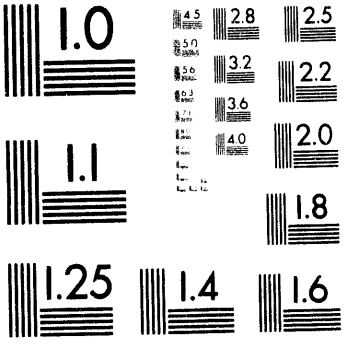
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1.1
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5.6

1 of 1

ES/ER/TM-89

Environmental Restoration Program Pollution Prevention Checklist Guide for the Feasibility Study Project Phase

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Date Issued—September 1993

Prepared for
U.S. Department of Energy
Office of Environmental Restoration and Waste Management
under budget and reporting code EW 20

MARTIN MARIETTA ENERGY SYSTEMS, INC.
managing the

Oak Ridge K-25 Site
Oak Ridge Y-12 Plant
Oak Ridge National Laboratory
under contract DE-AC05-84OR21400

Paducah Gaseous Diffusion Plant
Portsmouth Gaseous Diffusion Plant
under contract DE-AC05-76OR00001

for the
U.S. DEPARTMENT OF ENERGY

CONTENTS

ACRONYMS

AOC	area of contamination
ATTIC	Advanced Treatment Technologies Information Center
CAA	Clean Air Act of 1970
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
FS	feasibility study
NPDES	National Pollution Discharge Elimination System
PPT	physical treatment technologies
PP/WM	pollution prevention/waste minimization
QA	quality assurance
RCRA	Resource Conservation and Recovery Act of 1976
TCE	trichloroethylene
TTT	thermal treatment technologies
WA	waste assessment

1. PURPOSE

Feasibility studies (FS) determine what remedial alternatives are presented to regulators for site cleanup. A key consideration in this process is the waste to be generated. Minimizing the volume and toxicity of this waste will ultimately contribute to the selection of the best remedial option.

The purpose of this checklist guide is to assist the user in incorporating pollution prevention/waste minimization (PP/WM) in all FS phase projects of the Environmental Restoration (ER) Program. This guide will help users document PP/WM activities for technology transfer and reporting requirements. Automated computer screens will be created from the checklist data to assist users with implementing and evaluating waste reduction. Users can then establish numerical performance measures to measure progress in planning, training, self-assessments, field implementation, documentation, and technology transfer. Cost savings result as users train and assess themselves and perform preliminary waste assessments.

2. APPLICABILITY

This checklist guide applies to all ER Program participants performing FS phase projects for all sources of pollution including air emissions, water, and solid waste. This guide is intended to serve three primary audiences:

- Site project managers and others on the project team engaged in activities focusing on or ultimately serving the process of incorporating PP/WM in the FS phase project;
- ER PP/WM specialists—for use as a general overview to help ensure that PP/WM criteria are being applied whenever possible in all FS phase projects; and
- ER Technology Development and Application specialists—for use as a tool for providing new and effective technology information to the site project managers.

Although this checklist guide may be used by a number of individuals as indicated above, it is incumbent on the ER Program to ensure that the projects select and apply technologies that not only result in the smallest quantities of waste with the least toxicity, but also minimize environmental releases during remediation. Minimizing waste generation should be considered in addition to the capital, maintenance, and operating costs to implement liabilities and any potential threat to human health and the environment.

3. INTRODUCTION

ER activities differ significantly from routine production facilities. While the focus for PP/WM for production operations is often on source reduction and recycling, those techniques are not readily adaptable to ER projects. Opportunities for source reduction and recycling are limited for clean-up activities since ER inherits contaminated waste sites from previous production processes, where ongoing process operations generally do not exist. Although treatment is not a preferred alternative per the U.S. Environmental Protection Agency (EPA) hierarchy, the nature of ER activities is generally such that clean up of the site by the application of some treatment technology is often the only alternative. The fact that the waste exists cannot be changed.

The greatest impact on the minimization of waste from the standpoint of the overall ER Program would be the selection of the clean-up option for remediation at a site. The FS phase will generate the remedial alternatives from which the selection of the best clean-up option will be determined. The remediation will most likely encompass the following or combinations thereof:

- contain and control,
- in-situ immobilization,
- in-situ treatment,
- ex-situ treatment and return,
- ex-situ treatment and removal, and
- no action.

The success of incorporating PP/WM in the FS phase project will be determined ultimately on how well the volume and toxicity of the waste generated is minimized. However, the evaluation of options and selection of the most appropriate treatment technology for a site (when treatment is deemed appropriate) can be a complex undertaking when the many variables and issues during the remedy selection process are considered. This guide will be useful during the process of how PP/WM is incorporated when treatment technologies are evaluated. Therefore, all efforts contributing to the selection of the best remedial option and treatment technology will effectively achieve the objectives of PP/WM.

4. USE OF THIS CHECKLIST GUIDE FOR THE FS PROJECT

The document guide is organized in three sections. The first section of the checklist guide contains general questions concerning the generator's pollution prevention program. The second section of the checklist guide contains questions concerning the generator's pollution prevention program as it applies to the FS phase. The third section of the guide is more project specific and entails questions about contaminants, media, and waste streams. The generator is also asked to give their rationale on their evaluation of applicable technologies analysis and how they would incorporate pollution prevention.

5. INSTRUCTIONS FOR FS PROJECT PHASE USERS CHECKLIST

The following are steps used to simplify this guide.

5.1 PROJECT INFORMATION

Complete the project information as requested in Sect. 1 of the FS Project Phase Checklist (Fig. 1, p. 4).

5.2 SITE DESCRIPTION

Complete the site description as requested in Sect. 1 of the FS Project Phase Checklist (Fig. 1). Provide attachments if necessary.

5.3 GENERAL QUESTION INFORMATION

Complete the general questions as requested in Sect. 1 of the FS Project Phase Checklist (Fig. 1).

5.4 FS PHASE-SPECIFIC QUESTION INFORMATION

Complete the FS phase-specific questions as requested in Sect. 2 of the FS Project Phase Checklist (Fig. 1).

5.5 WASTE STREAM INFORMATION

Refer to the Example Waste Stream Information (Fig. 2, p. 14). Complete the waste stream information requested in Sect. 3 of the FS Project Phase Checklist (Fig. 1).

SECTION 1. GENERAL QUESTION INFORMATION

Project Name: Project Manager:
Phase: FS Project Location:

Site Description: _____

_____

_____

		YES	NO
1.	Is there a PP/WM Site Plan on site?	____	____
2.	Have those that report to management been trained on:		
	• Site general employee radiation training?	____	____
	• 24-hr SARA/OSHA (HAZWOPER) with 8-hr annual refresher?	____	____
	• RCRA hazardous waste generator?	____	____
	• Pollution prevention and waste minimization?	____	____
3.	Does the PP/WM Site Plan have the following objectives and statements of scope:		
	• A statement of PP/WM scope and objectives developed and distributed to all project personnel.	____	____
	• A statement of PP/WM scope and objectives developed and distributed to all contractor personnel.	____	____
	• A statement of PP/WM scope and objectives developed and distributed to all safety and emergency response personnel.	____	____
	• Specific numerical goals for PP/WM for each project waste stream set and distributed or displayed to all project personnel.	____	____
	• Specific numerical goals for PP/WM for each project waste stream set and distributed or displayed to all contractor personnel.	____	____
	• Specific numerical goals for PP/WM for each project waste stream set and distributed or displayed to all safety and emergency personnel.	____	____
4.	Have project managers or personnel initiated PP/WM site plans for projects that are scheduled to start within 180 days or less from now?	____	____

Fig. 1. FS Project Phase Checklist.

	YES	NO
• PP/WM incorporated in any of the project work and waste management plans?	____	____
• A section on PP/WM incorporated in at least of one of the project work and waste management plans?	____	____
• A section on PP/WM in all the project work and waste management plans?	____	____
• A section on PP/WM in all the project work and waste management plans. Each section discusses at least three techniques to reduce or prevent waste generation?	____	____

5. Do project managers or personnel have the following data relating to site operations and waste streams so that PP/WM opportunities can be identified:

• Supply and distribution record (i.e., chemical inventory, chain of custody, and waste drum tracking)?	____	____
• Maintenance records (i.e., inspection and preventive maintenance, repair orders)?	____	____
• Supervision records (i.e., QA audits, noncompliance, and personnel records)?	____	____
• Required permits and records (i.e., CAA, NPDES, and RCRA monitoring, RCRA accumulations facility inventories and manifests, CERCLA reportable quantity release, sample waste analyses, and RADCON Manual Compliance)?	____	____
• PP/WM Program documentation (i.e., all work and waste management plans for projects scheduled 180 days or less from now)?	____	____
• Design information (i.e., process flow diagrams and material balances)?	____	____
• Environmental information and reporting (i.e., sample waste analyses, RCRA/Tennessee Annual Report, EPA Biannual Report, and Pollution Prevention Act Tri-Report)?	____	____
• Raw material site information (i.e., material safety data sheets, contractor data logs, site operating procedures, and project schedules and milestones)?	____	____
• Economic information (i.e., waste treatment, disposal, operating, maintenance, departmental, and pollution prevention implementation costs)?	____	____

Fig. 1 (continued)

		YES	NO
6.	Have project managers or personnel had the PP/WM Program audited in the last 12 months?	____	____
	Was the program audited in the following manner:		
	• A periodic schedule for audit of activities made?	____	____
	• Audit performed by those who have direct responsibility for performing the activities being audited?	____	____
	• Audit performed by those who do not have direct responsibility for performing the activities being audited?	____	____
	• Audit always reviewed by responsible management?	____	____
	• Follow-up action is always taken as a result of the audit?	____	____
7.	Have project managers or personnel insisted on assessment of the waste streams to reduce or prevent waste generation?	____	____
	Have the following project waste assessment elements been performed:		
	• Review of the PP/WM operations and waste management issues and targeted work sites that should be assessed?	____	____
	• Development of flow diagrams and materials balances for each targeted work site?	____	____
	• Identification of PP/WM opportunities and projects that address those opportunities?	____	____
	• Evaluation and ranking of projects into a coordinated long-range plan?	____	____
8.	Do project managers or personnel have cost, schedule, and program contents specific to the PP/WM Program activities?	____	____
	What kind of waste accounting is performed?		
	• Are operating cost records kept?	____	____
	• Are treatment cost records kept?	____	____
	• Are disposal cost records kept?	____	____
	• Are maintenance cost records kept?	____	____

Fig. 1 (continued)

	YES	NO
• Are life-cycle cost records kept?	____	____
• Are costs to implement pollution prevention activities kept?	____	____
• Are real-time cost savings since PP/WM Site Plan implementations kept?	____	____
9. Have project managers or personnel evaluated the PP/WM Program to the numerical goal criteria in the last 12 months?	____	____
Are the following criteria used to evaluate the PP/WM Program:		
• Number of numerical goals achieved?	____	____
• Number of cost reductions achieved?	____	____
• Number of noncompliances cited?	____	____
• Number of new technologies integrated?	____	____
• Number of noncompliances corrected?	____	____
10. Do project managers or personnel keep and organize records from PP/WM activities for quality assurance purposes?	____	____
Are records from pollution prevention activities kept and organized in the following manner:		
• Records furnish documentary evidence from all pollution prevention activities.	____	____
• Records are well-organized and are easy to assess?	____	____
• Records are protected against damage, deterioration, or loss?	____	____
• Requirements and responsibilities for record transmittal, distribution, retention, maintenance, and dispositions are established and documented?	____	____
11. Is technology information available for comparison from other sites for PP/WM assessment?		
• Parameters and results of a material or characterization activity?	____	____
• Impact of the project of implementing a new technology?	____	____
• Characterization activities and materials currently used?	____	____

Fig. 1 (continued)

	YES	NO
• Remedial characterization activities and materials under consideration?	____	____
12. If new technology information is available from other sites, does the facility manager or personnel have a timetable, cost schedule, and possible implementation procedures on the new technology?	____	____
13. **Do facility managers or personnel implement mechanisms for quality improvement in PP/WM to prevent noncompliance?**	____	____

How often does management assess the PP/WM to quality assure that it is adequate and is effectively implemented?

____ Never.

____ No regular schedule for assessing the PP/WM Program; occasionally performed.

____ Regular schedule for assessing the PP/WM Program, performed every 2 years.

____ Regular schedule for assessing the PP/WM Program, performed every year.

____ Regular schedule for assessing the PP/WM Program, performed at least every 6 months.

14. **Does the facility manager/personnel know who handles the waste generated?**

____ It is not known who handles the waste.

____ The site waste management organization handles the waste.

____ The site management organization handles the waste and provides some data to meet reporting requirements.

____ The site waste management organization handles the waste and provides all data to meet reporting requirements.

SECTION 2. FS PHASE-SPECIFIC QUESTION INFORMATION

	YES	NO
1. **Is there a ER PP/WM Site Plan on site?**	____	____
2. Is PP/WM currently incorporated in the treatability study documents (optional)?	____	____

Fig. 1 (continued)

		YES	NO
3.	Is PP/WM currently incorporated in the feasibility study documents?	____	____
4.	Does the ER PP/WM Site Plan include specific quantitative goals for reducing the volume or toxicity of each waste stream?	____	____
5.	If specific numerical goals are not included for each waste stream, is a strategy outlined to arrive at numerical goals?	____	____
6.	Does the ER PP/WM Site Plan include programmatic goals for the evaluation of new technologies to reduce waste generation for FS activities?	____	____
7.	Does the ER PP/WM Site Plan contain a budget for its waste minimization program?	____	____
8.	Is there a method for tracking waste for the ER site's waste management activities from the point of generation to the point of discharge or treatment, storage, or disposal?	____	____
9.	Has the organization developed baseline data for the generation of waste?	____	____
10.	Is there a method for accounting for waste management costs?	____	____
11.	Has the organization developed guidance for applying quality assurance to waste minimization activities?	____	____
12.	Does the ER PP/WM Site Plan explain how PP/WM principles are incorporated into activities involving FS?	____	____
13.	Have ER PP/WM waste assessments (WAs) been conducted on the waste streams that have been generated?	____	____
14.	If ER PP/WM WAs have not been conducted, are there plans to conduct WAs in this fiscal year?	____	____
15.	Does the ER PP/WM Site Plan identify research and development projects related to FS activities?	____	____
16.	Does the ER PP/WM Site Plan describe technology transfer activities that are planned for FS activities?	____	____
17.	Does the ER PP/WM Site Plan describe a procedure for evaluating the FS PP/WM program?	____	____
18.	Does the ER PP/WM Site Plan explain how design principles that minimize waste generation are incorporated into new construction and into options that involve new or modified processes?	____	____

Fig. 1 (continued)

SECTION 3. WASTE STREAM INFORMATION

Site Description: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

WASTE GROUP IDENTIFICATION SUMMARY

Contaminant	Contaminant Group
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

APPLICABLE TREATMENT TECHNOLOGY SUMMARY

Contaminant Group(s): _____

_____

Media Type(s): _____

_____

Fig. 1 (continued)

Applicable Treatment Technologies:

Physical Treatments:

1)
2)
3)
4)
5)
6)
7)
8)
9)
10)

Thermal Treatments:

1)
2)
3)
4)
5)
6)
7)
8)
9)
10)

Chemical Treatments:

1)
2)
3)
4)
5)
6)
7)
8)
9)
10)

Fig. 1 (continued)

Biological Treatments:

1)
2)
3)
4)
5)
6)
7)
8)
9)
10)

TECHNOLOGY EVALUATION RATIONAL INCORPORATING PP/WM

Treatment Evaluation Rationale:

Fig. 1 (continued)

PP/WM Rationale:

Have any applicable treatment technologies been identified that reduce? __ Volume __ Toxicity__ Does Not Apply

	YES	NO
Have any applicable treatment technologies been identified that immobilize contaminants?	____	____
Can any primary waste stream(s) be reused or recycled after treatment?	____	____
Can any primary waste stream(s) be returned to the area of contamination (AOC) after treatment?	____	____
Can any primary waste stream(s) be exchanged for reuse after treatment?	____	____
Can any secondary waste stream(s) be reused or recycled?	____	____
Can any secondary waste stream(s) be returned to the AOC?	____	____
Can any secondary waste stream(s) be exchanged for reuse after treatment?	____	____

PP/WM Rational:

Fig. 1 (continued)

WASTE STREAM INFORMATION

Site Description: Site with soil contaminated with Arsenic and Trichloroethylene (TCE). The contamination is concentrated in the top 3 ft of soil at the site. The soil contains a high percentage of fines, clay, and rock and a significant amount of roots, leaves, and other decomposing material.

HAZARDOUS CONSTITUENT/WASTE GROUP IDENTIFICATION SUMMARY

Contaminant	Contaminant Group
Arsenic	Volatile Metal
TCE	Halogenated Volatile

APPLICABLE TREATMENT TECHNOLOGY CORRELATION SUMMARY

Contaminant Group(s): Volatile metals, Halogenated volatiles

Media Type(s): Solids

Fig. 2. Example Waste Stream Information.

Applicable Treatment Technologies:

Physical Treatments:

1) In-Situ Steam Injection and Vacuum Extraction
2) In-Situ Steam Enhanced Extraction
3) In-Situ Solidification and Stabilization
4) Chemical Treatment and Immobilization
5) Soil/Sediment Washing
6)
7)
8)
9)
10)

Thermal Treatments:

1) Thermal Gas Phase Reduction
2) Desorption and Vapor Extraction
3) Cyclone Furnace
4) Thermal Desorption
5)
6)
7)
8)
9)
10)

Chemical Treatments:

1)
2)
3)
4)
5)
6)
7)
8)
9)
10)

Fig. 2 (continued)

Biological Treatments:

1)
2)
3)
4)
5)
6)
7)
8)
9)
10)

TECHNOLOGY EVALUATION RATIONAL INCORPORATING PP/WM

Treatment Evaluation Rationale:

Based on the evaluation performed, all of the physical treatment options were eliminated for the following reasons. Physical treatment technologies (PPT) numbers 1 and 2 are in-situ extraction technologies that do not work well when the contamination is concentrated near the surface. PPT number 3, an in-situ immobilization technology, is limited by its ability to thoroughly immobilize some volatile and semivolatile organics including TCE. PPT number 4 was eliminated by detailed research of reference materials which concluded that this technology was limited by the presence of excessive fines and clays that inhibit mobility of the chemical treatment solution through the matrix. Finally, PPT number 5 was limited by particle size distribution of the matrix and the presence of significant quantities of roots, twigs, leaves, and other decomposing material that might inhibit the soil washing process.

Thus, with the elimination of the physical technologies, the focus is now on the thermal treatment technologies (TTT) identified previously as potentially applicable. Thermal desorption/reduction technologies identified as TTT numbers 1, 2, and 4 are effective for some volatile metals such as mercury, but will probably not be effective for arsenic because the boiling point of this metal is in excess of the upper temperature range of thermal desorption. It is determined that the high-temperature cyclone furnace incineration treatment technology (TTT number 3) is preferred for this stream. The cyclonic action provides the additional benefit of breaking apart tightly bound materials (such as clay) to facilitate thorough volatilization of the arsenic and TCE.

Fig. 2 (continued)

PP/WM Rationale:

Have any applicable treatment technologies been identified that reduce? __ Volume X Toxicity __ Does Not Apply

	YES	NO
Have any applicable treatment technologies been identified that immobilize contaminants?	X	
Can any primary waste stream(s) be reused or recycled after treatment?	X	
Can any primary waste stream(s) be returned to the AOC after treatment?	X	
Can any primary waste stream(s) be exchanged for reuse after treatment?		X
Can any secondary waste stream(s) be reused or recycled?	X	
Can any secondary waste stream(s) be returned to the AOC?		X
Can any secondary waste stream(s) be exchanged for reuse after treatment?		X

PP/WM Rational:

By using the cyclone furnace technology, the TCE is destroyed in the combustion chamber, and the volatilized arsenic is captured by the process. The treated soils resemble volcanic glass, which immobilizes trace quantities of any remaining metals. The vitrified material can be reused appropriately as fill material. Thus, only a small quantity of fly ash (primary soil) collected in a baghouse is produced as a secondary waste stream. Overall, toxicity was virtually eliminated, and overall volume remained fairly constant in this scenario.

Fig. 2 (continued)

5.5.1 Summary Hazardous Constituent/Waste Group Table

Identify waste groups for specific contaminants determining potentially applicable technologies based on the waste groups and media in the Example Waste Stream Information (Fig. 2). Locate the contaminants in Table 1, and identify the associated contaminant group (if not already known). Then complete Sect. 3 of the FS Project Phase Checklist (Fig. 1).

Comprehensive lists can be found in 40 CFR 268, Appendix III (FR July 1991) and the Risk Engineering Database (EPA July 1992) accessed through the Advanced Treatment Technologies Information Center (ATTIC) database (EPA May 1992).

5.5.2 Applicable Treatment Technology Summary

Identify the treatment technologies and correlate based on applicable contaminant and media information in the Example Waste Stream Information (Fig. 2). After identifying all known contaminants from the Summary Hazardous Constituent/Waste Group Table (Table 1), apply the information to the Summary Technology Correlation (Tables 2 through 5) to identify the technology or technologies potentially applicable to treating the contaminants and media. Then complete Sect. 3 of the FS Project Phase Checklist (Fig. 1).

Although the technology may be applicable to the project situation if the contaminants and media are indicated with the technology as being potentially applicable. The user is cautioned that this information is fairly broad in nature. Identification of a technology as potentially applicable is not to be interpreted any other way. Because most of the contaminant groups actually include many hazardous constituents, detailed research is required. Thus, treatability and feasibility studies focused on specific hazardous constituents, which simultaneously consider other technical issues during the screening processes, are needed to ensure the technology is appropriate.

Sources for technology information are too numerous to list here. The primary sources are the EPA's Superfund Innovative Technology Evaluation Program, Vendor Information System for Innovative Treatment Technologies, and ATTIC databases.

5.5.3 Treatment Technology Evaluation Incorporating PP/WM

Evaluate treatment technologies incorporating PP/WM in the Example Waste Stream Information (Fig. 2). Then complete Sect. 3 of the FS Project Phase Checklist (Fig. 1).

Table 1. Summary Hazardous Constituent/Waste Group Table

CONSTITUENT	CONTAMINANT GROUP
1, 2, 4-trichlorobenzene	Halogenated Semivolatiles
1, 4-dichlorobenzene	Halogenated Semivolatiles
1, 2-Dichloropropane	Halogenated Volatiles
1, 1, 1, 1-tetrachloroethane	Halogenated Volatiles
1, 1, 1-Trichloroethane	Halogenated Volatiles
1, 2-Trans-dichloroethene	Halogenated Volatiles
1, 1, 2-Trichloroethane	Halogenated Volatiles
1, 2-Dichloroethene	Halogenated Volatiles
1, 2-bis (2-chloroethoxy) ethane	Halogenated Semivolatiles
1, 1-Dichloroethene	Halogenated Volatiles
1, 2-dichlorobenzene	Halogenated Semivolatiles
1, 2-diphenylhydrazine	Nonhalogenated Semivolatiles
1, 1, 2-trichloro-1, 2, 2-trifluoroethane	Halogenated Volatiles
1, 3-dichlorobenzene	Halogenated Semivolatiles
1, 1-Dichloroethane	Halogenated Volatiles
1, 2-Dichloroethane	Halogenated Volatiles
2, 4, 5-Trichlorophenol	Halogenated Semivolatiles
2, 4, 6-Trichlorophenol	Halogenated Semivolatiles
2, 4-dichlorophenol	Halogenated Semivolatiles
2, 6-dinitrotoluene	Nonhalogenated Semivolatiles
2, 4-dinitrotoluene	Nonhalogenated Semivolatiles
2, 4-dimethyphenol	Nonhalogenated Semivolatiles
2, 4-dinitrophenol	Nonhalogenated Semivolatiles
2-buthanone	Nonhalogenated Volatiles
2-chloronapthalene	Halogenated Semivolatiles
2-chlorophenol	Halogenated Semivolatiles
2-hexanone	Nonhalogenated Volatiles
2-methylnapthalene	Nonhalogenated Semivolatiles
2-methylphenol	Nonhalogenated Semivolatiles
2-methynaphthalene	Nonhalogenated Semivolatiles
2-nitroaniline	Nonhalogenated Semivolatiles
3, 3-dichlorobenzidine	Halogenated Semivolatiles
3-nitroaniline	Nonhalogenated Semivolatiles
4, 4'-DDE	Organic Pesticides/Herbicides
4, 6-dinitro-2-methylphenol	Nonhalogenated Semivolatiles
4, 4'-DDt	Organic Pesticides/Herbicides
4, 4'-DDD	Organic Pesticides/Herbicides
4-bromophenyl phenyl ether	Halogenated Semivolatiles
4-chloroaniline	Halogenated Semivolatiles
4-chlorophenyl phenylether	Halogenated Semivolatiles
4-methyl-2-pentanone	Nonhalogenated Volatiles
4-methylphenol	Nonhalogenated Semivolatiles
4-nitroaniline	Nonhalogenated Semivolatiles
Acenaphthene	Nonhalogenated Semivolatiles
Acenapthylene	Nonhalogenated Semivolatiles
Acetic acid	Organic Corrosives
Acetone	Nonhalogenated Volatiles
Acetyl chloride	Organic Corrosives
Acrolein	Nonhalogenated Volatiles

Table 1 (continued)

CONSTITUENT	CONTAMINANT GROUP
Acrylonitrile	Nonhalogenated Volatiles
Aldrin	Organic Pesticides/Herbicides
Aluminum	Nonvolatile Metals
Aniline	Organic Corrosives
Anthracene	Nonhalogenated Semivolatiles
Antimony	Nonvolatile Metals
Aromatic sulfonic acids	Organic Corrosives
Arsenic	Volatile Metals
Asbestos	Asbestos
Barium	Radioactives
Barium	Nonvolatile Metals
Benzene	Nonhalogenated Volatiles
Benzidine	Nonhalogenated Semivolatiles
Benzo (ghi) perylene	Nonhalogenated Semivolatiles
Benzo (b) floranthene	Nonhalogenated Semivolatiles
Benzo (a) anthracene	Nonhalogenated Semivolatiles
Benzo (a) pyrene	Nonhalogenated Semivolatiles
Benzo (k) floranthene	Nonhalogenated Semivolatiles
Benzoic acid	Nonhalogenated Semivolatiles
Benzyl alcohol	Nonhalogenated Semivolatiles
Beryllium	Nonvolatile Metals
Bhc-alpha	Organic Pesticides/Herbicides
Bhc-beta	Organic Pesticides/Herbicides
Bhc-delta	Organic Pesticides/Herbicides
Bhc-gamma	Organic Pesticides/Herbicides
Bis phthalene	Nonhalogenated Semivolatiles
Bis (2-chloroethoxy) Phthalate	Halogenated Semivolatiles
Bis (2-ethylhexyl) phthalate	Nonhalogenated Semivolatiles
Bis (2-chlorethoxy) ether	Halogenated Semivolatiles
Bis-(2-chloroethoxy) methane	Halogenated Semivolatiles
Bis-(2-chloroethyl) ether	Halogenated Semivolatiles
Bis-(2-chloroisopropyl) ether	Halogenated Semivolatiles
Bismuth	Nonvolatile Metals
Bismuth	Nonmatallic Toxic Elements
Bismuth	Volatile Metals
Bromodichloromethane	Halogenated Volatiles
Bromoform	Halogenated Volatiles
Bromomethane	Halogenated Volatiles
Butyl benzyl phthalate	Nonhalogenated Semivolatiles
Cadmium	Nonvolatile Metals
Calcium hydroxide	Inorganic Corrosives
Calcium	Nonvolatile Metals
Calcium carbonate	Inorganic Corrosives
Carbon Disulfide	Nonhalogenated Volatiles
Carbon tetrachloride	Halogenated Volatiles
Chlorates	Oxidizers
Chlordane	Organic Pesticides/Herbicides
Chlorobenzene	Halogenated Volatiles
Chlorodibromomethane	Halogenated Volatiles

Table 1 (continued)

CONSTITUENT	CONTAMINANT GROUP
Chloroethane	Halogenated Volatiles
Chloroform	Halogenated Volatiles
Chloromethane	Halogenated Volatiles
Chloropropane	Halogenated Volatiles
Chromates	Oxidizers
Chromium	Nonvolatile Metals
Chrysene	Nonhalogenated Semivolatiles
Cis, 1, 3-dichloropropene	Halogenated Volatiles
Cobalt	Nonvolatile Metals
Copper	Nonvolatile Metals
Cresols	Nonhalogenated Semivolatiles
Cresylic acid	Organic Corrosives
Cyanide	Inorganic Cyanides
Cyclohexanone	Nonhalogenated Volatiles
Di-n-butyl phthalate	Nonhalogenated Semivolatiles
Di-n-octyl phthalate	Nonhalogenated Semivolatiles
Dibenzfuran	Nonhalogenated Semivolatiles
Dibenzo (a,h) anthracene	Nonhalogenated Semivolatiles
Dibromomethane	Halogenated Volatiles
Dichloroethylene (DCE)	Halogenated Volatiles
Dichloromethane	Halogenated Volatiles
Dieldrin	Organic Pesticides/Herbicides
Diethyl phthalate	Nonhalogenated Semivolatiles
Dimethyl phthalate	Nonhalogenated Semivolatiles
Dioxin	Dioxins/Furans
Endosulfan II	Organic Pesticides/Herbicides
Endosulfan sulfate	Organic Pesticides/Herbicides
Endosulfan I	Organic Pesticides/Herbicides
Endrin aldehyde	Organic Pesticides/Herbicides
Endrin	Organic Pesticides/Herbicides
Ethion	Organic Pesticides/Herbicides
Ethyl acetate	Nonhalogenated Volatiles
Ethyl ether	Nonhalogenated Volatiles
Ethyl parathion	Organic Pesticides/Herbicides
Fluorene	Nonhalogenated Semivolatiles
Fluorine	Nonmetallic Toxic Elements
Fluorothene	Nonhalogenated Semivolatiles
Fluorotrichoromethane	Halogenated Volatiles
Formic acid	Organic Corrosives
Furan	Dioxins/Furans
Hadrazine	Reducers
Heptachlor epoxide	Organic Pesticides/Herbicides
Heptachlor	Organic Pesticides/Herbicides
Hexachlorobenzene	Halogenated Semivolatiles
Hexachlorobutadiene	Halogenated Semivolatiles
Hexachlorocyclopentadiene	Halogenated Semivolatiles
Hexaochloroethane	Halogenated Volatiles
Hydrochloric acid	Inorganic Corrosives
Hydrofluoric acid	Inorganic Corrosives

Table 1 (continued)

CONSTITUENT	CONTAMINANT GROUP
Indeno (1, 2, 3-cd) pyrene	Nonhalogenated Semivolatiles
Iodine	Radioactives
Iron	Nonvolatile Metals
Isobutanol	Nonhalogenated Volatiles
Isophorone	Nonhalogenated Semivolatiles
Lead	Volatile Metals
Magnesium	Nonvolatile Metals
Manganese	Nonvolatile Metals
Mercury	Volatile Metals
Metalic cyanides	Inorganic Cyanides
Methanol	Nonhalogenated Volatiles
Methyl isobutyl ketone	Nonhalogenated Volatiles
Methylene cloride	Halogenated Volatiles
Methylparathion	Organic Pesticides/Herbicides
n-butyl alcohol	Nonhalogenated Volatiles
n-nitrosodi-n-propylamine	Nonhalogenated Semivolatiles
n-nitrosodimethylamine	Nonhalogenated Semivolatiles
n-nitrosodiphenylamine	Nonhalogenated Semivolatiles
Napthalene	Nonhalogenated Semivolatiles
Nickel	Nonvolatile Metals
Nitric acid	Inorganic Corrosives
Nitrobenzene	Nonhalogenated Semivolatiles
Organonitriles	Organic Cyanides
p-chloro-m-cresol	Halogenated Semivolatiles
Parathion	Organic Pesticides/Herbicides
PCB (Aroclor)-1242	PCBs
PCB (Aroclor)-1248	PCBs
PCB (Aroclor)-1232	PCBs
PCB NOS (Not otherwise Specified)	PCBs
PCB (Aroclor)-1254	PCBs
PCB (Aroclor)-1260	PCBs
PCB (Aroclor)-1221	PCBs
PCB (Aroclor)-1016	PCBs
Pentachlorophenol (PCP)	Halogenated Semivolatiles
Perchloroethylene (PCE)	Halogenated Volatiles
Phenanthrene	Nonhalogenated Semivolatiles
Phenol	Nonhalogenated Semivolatiles
Phenyl napthalene	Nonhalogenated Semivolatiles
Phosphides	Reducers
Plutonium	Radioactives
Polycyclic aromatic hydrocarbons (PAH)	Nonhalogenated Semivolatiles
Polynuclear aromatic hydrocarbons (PNA's)	Polynuclear Aromatics
Potassium	Nonvolatile Metals
Potassium carbonate	Inorganic Corrosives
Pyrene	Nonhalogenated Semivolatiles
Pyridine	Nonhalogenated Semivolatiles
Radium	Radioactives
Radon	Radioactives
Selenium	Nonvolatile Metals

Table 1 (continued)

CONSTITUENT	CONTAMINANT GROUP
Sodium	Nonvolatile Metals
Sodium hydroxide	Inorganic Corrosives
Solvents	Solvents
Styrene	Nonhalogenated Volatiles
Sulfides	Reducers
Sulfuric acid	Inorganic Corrosives
Tetrachloroethene	Halogenated Volatiles
Tetrachloroethylene	Halogenated Volatiles
Tetrachlorophenol	Halogenated Semivolatiles
Thorium	Radioactives
Tin	Volatile Metals
Toluene	Nonhalogenated Volatiles
Total chlorinated hydrocarbons	Halogenated Volatiles
Toxaphene	Organic Pesticides/Herbicides
Trans-1, 3-dichloropropene	Halogenated Volatiles
Trichloroethene	Halogenated Volatiles
Trichloroethylene (TCE)	Halogenated Volatiles
Trimethyl benzene	Nonhalogenated Volatiles
Uranium	Radioactives
Vanadium	Nonvolatile Metals
Vinyl chloride	Halogenated Volatiles
Vinyl acetate	Nonhalogenated Volatiles
Xylenes	Nonhalogenated Volatiles
Zinc	Nonvolatile Metals

Table 2. Summary Technology Correlation Table—Physical Treatment

Physical Treatments		Applicable Contaminants																				Media									
		Organic											Inorganic							Rad.		Solids						Liquids			
Item	Technology	Halogenated Volatiles	Halogenated Semivolatiles	Nonhalogenated Volatiles	Nonhalogenated Semivolatiles	Pesticides/Herbicides	PCBs	Organic Corrosives	Organic Cyanides	Dioxins/Furans	Solvents	Polynuclear Aromatics	Volatile Metals	Arsenic	Inorganic Corrosives	Nonvolatile Toxic Elements	Nonvolatile Metals	Radioactives	Inorganic Cyanides	Oxidizers	Reducers	Sludges	PWR Trash	Soils/Debris	PCB Contaminated Electrical Equipment	Equipment (other contaminants)	Water Metals	Miscellaneous (other) Solids	Purge, Decon, & Well Dev. Water	Solvents/Oils	Groundwater	Miscellaneous (other) Liquids
P-1	In-Situ Vacuum Extraction	•	•	•	•						•													•							
P-2	Solvent Extraction (Ex-Situ)	•	•	•	•	•	•				•													•							
P-3	Integr. Vapor Extr. & Steam Vac. Strip (In-Situ)	•	•	•	•	•					•	•												•						•	
P-4	In-Situ Steam & Air Stripping	•	•	•	•						•													•						•	
P-5	Subsurface Volatilization & Vent. (SVVS)	•	•	•	•						•													•						•	
P-6	In-Situ Steam Inject. & Vacuum Extr. (SIVE)	•	•	•	•					•			•											•						•	
P-7	In-Situ Steam Enhanced Extraction (ISEE)	•	•	•	•								•											•						•	
P-8	Contained Recovery of Oily Wastes (CROW)				•																			•							
P-9	Soil Washing & Catalytic Ozone Oxidation		•			•	•		•	•										•		•		•						•	•
P-10	Extract. of Oily Waste (Carver-Greenfield Pro)	•	•	•	•	•	•	•	•	•	•	•										•		•							
P-11	Solvent Extraction - BEST Process	•	•	•	•	•	•	•	•	•	•	•										•		•							
P-12	Solvent Extraction (Soil Restoration Unit)	•	•	•	•	•	•			•	•											•		•							
P-13	In-Situ Solid. & Stab. (deep soil mix. & inject.)	•	•	•	•		•						•				•							•							
P-14	In-Situ Solid. & Stab. (soil-cement mix. wall)		•		•	•	•						•				•							•							
P-15	Precip. Microfiltration & Sludge Dewatering					•							•																•		•	
P-16	Membrane Microfiltration	•	•	•	•								•					•	•										•		•	•
P-17	Heavy Metals & Radionuclide Filtration												•					•											•		•	
P-18	Ultrafiltration Reverse Osmosis												•																•		•	•
P-19	Ex-Situ Solidification & Stabilization (Micro)												•				•					•		•				•				
P-20	Chem Treatment & Immob (In-Situ or Ex-Situ)	•	•				•						•				•					•		•								
P-21	Solidi & Stabil (In-Situ Ex-Situ applications)				•								•				•					•		•								
P-22	Chemical Fixation Solidification (Ex-Situ)		•		•								•				•		•			•		•								
P-23	Solidification & Stabilization (Ex-Situ)		•		•		•						•				•					•		•								
P-24	Solidification & Stabilization										•	•										•		•								
P-25	Evaporation & Catalytic Oxidation	•	•	•	•								•				•												•		•	•
P-26	In-Situ Vitrification (with electric current)		•		•								•				•	•						•								
P-27	Plasma Arc Vitrification (Ex-Situ)												•				•	•				•		•				•				•
P-28	Entrained Bed Gas (noncatalytic partial oxid)	•	•	•	•												•	•				•		•				•				
P-29	Electrical Separation (In-Situ)												•				•	•						•								
P-30	In-Situ Soil Flushing (chem flooding/inj/recov)				•		•					•												•								
P-31	Soil Vapor Extraction (In-Situ, also Ex-Situ)	•	•	•	•						•													•								
P-32	Soil Vapor Extraction (In-Situ & Ex-Situ)	•	•	•	•						•	•										•		•								
P-33	Soil/Sediment Washing	•	•	•	•	•	•	•	•		•	•	•		•	•	•							•								
P-34	Soil Washing	•	•	•	•		•			•	•	•	•				•					•		•								
P-35	Soil Washing - Total Matrix (In-Situ)				•																	•		•								
P-36	Soil Washing System												•				•	•													•	
P-37	In-Situ Absorption with Sponge Material												•		•		•	•				•		•				•				
P-38	Acid Extraction Metal Recovery & Recycling			.									•		•		•	•				•		•				•				
P-39	Debris Washing					•	•						•													•	•	•				
P-40	Hydraulic Soil Mixing (In-Situ)		•		•								•				•					•		•								

Table 3. Summary Technology Correlation Table—Chemical Treatment

Chemical Treatments		Applicable Contaminants																				Media									
		Organic												Inorganic							Rea.		Solids						Liquids			
Item	Technology	Halogenated Volatiles	Halogenated Semivolatiles	Nonhalogenated Volatiles	Nonhalogenated Semivolatiles	Pesticides/Herbicides	PCBs	Organic Corrosives	Organic Cyanides	Dioxins/Furans	Solvents	Polynuclear Aromatics	Volatile Metals	Asbestos	Inorganic Corrosives	Nonvolatile Toxic Elements	Nonvolatile Metals	Radioactives	Inorganic Cyanides	Oxidizers	Reducers	Sludges	PRP/Trash	Soils/Debris	PCB Contaminated Electrical Equipment	Equipment (other contaminants)	Water Matrix	Miscellaneous (other) Solids	Prod., Process, & Well Dist. Water	Solvents/Oils	Groundwater	Miscellaneous (other) Liquids
C-1	Chemical Dehalogenation (APEG)	•	•			•	•			•		•						•	•	•		•		•					•		•
C-2	Granular Activated Carbon	•	•	•	•	•	•	•	•	•																					
C-3	Maectite Treatment												•									•		•				•			•
C-4	Dechlor/KGME Process		•				•			•														•							•
C-5	Chemical Treatment/Z Immobilization																•					•		•				•			
C-6	Chemical Oxidation & Cyanide Destruction		•					•	•												•			•				•		•	•
C-7	Perox - Pure Process	•				•	•				•																	•		•	•
C-8	Photolytic Oxidation	•																												•	
C-9	Chemical Gaseous Waste Treatment	•		•																				•						•	
C-10	Base - Catalyzed Dechlorination Process (BCD)						•																	•				•			
C-11	SAREX Chemical Fixation Process	•	•	•	•																	•		•					•		
C-12	Combined Chemical Binding & Precipitation																	•				•		•						•	•
C-13	Ultraviolet Radiation and Oxidation	•	•			•	•				•																			•	•
C-14	Pneumatic Fracturing & Catalytic Oxidation	•	•	•	•																			•							
C-15	Hydraulic Terrestrial Dissipation (HTD)					•																		•							
C-16	Chemclood Chemical Treatment												•		•							•		•				•			
C-17	Mercon Chemical Treatment												•									•		•				•		•	
C-18	TR-DETOX Chemical Treatment												•			•		•				•		•				•			•
C-19	In-Situ Hydrogen Peroxide Injection			•	•						•													•							
C-20	Wet Air Oxidation Chemical Treatment	•	•	•	•	•		•	•	•	•	•								•		•		•				•			

Table 4. Summary Technology Correlation Table—Thermal Treatment

Thermal Treatments		Applicable Contaminants																					Media										
		Organic											Inorganic								Rea.		Solids							Liquids			
Item	Technology	Halogenated Volatiles	Halogenated Semi-volatiles	Nonhalogenated Volatiles	Nonhalogenated Semi-volatiles	Pesticides/Herbicides	PCBs	Organic Corrosives	Organic Cyanides	Dioxins/Furans	Solvents	Polyaromatic Aromatics	Volatile Metals	Asbestos	Inorganic Corrosives	Nonvolatile Toxic Elements	Nonvolatile Metals	Radioactives	Inorganic Cyanides	Oxidizers	Reducers	Sludges	PPE/Trash	Soils/Debris	PCB Contaminated Electrical Equipment	Equipment (other contamination)	Water Metals	Miscellaneous (other) Solids	Purge, Drums, & Well Dev. Water	Solvents/Oils	Groundwater	Miscellaneous (other) Liquids
T-1	Thermal Gas Phase Reduction		•		•	•	•															•		•						•		•
T-2	Desorption & Vapor Extraction (DAVES)	•	•	•	•	•	•						•									•		•								
T-3	Entrained Bed Gasification	•	•	•	•																	•		•								
T-4	Solid Waste Desorption	•	•	•	•	•	•															•		•								
T-5	Low Temperature Thermal Treatment	•	•	•	•																			•								
T-6	Thermal Destr. (Dynamic Oxygen Controller)	•	•	•	•																	•	•	•								
T-7	Cyclone Furnace	•	•	•	•								•					•				•		•								
T-8	Thermal Desorption	•	•	•	•	•	•																	•								
T-9	Circulating Bed Combustor	•	•	•	•	•	•	•	•				•		•				•	•				•				•		•		•
T-10	High Temperature Thermal Processor	•	•	•	•		•		•													•		•								
T-11	Low Temperature Thermal Desorption	•		•		•	•			•	•													•								
T-12	Low Temperature Thermal Aeration	•	•	•	•	•					•	•										•		•								
T-13	Thermal Desorption/Ignition	•	•	•	•	•					•											•		•								
T-14	Thermal Desorption (off-gas treated)	•	•	•	•	•	•	•	•	•	•													•								
T-15	Low Temperature Thermal Desorption			•	•						•	•												•								
T-16	Infrared Thermal Destruction (incineration)	•	•	•	•		•				•													•								
T-17	Slagging												•			•						•		•				•				

Table 5. Summary Technology Correlation Table—Biological Treatment

Biological Treatments		Applicable Contaminants																				Media									
		Organic											Inorganic							Rea.		Solids							Liquids			
Item	Technology	Halogenated Volatiles	Halogenated Semivolatiles	Nonhalogenated Volatiles	Nonhalogenated Semivolatiles	Pesticides/Herbicides	PCBs	Organic Corrosives	Organic Cyanides	Dioxins/Furans	Solvents	Polynuclear Aromatics	Volatile Metals	Arsenic	Inorganic Corrosives	Nonvolatile Toxic Elements	Heavy Metals	Radioactives	Inorganic Cyanides	Oxidizers	Reducers	Sludges	PRP/Fresh	Soil/Debris	PCB Contaminated Electrical Equipment	Equipment (other contaminated)	Waste Metals	Miscellaneous (other) Solids	Pumps, Drums, & Well Dev. Water	Solvents/Oils	Groundwater	Miscellaneous (other) Liquids
B-1	Biological Aqueous Treatment System	•	•		•	•																								•	•
B-2	Bioremediation - Solid Phase	•	•	•	•																	•		•				•			
B-3	Immobilized Cell Bioreactor System	•	•	•	•																									•	•
B-4	Biological Sorption												•				•	•												•	•
B-5	In-Situ Biological Treatment	•																				•		•				•		•	
B-6	Safesoil™ Bioreatment System	•	•	•	•																			•							
B-7	Deep In-Situ Bioremediation Process	•	•	•	•	•	•	•	•	•														•							
B-8	Geolock & Biodrain Treatment Platform	•	•	•	•		•																	•					•		
B-9	Liquid & Solid Biological Treatment			•	•					•	•	•										•		•				•			
B-10	Bioventing	•	•	•	•																			•							
B-11	Fungal Treatment Technology	•	•																					•							
B-12	Membrane Separation and/or Biorem	•	•	•	•																	•		•						•	
B-13	PACT™ Waste Water Treatment System	•	•	•	•																									•	•
B-14	Rotating Biological Contactor (RBC)	•	•	•	•	•	•	•	•										•											•	
B-15	Wetlands-Based Treatment																•													•	•
B-16	Biogenesis™ Soil Cleaning Process	•					•					•												•					•		
B-17	Bioremediation (In-Situ)	•	•	•	•	•					•	•												•						•	
B-18	Bioremediation - Solid Phase					•	•			•												•		•				•			
B-19	Augumented In-Situ Subsurface Bioremediation	•																						•						•	
B-20	END. VIP™ Bioremediation	•	•	•	•	•	•			•	•	•										•		•				•			
B-21	BEVROX™ Biotreatment Train Process	•	•	•	•	•	•	•	•		•	•										•		•				•			
B-22	Bioclean Mobile Remediation (siteworks)	•	•	•	•	•	•	•			•	•				•			•			•		•				•			
B-23	Slurry Bioreactor	•	•	•	•	•	•			•	•	•										•		•				•			
B-24	MIXFLOW™ Bioreactor	•	•	•	•	•	•				•	•										•		•				•			
B-25	White Rot Fungus Enzyme Biotreatment			•	•	•	•			•	•	•										•		•				•			
B-26	Engineered Biodegradation System (EBS)										•	•										•		•							
B-27	Fungal Enzyme Degradation		•		•	•	•			•	•	•										•		•				•			
B-28	Ex-Situ Bioremediation treatment cells)	•	•	•	•	•	•			•	•	•										•		•							
B-29	Prepared Bed/Treatment Cell Bioremediation			•	•	•					•	•										•		•				•			
B-30	Air Sparging, In-Situ Groundwater	•	•	•	•						•																			•	
B-31	Bioaugument Soil/Vapor Extraction			•	•						•	•										•		•							

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