

 DESIGN PRACTICES	SOLID WASTE MANAGEMENT AND SITE REMEDIATION GUIDELINES FOR SELECTING SOIL REMEDIATION TECHNOLOGY	Section	Page
		XX-B4	1 of 34
		December, 2002	

Changes shown by ♦

CONTENTS

Section	Page
SCOPE	3
REFERENCES	3
DEFINITIONS	3
TECHNOLOGY SELECTION PROCESS	4
TYPICAL DATA REQUIREMENTS	5
COST	7
TECHNOLOGY DESCRIPTIONS	10
IN-SITU TECHNOLOGIES	10
Bioflushing (In Situ Bioremediation With Ground Water Recovery/Recirculation)	10
Natural Attenuation (NA) and Intrinsic Bioremediation (IB)	11
Bioventing	12
In Situ Vitrification	15
Phytoremediation (The use of plants to promote remediation of soil)	17
In Situ Thermal Treatment	17
TECHNOLOGIES THAT MAY BE APPLIED IN SITU OR EX SITU	20
Soil Vapor Extraction (SVE)	20
Land Treatment	21
Stabilization/Solidification (S/S)	23
EX-SITU TECHNOLOGIES	25
Offsite Treatment/Disposal	25
Biopile	26
Soil Washing	27
Beneficial Reuse	29
Thermal Desorption	30
Incineration	32
TABLES	
Table 1 Tier 1 Characterization Parameters for Soil Remediation Technology Selection	8
Table 2 Tier 2 Characterization of Soil	9
FIGURES	
Figure 1 Decision Tree for Soil Remediation Technology Selection	6
Figure 2 Treatment Technology Applicability: Hydrocarbon vs. Technology	7
Figure 3 Bioflushing of Vadose Zone	11
Figure 4 Bioventing/Soil Vapor Extraction	14
Figure 5 In Situ Vitrification	16
Figure 6 Steam/hot air injection system	18
Figure 7 Terratherm Remediation System	19
Figure 8 Land Treatment (Ex Situ)	22
Figure 9 Examples of Stabilization/Solidification Processes	24
Figure 10 Biopile Schematic	27

**Documents**

Document Sharing Hub

Section	Page	<i>SOLID WASTE MANAGEMENT AND SITE REMEDIATION</i> GUIDELINES FOR SELECTING SOIL REMEDIATION TECHNOLOGY	 DESIGN PRACTICES
XX-B4	2 of 34		
December, 2002			

Figure 11 Simple (Two-Step) Soil Washing Processes for Hydrocarbon Clean-Up..... 28

Figure 12 Example of Beneficial Reuse Typical Asphalt Batching Plant 30

Figure 13 Examples of Thermal Desorption Processes..... 32

Figure 14 Rotary Kiln Soil Incineration 34

Revision Memo

12/02 Updated technology selection and applicability criteria. Added two new technologies: Phytoremediation and In situ Thermal treatment.

 DESIGN PRACTICES	SOLID WASTE MANAGEMENT AND SITE REMEDIATION GUIDELINES FOR SELECTING SOIL REMEDIATION TECHNOLOGY	Section XX-B4	Page 3 of 34
		December, 2002	

SCOPE

This section of Design Practices is a guide for selection of available technology for soil remediation. The selection process must consider many inputs, as discussed in **TECHNOLOGY SELECTION PROCESS** below and in [Section XX-B, Guidelines and Considerations for Site Remediation](#). Frequently, ground water will also be impacted where there is soil to be remediated. Ground water treating is covered by [Section XX-B3](#).

This section provides a "decision-tree" type selection method. Brief summaries of the leading soil clean-up techniques are also presented. This section does not provide design guidance for individual soil remediation technologies. Additional Design Practice sections will cover details of specific soil remediation technologies (see [Section XX, Contents](#)). Until those sections are released, the references can provide background.

The technologies discussed in this section are primarily intended for remediation at manufacturing sites; that is, refineries and petrochemical plants. At these sites, much of the impacted soil will be contaminated with aged heavy petroleum hydrocarbons and byproducts. This section also covers clean-up technologies applicable to soils contaminated with lighter products (e.g., gasoline, diesel), as are found at many areas in manufacturing sites.

REFERENCES

1. American Academy of Environmental Engineers, *Innovative Site Remediation Technology*, (8 volume monograph series), WASTECH Project (1993-1995).
2. Archibald, B. B., Becker, P. W., Smith, H. A., and Wilkinson, J. B., *Site Remediation Technology Screening Studies*, EE.3E.93, (February, 1993).
3. Battaglia, F. J., *In Situ Remediation Technology Screening Studies Part 1 - Soil Cases*, 95 ECS4 016 (March 10, 1995).
4. Environmental Solutions, Inc., *Onsite Treatment - Hydrocarbon Contaminated Soils*, Western States Petroleum Association, Irvine, CA, (c. 1992).
5. Higinbotham, J. H., *Bayway Technology Development Plan - Final Report; Innovative Technology Evaluation*, 94 ECS4 073, (June 29, 1994).
6. USEPA, US Air Force, *Remediation Technologies Screening Matrix and Reference Guide*, EPA 542-B-93-05 (July, 1993).
7. USEPA, *Introduction to Phytoremediation*, EPA/600/R-99/107, (February 2000).
8. Wrenn, B.A., and A.D. Venosa. 1996. Selective enumeration of aromatic and aliphatic hydrocarbon degrading bacteria by a most-probable-number procedure. *Can. J. Microbiol.* 42:252-258.
9. Von Fahnestock, F. M., G.B. Wickramanayake, R. J. Kratzke, W. R. Major, *Biopile Design, Operation, and Maintenance Handbook for Treating Hydrocarbon-Contaminated Soils*, 1998, Battelle Press.
10. USEPA, *Evaluation of Demonstrated and Emerging Technologies for the Treatment and Clean Up of Contaminated Land and Groundwater*, EPA 542-C-01-002.
11. USEPA, *Introduction to Phytoremediation*, EPA/600/R-99/107.
12. Report 95ECS4 007, *Bayway Sludge Lagoon Screening Study - Bench Scale Technology Testing*.
13. Report 96ECS4 020, *Bayway Sludge Lagoon Operable Unit Remediation Project - Screening Study Memorandum*.
14. USEPA, *Treatment Technologies for Site Cleanup: Annual Status Report (ASR)*, Tenth Edition, EPA 542-R-01-004.

DEFINITIONS

Attenuation - Is the ability of soil to reduce the impact of its contamination (or contamination from groundwater) via mechanisms such as sequestration (capture within soil matrix), chemical decomposition, volatilization and intrinsic (naturally occurring) bioremediation.

BTEX - Is the family of one-ring aromatic compounds: benzene, toluene, ethylbenzene and xylenes. Analytical procedure EPA 8020 (GC) quantifies these.

Co-Substrate - Is a supplemental food source for microorganisms which enables them to degrade the target contaminant more readily.

Section	Page	SOLID WASTE MANAGEMENT AND SITE REMEDIATION GUIDELINES FOR SELECTING SOIL REMEDIATION TECHNOLOGY	 DESIGN PRACTICES
XX-B4	4 of 34		
December, 2002			

Electron Acceptors - Are chemical species that are reduced (accept electrons) by microorganisms in the process of biodegrading (oxidizing) hydrocarbons, which donate electrons. The most common electron acceptor is oxygen (aerobic biodegradation). Anaerobic electron acceptors include nitrate, ferric iron, and sulfate.

Fenton's Reagent - Is a mixture of hydrogen peroxide and ferrous sulfate (FeSO_4) which is used to chemically oxidize contaminants.

NAPL - Non-aqueous phase liquid, also known as product and free phase hydrocarbon. This is hydrocarbon which is not dissolved and not adsorbed on soil particles. It may exist in pools. NAPL can be lighter than water (LNAPL) and so will "float" on the water table. NAPL can also be denser than water (DNAPL) and so will "sink" below the water table.

PAH - Polycyclic aromatic hydrocarbons, also known as PNA or polynuclear aromatics. These are multi-ring aromatic compounds such as naphthalene (2-ring), anthracene (3-ring), chrysene (4-ring) and benzo (a) pyrene (5-ring). There are often regulatory limits for the concentration of these compounds in soil. Some are known and suspected carcinogens.

Phytoremediation - The name given to a set of technologies that use plants to clean contaminated soil and ground water.

Pneumatic Fracturing - A method of increasing the permeability of tight soils by injecting high-pressure pulses of air, which open up horizontal, pancake-shaped fractures. Can also be done with pressurized fluids, known as "Hydraulic Fracturing."

PSD - Particle size distribution of soil particles.

Rhizodegradation - The breakdown of organic contaminants in soil through microbial activity that is enhanced by the presence of plant roots. Synonyms: Plant-assisted degradation, Plant-assisted bioremediation, Plant-aided in situ biodegradation, Enhanced rhizosphere biodegradation.

Saturated Zone - Consists of soil below the groundwater table.

Semi-Volatile Organics Compounds or SVOCs - Are organic compounds, primarily hydrocarbons, that generally have greater than ten carbon atoms. Their quantity is defined by USEPA Test Method 8270.

Surfactant - Is a surface active chemical which can be used to enhance contaminant availability by physically modifying (e.g., solubilizing) the contaminant.

TPH - Total Petroleum Hydrocarbon as measured by USEPA Method 1664. The analytical method consists of extraction with n-hexane. The extract is then quantified by gravimetric measurement. When methylene chloride is used as the extraction solvent, the analysis is known as **TEH** - Total Extractable Hydrocarbons.

Vadose Zone or Unsaturated Zone - Consists of the soil above the groundwater table.

Volatile Organics Compounds or VOCs - Are organic compounds, primarily hydrocarbons, that generally have less than ten carbon atoms. Their quantity is defined by USEPA Test Method 8240 (GC/MS). VOCs include BTEX.

Weathered Contamination - Is organic contamination which has changed chemical composition and structure over time. For example, lighter hydrocarbons evaporate and biodegradation removes alkyl chains from large aromatic ring compounds.

TECHNOLOGY SELECTION PROCESS

For a given soil contamination scenario, there often is no single remediation technology that is the obvious choice. In general, several technologies may be applicable. The challenge is to choose the best applicable technology, the one that offers the required clean-up effectiveness at the lowest cost.

[Figure 1](#) is a decision tree to help guide the technology selection process. It provides a method for evaluating potentially applicable technologies, but without respect to cost or regulatory requirements. The tree has been arranged so that those technologies that are typically less costly will be reached first. However, this is not always the case, as remediation cost is very dependent on the specific application, and involves many parameters other than the technology selected. Incineration and vitrification are not outcomes of [Figure 1](#). These are high cost technologies which are only considered when other methods cannot achieve the desired endpoint.

[Figure 2](#), the technology applicability chart, compares the technologies identified in [Figure 1](#) by their applicability to the type of hydrocarbon present, successful application experience and cost. Specific factors that may affect the selection of individual remediation technologies are discussed in the technology descriptions that follow.

Technology selection should also include an economic evaluation of several alternative technologies (for example, the technology identified using the decision tree as well as options that are "nearby" on [Figure 2](#)). This is necessary because remediation costs depend on the specific application as well as site specific factors. Also, a review of

 DESIGN PRACTICES	SOLID WASTE MANAGEMENT AND SITE REMEDIATION GUIDELINES FOR SELECTING SOIL REMEDIATION TECHNOLOGY	Section XX-B4	Page 5 of 34
		December, 2002	

applicable regulations is necessary to determine if the selected technology can achieve the treatment targets and meet all other regulatory requirements. This evaluation should account for design and construction costs for the selected remedy, operating costs over the duration of the remedy, decommissioning and closure of the remedial system, and any post-closure monitoring that may be required.

Laboratory or field treatability studies of the most applicable technologies are often performed as part of the selection process. Few soil remediation technologies have had commercial application under a broad enough range of conditions to accurately predict their performance in treating a specific soil. Field tests should be performed whenever they would be practical, especially for in situ technologies, as site characteristics often vary significantly within the treatment zone. Contaminated soil properties typically are not homogeneous, and the chosen technology should be able to treat soil throughout the contaminated area.

For large projects, it is sometimes economic to own, construct and operate the remediation equipment. For smaller projects, it typically is more cost-effective to rent equipment from a vendor or contractor. This is particularly true for technologies, such as in situ stabilization, that require intensive use of large machines over a short period of time.

If multiple contaminants are present (e.g., metals and hydrocarbon), more than one remediation technology may be required. For example, while bioremediation or thermal desorption will remove hydrocarbon contamination, they do not impact metals. Soil washing does not do as well in removing hydrocarbon, but does remove metals. When clean-up units are run in series, this arrangement is referred to as a treatment train.

TYPICAL DATA REQUIREMENTS

A significant amount of information is required to select appropriate remediation technologies. Technology selection must account for a number of site-specific factors, such as:

- Site characteristics: nature and extent of contaminants, hydrogeology, contaminant fate & transport.
- Clean-up levels: set by regulatory requirements or negotiated on the basis of risk assessment.
- Business considerations: time restrictions, economic requirements, space limitations, and ultimate site use.

In some instances, such as remediation of many underground storage tank (UST) leaks, the site will have one or two contaminants of concern with few potential receptors and impacts limited to a defined area. Under those circumstances, technology selection may be straightforward: a candidate technology can be identified on the basis of successful experience at similar sites. For other cases, such as former manufacturing sites or sites with complex hydrogeology, a comprehensive technology assessment program may be needed.

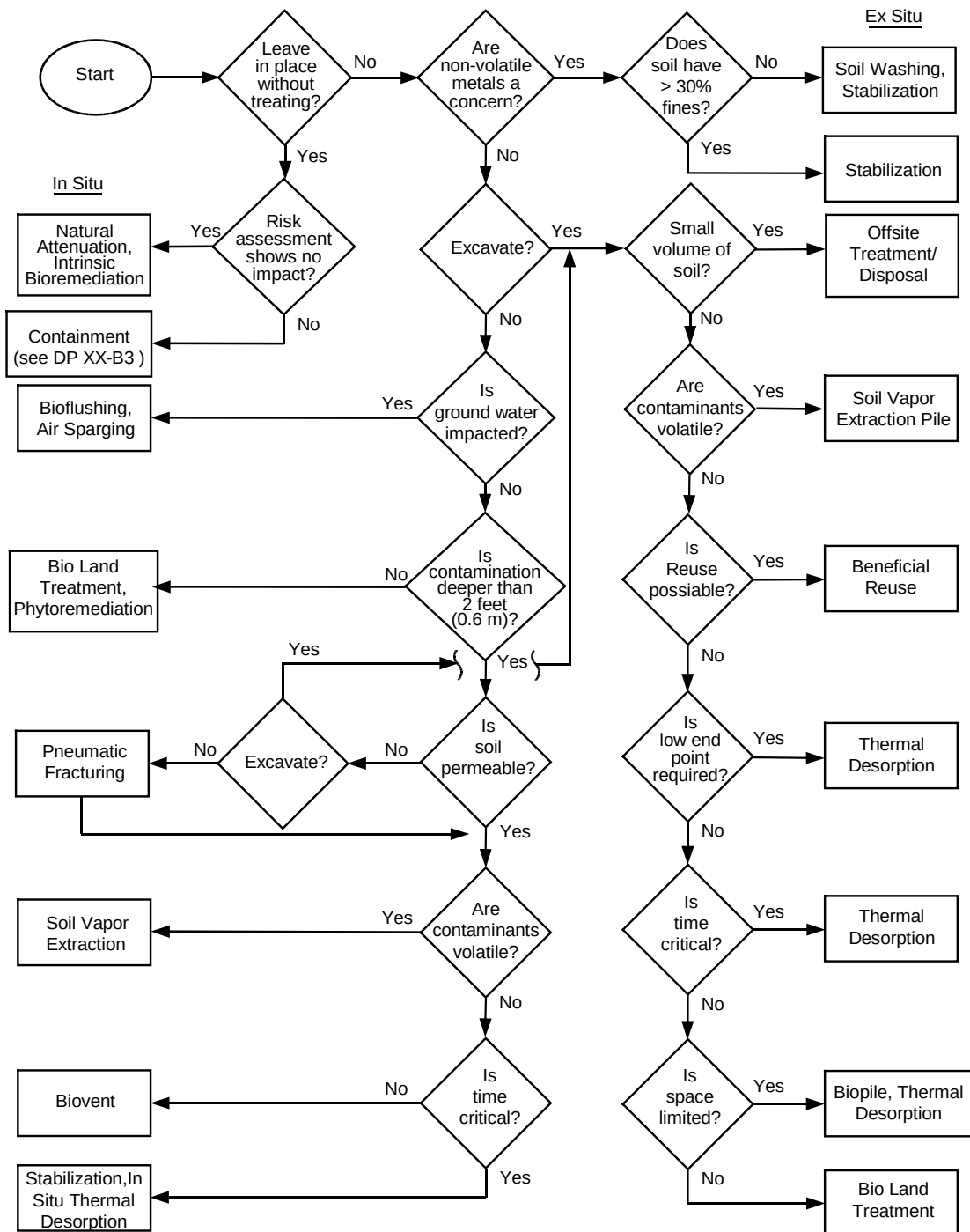
Specific data on soil and contaminant properties will be necessary to demonstrate the feasibility of the selected technology at a given site. To aid in the technology selection process, a first-pass suite of analytical procedures on soil and contaminants is typically performed. These tests, known as Tier 1, are listed in [Table 1](#). Additional data requirements for specific technologies, known as Tier 2, are summarized in [Table 2](#).



SOLID WASTE MANAGEMENT AND SITE REMEDIATION

GUIDELINES FOR SELECTING SOIL REMEDIATION TECHNOLOGY

FIGURE 1
DECISION TREE FOR SOIL REMEDIATION TECHNOLOGY SELECTION



Notes:

- (1) All technologies subject to proof of feasibility by treatability tests and economic comparisons to other technologies.
- (2) In some cases, ex situ technologies may be less costly than in situ technologies.
- (3) If treatability tests indicate end point cannot be achieved, consider higher cost technologies such as high temperature thermal treatment (incineration, vitrification, etc.) and offsite disposal.

DP20B4f01a



Documents

Document Sharing Hub

ExxonMobil DESIGN PRACTICES	SOLID WASTE MANAGEMENT AND SITE REMEDIATION GUIDELINES FOR SELECTING SOIL REMEDIATION TECHNOLOGY	Section	Page
		XX-B4	7 of 34
		December, 2002	

FIGURE 2
TREATMENT TECHNOLOGY APPLICABILITY: HYDROCARBON VS. TECHNOLOGY

			PETROLEUM HYDROCARBON APPLICABILITY												
			Gasoline	JP/4 Naphtha	Jet Kerosene	Diesel	Light fuel Oils #1, #2	Heavy fuel Oils #4, #5	Heavy Fuel Oil #6	Gas Oil	Lubricating Oil	Heavy Crude	Light Crude	Tank Bottoms	Used Oil
TECHNOLOGY		COST													
IN SITU	Bioflushing	\$\$\$	✓	✓	✓	✓	✓	✓	✓	✓	✓	?	?	?	?
	Natural Attenuation/Intrinsic Bioremediation	\$	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	Air Sparging	\$	✓	✓	✓	✓	✓								
	Bioventing	\$	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	?	?	?
	Phytoremediation	\$	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	Vitrification	\$\$\$\$	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	In Situ Thermal Treatment	\$ - \$\$\$	✓	✓	✓	✓	✓	✓							
IN SITU OR EX SITU	Soil Vapor Extraction	\$	✓	✓	✓	✓	✓	?							
	Land Treatment	\$	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	Stabilization/Solidification	\$\$\$	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
EX SITU	Offsite Treatment/Disposal	\$\$\$	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Soil Washing	\$\$\$				✓	✓	✓	✓	✓	✓	✓	✓		
	Beneficial Reuse	\$\$				✓	✓	✓	✓	✓	✓	✓	✓		
	Biopiles	\$\$	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
	Thermal Desorption	\$\$	✓	✓	✓	✓	✓	✓							
	Incineration	\$\$\$\$	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

LEGEND:	✓ Proven technology	\$	< 50 \$/ton
	? Developmental technology	\$\$	50 – 100 \$/ton
		\$\$\$	100 – 150 \$/ton
		\$\$\$\$	> 150 \$/ton

Section	Page	SOLID WASTE MANAGEMENT AND SITE REMEDIATION GUIDELINES FOR SELECTING SOIL REMEDIATION TECHNOLOGY	ExxonMobil DESIGN PRACTICES
XX-B4	8 of 34		
December, 2002			

TABLE 1
TIER 1 CHARACTERIZATION
PARAMETERS FOR SOIL REMEDIATION TECHNOLOGY SELECTION

DATA	TECHNIQUE
Total Petroleum Hydrocarbons (TPH), EPA 1664	Hexane Extraction, Gravimetric
Total Extractable Hydrocarbons (TEH)	Methylene Chloride Extraction, Gravimetric
Saturates, aromatics, polars distribution	High Performance Liquid Chromatography (HPLC)
Boiling points, n-paraffins	Gas Chromatography (GC)
Soil moisture content	Oven drying
Soil particle size distribution	Combined sieve and hydrometer
pH	pH analysis of water contacted with soil



ExxonMobil DESIGN PRACTICES	SOLID WASTE MANAGEMENT AND SITE REMEDIATION GUIDELINES FOR SELECTING SOIL REMEDIATION TECHNOLOGY	Section	Page
		XX-B4	9 of 34
		December, 2002	

TABLE 2
TIER 2 CHARACTERIZATION OF SOIL

	TPH - BY USEPA MODIFIED METHOD 8015*	INORGA- NICS**	REDOX POTENTIAL (ASTM 1495)	USEPA METHOD 8240 FOR VOCs	USEPA METHOD 8270 FOR SEMI- VOLATILES	SOIL PARTICLE SIZE DISTRIBUTION (ASTM D422)	FIELD SOIL PERMEA- BILITY†	SOIL pH (ASTM D4972)	MPN BIOLOGICAL COLONY ANALYSIS FOR HYDROCARBON DEGRADERS††	
EX SITU										EX SITU
Bioremediation	X	X	X	S	S	X		X	X	Bioremediation
Incineration/ Thermal Desorption	X	X	X	S	S	X				Incineration/ Thermal Desorption
Off-site Disposal	X	X	X	X	X			X		Off-site Disposal
Soil Washing	X	X	X	S	S	X				Soil Washing
Solvent Extraction	X	X	X	S	S	X				Solvent
IN SITU										IN SITU
Bioremediation	X	X	X	S	S	X		X	X	Bioremediation
Phytoremediation	X	X	X	S	S	X	X	X	X	Phytoremediation
Natural Attenuation	X	X	X	S	S	X		X	X	Natural Attenuation
Containment/ Isolation	X	X	X	S	S		X			Containment/ Isolation
Soil Flushing	X	X	X	S	S		X			Soil Flushing
Soil Vapor Extraction	X	X	X	S	S		X			Soil Vapor Extraction
Thermal Desorption	X	X	X	S	S					Thermal Desorption
Stabilization	X	X	X	S	S		X			Stabilization

Notes:

* In cases where thorough site history has shown impacting chemical to be light (< C10) run purgeables only. For heavy chemicals (> C10) run extractables only. Where unknown, run both purgeables and extractables.

** Inorganics typically analyzed include: metals (silver, arsenic, barium, cadmium, copper, mercury, nickel, lead, selenium) by EPA method 6010, sulfate (EPA methods 9035/9036), and nitrate (EPA method 9200).

† There are a number of field methods to determine permeability or hydraulic conductivity of soil. For references, see standards published by ASTM Subcommittee D18.21 on Ground Water and Vadose Zone Investigations (ASTM, 1994).

†† A number of laboratories, including ExxonMobil Corporate Strategic Research, have developed methods based on referenced standard methods for MPN (Most Probable Number determination) of hydrocarbon degrading micro-organisms in water.

S = Run for selected samples only.

X = Run for all samples.

Section	Page	SOLID WASTE MANAGEMENT AND SITE REMEDIATION GUIDELINES FOR SELECTING SOIL REMEDIATION TECHNOLOGY	 DESIGN PRACTICES
XX-B4	10 of 34		
December, 2002			

TECHNOLOGY DESCRIPTIONS

Following are summary descriptions of the leading soil remediation technologies that appear in [Figure 1](#). The descriptions follow a consistent format: an introduction providing background on the technology; a table of advantages and disadvantages; and one line comments on the typical treatment zone, target contaminants, best soil conditions, clean-up effectiveness; technology status, treatment time and cost. The costs are rated low, moderate and high, with the following definitions:

Low	< \$50/ton
Moderate	\$50 - 150/ton
High	> \$150/ton

IN-SITU TECHNOLOGIES

1. Bioflushing (In Situ Bioremediation With Ground Water Recovery/Recirculation)

Bioflushing is the in situ treatment of unsaturated soil and ground water by stimulating the activity of naturally occurring microorganisms through recirculation of ground water containing oxygen and nutrients (nitrogen and phosphorus) (see [Figure 3](#)). Contaminated ground water is brought to the surface via a recovery system. Nutrients and O₂ (air) are added. pH is adjusted if necessary. Then the water is re-injected or allowed to infiltrate through the soil zone to be treated. The process is usually carried out aerobically.

Effective delivery of nutrients and oxygen to the subsurface is a key design consideration. Since dissolved oxygen levels are limited to 8 to 12 mg/L (0.067 to 0.084 lb O₂/1000 gal H₂O), this method of O₂ delivery is limited to sites with low levels of contamination or where remediation time is not a primary concern. Pure oxygen (delivers up to 58 mg/L) or hydrogen peroxide (delivers 90 to 200 mg/L) can be used to deliver higher levels of oxygen. Approximately 3 lb of O₂ is required to biologically degrade 1 lb of hydrocarbon.

Additional information on the implementation of bioremediation technology is available in [Reference 6](#) and [Design Practice XX-C1](#).

During remediation, it is usually necessary to contain the dissolved-phase plume. This is generally accomplished by a system of recovery wells positioned to capture the plume. An oil recovery system (not shown in [Figure 3](#)) is often required to remove free-phase (NAPL - non aqueous phase liquid) material for above ground treatment. NAPL recovery systems are discussed in [Design Practice XX-B6](#).

ADVANTAGES	DISADVANTAGES
Relatively low cost treatment technology.	May take many years to complete.
Can be used to treat both soils and ground water simultaneously.	Clean-up level achieved depends on type of hydrocarbon.
Requires minimal labor and equipment.	Potential clogging of well screens or formation.
Limited excavation. System can be installed adjacent to existing subsurface structures.	May transfer contaminants to ground water.
No residuals for treatment or disposal.	Delivery of oxygen and nutrients difficult to control in low permeability or heterogeneous soils.
	Metals may inhibit or be toxic to microorganisms.

Treatment Zone - Unsaturated soil (vadose) zone; shallow unconfined aquifers.

Target Contaminants - Volatile and semi-volatile organics, light to medium petroleum hydrocarbons - gasoline, kerosene, diesel, jet, heating oil. Weathered crude or heavy oils require longer treatment times.

Best Soil Conditions - Homogeneous soils, soils with high sand content, hydraulic conductivity of 10⁻⁴ cm/sec or greater.

Clean-Up Effectiveness - TPH levels of 500 to 2,000 ppm in soil may be achieved.

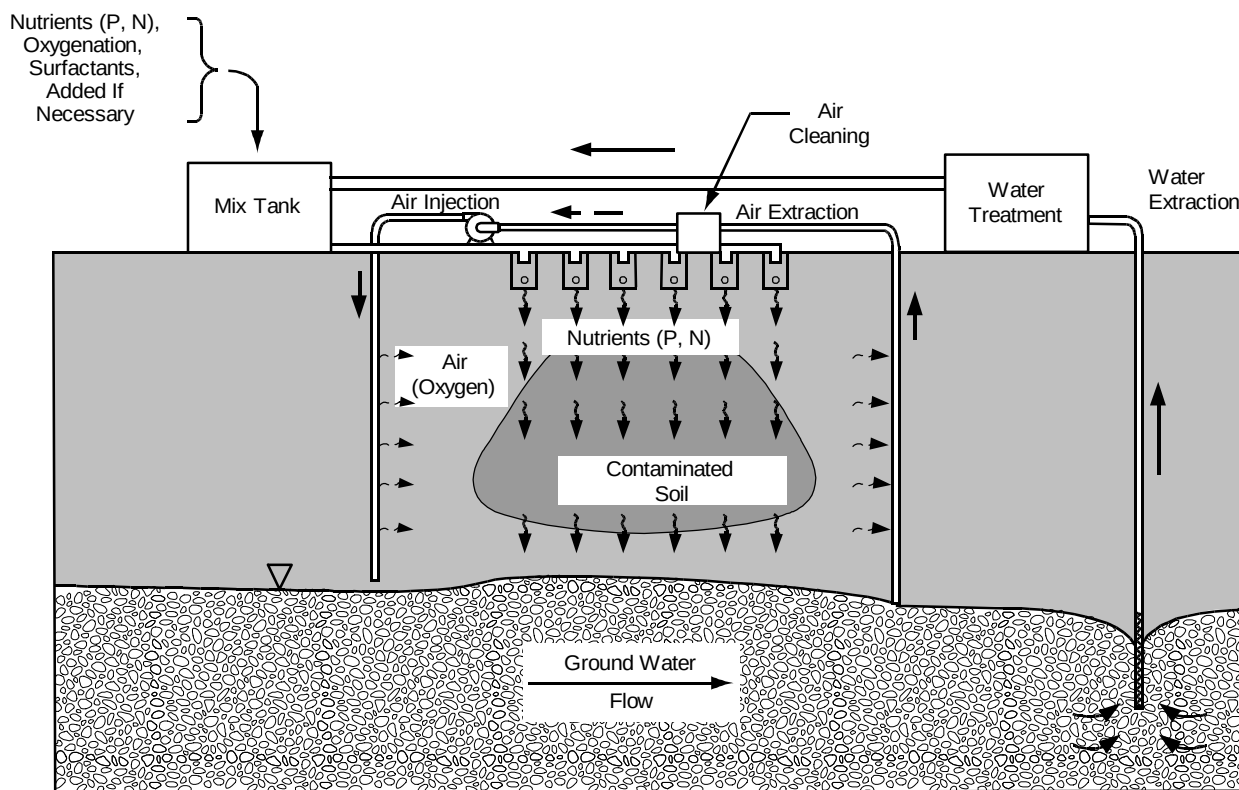
ExxonMobil DESIGN PRACTICES	SOLID WASTE MANAGEMENT AND SITE REMEDIATION GUIDELINES FOR SELECTING SOIL REMEDIATION TECHNOLOGY	Section XX-B4	Page 11 of 34
		December, 2002	

Technology Status - Developed technology which has been used at several ExxonMobil sites for both soil and ground water clean-up.

Treatment Time - Typically long - 6 months to 6 years.

Treatment Cost - Moderate - actual cost depends on concentration and types of contaminants, oxygen delivery method, and soil conditions.

FIGURE 3
BIOFLUSHING OF VADOSE ZONE



DP20B4f03

2. Natural Attenuation (NA) and Intrinsic Bioremediation (IB)

Also known as passive remediation, NA involves monitoring to ensure that contaminants present in an area of contaminated soil are adequately diminishing or being contained through natural processes. It has most commonly been applied to groundwater plumes but is also applicable to soils. Intrinsic bioremediation is a subset of natural attenuation wherein the destruction of contaminants by micro-organisms is the main mechanism of attenuation. It reduces the total amount of hydrocarbon in the soil and can control contaminant migration by degrading contaminants at the edge of the mobile phase to negligible concentrations. Other natural attenuation processes in soil include volatilization, leaching, and adsorption.

NA or IB typically requires the collection of site characterization data as well as fate and transport assessments and modeling to demonstrate that clean-up criteria can be met by allowing natural attenuation processes to take place. Rigorous monitoring is necessary to demonstrate that contaminant concentrations are decreasing as predicted and that migration outside of the treatment zone is controlled. In some instances, supplemental actions, such as the addition of hydrogen peroxide, are taken to enhance natural biological activity.