractical. Of course, if the facility as a whole needs to be near surface water, an attempt should be made to choose a location that minimizes the risk to groundwater.

Environmental considerations should also be considered in siting the components of a facility. Components that would present the greatest potential threat to groundwater should, to the extent practical, be located in the parts of the site where any release can most easily be detected and contained. When siting in a sensitive area is unavoidable, necessary additional protection against releases may be accomplished through special design standards.

### 3.2.2 DESIGN STANDARDS

Every petroleum facility contains many different types of components, such as the following:

a. Raw material storage areas.
b. Aboveground storage tanks (AST).
c. Underground storage tanks (UST).
d. Pipes, pumps, valves, and seals.
e. Process equipment.
f. Loading and unloading facilities.
g. Sewers.
h. Oil/water separators and wastewater treatment facilities.
i. Waste handling facilities and equipment.

Measures for the protection of groundwater can be made part of this equipment when it is constructed or reconstructed. Some of the possibilities for consideration include the following measures:

a. *Materials.* The compatibility of the material used to make a component with the substance to be stored or processed should be assured. Components made of steel can be protected against corrosion when necessary. Cathodic protection is one important method of corrosion protection. It is useful for any component that is in contact with the soil, and it is particularly important for underground components, such as pipes, USTs, and AST bottoms that cannot easily be visually inspected. In general, the components of a petroleum facility can be manufactured from materials that are corrosion resistant. In some cases, noncorroding fiberglass components can be used where appropriate. In some cases, steel components can be cathodically protected, coated, or made of corrosion-resistant stainless steel where appropriate.

b. *Design of individual components.* In some cases, individual components of a facility can be designed to facilitate inspection, maintenance, and repair making potential releases more easily detectable. For example, some lines can be constructed aboveground to minimize potential contamination.

c. *Secondary containment.* Secondary containment can be designed to hold the contents of a storage vessel in the event of a failure, or it can be designed as a method of detecting a release. In this second mode, the purpose of the secondary containment is to capture released product long enough for the leak to be detected and for the facility to respond. Acceptable forms of secondary containment range from a second shell surrounding an UST, to a lining under the bottom of an AST, to a sump under a valve, or to a diked containment area designed to hold product in the event of an AST or process vessel leak.

d. *Overfill and spill protection.* Many kinds of equipment exist that are designed to prevent overfills and spills when petroleum products are transferred. These include high level alarms for ASTs, spill containment devices for USTs, and automatic shutoff devices for hoses.

e. *Retrofit.* For the most part, engineering controls can be most economically installed when a facility is first constructed, or, if practical, when major renovation is undertaken. However, a few types of controls can be installed on existing components and should be considered by the facility management. For example, high level alarms can be retrofitted onto some ASTs.

## 3.3 Management Measures and Operating Controls

### 3.3.1 PERSONNEL

One of the most important measures a facility can take is to ensure that personnel at all levels understand the impor-

tance of protecting groundwater. If management regards groundwater protection as a high priority and expects all employees to treat it as such, the overall groundwater protection plan will be more effective. To promote this, facility management and facility personnel should be involved in preparing specific plans for the prevention and control of releases to groundwater. The identification of a point of contact for groundwater issues at each facility is also an important consideration.

### 3.3.2 FACILITY PLANS

As noted earlier, many petroleum industry facilities are subject to SPCC and OPA regulations that require the development of prevention and control plans to protect navigable waters. While such plans are not specifically designed to protect groundwater, they can help by reducing the potential for spills and the reduction of the area affected by spills.

### 3.3.3 INSPECTIONS AND MAINTENANCE

A schedule for inspecting components of the facility that have the potential to release their contents may be established as part of a groundwater protection plan. For critical units, the use of technologies such as ultrasonic probing of metal thickness can be considered. Industry standards such as API Standards 653 and 2610 may also be used to help guide a facility's preparation and initiation of an inspection and maintenance program for tanks. At the same time, management can review maintenance plans and schedules and adopt any appropriate programs of preventive maintenance.

The program of inspection and maintenance should pay special attention to the equipment specifically designed to protect the environment, such as secondary containment installations, monitoring wells, and sampling devices. Sumps and interstitial spaces should be checked for signs of contamination.

Similarly, equipment designed to meet emergency release situations should be inspected and tested regularly.

It may be desirable to record inspection and maintenance practices as completed. In many jurisdictions the maintenance of such records is mandatory.

### 3.3.4 HOUSEKEEPING

Good housekeeping practices are important for groundwater protection. Spills of any product should not be left uncorrected.

### 3.3.5 TRAINING

Employees should be informed of the potential for groundwater contamination at the facility and should be confident of the company's determination to protect the groundwater. Personnel with duties that would entail some aspect of operation and maintenance of equipment to prevent the discharge of oil should receive the training necessary to protect surface and groundwater. Personnel that would receive training under SPCC and OPA may be the same individuals responsible for groundwater protection. Therefore, training beyond that required under other regulations may not be necessary and is not suggested by this guidance. Following are some particularly important points about training:

a. Appropriate personnel should be trained in emergency response.
b. Emphasis should be placed on training in those activities that present special risks of releases into the groundwater. For example, loading and unloading products and raw materials, collecting samples, transferring products, and cleaning and maintaining equipment. Personnel need the proper training to perform these tasks in a manner that avoids releases.
c. Special training should be provided to the workers who operate environmental protection equipment. These workers should be trained properly to draw samples, inspect equipment, check monitoring wells, or any other similar activity. Backup personnel should be equally well-trained.
d. Workers who do not have an opportunity to practice their skills regularly should be retrained periodically.
e. Many environmental protection activities are subject to government regulations, with potential civil and even criminal penalties for dereliction. Penalties can apply to individuals as well as to the company. Workers need to be trained to understand their roles and responsibilities in performing environmental protection duties properly.

### 3.3.6 RECORDKEEPING

Records documenting activities related to groundwater protection, as well as other activities (such as meeting the requirements of SPCC and OPA) are important and, in some cases, are required by law. Recordkeeping is typically required for the following activities:

a. Site assessments.
b. Inspection records.
c. Inventory records.
d. Routine and special maintenance.
e. Monitoring results.
f. Sampling records.
g. Emergency drills and their results.
h. Responses to major and minor releases.
i. False alarms and responses to reports of possible problems.
j. Training activities.
k. Formal compliance obligations and steps taken as a result.

Recordkeeping is important as a method of ensuring compliance with the many applicable government recordkeeping requirements, and as a way of assuring the government, management, and the community that the facility is dedicated to groundwater protection.

### 3.3.7 PUBLIC EDUCATION AND INFORMATION

Facility managers should be mindful of the importance of keeping the surrounding community appropriately informed about groundwater protection efforts. API members are committed to managing their businesses according to a set of Environmental Mission and Guiding Principles. The following guiding principles have been determined to be especially relevant to this document:

- To recognize and respond to community concerns about our raw materials, products and operations.
- To operate our plants and facilities, and to handle our raw materials and products in a manner that protects the environment, and the safety and health of our employees and the public.
- To make safety, health and environmental considerations a priority in our planning, and our development of new products and processes.
- To advise promptly, appropriate officials, employees, customers and the public of information on significant industry-related safety, health and environmental hazards, and to recommend protective measures.

These principles are embodied in API's STEP program. Adherence to them is not just a matter of being a good neighbor; it also has a practical component. By adhering to these principles, the facility reassures both community members and local government that it takes its responsibilities seriously. By keeping the community informed company managers can obtain feedback on issues that concern the community; managers can receive early warning of adverse community reactions and can respond quickly. In addition, some community members may have knowledge that will improve the groundwater protection plan or save the facility time and trouble in obtaining information.

## 3.4 Additional Materials

The expertise of API's member company personnel on the design and management of petroleum storage and handling facilities has been incorporated into numerous recommended practices, standards, bulletins, and other guidance documents published by the Institute. Particular emphasis has been placed on construction of aboveground storage tanks (ASTs) and underground storage tanks (USTs), but the basic principles developed in these contexts are often applicable to other types of installations as well. These publications are listed in the last section of this document.

If contamination is found at a petroleum industry facility, or if, despite the facility's best efforts, a release occurs in the future, then remedial action should be considered.

# SECTION 4—REMEDIATION/MITIGATION

Detailed guidance on remedial action is beyond the scope of this document. However, several existing API publications deal with the topic, including a number of those listed in the final section of this document.

Federal, state, and local agencies are often concerned with groundwater remediation, and may specify cleanup levels by regulation or order. To the degree that the remediator has latitude, however, API recommends that a methodology based on exposure and risk level be used to define a site-specific target cleanup level protective of human health and the environment. Use of such a methodology provides a means to set priorities for remediation so that limited available remediation resources can be optimized.

The site-specific exposure/risk-based methodologies can incorporate consideration of site characterization, assessment of the potential beneficial uses of the groundwater, exposure and risk characterization, site prioritization, and selection of corrective action alternatives.

State and federal agencies have tended to establish cleanup standards equal to that of the standards for drinking water. While such standards represent the fullest possible degree of protection, they do not recognize the other important factors that may support the use of different standards. The selection of ideal but technically impractical cleanup goals is counterproductive in that it promotes unrealizable expectations and continues the consumption of resources not linked to any technically achievable end point.

Cleanup goals that protect the public health while reflecting technically feasible remediation procedures should be preferred to ideal goals that disregard the practical considerations. In some specific instances, the control of water use or containment of the contamination may protect public health more cost-effectively than aquifer restoration. For example, it may be more cost-effective, and equally protective, to suspend active mitigation efforts while contaminants are removed naturally by biodegradation or other processes. Also, treatment of contamination at a wellhead or replacement of the water supply may be more effective than groundwater restoration. A strong case can also be made for containment of contamination where remediation is impossible or impractical. It is important, however, that this concern with cost-effectiveness be balanced with the need to provide adequate protection for human health.

# SECTION 5—REFERENCE MATERIAL

## 5.1 Refining

### 5.1.1 PRESSURE VESSELS AND TANKS AND MATERIALS ENGINEERING

1. API Standard 620, *Design and Construction of Large, Welded Low-Pressure Storage Tanks,* 8th edition, American Petroleum Institute, Washington D.C., 1990.
2. API Standard 650, *Welded Steel Tanks for Oil Storage,* 9th edition, American Petroleum Institute, Washington D.C., 1993 (includes Appendix I—*Undertank Leak Detection and Subgrade Protection*, 1992).
3. API Recommended Practice 651, *Cathodic Protection of Aboveground Petroleum Storage Tanks,* 1st edition, American Petroleum Institute, Washington D.C., 1991.
4. API Recommended Practice 652, *Lining of Aboveground Petroleum Storage Tank Bottoms,* 1st edition, American Petroleum Institute, Washington D.C., 1991.
5. API Standard 653, *Tank Inspection, Repair, Alteration, and Reconstruction.* 1st edition, American Petroleum Institute, Washington D.C., 1991 (includes Supplement 1, January 1992).
6. API Recommended Practice 2350, *Overfill Protection for Petroleum Storage Tanks,* 1st edition, American Petroleum Institute, Washington D.C., 1987.
7. API Publication 920, *Prevention of Brittle Fracture of Pressure Vessels*, 1st edition, American Petroleum Institute, Washington D.C., 1990.

### 5.1.2 REFINERY ENVIRONMENTAL RESEARCH

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