

CONTENTS

Section	Page
SCOPE	2
REFERENCES	2
DEFINITIONS	2
BACKGROUND	3
WASTE CHARACTERIZATION	3
TECHNOLOGY SELECTION	3
TECHNOLOGY DESCRIPTION	4
Solidification and Stabilization	4
Containment and Capping	5
Liquid/Solids Contact (LSC) Biotreatment	5
Land Biotreatment	5
Thermal Desorption	5
Dewatering and Oil Recovery	5
Beneficial Reuse	6
ECONOMICS	6
TABLE & FIGURES	7
Table 1 Sludge Characteristics from Exxon Facilities	7
Figure 1 Pond and Lagoon Design Impact on Underlying Soil and Groundwater	8
Figure 2 Technology Selection Decision Tree for Remediation of Ponds and Lagoons	9



DESIGN PRACTICES		SOLID WASTE MANAGEMENT AND SITE REMEDIATION REMEDIATION OF PONDS AND LAGOONS PROPRIETARY INFORMATION — For Authorized Company Use Only	
Section	Page		
XX-B5	2 of 9		
Date December, 1996			

SCOPE

This subsection of Design Practices describes treatment technologies currently available for cleanup of oily sludges, contaminated sediments and soils found in ponds and lagoons. General background information on the treatment technologies as well as a technology selection decision tree are provided to guide in the selection of an applicable treatment technology or technologies. Details on specific technologies can be found in the relevant Design Practices and other references listed below.

REFERENCES

- Design Practices
 - [Section XX](#) Solid Waste Management and Site Remediation
 - [Section XX-A3](#) Mechanical Sludge Dewatering
 - [Section XX-A6](#) Solid Waste Fixation and Stabilization
 - [Section XX-B](#) Guidelines and Considerations for Site Remediation
 - [Section XX-B2](#) Containment
 - [Section XX-B4](#) Guidelines for Selection of Soil Remediation Technology
 - [Section XX-C1](#) BioRemediation
 - [Section XX-C2](#) Thermal Treatment
- "Site Characterization and Remedial Technology Selection Guide", Chapter 3, EE.4M.95
- "Remediation of Ponds and Lagoons – Status Report", 95-ECS4-015
- "Guidance Document for Cleanup of Surface Impoundment Sites", EPA Document PB87-110664
- "Environmental Control Newsletter 92-1, Use of Liquid/Solids Contact Biotreatment for the Management of Oily Sludges", EE.1DA.92
- "Biological Decontamination Technologies for Oil Contaminated Soils and Oily Sludges", EE.59E.89
- "BioRemediation Using the Land Treatment Concept", EPA document 600/R-93/164
- "Remediation of Petroleum Contaminated Soils by Thermal Desorption", 95-ECS4-020
- "Engineering Bulletin – Solidification/Stabilization of Organics and Inorganics", EPA 94-106333
- "Bayway Sludge Lagoon Operable Unit – Beneficial Reuse Screening Studies – Final Summary", 96-ECS4-031
- "Potential Reuse of Petroleum-Contaminated Soil: A Directory of Permitted Recycling Facilities", EPA 600/R-92/096
- "Site Characterization Guide", EE.22E.94
- "Screening Study Memorandum for Bayway Sludge Lagoon Operable Unit Remediation Project", 96-ECS4-020.

DEFINITIONS

Ponds and Lagoons – Ponds and lagoons can be either natural topographical depressions or man made excavations or diked areas formed primarily of earthen material. In some cases the pond or lagoon is lined with clay or a synthetic lining to prevent infiltration into the underlying soil. Physical size of ponds and lagoons vary widely with surface areas ranging from less than 1 acre (0.4 hectare) to greater than 100 acres (40 hectares) and depths ranging from 2 to 30 feet (0.6 to 9 meters). These facilities are designed to hold liquid wastes or sludges that contain free liquids. Removal of the free liquid can either be continuous or intermittent. Ponds and lagoons may be aerated mechanically through surface or diffused aeration systems.

Impoundment – For this Design Practice, impoundment is used to describe ponds or lagoons in a general sense and has no regulatory implications.

Heavy Sludge – This material is generally not pumpable and typically has an oil content which is greater than the water content. Heavy sludges can be subdivided into two categories; 1) thick, tar-like oily sludges and 2) contaminated soils. Thick, tar-like sludges generally result from the disposal of oily sludges and weathering, which is the disappearance of lighter components via volatilization and degradation. Contaminated soils are generally present when the material deposited into the pond or lagoon has leaked into the underlying soil.

Soft Sludge – Sludges that fall into this category are generally pumpable and have a water content that is greater than the oil content. For example, sludges from biological wastewater treatment systems are classified as soft sludge.

EXXON EXXON ENGINEERING	SOLID WASTE MANAGEMENT AND SITE REMEDIATION REMEDIATION OF PONDS AND LAGOONS PROPRIETARY INFORMATION — For Authorized Company Use Only		DESIGN PRACTICES	
			Section XX-B5	Page 3 of 9
			Date December, 1996	

BACKGROUND

Chemical, marketing and refining operations have used or are currently using ponds and lagoons as an integral part of wastewater treating and waste handling facilities. Materials deposited in these impoundments over their lifetimes include but are not limited to API sludges, tank bottoms and biological solids. Regulatory changes have, in many locations, restricted or banned the use of ponds and lagoons as waste disposal facilities and, in some cases, are requiring the clean up of these facilities (e.g., RCRA Corrective Action in the U.S.). Clean up of these sites can be a challenge since sludge characteristics often vary significantly within the impoundment, and few treatment technologies have been applied under a broad enough range of conditions to accurately predict their performance in treating a specific material.

WASTE CHARACTERIZATION

Characterization of the material in ponds and lagoons is required before a treatment technology can be selected. For impoundments where different types of wastes were disposed, the characteristics of the waste material may not be uniform across the impoundment. Therefore it is necessary to characterize the waste material at multiple sample locations to achieve a cross section of the sludge characteristics. Proper selection of sample location and sampling techniques are critical for obtaining high quality data (Ref. 2 and 12).

Sludge samples taken from impoundments at several Exxon facilities have been analyzed to gain a better understanding of the composition, the nature of contamination and the type of sludge found in ponds and lagoons. Listed in **Table 1** is a summary of the sludge characteristics of the samples collected at the Exxon sites. As this table indicates, the characteristics of the sludges vary widely for both soft and heavy sludges.

Parameters typically used to characterize petroleum contaminated soil and waste are listed below. Collectively, the tests listed are known as a TIER 1 characterization and are routinely performed at ER&E.

PARAMETER	METHOD
Total Petroleum Hydrocarbon (TPH)	Freon Silica Gel/IR
Total Extraction of Hydrocarbons	Methylene Chloride
Chemical Class Characterization of Contaminants	High Pressure Liquid Chromatography (HPLC) for Saturates, Polars, 1, 2, 3 and 4+ Ring Aromatics
Boiling Point Distribution of Contaminants	Gas Chromatography
Distribution of Normal Paraffin with Bio-markers	Gas Chromatography
Solids Characterization	ASTM Particle Size Distribution and pH
Analysis for Leachable Metals	Toxic Characteristic Leaching Protocol (TCLP) for Ag, As, Ba, Cd, Cr, Hg, Pb and Se

In addition to the sludge characterization, site specific factors must be considered when evaluating potential treatment technologies. Design of the pond or lagoon, especially for older facilities, is one factor that must be considered when developing a clean up strategy. As shown on **Figure 1**, the design of the impoundment may impact underlying soil and groundwater. If the impoundment is found to be leaking, the underlying soil and groundwater may also require remediation. Also, if the impoundment is physically connected to the groundwater, dewatering of the pond or lagoon may be necessary during the remediation period to keep the impoundment as dry as possible. Other factors to be considered include: area to be cleaned, sludge volume, clean up levels set by regulatory requirements and economic requirements.

TECHNOLOGY SELECTION

Figure 2 is a decision tree designed to guide the technology selection process. It provides a method for evaluating potentially applicable technologies but does so without considering economics or regulatory requirements. No single remediation technology may be the obvious choice for the sludge or soil to be remediated. The challenge is to choose the best applicable technology that provides the required clean-up level at the lowest cost. The remediation can be done either in situ or ex situ and may require remediation of the underlying soil and groundwater.