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U.S. Environmental Protection Agency

EPA Region 4

RESPONSE ACTION CONTRACT

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BLACK & VEATCH Special Projects Corp.

ADDENDUM
Remedial Investigation/Supplemental Feasibility Study Report (Revision 1)
Analysis of Alternatives
Cabot Carbon/Koppers (Koppers Portion)
Superfund Site
Gainesville, Alachua County, Florida
April 23, 2001

ADDENDUM

Remedial Investigation/Supplemental Feasibility Study Report
Revision 1
Analysis of Alternatives

Section 4.0 -- Assembly of Remedial Alternatives

Section 5.0 -- Detailed Analysis of Alternatives

Section 6.0 -- Comparative Analysis of Alternatives

Cabot Carbon/Koppers Superfund Site
Gainesville, Alachua County, Florida

U.S. EPA Work Assignment No. 023-RSBD-0416
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Contents

4.0 Assembly of Remedial Alternatives

4.1 Overall Approach

In Chapter 2.0, GRAs, remedial response technologies, and process options were identified and screened for four media (surface soils, subsurface soils above the water table, subsurface soils below the water table, and DNAPL) that present different remediation challenges. In this chapter, GRAs, remedial technologies, and process options that were retained after screening discussed in Chapter 2.0 are assembled into remedial alternatives. Assembly of remedial alternatives is required because most GRAs, remedial response technologies, and process options deal with either surface soil or groundwater, or have limited overall effectiveness. This chapter identifies combinations of individual options screened in Chapter 2.0 that optimize overall effectiveness and practicability based on criteria discussed in Chapter 2.0. Ten basic alternatives have been selected, and most contain a range of subalternatives. There are a total of 41 alternatives and subalternatives.

None of the physical remedial technologies in any combination would be capable of completely achieving Site cleanup goals for soil and groundwater. Therefore, institutional controls are included in each of the alternatives developed.

Because there are several media of interest and multiple COCs, and because the distribution of individual COCs and industrial activities vary within the Site, it is possible that minor refinements would be made to the alternative that is selected. It is also possible that further requirements will be made to the selected alternative during the design stage as more data is collected and as details of remedy logistics are further developed. Any refinements would be made to improve the effectiveness and implementability of the selected alternative and would only be made with U.S. EPA knowledge. For example, refinements might include offsite or onsite disposal of small quantities of soil for alternatives that do not include these measures. If capping or covering are selected, different types of caps and covers may be placed in various parts of the Site to accommodate land uses.

Each of the alternatives defined in this chapter include monitoring to document performance of the remedy that will be implemented.

TABL
SUMMARY O
CABOT CARBON/K(

ALTERNATIVE	NO FURTHER ACTION	INSTITUTIONAL CONTROLS				CONTAINMENT				
		Preserve Commercial/ Industrial Land Use	Prohibit Shallow Ground Water Use	Long Term Subsurface Soils Manage- ment Program	Restrict Site Access	Asphalt or Concrete Cap	RCRA Equivalent Cap	Wearing Surface Cover	Hydraulic Barrier (ground water extraction)	C (e
Alternative 1 - No Further Action	X								X	
Alternative 2 - Continued Ground Water Extraction and Treatment, and Institutional Controls		X	X	X	X				X	
Alternative 3 - Containment by a Wearing Surface Cover or cap, Continued Ground Water Extraction and Treatment, and Institutional Controls										
• Alternative 3A		X	X	X				X	X	
• Alternative 3B		X	X	X		X	X		X	
Alternative 4 - Containment by a Wearing Surface Cover and Biotreatment Containment Wall and, Institutional Controls										
• Alternative 4A		X	X	X		(1)		X		
• Alternative 4B		X	X	X		(1)		X		
Alternative 5 – Containment by a Low Permeability Cap and Continuous Physical Barrier, and Institutional Controls										
• Alternative 5A		X	X	X			X			
• Alternative 5B		X	X	X		X				
Alternative 6 – Removal of Surface Soils and Metal Impacted Subsurface Soils, Containment of Remaining Subsurface Soils with a Biotreatment Containment Wall, and Institutional Controls										
• Alternative 6A		X	X	X				(2)		
• Alternative 6B		X	X	X				(2)		
• Alternative 6C		X	X	X				(2)		
• Alternative 6D		X	X	X				(2)		
• Alternative 6E		X	X	X				(2)		
• Alternative 6F		X	X	X				(2)		
• Alternative 6G		X	X	X				(2)		

TABL
SUMMARY OF A
CABOT CARBON/KOPP
(Conti

ALTERNATIVE	NO FURTHER ACTION	INSTITUTIONAL CONTROLS				CONTAINMENT				
		Preserve Commercial/ Industrial Land Use	Prohibit Shallow Ground Water Use	Long Term Subsurface Soils Manage-ment Program	Restrict Site Access	Asphalt or Concrete Cap	RCRA Equivalent Cap	Wearing Surface Cover	Hydraulic Barrier (ground water extraction)	Co F I (e.
Alternative 7 - Removal of Surface Soils and Metal Impacted Subsurface Soils, Containment of Remaining Subsurface Soils with a Continuous Physical Barrier, and Institutional Controls										
• Alternative 7A		X	X	X				(2)		
• Alternative 7B		X	X	X				(2)		
• Alternative 7C		X	X	X				(2)		
• Alternative 7D		X	X	X				(2)		
• Alternative 7E		X	X	X				(2)		
• Alternative 7F		X	X	X				(2)		
• Alternative 7G		X	X	X				(2)		
Alternative 8 - Removal of Surface Soils and Metal Impacted Subsurface Soils, Steam Extraction, In-situ Bioremediation, and Institutional Controls										
• Alternative 8A		X	X	X				(2)		
• Alternative 8B		X	X	X				(2)		
• Alternative 8C		X	X	X				(2)		
• Alternative 8D		X	X	X				(2)		
• Alternative 8E		X	X	X				(2)		
• Alternative 8F		X	X	X				(2)		
• Alternative 8G		X	X	X				(2)		
Alternative 9 - Removal to the Hawthorne Clay, Ex-situ Treatment, DNAPL Removal and In-situ Bioremediation Where Removal is Not Practical, and Institutional Controls										
• Alternative 9B(5)		(2)	(2)	(2)				(2)		
• Alternative 9C		(2)	(2)	(2)				(2)		
• Alternative 9D		(2)	(2)	(2)				(2)		
• Alternative 9E		(2)	(2)	(2)				(2)		
• Alternative 9F		(2)	(2)	(2)				(2)		
• Alternative 9G		(2)	(2)	(2)				(2)		

TABL
SUMMARY OF A
CABOT CARBON/KOPP
(Conti

ALTERNATIVE	NO FURTHER ACTION	INSTITUTIONAL CONTROLS				CONTAINMENT				
		Preserve Commercial/ Industrial Land Use	Prohibit Shallow Ground Water Use	Long Term Subsurface Soils Manage-ment Program	Restrict Site Access	Asphalt or Concrete Cap	RCRA Equivalent Cap	Wearing Surface Cover	Hydraulic Barrier (ground water extraction)	C (e
Alternative 10 - Removal to the Hawthorne Clay, Ex-situ treatment, Backfilling with Treated Soils, Containment of Subsurface Soils Where Removal is not Practical using a Biotreatment Containment Wall and Contingency Measures, and Partial Institutional Controls • Alternative 10B(5)		(2)	(2)	(2)		(1)		(2)		
• Alternative 10C		(2)	(2)	(2)		(1)		(2)		
• Alternative 10D		(2)	(2)	(2)		(1)		(2)		
• Alternative 10E		(2)	(2)	(2)		(1)		(2)		
• Alternative 10F		(2)	(2)	(2)		(1)		(2)		
• Alternative 10G		(2)	(2)	(2)		(1)		(2)		

1) Incorporated as a possible contingency measure if monitoring does not demonstrate conformance with cleanup g
(2) Incorporated for areas that are not practical to excavate.
(3) Incorporated for use on metal impacted soils, if needed.
(4) Incorporated for pretreatment of biotreatment feed, if needed.
(5) There is no Alternative 9A or 10A because shallow ground water and surface area constraints would not accommodate onsite disposal of the quantity of soil that would be excavated for these alternatives.

In the open areas of the Site, the wearing surface would have a 2-foot thickness where it would not create grading or drainage problems. Near buildings, pipelines and other active facilities, the minimum thickness would be one foot. The wearing surface will include a geotextile or other marker layers, as appropriate, in order to easily identify areas that wear thinner over time. A formal written maintenance and inspection program would be developed and implemented to assure that minimum thickness specifications of the wearing surface are maintained.

The types of low permeability caps that could be installed as part of Alternative 3B are detailed in Sections 2.3.3.2 and 2.3.3.3 of the RSFS. As for the wearing surface, the low permeability cap would be constructed over existing grade, except for local grading. The cap would also be managed under a formal maintenance and inspection program to maintain its integrity. For the low permeability cap alternatives, the planned detention structures would need to be expanded or new ones constructed to control run-off from the cover areas. To manage run-off from the 100-year, 24-hour storm, a total additional detention capacity of approximately 5.9 acre-feet would need to be provided. This represents a 22 percent increase over the currently planned system (see Appendix I of the RSFS). While this is a moderate increase, it will be difficult to accommodate as the current pond sizes are significant. They represent over 12 percent of the site area, and it will be difficult to expand them.

4.2.4 Alternative 4 – Containment By a Wearing Surface Cover and Bio-Active Containment System, With Institutional Controls

This Alternative includes the same gravel-wearing surface cover and institutional controls as Alternative 3A. The primary difference is that the Bio-Active Containment System (BACS) technology would be used as the primary long-term groundwater containment mechanism instead of the existing groundwater extraction system. After groundwater monitoring shows that contaminant levels at the site boundary do not exceed cleanup criteria, the existing groundwater extraction system would cease and some of the wells would be used for monitoring purposes. Approximately 5,000 linear feet of BACS would be constructed, as shown in Figure 4.2. The wall would extend from above the water table to the top of the Hawthorn clay. It would be keyed into the Hawthorn clay to assure a seal is achieved.

The groundwater migration modeling in Appendix G of the RSFS shows that a BACS configuration similar to that shown in Figure 4.2 of the RSFS would effectively control COC migration. As discussed in Section 2.5.3.2 of the RSFS, the BACS would allow a controlled rate of release of COC from the "open" portion of the wall. The controlled release rate is designed such that COC are attenuated within and adjacent to the wall, and groundwater quality goals are achieved in water migrating away from the BACS.

- Alternative 6G - For this subalternative, the excavated soils would be treated by offsite thermal treatment. Treated soils would be disposed of at an appropriately permitted offsite landfill.

Based on the estimated impacted soil volumes provided in Table 1.10, approximately 56,400 cy of impacted soil (45,130 cy plus 25 percent contingency) would be excavated for Alternative 6.

For Alternative 6A, this material would be placed in one or two small onsite cells, according to procedures outlined in Section 2.3.6.2, and the excavation would be backfilled with clean soil.

For Alternatives 6B, 6C, 6D, and 6F, the impacted soils would be treated and the residual soil, after treatment, would be used for backfill. Backfilling would occur in a manner such that final surface soils do not contain metals above Site soil cleanup criteria.

For Alternatives 6E and 6G, excavated soils would be removed from the Site and treated offsite. Clean soil would be imported for backfill.

4.2.7 Alternative 7 - Removal of Surface Soils and Metal-Impacted Subsurface Soils, Containment of Remaining Subsurface Soils With a Continuous Physical Barrier, and Institutional Controls

This Alternative incorporates the same removal of surface soils and metal-impacted subsurface soils as Alternative 6. Alternative 7 includes the same subalternative options as Alternative 6 for handling excavated soils. As for Alternative 6, areas where soils cannot be practically excavated would be treated by in-situ bioremediation or covered by a wearing surface (see Figure 4.5 of RSFS). Institutional controls would be the same as for Alternatives 3 through 6.

This alternative differs from Alternative 6 in that a Continuous Physical Barrier is used for containment of remaining organic COC impacted subsurface soils, instead of a BACS. Alternative 7 therefore includes groundwater pumping and treatment from within the containment barrier.

Subalternatives are as follows:

- Alternative 7A - For this subalternative, the excavated soils would be disposed of in an onsite landfill.
- Alternative 7B - For this subalternative, the excavated soils would be treated by onsite incineration. For soils with metals, incinerated residue would be tested and treated by

handling excavated soils. As for Alternatives 6 and 7, areas where soils cannot be practically excavated would be treated by in-situ bioremediation or covered by a wearing surface (see Figure 4.6 of RSFS).

This alternative differs from Alternatives 6 and 7 in the remediation of soils that remain after excavation. Remediation of these soils would primarily consist of application of a steam extraction technology (e.g., SEE, DUS/HP or CROW) followed by in-situ bioremediation. The steam extraction and subsequent bioremediation would occur in DNAPL areas. The existing groundwater extraction and treatment system would continue to be operated to remediate the downgradient dissolved-phase plume until groundwater cleanup criteria are achieved at the extraction wells.

This alternative includes the same institutional controls as Alternatives 3 through 7. Application of a steam extraction technology would require construction of an array of new wells for steam injection and extraction. After a cooling period, some of the wells would be used to inject bioremediation microbes and nutrients.

This alternative would include institutional controls to prohibit groundwater extraction for any use that could be negatively impacted by COC until Site groundwater cleanup criteria are met.

The subalternatives are as follows:

- Alternative 8A - For this subalternative, the excavated soils would be disposed of in an onsite landfill.
- Alternative 8B - For this subalternative, the excavated soils would be treated by onsite incineration. For soils with metals, incinerated residue would be tested and treated by stabilization/solidification, if necessary to achieve Site soil cleanup criteria. Treated residue would be backfilled.
- Alternative 8C - For this subalternative, the excavated soils would be treated onsite by thermal desorption. For soils with metals, treated residue would be tested and treated by stabilization/solidification, if necessary to achieve Site soil cleanup criteria. Treated residue would be backfilled.
- Alternative 8D - For this subalternative, the excavated soils would be treated onsite by bioremediation (landfarming or bioreactor). For soils with metals, residue would be tested and treated by stabilization/solidification, if necessary. In addition, soils that are highly contaminated such that bioremediation may not be efficient would be pretreated by soil washing. Treated residue would be backfilled.

The subalternatives are as follows:

- Alternative 9B - For this subalternative, the excavated soils would be treated by onsite incineration. For soils with metals, incinerated residue would be tested and treated by stabilization/solidification, if necessary to achieve Site soil cleanup criteria. Treated residue would be backfilled.
- Alternative 9C - For this subalternative, the excavated soils would be treated onsite by thermal desorption. For soils with metals, treated residue would be tested and treated by stabilization/solidification, if necessary. Treated residue would be backfilled.
- Alternative 9D - For this subalternative, the excavated soils would be treated onsite by bioremediation using landfarming or a bioreactor. For soils with metals, residue would be tested and treated by stabilization/solidification, if necessary. Soils that are too impacted with COC for bioremediation would be pretreated by soil washing. Treated residue would be backfilled.
- Alternative 9E - For this subalternative, the excavated soils would be treated by offsite incineration. For soils with metals, incinerated residue would be tested and treated by stabilization/solidification, if necessary to LDR standards. Treated residue would be disposed of at an appropriately permitted offsite landfill.
- Alternative 9F - For this subalternative, all of the excavated soils would be treated by stabilization/solidification. Treated soils would be backfilled.
- Alternative 9G - For this subalternative, the excavated soils would be treated by offsite thermal treatment. Treated soils would be disposed of at an appropriately permitted offsite landfill.

Based on the estimated impacted soil volumes provided in Table 1.10 of the RSFS, approximately 248,400 cy of impacted soil (198,710 cy plus 25 percent contingency) would be excavated for Alternative 9. Approximately 70 percent of this material would be excavated from the saturated zone below the water table. The excavation would range in depth from an average of about 23 feet in the former Drip Track area to an average of about 28 feet in the former North Lagoon area. Dewatering of the affected areas would be required prior to or concurrent with excavation. The sides of the excavation will need to be supported by vertical shoring such as a sheetpile barrier or laid back to a low slope angle (e.g., 2 or more horizontal:1 vertical) to prevent caving or running of the sandy material that is characteristic of the excavation areas.

As shown in Table 4.1 of the RSFS, Subalternatives 9B through 9G include the same treatment options as subalternatives B through G for Alternatives 6 through 8. There is no Subalternative 9A because the soil volume excavated under Alternative 9 is too large to be accommodated in onsite cells. For a cell with a maximum height of 20 to 25 feet, the footprint area would be too impacted with COC for bioremediation would be pretreated by soil washing. Treated residue would be backfilled.

- Alternative 10E - For this subalternative, the excavated soils would be treated by offsite incineration. For soils with metals, incinerated residue would be tested and treated by stabilization/solidification, if necessary to LDR standards. Treated residue would be disposed of at an appropriately permitted offsite landfill.
- Alternative 10F - For this subalternative, all of the excavated soils would be treated by stabilization/solidification. Treated soils would be backfilled.
- Alternative 10G - For this subalternative, the excavated soils would be treated by offsite thermal treatment. Treated soils would be disposed of at an appropriately permitted offsite landfill.

The volume and depth of soil excavation would be the same as discussed for Alternative 9 in Section 4.2.9. There is no Alternative 10A because the approximately 248,000 cy of soil to be excavated under Alternative 10 could not be readily accommodated in onsite cells.

For Subalternatives 10B through 10D and 10F, backfilling would occur with treated soil, in a manner such that final surface soils do not contain metals above Site soil cleanup criteria.

For Subalternatives 10E and 10G, excavated soils would be removed from the Site and treated offsite. Clean soil would be imported for backfill.

5.0 Detailed Analysis of Alternatives

5.1 National Oil and Hazardous Substances Pollution Contingency Plan Criteria for Evaluating Remedial Alternatives

5.1.1 Introduction

The NCP [40 CFR Section 300.430(e)(9)(iii)] identifies nine criteria for evaluation of remedial alternatives. These nine criteria are as follows:

- Threshold Criteria:
  - Overall protection of human health and the environment.
  - Compliance with ARARs.
- Primary Balancing Criteria:
  - Long-term effectiveness and permanence.
  - Reduction of toxicity, mobility or volume through treatment.
  - Short-term effectiveness.
  - Implementability.
  - Cost.
- Modifying Criteria:
  - State acceptance.
  - Community acceptance.

Each of the above nine criteria is described in the following subsections. The alternatives assembled in Chapter 4.0 of this RSFS are evaluated based on these criteria in Section 5.2 with the exception of state and community acceptance. These two criteria will not be evaluated until after the receipt of public comments and will be addressed in the Responsiveness Summary and the ROD.

5.1.2 Overall Protection of Human Health and the Environment

This evaluation criterion is a threshold requirement that serves as a final check to assess whether each alternative provides adequate protection of human health and the environment. Alternatives are assessed to determine whether they can adequately protect human health and the environment, in both the short and long term, from unacceptable risks posed by hazardous substances, pollutants or contaminants present at the Site. This criterion is also used to evaluate how risks would be eliminated, reduced or controlled through treatment, engineering, institutional controls or other remedial activities.

The primary threats to human health and the environment include releases of contaminant sources to the media of concern (air, soil, surface water and groundwater). Detailed analyses preference is satisfied when treatment is used to reduce the principal threats at a site through destruction of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media. This criterion focuses on the following:

- The treatment processes used in the remedy, and the materials they would treat.
- The relative amount of hazardous materials that would be destroyed or treated, including the degree to which treatment reduces the inherent hazards posed by the principal threats at the Site.
- The degree or extent of expected reduction in toxicity, mobility or volume measured as a percentage of reduction.
- The degree or extent of irreversibility of the treatment process.
- The type, quantity, and characteristics of residuals remaining following treatment.
- Whether the alternative would satisfy the statutory preference for treatment as a principal element, including whether treatment is used to reduce inherent hazards posed by principal threats at the Site.

5.1.6 Short-Term Effectiveness

Short-term effectiveness addresses the effects of each remedial alternative on the protection of human health and the environment during the construction and implementation process. The following factors are addressed during the evaluation process:

- Potential short-term risk to the community that might be imposed from implementation of the proposed remedial alternatives (e.g., dust from excavation activities, or transportation of hazardous material).
- Threats that may be posed to workers during remedial actions and the effectiveness and reliability of measures that would be taken to minimize those threats.
- Potential adverse environmental impacts that may result from construction and implementation of a remedial alternative and the reliability of mitigation measures, if necessary, in preventing or reducing the potential impacts.
- Time until remedial action objectives are achieved, either for the entire Site or individual elements associated with specific Site areas or threats.

5.1.7 Implementability

This criterion evaluates the technical feasibility and administrative feasibility (i.e., the ease or difficulty) of implementing each alternative and the availability of required services and materials during its implementation. The following factors are addressed during the evaluation process:

TABLE 5.1
Summary of Evaluation of Alternatives
Cabot Carbon/Koppers Superfund Site

ALTERNATIVE	THRESHOLD CRITERIA		PRIMARY BALANCING CRITERIA[1]				
	Overall Protection of Human Health and the Environment	Compliance With Potential ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, and Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost
Alternative 1 - No Further Action (Continued Operation of the Existing Ground Water Extraction and Treatment System)	GW – Not protective. Soil – Not protective. SW – Sampling results from the surface water and sediments have shown no significant impact from the site. This alternative would continue to be protective. DNAPL – COC remains in the soils and ground water onsite, but does not leave the site.	GW - Does not meet the MCLs in the shallow aquifer onsite, but meets the MCLs in the shallow aquifer off site. Soil - Does not meet standards established in the ROD for onsite surface soil. SW – This would comply with all ARARs. DNAPL – MCLs are not met in surface soil or ground water onsite.	GW – Effective control of the migration of ground water contamination requires long-term maintenance of current pump and treat system. Ineffective in preventing exposure to onsite ground water. Does not prevent incompatible future ground water or site uses. Soil – Ineffective in reducing direct soil exposure potential. SW – There should be no long-term changes to the surface water pathway. DNAPL – Very gradual decrease in concentrations as COCs leach to the ground water and attenuate.	GW - Some long-term reduction in COC in ground water by attenuation and well capture and treatment. Onsite ground water would contain elevated concentrations of organic COC for the foreseeable future. Soil – No significant reductions. SW – No significant reductions. DNAPL – Very gradual decrease in volume as COCs leach to the ground water and attenuate.	GW - Would effectively prevent additional offsite migration of COC through ground water. The ground water remedy is in place, so implementation could be completed within several months of ROD amendment. Ineffective in preventing exposure to onsite ground water. Soil - Ineffective in reducing direct soil exposure potential, but no soil handling or related potential for exposure would be required. SW – There should be no short-term changes to the surface water pathway. DNAPL – Little short-term effect.	• This alternative is currently in operation, so it is implementable.	$6.7 million for 30 Years

1 – Primary balancing criteria used in weighing the various alternatives.

GW – Ground water
Soil – Surface and subsurface soil
SW – Surface water and sediment
DNAPL – Dense, non-aqueous phase liquids

TABLE 5.1 (Continued)
Summary of Evaluation of Alternatives
Cabot Carbon/Koppers Superfund Site

ALTERNATIVE	THRESHOLD CRITERIA		PRIMARY BALANCING CRITERIA[1]				
	Overall Protection of Human Health and the Environment	Compliance With Potential ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, and Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost
Alternative 3 - Containment by a Wearing Surface Cover or Cap, Continued Ground Water Extraction and Treatment and Institutional Controls Alternative 3A - Containment by a Wearing Surface Cover (e.g. - gravel) Alternative 3B - Containment by a Low-Permeability Cap	GW - Protective as long as ground water extraction system is maintained and institutional controls are in place. Soil - Protective as long as surface containment is maintained or institutional controls are in place. SW – Sampling results from the surface water and sediments have shown no significant impact from the site. Runoff from excavation associated with the cover could result in some short-term increase in contamination in Springstead Creek. DNAPL – COC remains in the soils and ground water onsite, but does not leave the site.	GW - Does not meet the MCLs in the shallow aquifer onsite, but institutional controls would prevent human exposure. Meets the MCLs in the shallow aquifer off site. Soil – Meets ROD standards as long as surface containment is maintained and institutional controls are in place. SW – Currently complies with all ARARs, but COCs could leach from soils during excavation and runoff into Springstead Creek. DNAPL – MCLs are not met in ground water onsite and are waived for surface soil onsite.	GW – Effective control of the migration of ground water contamination requires long-term maintenance of current pump and treat system. Effective in preventing exposure to onsite ground water. Prevents incompatible future ground water or site uses. Soil – Effective in preventing exposure to contaminated surface soils for as long as institutional controls remain in place and the cover or cap is properly maintained. Difficult to maintain wearing cover over a protracted period when the site is not under direct control, making 3A ineffective for the long term. SW – There should be no long-term problems with COC runoff to the surface water pathway. DNAPL – Very gradual decrease in concentrations as COCs leach to the ground water and attenuate.	GW – Some long-term reduction in COC in ground water by attenuation and well capture and treatment. Onsite ground water would contain elevated concentrations of organic COC for the foreseeable future. Soil – No significant reductions. SW – No significant reductions. DNAPL – Very gradual decrease in concentrations as COCs leach to the ground water and attenuate.	GW – Would effectively prevent additional offsite migration of COC through ground water and exposure to COC in ground water. The ground water remedy is in place, so implementation could be completed within several months of ROD amendment. Soil - Effective in reducing direct soil exposure potential, but soil handling would be required during installation of the cap. SW – Runoff from excavation associated with the cover could result in some short-term increase in contamination in Springstead Creek. DNAPL – Little short-term effect.	• Implementation of institutional controls is made easier by the controls precluding activities that are not ongoing or anticipated near the site. • Implementation of a wearing surface cover may be difficult because the current owner of the property may require that the original grade be maintained and maintenance will need to be for the long term. • Some constraints on areas where RCRA Equivalent or PCC cap (3B) could be installed. • The low permeability cap (3B) would result in large peak flows during storm events. Special engineering measures (e.g., retention basins) could be required to control peak flows leaving the site. • It may be difficult to prevent damage to a RCRA-equivalent cap or other low permeability cap, if used in active site areas.	Alternative 3A: $8.3 million for 30 Years Alternative 3B: $9.2 million for 30 Years

1 – Primary balancing criteria used in weighing the various alternatives.

GW – Ground water
Soil – Surface and subsurface soil
SW – Surface water and sediment
DNAPL – Dense, non-aqueous phase liquids

TABLE 5.1 (Continued)
Summary of Evaluation of Alternatives
Cabot Carbon/Koppers Superfund Site

ALTERNATIVE	THRESHOLD CRITERIA		PRIMARY BALANCING CRITERIA[1]				
	Overall Protection of Human Health and the Environment	Compliance With Potential ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, and Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost
Alternative 5 - Containment by a Low Permeability Cap and Continuous Physical Barrier, Ground water Extraction and Treatment, and Institutional Controls Alternative 5A – RCRA equivalent cap where feasible and ACC or PCC cap elsewhere Alternative 5B – ACC cap where feasible and PCC cap elsewhere	GW - Protective as long as institutional controls are in place. Soil - Protective as long as cap is maintained or institutional controls are in place. SW – Sampling results from the surface water and sediments have shown no significant impact from the site. Runoff from excavation could result in some short-term increase in contamination in Springstead Creek. DNAPL – COC remains in the soils and ground water onsite, but does not leave the site. Some long-term decrease in COC due to ground water extraction.	GW - Does not meet the MCLs in the shallow aquifer within the continuous physical barrier, but institutional controls would prevent human exposure. Will meet the MCLs off site. Soil – Meets ROD standards as long as surface containment is maintained or institutional controls are in place. SW – Currently complies with all ARARs. DNAPL – MCLs may not be met in ground water onsite and are waived for surface soil onsite.	GW - Would provide dependable ground water contamination migration control, but would require long-term maintenance. Institutional controls would prevent exposure to COC through ground water. Soil – Effective in preventing exposure to contaminated surface soils for as long as institutional controls remain in place and the cover is properly maintained. SW – There should be no long-term problems with COC runoff to the surface water pathway. DNAPL – Very gradual decrease in concentrations as COCs leach to the ground water and attenuate. Extraction wells may result in moderate decreases in COC levels.	GW - COC would be unable to leave the physical barrier, but would still be present. Some long-term reduction in COC by well capture. Containment areas would contain elevated concentrations of organic COC for the foreseeable future. Soil – Mobility of COC from soil to GW would be greatly reduced. SW – No significant reductions. DNAPL – Very gradual decrease in concentrations as COCs leach to the ground water and attenuate. Extraction wells may result in moderate decreases in COC levels.	GW - Would effectively prevent additional offsite migration of COC. Would effectively prevent exposure to COC. Current ground water treatment will continue until system is proven effective. Soil - Effective in reducing direct soil exposure potential, but soil handling would be required during installation of the cover and containment wall. SW – Runoff from excavation could result in some short-term increase in contamination in Springstead Creek but this can be mitigated by engineering controls. DNAPL – The extraction wells may result in moderate rates of decreases in COC levels.	• Implementation of institutional controls is made easier by the controls precluding activities that are not ongoing or anticipated near the site. • Implementation of a cap may be difficult because the current owner of the property may require that the original grade be maintained. • Some constraints on areas where RCRA Equivalent or PCC cap could be installed. • The low permeability cap would result in large peak flows during storm events. Special engineering measures (e.g., retention basins) could be required to control peak flows leaving the site. • It may be difficult to prevent damage to a RCRA-equivalent cap or other low permeability cap, if used in active site areas. • Continuous physical barrier should be implementable.	Alternative 5A: $11.0 million for 30 Years Alternative 5B: $12.1 million for 30 Years

1 – Primary balancing criteria used in weighing the various alternatives.

GW – Ground water
Soil – Surface and subsurface soil
SW – Surface water and sediment
DNAPL – Dense, non-aqueous phase liquids

TABLE 5.1 (Continued)
Summary of Evaluation of Alternatives
Cabot Carbon/Koppers Superfund Site

ALTERNATIVE	THRESHOLD CRITERIA		PRIMARY BALANCING CRITERIA[1]				
	Overall Protection of Human Health and the Environment	Compliance With Potential ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, and Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost
Alternative 7 - Removal of Surface Soils and Metal Impacted Subsurface Soils, Containment of Remaining Subsurface Soils with a Continuous Physical Barrier, and Institutional Controls	GW - Protective as long as institutional controls are in place. Soil - Extensive handling of soil impacted by dioxins/ furans, pcPAHs and other COCs has the potential not to be overall protective in the short term. Otherwise protective as long as institutional controls are in place and surface cover is maintained over any soils not removed. SW – Sampling results from the surface water and sediments have shown no significant impact from the site. Runoff from excavation could result in some short-term increase in contamination in Springstead Creek. DNAPL – Most of the COC remains in the soils and ground water onsite, but does not leave the site.	GW - Does not meet the MCLs in the shallow aquifer within the continuous physical barrier, but institutional controls would prevent human exposure. Will meet the MCLs outside the barrier. Soil - Differences in compliance with ARARs for excavated soil handling subalternatives are evaluated in Table 5.2. SW – Currently complies with all ARARs. DNAPL – MCLs may not be met in ground water onsite and are waived for surface soil onsite.	GW - Would provide dependable ground water contamination migration control, but would require long-term maintenance. Institutional controls would prevent exposure to COC through ground water. Reduction of soil contaminant levels will result in lower ground water contaminant levels in the long term. Soil - Effective long-term exposure control with maintenance of the cover over the areas not excavated. Differences for excavated soil handling subalternatives are evaluated in Table 5.2. SW – There should be no long-term problems with COC runoff to the surface water pathway. DNAPL – Permanent decrease in COC from removed soils. Extraction wells may result in moderate decreases in COC levels.	GW - COC in ground water would be unable to leave the physical barrier, but would still be present. Some long-term reduction of COC by well capture. Containment areas would contain elevated concentrations of organic COC for the foreseeable future. Soil - Reduction in COC toxicity, mobility, or volume by excavation and subsequent treatment of shallow and metal-impacted soils. SW – No significant reductions. DNAPL – Reduction in COC mass from removed soils and extraction wells.	GW - Effectively prevents additional offsite migration of COC. There would be considerable soil handling that could increase mobility of COC during the remedial construction period. Current GW treatment will continue until system is proven. Soil - Immediate source reduction by shallow soil excavation, but there would be significant soil handling that could increase mobility of COC during the remedial construction period. Differences for excavated soil handling subalternatives are evaluated in Table 5.2. SW – Runoff from excavation could result in some short-term increase in contamination in Springstead Creek but this can be mitigated by engineering controls. DNAPL – Immediate reduction in COC mass from removed soils.	• Implementation of institutional controls can be difficult, but is made easier because these controls would preclude activities that are not ongoing or anticipated near the site. • Continuous physical barrier should be implementable. • Implementable, but extensive emission controls might be required for excavation and soil handling. • Some subalternatives for excavated soil handling may not be implementable (Table 5.2).	Alternative 7A: $8.1 million for 30 Years Alternative 7B: $34.7 million for 30 Years Alternative 7C: $10.4 million for 30 Years Alternative 7D: $9.2 million for 30 Years Alternative 7E: $36.0 million for 30 Years Alternative 7F: $17.3 million for 30 Years Alternative 7G: $36.0 million for 30 Years

1 – Primary balancing criteria used in weighing the various alternatives.

GW – Ground water
Soil – Surface and subsurface soil
SW – Surface water and sediment
DNAPL – Dense, non-aqueous phase liquids

TABLE 5.1 (Continued)
Summary of Evaluation of Alternatives
Cabot Carbon/Koppers Superfund Site

ALTERNATIVE	THRESHOLD CRITERIA		PRIMARY BALANCING CRITERIA[1]				
	Overall Protection of Human Health and the Environment	Compliance With Potential ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, and Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost
Alternative 9 - Removal to the Hawthorne Clay, Ex-situ Treatment, DNAPL Removal and In-situ Bioremediation Where Removal is Not Implementable, and Institutional Controls	GW- The portion of the existing ground water extraction and treatment system downgradient of the process and tank farm areas where excavation is not practical would have to continue to be operated in order for this alternative to be overall protective. Soil - Extensive handling of soil impacted by dioxins/ furans, pcPAHs and other COCs has the potential not to be overall protective in the short term, but this alternative is very protective in the long term. SW – Sampling results from the surface water and sediments have shown no significant impact from the site. Runoff from excavation could result in some short-term increase in contamination in Springstead Creek. DNAPL – COC levels decrease greatly due to excavation and treatment.	GW - Could meet ARARs except for MCLs in the treatment area where excavation is not practical and possibly other areas if small unknown pockets of DNAPL occur that are not removed. The existing ground water extraction and treatment system would have to continue to be operated downgradient of the treatment area to achieve MCLs at the property boundary. Soil - Differences in compliance with ARARs for excavated soil handling subalternatives are evaluated in Table 5.2. SW – Currently complies with all ARARs. DNAPL – MCLs may be met in ground water onsite and are waived for surface soil onsite.	GW - COC in areas that cannot be excavated would be reduced by DNAPL removal and bioremediation. These processes would be slow and significant concentrations of COC would remain for an extended period of time. Treatment/containment of COC in areas that cannot be excavated would require long-term operation and maintenance. Soil - Effective long-term exposure control by greatly reducing the toxicity, mobility, or volume of contamination present. Differences for excavated soil handling subalternatives are evaluated in Table 5.2. SW – There should be no long-term problems with COC runoff to the surface water pathway. DNAPL – Permanent decrease in COC toxicity, mobility, or volume from removed soils.	GW – The soil removal and treatment processes would remove the source of future ground water COC. COC in areas that cannot be excavated would be reduced by biodegradation and DNAPL removal. Soil – Most COC would be permanently removed by excavation, and destroyed or immobilized. Further COC mass reduction by in-situ treatment. SW – No significant reductions. DNAPL – Reduction in COC mass from removed soils and in situ remediation.	GW - There would be considerable soil handling that could increase mobility of COC during the remedial construction period. Current ground water treatment will continue until system is proven effective. Soil - Immediate source reduction by soil excavation, but there would be significant soil handling that could increase mobility of COC during the remedial construction period. Differences for excavated soil handling subalternatives are evaluated in Table 5.2. SW – Runoff from excavation could result in some short-term increase in contamination in Springstead Creek but this can be mitigated by engineering controls. DNAPL – Immediate reduction in COC mass from removed soils and in situ remediation.	• Implementation of institutional controls can be difficult, but is made easier because these controls would preclude activities that are not ongoing or anticipated near the site. • Implementable, but extensive emission controls might be required for excavation and soil handling. • Some subalternatives for excavated soil handling may not be implementable (Table 5.2).	Alternative 9B: $173 million for 30 Years Alternative 9C: $34.5 million for 30 Years Alternative 9D: $27.2 million for 30 Years Alternative 9E: $180 million for 30 Years Alternative 9F: $55.4 million for 30 Years Alternative 9G: $180 million for 30 Years

1 – Primary balancing criteria used in weighing the various alternatives.

GW – Ground water
Soil – Surface and subsurface soil
SW – Surface water and sediment
DNAPL – Dense, non-aqueous phase liquids

TABLE 5.2
Evaluation of Treatment Trains for Excavated Soils
Cabot Carbon/Koppers Superfund Site

Alternative	THRESHOLD CRITERIA		PRIMARY BALANCING CRITERIA[1]				
	Overall Protection of Human Health and the Environment	Compliance with Potential ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity Mobility and Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost
Alternative A – Onsite Landfill	Protective	• An onsite landfill could comply with ARARs.	Effective immobilization of COC may require long-term maintenance.	• Treatment would not occur.	• Potentially not effective for the short term due to increased mobility of COC during excavation and material handling. • Landfill preparation could extend remedy construction period several months.	• Shallow depth to ground water, stormwater management facilities, and existing facilities limit the siting and volume of onsite disposal capacity. • State law may prohibit onsite disposal unless treated to LDR standards.	$80/cy
Alternative B – Onsite Incineration, Solidification/ Stabilization of Metal Impacted Soil Residue, Backfill with Treated Soil	Protective	• Could comply with ARARs provided that permits are attainable. • Extensive onsite testing may be required to demonstrate thermal destruction effectiveness and compliance with emission standards.	Effective	• Organic COC concentrations could be reduced below Site cleanup goals. • Residue may contain metals at concentrations above Site cleanup goals. Stabilization/solidification would occur, if necessary, to reduce metal mobility.	• Potentially not effective for the short term due to increased mobility of COC during excavation and material handling. • Material handling and treatment could extend remedy construction period.	• Could be difficult to permit, particularly for soils containing dioxins/furans. • Soil preparation (e.g., debris removal, size classification) would require considerable material handling.	$700/cy (onsite incineration) $60/cy (solidification/ stabilization)
Alternative C – Onsite Thermal Desorption, Solidification/ Stabilization of Metal Impacted Soil Residue, Backfill with Treated Soil	Protective	• The Site cleanup criteria for penta, dioxins/furans and metals would not be attainable. • Land Disposal Restriction Treatment standards would not be met.	Effective	• PAH concentrations could be reduced to levels near or below Site cleanup goals. • Residue may contain Penta, Dioxins/Furans and metals at concentrations above Site cleanup goals. Stabilization/solidification would occur, if necessary, to reduce metal mobility. Stabilization may not be effective for residual organic COC.	• Potentially not effective for the short term due to increased mobility of COC during excavation and material handling. • Material handling and treatment could extend remedy construction period.	• Could be difficult to permit, particularly for soils containing dioxins/furans. • Soil preparation (e.g., debris removal, size classification) would require considerable material handling. • May not be implementable due to LDRs. A CAMU would be required and may not be attainable.	$120/cy (thermal desorption) $60/cy (solidification/ stabilization)

(1) Primary criteria used in weighing the various alternatives.

5.2.1 *Alternative 1 - No Further Action*

The No Further Action alternative consists of continued operation of the existing groundwater extraction, pretreatment and discharge system, with no other additional action.

5.2.1.1 *Overall Protection of Human Health and the Environment*. The No Further Action alternative would not be protective of human health and the environment. Continued operation of the existing extraction wells would prevent further COC migration offsite but would not address onsite water quality or source control. Organic COC would continue to be released from the source areas. Alternative 1 does nothing to mitigate the potential for direct exposure of site workers to contaminated surface soils.

5.2.1.2 *Compliance With ARARs.* The No Action Alternative would not be capable of meeting pertinent ARARs (Safe Drinking Water Act MCLs) in the shallow aquifer onsite. The existing groundwater extraction system that would continue operation under this alternative could be capable of achieving MCLs in groundwater of the shallow aquifer offsite over the long term. Compliance with ROD standards for surface soil would not be achievable with this alternative.

5.2.1.3 *Long-Term Effectiveness and Permanence.* The No Action Alternative would be effective in preventing migration of COC offsite in groundwater as long as the extraction well system is operated and maintained. The gradient control provided by the extraction wells is a demonstrated technology for migration control.

The No Action Alternative would not provide any effective source reduction or mitigate the potential for direct exposure to impacted soils. It would not provide for protection from exposure to onsite groundwater.

Surface water and sediment sampling results have shown little effect from site operations and the No Action Alternative should not affect this.

5.2.1.4 *Reduction of Toxicity, Mobility, and Volume of COC.* Under the No Action Alternative, concentrations of COC in groundwater above the Site cleanup criteria would be confined to the containment area upgradient from the extraction wells. There would not be extensive direct treatment or removal of COC from soils and there would be no direct treatment or removal of DNAPL. Some reduction in COC toxicity and volume would occur over the long

However, institutional controls are only partially effective and the ARARs for surface soil are not likely to be met.

5.2.2.3 Long-Term Effectiveness and Permanence. Alternative 2 would be effective in preventing migration of COC offsite in groundwater as long as the extraction well system is operated and maintained. Extraction wells are a demonstrated technology for migration control. Because this alternative does not incorporate source control measures, soil and groundwater onsite would continue to exceed Site cleanup criteria for the foreseeable future. In theory, institutional controls would be effective for the long term for preventing unacceptable exposure to COC in onsite soils and groundwater. Surface water and sediment sampling results have shown little effect from site operations and Alternative 2 should not affect this.

5.2.2.4 Reduction of Toxicity, Mobility, and Volume of COC. Concentrations of COC above the Site cleanup criteria in groundwater in the shallow aquifer would be confined to the containment area. There would not be extensive direct treatment or removal of COC from soils and no direct treatment or removal of DNAPL. Some reduction in COC volume would occur over the long term due to natural attenuation, capture by the extraction wells, and treatment of the captured water. However, onsite groundwater quality would continue to contain concentrations of organic COC as long as DNAPL is present. Source removal in the drip pad area would result in the immediate decrease in toxicity, mobility, or volume of soil contamination, depending on the subalternative chosen.

5.2.2.5 Short-Term Effectiveness. The groundwater extraction that would occur is an effective means to prevent additional migration of COC offsite in groundwater for the short term. Alternative 2 would not provide for effective source control. Institutional controls would be effective for preventing unacceptable exposure to COC in onsite soils and groundwater.

Source removal in the drip pad area might result in the short-term mobilization of contamination to groundwater or surface water and the short-term exposure of workers to soil contamination. Source removal would also result in the immediate decrease in volume of contaminant.

5.2.2.6 Implementability. Alternative 2 is implementable. The groundwater extraction system is in place and currently in operation. Deed restrictions could be enacted. Beazer has, by contract, the ability to obtain deed restrictions for the Site. EPA has authority to implement institutional controls for offsite areas pursuant to CERCLA, but whether EPA chooses to exercise this authority will likely be influenced by community acceptance.

However, institutional controls are only partially effective and the ARARs for surface soil would need to be waived.

5.2.3.3 Long-Term Effectiveness and Permanence. Alternative 3 would be effective in preventing migration of COC offsite in groundwater as long as the extraction well system is operated and maintained. Extraction wells are a demonstrated technology for migration control. Because this alternative does not incorporate extensive source control measures, groundwater quality onsite would continue to exceed Site cleanup criteria for the foreseeable future. Alternative 3A is not effective in the long term. The wearing cover would deteriorate quickly due to the frequent heavy equipment operation in areas where the cover would be. The surface containment component would require long-term maintenance to remain effective, which can be difficult to achieve.

5.2.3.4 Reduction of Toxicity, Mobility and Volume of COC. Under Alternative 3, concentrations of COC above the Site cleanup criteria would be confined to the containment area in the shallow aquifer. There would not be extensive direct treatment or removal of COC from soils and there would be no direct treatment or removal of DNAPL. Some reduction in COC volume would occur over the long term due to natural attenuation, capture by the extraction wells, and treatment of the extracted groundwater. However, onsite groundwater quality would continue to contain concentrations of organic COC as long as DNAPL is present. Source removal in the drip pad area and removal of surface soils for installation of the surface cover would result in the immediate decrease in toxicity, mobility, or volume of soil contamination, depending on the subalternative chosen.

5.2.3.5 Short-Term Effectiveness. The groundwater extraction that would occur under Alternative 3 would be an effective means to prevent additional migration of COC offsite in groundwater for the short term. Alternative 3 would not provide for effective source control. Surface containment and institutional controls would be effective in preventing unacceptable exposure to COC in onsite soils and groundwater. A site Health and Safety Plan would be developed for the remedial action to safeguard workers and the public during construction of the surface containment component. There would be a significant amount of excavation and grading of impacted soils that could increase mobility of COC while remedial construction is occurring. Source removal in the drip pad area might result in the short-term mobilization of contamination to groundwater or surface water and the short-term exposure of workers to soil contamination. Source removal would also result in the immediate decrease in the toxicity, mobility, or volume of contaminant.

5.2.4 *Alternative 4 - Containment by a Permeable Cover and BACS and Institutional Controls*

As discussed in Section 4.2.4, this alternative includes installation of a gravel-wearing surface to prevent exposure to COC in surface soil, a BACS containing DNAPL source areas to prevent offsite migration of COC via groundwater, and institutional controls to prevent exposure to COC that would remain in place. Monitoring and contingency measures would be included to assure that migration of COC away from the treatment areas does not occur. The surface cover would eliminate the need for the increased Site security component of the institutional controls. Existing surface soils would need to be excavated in order to maintain existing grade after the installation of the surface cover or cap. In addition, removal of source material in the area of the drip pads will be a part of this remedial alternative.

5.2.4.1 Overall Protection of Human Health and the Environment. This alternative would be protective of human health and the environment. Groundwater modeling based on site-specific hydrologic and geochemical parameters demonstrates that the BACS would be effective in achieving groundwater cleanup criteria downgradient of the treatment/containment areas. The treatment/containment area under this alternative would be smaller than the containment area for Alternatives 1 through 3. Also, a reduction of the volume of COC would be expected over time because the BACS and permeable cover would allow continued bioremediation in groundwater near the margins of the source areas. Monitoring would be used to assure that groundwater cleanup criteria are met at the point of compliance, and additional levels of protectiveness would be added as contingency measures if needed. Once the BACS is demonstrated through monitoring, it would contain COC near source areas without long-term maintenance.

While the COC volume would be reduced over time, groundwater quality within the treatment/containment areas would continue to exceed Site cleanup criteria for the foreseeable future. The surface cover, and institutional controls would effectively prevent exposure to the COC that remain onsite.

Subalternatives 4A and 4B are the same except that Alternative 4B includes the installation of recirculation wells (or equivalent) at strategic locations both to remove DNAPL and to increase the rate of biodegradation in the dissolved phase. If the recirculation wells are successful in recovering significant volumes of DNAPL, Alternative 4B would reduce the volume of COC and the total time required for remediation, but would not be significantly more protective than 4A. Because only limited quantities of free-phase DNAPL have been measured (see Section 1.3.2.4), there is no assurance that recirculation wells would be successful in recovering large volumes of DNAPL; however, free-phase DNAPL is likely to collect at the downgradient portions of the

The BACS would contain the DNAPL and allow the oxygen associated with the groundwater to mix with the dissolved phase constituents that migrate out through the gaps in the BACS. Most of this oxygen would therefore be available for biodegradation of the dissolved phase. Currently, without a BACS, much of this oxygen is likely consumed in the DNAPL area and does not reach the downgradient dissolved phase.

For the BACS subalternatives with permeable covers, the natural oxygen flows to the shallow soils and the surface of the groundwater would continue to support biodegradation in this area. For the impermeable cap subalternatives, this oxygen flux, which is significant, would be cut off. Appendix G provides support calculations. Because of the high concentration of some organic COC present, groundwater cleanup goals would not be achieved within the treatment/containment areas within the foreseeable future.

The recirculatory/recovery systems (e.g., recirculation wells, recovery wells, infiltration trenches) that would be included as part of Alternative 4B would also reduce the mobility and volume of COC if they are successful in recovering significant quantities of DNAPL. They would also enhance degradation of the dissolved phase constituents.

Source removal in the drip pad area and removal of surface soils for installation of the surface cover would result in the immediate decrease in toxicity, mobility, or volume of soil contamination, depending on the subalternative chosen.

5.2.4.5 Short-Term Effectiveness. Alternative 4 would be effective in the short term, but existing groundwater control measures would continue until the effectiveness is demonstrated. The BACS, surface containment, and institutional controls could be implemented within a relatively short time frame (e.g., a several month construction period). A Site Health and Safety Plan would be developed for the remedial action to safeguard workers and the public during construction of the remedy. There would be significant grading and excavation of impacted soils for the surface cover that could increase mobility of COC while remedial construction is occurring. Excavation for the BACS may result in emissions of organic COC from excavated soil. Emissions and worker exposure would need to be monitored, and controlled if necessary to avoid unacceptable exposure. Source removal in the drip pad area might result in the short-term mobilization of contamination to groundwater or surface water and the short-term exposure of workers to soil contamination. Source removal would also result in the immediate decrease in toxicity, mobility, or volume of contaminant.

would be smaller than the containment area for Alternatives 1 through 3. It would be slightly smaller than the treatment containment area for Alternative 4.

Subalternatives 5A and 5B are the same except for the type of low permeability cap that would be installed. For Alternative 5A, a RCRA-equivalent cap would be installed wherever practical, with ACC or PCC used for capping in those areas where a RCRA cap is impractical. For Alternative 5B, an ACC cap would be installed wherever practical, with PCC used for capping in those areas where an ACC cap is impractical. The RCRA-equivalent cap would have the lowest permeability, but any of the cap configurations would eliminate the majority of infiltration if maintained. The COC present are not volatile so any of the cap configurations would effectively prevent exposure to COC in surface soils. Because the containment areas would be surrounded by a continuous physical barrier, and much of the area within the barriers would be capped, there would be little flux of oxygen and nutrients through the containment areas. The lower the permeability of the cap material selected, the more reduction there will be in the infiltration of oxygen and nutrients and long-term attenuation.

The RCRA cap could reduce the amount of groundwater extraction needed for gradient control but otherwise would not significantly improve the ability of the remedial system to provide groundwater containment.

5.2.5.2 Compliance With ARARs. Alternative 5 would be capable of meeting pertinent ARARs except for Safe Drinking Water Act MCLs in the shallow aquifer onsite within the containment areas (TI waiver zones). The continuous physical barrier and gradient control would be capable of achieving MCLs in groundwater downgradient of the containment areas. Compliance with other pertinent ARARs would be achievable with this alternative.

5.2.5.3 Long-Term Effectiveness and Permanence. Alternative 5 would be protective of human health and the environment with long-term operation and maintenance of remedial systems for groundwater extraction from the shallow aquifer and surface containment. Groundwater quality within the containment areas would not be improved, but surface containment and institutional controls would be effective for the long term for preventing unacceptable exposure to COC in onsite soils and groundwater.

5.2.5.4 Reduction of Toxicity, Mobility, and Volume of COC. Under Alternative 5, concentrations of COC in groundwater above the Site cleanup criteria would be confined to the shallow aquifer in the containment area. There would be no direct treatment or removal of COC

The RCRA-equivalent cap or other low permeability cap may require extensive maintenance and it could be difficult to construct a cap to resist damage in active areas of the Site. Therefore, as discussed in Sections 2.3.3.2 and 2.3.3.3, the RCRA-equivalent cap or ACC cap may not be practical in certain areas of the Site that have active operations or buildings. These implementability constraints could be accommodated by using a different surface material at locations where the selected material is impractical. If a RCRA-equivalent cap or ACC cap is selected, a construction configuration would be determined during remedial design that would optimize the use of the selected cap material.

5.2.5.7 Cost Effectiveness. The costs for Alternative 5A and 5B are approximately $11.0 million and $12.1 million (see Table 5.1). Appendix F provides the details of the cost estimates. This cost does not include the cost for removal of source material in the drip pad area or for the excavation and removal of the surface soils underlying the surface cover or cap. These costs, when determined, will be added to the costs listed above.

5.2.6 Alternative 6 - Removal of Surface Soils and Metal Impacted Subsurface Soils, Containment of Remaining Subsurface Soils With a BACS and Institutional Controls

As discussed in Section 4.2.6, this alternative includes excavation of impacted surface soils, and metal impacted subsurface soils. Organic COC impacted soil that would remain after excavation would be contained using the same BACS as Alternative 4. Where soils cannot be practically excavated, they would be treated through in-situ bioremediation or covered with a gravel wearing surface. Institutional controls would prevent exposure to COC in the treatment/containment areas.

Several subalternatives provide different treatment trains for excavated soil that are evaluated in Table 5.2.

5.2.6.1 Overall Protection of Human Health and the Environment. This alternative includes excavation to remove impacted surface soils and subsurface soils with metals. Removal of these soils would eliminate the surface exposure potential and the potential for migration of metals from source areas. Details for the subalternative treatment trains for soil excavated under this alternative are evaluated in Table 5.2.

This alternative would include excavation and handling of soil impacted by dioxins/furans, pcPAHs and other COC. During remediation work, the mobility of COC would be increased. Soil would have to be excavated, and the options for treating excavated soil could require

For the COC that remain following excavation, modeling demonstrates that the BACS would be effective at achieving groundwater cleanup standards downgradient of the treatment/containment areas given the biodegradation rates assumed in the model. The uncertainty inherent in the biodegradation process and in the rates of biodegradation is discussed in Section 4.2.4. Even if the BACS works as modeled, groundwater quality within the treatment/containment areas would continue to exceed Site cleanup criteria for the foreseeable future.

Institutional controls would be effective for the long term for preventing exposure to COC remaining in onsite soils and groundwater. For Alternative 6A, maintenance of the onsite landfill would be required to assure long-term effectiveness of the remedy. Each of the other subalternatives for the soil excavation component would be effective without long-term operation or maintenance activities.

5.2.6.4 Reduction of Toxicity, Mobility, and Volume of COC. The excavation and disposal or treatment of impacted surface soils and subsurface soils containing metals would directly remove or immobilize most inorganic COC. There would only be a relatively small direct reduction in the volume of organic COC because most of the organic COC and DNAPL occurs in deeper soils that would not be excavated. Organic COC that remain after excavation would be contained. Reduction of COC would occur by natural biodegradation as for Alternative 4. The BACS would be designed to allow a controlled rate of release of COC from source areas that would be naturally attenuated. The permeable surface cover and the "open" configuration of the containment wall on the upgradient side would maximize the natural addition of oxygen and nutrients to the treatment areas. Because of the high concentration of some organic COC present, groundwater cleanup goals would not be achieved within the treatment/containment areas within the foreseeable future.

The subalternative treatment trains would achieve different levels of reductions in toxicity, mobility and volume. Alternative 6A relies on immobilization of COC in excavated soils in an onsite landfill. Alternatives 6B, 6C, 6D, and 6F include treatment and backfill of treated residue. Each of the four treatment trains would reduce the COC toxicity, mobility and volume in the soil to be backfilled. Alternatives 6E and 6G include offsite treatment that would remove the excavated COC from the Site and reduce the COC toxicity, mobility and volume.

5.2.6.5 Short-Term Effectiveness. Alternative 6 would be effective in the short term, but existing groundwater control measures would continue until the effectiveness is demonstrated. Alternative 6 includes approximately 56,400 cy of excavation for removal of surface soils and with a gravel-wearing surface. Institutional controls would prevent exposure to COC that remain.

Several subalternatives providing different treatment trains for excavated soil are evaluated in Table 5.2.

5.2.7.1 Overall Protection of Human Health and the Environment. Excavation would remove impacted surface soils and subsurface soils with metals. This would eliminate the surface exposure potential and the potential for migration of metals. The subalternative treatment trains for the excavated soils would be protective to human health and the environment, but there are differences in some of the evaluation criteria, as outlined in Table 5.2.

Most of the organic COC occurs below the water table and would not be removed. Human health and the environment would be protected provided groundwater extraction for gradient control is maintained. Continuous physical barriers with gradient control are a demonstrated technology for preventing COC migration from source areas via groundwater. Under this alternative, the COC would remain inside the containment areas where the institutional controls would prevent exposure. This alternative would not significantly reduce the volume or toxicity of COC. There would be some reduction in COC over the long term due to removal by the extraction wells used for gradient control, but natural attenuation would be inhibited by isolation from surrounding soil and groundwater. Groundwater quality within the containment areas would continue to exceed Site cleanup criteria for the foreseeable future.

This alternative would include excavation and handling of large quantities of soil impacted by dioxins/furans, pcPAHs and other COC. During remediation work, the mobility of COC would be increased. These soil-handling activities would increase the risk of short-term exposure to COC by workers or the public.

5.2.7.2 Compliance With ARARs. Alternative 7 would be capable of meeting pertinent ARARs except Safe Drinking Water Act MCLs in the shallow aquifer onsite within containment areas (TI waiver zones). The continuous physical barrier and gradient control would be capable of achieving MCLs in groundwater outside containment areas. Compliance with other pertinent ARARs would be achievable with this alternative.

For the shallow soil and the metal-impacted soil that would be excavated, differences in compliance with ARARs are outlined in Table 5.2.

A Site Health and Safety Plan would be needed for the remedial action to safeguard workers and the public during construction of the remedy. Excavation of soils would result in potential emissions of organic COC. Emissions would need to be monitored, and controlled, if necessary. Dioxins/furans and other potentially carcinogenic COC that are present are not volatile and are not highly mobile under current conditions. During remedy construction, excavation of soil containing dioxins/furans, pcPAHs and other organic COC would increase mobility of these COC to air and surface water runoff and could result in conditions that are not protective of human health and the environment; however, these effects can be mitigated by engineering controls. To prepare the soil for treatment, Alternatives 7B, 7C, 7D, 7E, 7F, and 7G would require soil processing, such as debris removal and size classification. Each of the subalternatives has the potential for increased exposure to remedial workers and the general public during excavation and materials handling.

5.2.7.6 Implementability. The soil removal, slurry wall construction and institutional controls for this alternative are implementable using standard procedures and equipment. Vapor emissions and odors will have to be controlled in the excavation areas. Deed restrictions and other institutional controls could be enacted.

There are implementability differences between subalternatives that are detailed in Table 5.2. Permitting and other administrative difficulties may render subalternatives 7A, 7B, 7C and 7D nonimplementable.

5.2.7.7 Cost Effectiveness. The costs for Alternatives 7A through 7G range between approximately \$8.1 million and \$36.0 million (see Table 5.1). Appendix F provides the details of the cost estimates.

5.2.8 Alternative 8 - Removal of Surface Soils and Metal Impacted Subsurface Soils, Steam Extraction, In-Situ Bioremediation and Institutional Controls

As discussed in Section 4.2.8, this alternative includes excavation of shallow soils and metal-impacted subsurface soils. Organic COC-impacted soil that remains after excavation would be treated using an in-situ steam extraction technology followed by bioremediation. In areas where it is not practical to excavate the surface soils, they would be treated through in-situ bioremediation or covered with a gravel-wearing surface. Institutional controls would prevent exposure to COC that remain in the treatment zone. Several subalternatives provide different treatment trains for excavated soil that are evaluated in Table 5.2.

This alternative has the potential to not be protective to human health and the environment because of the risk associated with increasing the mobility of COC. This increased mobility could cause COC species such as pcPAHs and dioxins to become mobile and migrate away from source areas. Groundwater extraction and treatment could be necessary in the long term, if the in-situ treatment does not achieve relatively low COC concentration levels.

5.2.8.4 Reduction of Toxicity, Mobility and Volume of COC. The excavation and disposal or treatment of impacted surface soils and subsurface soils containing metals would remove or immobilize most inorganic COC. Alternative 8A relies on immobilization of COC in excavated soils in an onsite landfill. Alternative 8B, 8C, 8D, and 8F include treatment and backfill. Each of the four treatment trains would significantly reduce the COC toxicity, mobility and volume in the excavated soil. Alternatives 8E and 8G include offsite treatment that would remove the excavated COC from the Site, reduce the COC toxicity, mobility and volume.

Relatively low levels of COC concentrations may be achievable in the subsurface soils that are not excavated, but steam technologies are not capable of removing COC to Site cleanup criteria. In-situ biotreatment may be used as a polishing step but it may have limited effectiveness due to practical difficulties in getting nutrients to the impacted subsurfaces and due to the presence of highly chlorinated PAHs, dioxins/furans and certain other organic COC that are not amenable to biotreatment (see Section 2.5.7.4). A polishing step may not be necessary, because the reduced COC levels in the subsurface soils might prevent groundwater COC migration from reaching the site boundary.

5.2.8.5 Short-Term Effectiveness. Alternative 8 would be effective in the short term, but existing groundwater control measures would continue until the effectiveness is demonstrated. Alternative 8 includes approximately 56,400 cy of excavation for removal of surface soils and subsurface soils impacted by metals. In-situ steam treatment is a relatively short-term process, but enhanced bioremediation or natural attenuation could occur over a period of several years to decades.

A Site Health and Safety Plan would be required for the remedial action to safeguard workers and the public during construction of the remedy. Excavation of soils and steam extraction would result in potential emissions of organic COC. Emissions would need to be monitored, and controlled as necessary.

5.2.9.1 Overall Protection of Human Health and the Environment. This alternative includes excavation and treatment of impacted soils in the North Lagoon, South Lagoon and Drip Track areas. The subalternative treatment trains for soil excavated under this alternative would be protective to human health and the environment, but there are differences in some of the evaluation criteria for the different treatment trains as outlined in Table 5.2.

Soil removal cannot be implemented in the former Process and Tank Farm areas because of existing structures and ongoing operations. These soils would be treated in-situ by bioremediation and by extraction of DNAPL using recirculation wells.

Within the former Process and Tank Farm areas where soil removal is not implementable, soil and groundwater would continue to exceed Site cleanup criteria for the foreseeable future. In the former Process and Tank Farm areas, DNAPL removal and in-situ bioremediation would reduce the volume of COC over the long term, but there would be no significant reduction in potential for exposure in the foreseeable future. Recirculation wells might be capable of reducing the volume of DNAPL present, but the removal of DNAPL probably would be slow and limited, because most of the DNAPL present is old and is in the residual phase. Recirculation wells or any other NAPL removal systems are not capable of removing this residual phase DNAPL.

DNAPL can be difficult to locate. There is no assurance that all DNAPL would be removed from outside of the Processing and Tank Farm areas even if the excavations included in Area 9 were to be completed.

Alternative 9 would include excavation and handling of large quantities of soil impacted by dioxins/furans, pcPAHs and other COC. During remediation work, the mobility of COC would be increased. This could make Alternative 9, and any other alternative involving substantial excavation, potentially not protective to human health and the environment. This is further discussed in Section 5.2.9.5.

5.2.9.2 Compliance With ARARs. Because DNAPL is difficult to locate, there is no assurance that all DNAPL would be found and excavated in any portion of the Site. Significant quantities of DNAPL would remain in the former Process and Tank Farm area for the foreseeable future. MCLs would be exceeded over the long term and TI waiver zones would be required.

A Site Health and Safety Plan would be required to safeguard workers and the public during construction of the remedy. However, because of the large volume of soil involved, and the depth of the required excavation with an operating facility, there would still likely be some residual risk to construction workers. Excavation of soils would result in potential emissions of organic COC. These emissions would need to be monitored, and controlled if necessary, to avoid unacceptable exposure.

Dioxins/furans and other potentially carcinogenic COC that are present are not volatile and are not highly mobile under current conditions. During remedy construction, excavation of soil containing dioxins/furans, pcPAHs and other organic COC would increase mobility of these COC to air and surface water runoff and could result in conditions that are not protective of human health and the environment; however, these can be mitigated by engineering controls. Alternative 9 would require considerable soil processing such as debris removal and size classifications to prepare the soil for treatment.

Because of the potential for increased exposure by remedial workers and the general public during excavation and materials handling, each of the alternatives that incorporate excavation of large quantities of soil are considered potentially not effective for the short term.

5.2.9.6 *Implementability.* The soil removal is implementable using standard procedures and equipment in source areas other than the former Process and Tank Farm areas. Emission controls (e.g., excavation enclosure) will be required in some areas to prevent emissions and/or odors.

There are implementability differences between subalternatives that are detailed in Table 5.2. Permitting and other administrative difficulties may make subalternatives 9B, 9C and 9D nonimplementable.

Construction of the gravel wearing surface and in-situ bioremediation is implementable in the former Process and Tank Farm areas where excavation is not practical. Institutional controls are also implementable in these areas to mitigate the potential for exposure to COC. Installation of DNAPL recirculation wells is implementable.

5.2.9.7 *Cost Effectiveness.* The cost for Alternative 9 ranges between approximately $27.2 million and $180 million (see Table 5.1). Appendix F provides the details of the cost estimates.

5.2.10.2 Compliance With ARARs. Alternative 10 would not be capable of achieving Safe Drinking Water Act MCLs in the areas that are not practical to excavate. TI waiver zones would therefore be required. COC in areas that cannot be excavated would be contained.

Because DNAPL is difficult to locate, there is no assurance that all DNAPL would be found and excavated. The majority of the DNAPL would be removed from outside the containment areas, but there is some probability that unknown pockets of DNAPL occur that would remain in place outside of containment areas following excavation. These residual DNAPL areas would cause MCLs to be exceeded until natural attenuation reduces the COC over the long term.

For the soil and DNAPL that is excavated, compliance with ARARs would be achieved as outlined in Table 5.2. Only Alternatives 10A and 10D that utilize incineration for treatment would be capable of meeting LDRs.

Alternative 10 would be capable of compliance with pertinent ARARs other than MCLs and LDRs.

5.2.10.3 Long-Term Effectiveness and Permanence. This alternative would be only partially effective in reducing the volume of COC in the foreseeable future, as soils in the former Process and Tank Farm areas could not be removed.

Excavation of impacted soils would reduce the long-term potential for exposure to COC that occur in the areas where excavation is implementable. As described in Table 5.2, some COC would remain in the treated and backfilled soils under some of the subalternatives, but the volume of COC in areas that can be excavated would be permanently reduced or the COC would be immobilized.

There would be no immediate reduction in the volume or toxicity of COC in areas where soil removal is not implementable. However, the BACS would be effective for immobilizing COC and achieving groundwater cleanup standards downgradient of the treatment/containment zones. Groundwater quality within the treatment/containment areas would continue to exceed Site cleanup criteria for the foreseeable future. Once the BACS is demonstrated by monitoring, it would be effective for the long term without reliance on operations or maintenance activities.

Because of the potential for increased exposure by remedial workers and the general public during excavation and materials handling, each of the alternatives that incorporate excavation of large quantities of soil are considered potentially not effective for the short term.

5.2.10.6 Implementability. Soil removal is not implementable in the former Process and Tank Farm areas because of existing structures and active Site operations. Alternative 10 includes containment measures in these areas for this reason. Construction of the gravel-wearing surface and BACS in the Process and Tank Farm areas is implementable using standard construction procedures and equipment. Institutional controls are also implementable to protect against exposure to COC that would remain in these areas.

The soil removal is implementable using standard construction procedures and equipment in source areas other than the former Process and Tank Farm areas. Emission control (e.g., excavation enclosure) will be required in some areas to prevent emissions and/or odors.

There are implementability differences between subalternatives that are detailed in Table 5.2. Permitting and other administrative difficulties may render subalternatives 10B, 10C and 10D nonimplementable.

Construction of the BACS and gravel-wearing surface is implementable in the former Process and Tank Farm areas where excavation is not practical. Institutional controls are implementable in these areas to mitigate the potential for exposure to COC in these areas.

5.2.10.7 Cost Effectiveness. The cost for Alternative 10 ranges between approximately \$25.1 million and \$178 million (see Table 5.1). Appendix F provides the details for the cost estimates.

6.0 Comparative Analysis of Alternatives

6.1 Introduction

This chapter compares the relative benefits and drawbacks of each alternative based on the evaluations for each of the NCP criteria discussed in Chapter 5.0, and details of individual technologies presented in Chapter 2.0. This comparison will be used in the selection of the preferred alternative.

Comparative evaluations are provided for each of the seven evaluation criteria in separate sections below. A summary of the comparative evaluations is provided in Table 6.1. The semi-quantitative rating system used for summarizing comparisons in Table 6.1 is as follows:

- For "Overall Protection of Human Health and the Environment," each alternative is rated based on the overall results of the more specific evaluations for:
  - Long-term effectiveness;
  - Reduction of toxicity, mobility and volume through treatment; and
  - Short-term effectiveness.

  Alternatives are rated as either:
  - "N" for Not Protective;
  - "P" for Protective; or
  - "PN" for Potentially Not Protective.

  Further discussion of these ratings is provided in Section 6.2.
- For the "Compliance With ARARs," "Long-Term Effectiveness and Permanence," "Reduction of Toxicity, Mobility and Volume Through Treatment," "Short-Term Effectiveness," and "Implementability," evaluation criteria; each alternative is rated:
  - (SPI) An alternative receives a rating of "SPI" if it has an overall Significant Positive Impact. The rating incorporates consideration of identified potential drawbacks for the alternative, if any. For example, even if an alternative has a significant advantage, it may not receive the "SPI" rating if it has critical drawbacks under the same evaluation criteria that would offset the advantages.
  - (PI) An alternative receives a rating of "PI" if it has an overall Positive Impact. This rating implies an important benefit, but of smaller magnitude than the "SPI" rating.

TABLE 6.1
COMPARATIVE EVALUATION OF ALTERNATIVES
Cabot Carbon/Koppers Superfund Site

ALTERNATIVE	THRESHOLD CRITERIA		PRIMARY BALANCING CRITERIA[1]				
	Overall Protection of Human Health and the Environment	Compliance with Potential ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity Mobility and Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost
Alternative 1 - No Further Action	N	SNI	SNI	O	O	SNI	$6.7 million
Alternative 2 - Continued Ground Water Extraction and Treatment, and Institutional Controls	P	O	O	O	SPI	SPI	$6.8 million
Alternative 3 - Containment by a Wearing Surface Cover or Cap, Continued Ground Water Extraction and Treatment, and Institutional Controls							
Alternative 3A - Wearing Surface Cover	P	O	PI	PI	PI	PI	$8.3 million
Alternative 3B - Low Permeability Cap	P	O	O	PI	PI	PI	$9.2 million
Alternative 4 - Containment by a Wearing Surface Cover and Biotreatment Containment Wall, and Institutional Controls							
Alternative 4A	P	O	O	O	O	O	$4.7 million
Alternative 4B - with DNAPL Recovery	P	O	O	PI	O	O	$5.7 million
Alternative 5 - Containment by a Low Permeability Cap and Continuous Physical Barrier, and Institutional Controls							
Alternative 5A - RCRA Equivalent Cap	P	O	PI	PI	O	O	$11.0 million
Alternative 5B - ACC Cap	P	O	PI	PI	O	O	$12.1 million
Alternative 6 - Removal of Surface Soils and Metal-Impacted Subsurface Soils, Containment of Remaining Subsurface Soils with a Biotreatment Containment Wall, and Institutional Controls							
Alternative 6A[2]	P	NI	O	PI	NI	NI	$6.4 million
Alternative 6B[2]	P	PI	O	PI	NI	NI	$33.0 million
Alternative 6C[2]	P	NI	O	PI	NI	NI	$13.8 million
Alternative 6D[2]	P	NI	O	PI	NI	NI	$7.4 million
Alternative 6E [2]	P	PI	O	PI	NI	NI	$34.2 million
Alternative 6F[2]	P	PI	O	PI	NI	NI	$6.5 million
Alternative 6G [2]	P	PI	O	PI	NI	NI	$26.7 million

TABLE 6.1
COMPARATIVE EVALUATION OF ALTERNATIVES
Cabot Carbon/Koppers Superfund Site
(Continued)

ALTERNATIVE	THRESHOLD CRITERIA		PRIMARY BALANCING CRITERIA[1]				
	Overall Protection of Human Health and the Environment	Compliance with Potential ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity Mobility and Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost
Alternative 9[3] - Removal to the Hawthorne Clay, Ex-situ Treatment, DNAPL Removal and In-situ Bioremediation Where Removal is not Practical, and Institutional Controls							
Alternative 9B[2]	P	PI	SPI	SPI	SNI	SNI	$173 million
Alternative 9C[2]	P	NI	SPI	SPI	SNI	SNI	$34.5 million
Alternative 9D[2]	P	NI	SPI	SPI	SNI	SNI	$27.2 million
Alternative 9E [2]	P	PI	SPI	SPI	SNI	SNI	$180 million
Alternative 9F [2]	P	PI	SPI	SPI	SNI	SNI	$39.4 million
Alternative 9G [2]	P	PI	SPI	SPI	SNI	SNI	$141 million
Alternative 10[3] - Removal to the Hawthorne Clay, Ex-situ Treatment, Containment of Subsurface Soils Where Removal is Not Practical Using a Biotreatment Containment Wall, and Institutional Controls							
Alternative 10B[2]	P	PI	SPI	SPI	SNI	SNI	$171 million
Alternative 10C[2]	P	NI	SPI	SPI	SNI	SNI	$32.4 million
Alternative 10D[2]	P	NI	SPI	SPI	SNI	SNI	$25.1 million
Alternative 10E [2]	P	PI	SPI	SPI	SNI	SNI	$178 million
Alternative 10F [2]	P	PI	SPI	SPI	SNI	SNI	$37.3 million
Alternative 10G [2]	P	PI	SPI	SPI	SNI	SNI	$139 million

- (O) An alternative receives a rating of "O" if has no net impact. A rating of "O" can be assigned if the alternative has little or no effect on a given evaluation criteria, or if is has both advantages and drawbacks that cancel each other.
- (NI) An alternative receives a rating of "NI" if it has an overall Negative Impact.
- (SNI) An alternative receives a rating of "SNI" if it has a Significant Negative Impact. Even if an alternative has some advantages, it may receive the "SNI" rating if it has critical drawbacks that more than offset the advantages.

- Evaluations of "Cost" are provided directly by the net present dollar value of the alternative for a 30-year period. Cost effectiveness can be determined by comparison of the dollar cost with the relative ratings of each alternative for other criteria.

In addition to these summary evaluations, a graphical depiction of the comparisons is presented in Table 6.2. In this table the comparative ratings for the threshold and primary balancing criteria are shaded. The dark shading represents a significant positive impact ("SPI"). The shading is lightened for each successive reduction in the ratings. White represents a significant negative impact ("SNI"). Alternatives with the greatest amount of dark shading have more positive impact than those with lighter shading.

The Modifying Criteria of State and Community Acceptance (the eighth and ninth evaluation criteria) discussed in Section 5.0 will be evaluated based on public comments to the proposed remedy, and, therefore, are not addressed in this analysis.

6.2 Overall Protection of Human Health and the Environment

Alternatives 2, 3, 4, 5, 6 and 7 each provide overall protection of human health and the environment. Each of these alternatives relies, to some extent, on institutional controls, but Alternative 2 would require extensive institutional controls to ensure that it is protective. Such controls may not be implementable considering that the site is an active industrial site. Alternatives 2, 3, 5, and 7 also rely on adequate health and safety controls for the long-term O&M of a groundwater extraction and treatment system. Alternatives 4, 5, 6 and 7 also require special measures during the surface soil excavation to protect construction workers. Alternative 3 will also require these measures if the surface cover or cap must be installed to the existing grade.

The subalternatives that include DNAPL removal, i.e., those that are included with Alternatives 4 and 9 would also require special measures to protect human health and the environment while operating the removal systems.

TABLE 6.2
COMPARATIVE EVALUATION CONCLUSIONS
Cabot Carbon/Koppers Superfund Site

ALTERNATIVE		THRESHOLD CRITERIA		PRIMARY BALANCING CRITERIA[1]				
		Overall Protection of Human Health and the Environment	Compliance with Potential ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity Mobility and Volume Through Treatment	Short-Term Effectiveness	Implement-ability	Cost
Alternative 1 - No Further Action								$6.7 million
Alternative 2 - Continued Ground Water Extraction and Treatment, and Institutional Controls								$6.8 million
Alternative 3 - Containment by a Wearing Surface Cover or Cap, Continued Ground Water Extraction and Treatment, Institutional Controls	Alternative 3A: Wearing Surface Cover							$8.3 million
	Alternative 3B - Low Permeability Cap							$9.2 million
Alternative 4 - Containment by a Wearing Surface Cover and Biotreatment Containment Wall, and Institutional Controls	Alternative 4A							$4.7 million
	Alternative 4B – with DNAPL Recovery							$5.7 million
Alternative 5 - Containment by a Low Permeability Cap and Continuous Physical Barrier, and Institutional Controls	Alternative 5A - RCRA Equivalent Cap							$11.0 million
	Alternative 5B - ACC Cap							$12.1 million
Alternative 6 - Removal of Surface Soils and Metal Impacted Subsurface Soils, Containment of Remaining Subsurface Soils with a Biotreatment Containment Wall, and Institutional Controls	Alternative 6A[2]							$6.4 million
	Alternative 6B[2]							$33.0 million
	Alternative 6C[2]							$13.8 million
	Alternative 6D[2]							$7.4 million
	Alternative 6E[2]							$34.2 million
	Alternative 6F[2]							$6.5 million
	Alternative 6G[2]							$26.7 million
Alternative 7 - Removal of Surface Soils and Metal Impacted Subsurface Soils, Containment of Remaining Subsurface Soils With a Continuous Physical Barrier, and Institutional Controls	Alternative 7A[2]							$8.1 million
	Alternative 7B[2]							$34.7 million
	Alternative 7C[2]							$10.4 million
	Alternative 7D[2]							$9.2 million
	Alternative 7E[2]							$36.0 million
	Alternative 7F[2]							$6.6 million
	Alternative 7G[2]							$28.3 million
Alternative 8 – Removal of Surface Soils and Metal Impacted Subsurface Soils, Steam Extraction, In-situ Bioremediation, and Institutional Controls	Alternative 8A[2]							$20.1 million
	Alternative 8B[2]							$51.9 million
	Alternative 8C[2]							$22.4 million
	Alternative 8D[2]							$21.1 million
	Alternative 8E[2]							$53.1 million
	Alternative 8F[2]							$20.2 million
	Alternative 8G[2]							$41.9 million

TABLE 6.2
COMPARATIVE EVALUATION CONCLUSIONS
Cabot Carbon/Koppers Superfund Site
(Continued)

ALTERNATIVE		THRESHOLD CRITERIA		PRIMARY BALANCING CRITERIA[1]				
		Overall Protection of Human Health and the Environment	Compliance with Potential ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity Mobility and Volume Through Treatment	Short-Term Effectiveness	Implement-ability	Cost
Alternative 9 - Removal to the Hawthorne Clay Ex-situ Treatment DNAPL Removal and In-situ Bioremediation Where Removal is Not Practical, and Institutional Controls	Alternative 9B[(2)(3)]							$173 million
	Alternative 9C[(2)]							$34.5 million
	Alternative 9D[(2)]							$27.2 million
	Alternative 9E[(2)]							$180 million
	Alternative 9F[(2)]							$39.4 million
	Alternative 9G[(2)]							$141 million
Alternative 10 - Removal to the Hawthorne Clay, Ex-situ Treatment, Containment of Subsurface Soils Where Removal is Not Practical Using a Biotreatment Containment Wall, and Institutional Controls	Alternative 10B[(2)(3)]							$171 million
	Alternative 10C[(2)]							$32.4 million
	Alternative 10D[(2)]							$25.1 million
	Alternative 10E[(2)]							$178 million
	Alternative 10F[(2)]							$37.3 million
	Alternative 10G[(2)]							$139 million

(1) Primary criteria used in weighing the various alternatives.

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(2) Subalternatives incorporate handling of excavated soil as follows:

A - Onsite Landfill

B - Onsite Incineration Solidification/Stabilization of Metal Impacted Soil Residue, Backfill with Treated Soil

C - Onsite Thermal Desorption, Solidification/ Stabilization of Metal Impacted Soil Residue, Backfill with Treated Soil

D - Bioremediation (w/ Soil Washing Pretreatment where necessary). Solidification/Stabilization of Metal-Impacted Soil Residue, Backfill with Treated Soil

E - Offsite Incineration, Solidification/Stabilization of Metal Impacted Soil Residue, Disposal of Residue in an Offsite Landfill

F - Onsite Stabilization, Backfill with treated soil.

G - Offsite Thermal Treatment, Dispose of Residue in an Offsite Landfill.

(3) There is no Alternative 9A or 10A because shallow groundwater and surface area constraints would not allow onsite disposal of the quantity of soil that would be excavated.

LEGEND: Best Comparative | Intermediate Comparative Rating | Low Comparative Rating

TABLE 6.2
COMPARATIVE EVALUATION CONCLUSIONS
Cabot Carbon/Koppers Superfund Site

ALTERNATIVE		THRESHOLD CRITERIA		PRIMARY BALANCING CRITERIA[1]				
		Overall Protection of Human Health and the Environment	Compliance with Potential ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity Mobility and Volume Through Treatment	Short-Term Effectiveness	Implement-ability	Cost
Alternative 1 - No Further Action								$6.7 million
Alternative 2 - Continued Ground Water Extraction and Treatment, and Institutional Controls								$6.8 million
Alternative 3 - Containment by a Wearing Surface Cover or Cap, Continued Ground Water Extraction and Treatment, Institutional Controls	Alternative 3A: Wearing Surface Cover							$8.3 million
	Alternative 3B - Low Permeability Cap							$9.2 million
Alternative 4 - Containment by a Wearing Surface Cover and Biotreatment Containment Wall, and Institutional Controls	Alternative 4A							$4.7 million
	Alternative 4B – with DNAPL Recovery							$5.7 million
Alternative 5 - Containment by a Low Permeability Cap and Continuous Physical Barrier, and Institutional Controls	Alternative 5A - RCRA Equivalent Cap							$11.0 million
	Alternative 5B - ACC Cap							$12.1 million
Alternative 6 - Removal of Surface Soils and Metal Impacted Subsurface Soils, Containment of Remaining Subsurface Soils with a Biotreatment Containment Wall, and Institutional Controls	Alternative 6A[2]							$6.4 million
	Alternative 6B[2]							$33.0 million
	Alternative 6C[2]							$13.8 million
	Alternative 6D[2]							$7.4 million
	Alternative 6EF[2]							$34.2 million
	Alternative 6F[2]							$15.5 million
	Alternative 6G[2]							$34.2 million
Alternative 7 - Removal of Surface Soils and Metal Impacted Subsurface Soils, Containment of Remaining Subsurface Soils With a Continuous Physical Barrier, and Institutional Controls	Alternative 7A[2]							$8.1 million
	Alternative 7B[2]							$34.7 million
	Alternative 7C[2]							$10.4 million
	Alternative 7D[2]							$9.2 million
	Alternative 7E[2]							$36.0 million
	Alternative 7F[2]							$17.3 million
	Alternative 7G[2]							$36.0 million
Alternative 8 – Removal of Surface Soils and Metal Impacted Subsurface Soils, Steam Extraction, In-situ Bioremediation, and Institutional Controls	Alternative 8A[2]							$20.1 million
	Alternative 8B[2]							$51.9 million
	Alternative 8C[2]							$22.4 million
	Alternative 8D[2]							$21.1 million
	Alternative 8E[2]							$53.1 million
	Alternative 8F[2]							$34.4 million
	Alternative 8G[2]							$53.1 million

TABLE 6.2
COMPARATIVE EVALUATION CONCLUSIONS
Cabot Carbon/Koppers Superfund Site
(Continued)

ALTERNATIVE		THRESHOLD CRITERIA		PRIMARY BALANCING CRITERIA(1)				
		Overall Protection of Human Health and the Environment	Compliance with Potential ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity Mobility and Volume Through Treatment	Short-Term Effectiveness	Implement-ability	Cost
Alternative 9 - Removal to the Hawthorne Clay Ex-situ Treatment DNAPL Removal and In-situ Bioremediation Where Removal is Not Practical, and Institutional Controls	Alternative 9B(2)(3)							$173 million
	Alternative 9C(2)							$34.5 million
	Alternative 9D(2)							$27.2 million
	Alternative 9E(2)							$180 million
	Alternative 9F(2)							$55.5 million
	Alternative 9G(2)							$180 million
Alternative 10 - Removal to the Hawthorne Clay, Ex-situ Treatment, Containment of Subsurface Soils Where Removal is Not Practical Using a Biotreatment Containment Wall, and Institutional Controls	Alternative 10B(2)(3)							$171 million
	Alternative 10C(2)							$32.4 million
	Alternative 10D(2)							$25.1 million
	Alternative 10E(2)							$178 million
	Alternative 10F(2)							$55.4 million
	Alternative 10G(2)							$178 million

Primary criteria used in weighing the various alternatives.

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) Subalternatives incorporate handling of excavated soil as follows:

A - Onsite Landfill

B - Onsite Incineration Solidification/Stabilization of Metal Impacted Soil Residue, Backfill with Treated Soil

C - Onsite Thermal Desorption, Solidification/ Stabilization of Metal Impacted Soil Residue, Backfill with Treated Soil

D - Bioremediation (w/ Soil Washing Pretreatment where necessary). Solidification/Stabilization of Metal-Impacted Soil Residue, Backfill with Treated Soil

E - Offsite Incineration, Solidification/Stabilization of Metal Impacted Soil Residue, Disposal of Residue in an Offsite Landfill

` There is no Alternative 9A or 10A because shallow groundwater and surface area constraints would not allow onsite disposal of the quantity of soil that would be excavated.

LEGEND: Best Comparative | Intermediate Comparative Rating | Low Comparative Rating

Alternative 8 is considered potentially nonprotective as the steam extraction and in-situ bioremediation may not be effective. Alternative 8 also requires special measures during excavation of surface soils.

Alternatives 9 and 10 are considered protective because these alternatives are the most effective in the long term because they remove the contaminated soils. There are difficulties with both of these alternatives associated with excavating large quantities of saturated soils, but these difficulties can be overcome through proper engineering controls.

6.3 Compliance With Potential ARARs

There is no technology that would allow treatment or removal of organic COC to Site cleanup criteria in all affected areas within the foreseeable future. As a result, if MCLs were applied to the shallow groundwater onsite, none of the alternatives would be capable of achieving all MCLs for organic constituents. In addition, Alternatives 1, 2, 3, 4, and 5, which do not include removal of metal impacted soils, would not be capable of achieving MCLs for inorganic COC in the source areas.

As Alternatives 2, 3, 4 and 5 are protective of human health and the environment; a waiver from the MCL ARAR could be justified. There are also other factors, discussed in Chapter 3.0, that suggest that a waiver might be granted. These alternatives are therefore noted with an "O", no net impact. The waiver could not apply to the Alternative 1, No Further Action, because a waiver may not be justified for the No Further Action alternative, so this alternative receives a rating of "SNI".

Alternatives 6 and 7 fall generally in the same category as Alternatives 4 and 5 above, except that metal-impacted soils are removed. A "PI" rating is appropriate. However, Subalternatives 6C, 6D, 7C and 7D include treatment technologies that are unlikely to meet the LDRs. In addition, Subalternative 6A and 7A constitute disposal and not treatment of the waste, so they are not likely to obtain LDR variances. These are therefore rated with a "NI".

Alternative 8 might not achieve MCLs in shallow groundwater offsite because the in-situ steam treatment used in this alternative would increase mobility of COC and might cause the COC to migrate to offsite areas. Alternative 8 therefore has a "NI" rating. The in-situ biotreatment used in Alternatives 8 and 9 will not likely meet MCLs in groundwater onsite, but waivers are just as likely for these alternatives as for Alternatives 2 through 5. If low COC concentrations are not achieved in a reasonable period of time, long-term O&M of the existing extraction well system the long term if sufficiently low COC concentrations are not achieved within a reasonable period of time. An additional important consideration for Alternative 8 is the potential for the heterogeneities within the in-situ material to make complete removal of the COC impossible.

Alternative 7 includes a physical barrier, and a hard cap. Although it requires some O&M, it is more likely to contain contaminated soil, groundwater and DNAPL effectively than the other alternatives and its long-term effectiveness rating is "SPI". Alternatives 9 and 10 include "removal" of source material. In the long term nothing is more effective than removal and an "SPI" rating is appropriate.

6.5 Reduction of Toxicity, Mobility and Volume Through Treatment

Alternatives 1, 2, and 4A are ranked "O" because they include only minimal direct removal or treatment of COC as a principal or significant element. These alternatives do, however, allow treatment through natural attenuation in the groundwater, and Alternatives 1 and 2 include some removal and treatment by groundwater extraction.

Alternatives 3, 4B, 5, 6, 7, and 8 are rated "PI". Alternatives 3 and 5 are rated "PI" because they reduce contaminant mobility greatly. Alternative 4B is rated "PI" under the assumption that it is effective in reducing the DNAPL volume. Alternatives 6 and 7 address the inorganic COC as well as some of the organic COC. The majority of the organic COC and DNAPL occur in deeper soils, which are not removed or treated. Alternative 8 employs steam treatment and in-situ bioremediation to remove COC. The benefit of the significant reduction in COC is partially offset, however, by the increase in mobilization of COC that remain. If the steam treatment does not achieve low COC concentrations within a reasonable period of time, long-term groundwater extraction and treatment may be required to prevent further offsite migration of COC.

Alternatives 9 and 10 are rated "SPI". As for Alternatives 4 and 6, these alternatives include as a principal element the treatment of impacted soil below the water table where most COC and DNAPL occur. Alternatives 9 and 10 are rated higher than Alternatives 4 and 6 because treatment of COC in areas excavated to the Hawthorn clay, would occur over a shorter period of time. The cleanup criteria would continue to be exceeded for the foreseeable future in the source areas where excavation is not practical, and possibly in other areas outside the excavation if small, undetected pockets of DNAPL occur.

Alternatives 9 and 10 are rated highest in this category. However, none of the other alternatives receive a "NI" or "SNI" rating.

to maintain exposure to COC within acceptable levels, the additional time required for remedial construction and the increased potential for short-term exposure to COC make these alternatives less protective in the short term compared to Alternatives 2 and 3.

Alternatives 6 and 7 are rated "NI" due to the excavation and soil handling that would occur under these alternatives compared to Alternatives 1 through 5. Approximately 56,400 cy of soil would be removed and treated or disposed of. Each of the subalternatives except for 6A and 7A incorporate treatment technologies that would require further soil processing for debris removal and material classification. Soil handling activities would significantly increase the potential for public exposure to COC from dust and for remedial construction worker exposure to COC from dust and direct contact. There would be additional potential for public and worker exposure to COC emissions from treatment processes. Because of the amount of soil processing and area constraints posed by active operations at the Site, the time required to implement the remedy would be significantly longer compared to Alternatives 2 through 5. As for Alternatives 3, 4, and 5, engineering controls would be implemented to minimize the potential for unhealthful levels of exposures to COC.

Alternative 8 is rated "SNI". This alternative would have all of the short-term effectiveness drawbacks of Alternatives 6 and 7, plus additional short-term effectiveness drawbacks due to the in-situ treatment component. The steam extraction treatment that would occur under this alternative will increase the mobility of COC in both the short and long term. Furthermore, the time required to implement Alternative 8 is significantly longer than that for Alternatives 2 through 7.

Alternatives 9 and 10 are rated "SNI" due to the extensive excavation and processing of impacted soils, the complexity of remedial construction work within the saturated zone, and the relatively long period of time that would be required to implement this alternative. Alternatives 9 and 10 would include excavation of about 248,000 cy of impacted soil down to the Hawthorn clay. Most of this excavation would be soils below the water table. Excavation and handling of the large quantity of soils would likely have to be phased and would involve soil stockpiling. Much of the soil below the water table may contain DNAPL. The handling of multiple phases (i.e., excavated soils, water and DNAPL) could be complex and some material may be difficult to handle once unearthed. Engineering controls would be implemented to minimize the potential for unhealthful public or worker exposure to COC. However, the risk of unhealthful exposure cannot be completely eliminated. As the length of time and complexity of construction of a remedy increases, so does the short-term risk of increased exposure to COC. The extensive surface cover or cap. This would result in Alternatives 4 and 5 becoming the equivalents of Alternatives 6 and 7 other than the removal of subsurface soils with inorganic COC.

Alternatives 6 through 10 are not easily implemented and, therefore, receive negative comparative ratings. Each of these alternatives would require substantial construction efforts including excavation and handling of large quantities of soil affected by dioxins/furans, pcPAHs, penta and other COC. Extensive efforts would be required during remedy construction to phase excavation and material handling around ongoing activities, to prevent mobilization of COC via air emissions, stormwater run-off or other potential migration pathways, and to minimize disruption to the surrounding community. Because of these considerations, Alternatives 6 and 7 are rated "NI" because they involve handling smaller quantities of excavated soil, and 8A is rated "NI" because it involves onsite disposal of excavated soil. Each of the other subalternatives for handling excavated soil under Alternative 8 and all of the subalternatives under Alternatives 9 and 10 are rated "SNI" because of additional implementability difficulties discussed in the following paragraphs.

Each of the subalternatives incorporating onsite treatment (i.e., subalternatives with soil treatment options B, C, D, and F) would require mobilization of additional equipment to prepare soils for treatment (e.g., loaders, screens, conveyors). Processing of excavated soil would be required for debris removal and material (e.g., grain size) classification. Dust control, air monitoring, and other precautions for minimizing emissions of COC would be required throughout the construction period.

Subalternatives that incorporate either an onsite or offsite incinerator (i.e., subalternatives with soil treatment options B and E) might not be implementable because new LDR treatment standards for wood treatment wastes becoming effective in 1999 may result in an incinerator capacity shortage. Incineration is the only treatment technology that is demonstrated to be capable of achieving the new LDR treatment standards. Even if a portable unit is available for onsite incineration, permitting of onsite incineration will be difficult to impossible. Each of the subalternatives incorporating offsite incineration have additional considerations related to safe transport of the large volume of affected soils away from the Site.

Subalternatives with soil treatment trains not including incineration (i.e., subalternatives with soil treatment options C and D) would not be implementable without a variance from the new LDR treatment standards. A variance could be pursued, particularly if an incinerator capacity shortage can be demonstrated. However, there is no guarantee that a variance would be granted. In addition, subalternatives with soil treatment option C may have permitting difficulties due to the

6.9 Conclusions

Conclusions of the comparative evaluations are summarized in Table 6.2. Based on the comparisons discussed in Sections 6.2 through 6.8 and supporting detailed information in Chapters 2.0 and 5.0, Alternatives 2, 3, 4, 5, 6, 7, 9, and 10 meet the threshold of being protective of human health and the environment.

Overall, for compliance with ARARs, Alternatives 6B, 6E, 6F, 6G, 7B, 7E, 7F, 7G, 9B, 9E, 9F, 9G, 10B, 10E, 10F, and 10G are equal in performance and superior to other alternatives. These alternatives would conform with ARARs except for MCLs if applied onsite and, if necessary, a waiver of this ARAR is justified.

For the Long-Term Effectiveness and Permanence criteria, Alternatives 9 and 10 are superior to the other alternatives because they permanently remove the contaminated soils. Alternatives 3A, 5, and 7 and also effective in the long term because of the use of a low-permeability cap.

Alternatives 9 and 10 are the best alternatives for reducing the toxicity, mobility or volume of waste through treatment. The majority of the DNAPL would be removed through excavation and treatment down to the Hawthorn clay. Most of the inorganic COC source would also be removed. Alternatives 3, 4B, 5, 6, 7, and 8 also have good ratings for this criterion.

Alternative 2 has the highest rating for short-term effectiveness because it would quickly and effectively control the risk of exposure to COC. This alternative requires little or no construction and has the lowest potential for short-term impacts during implementation. Alternative 3 also has a good rating and would effectively control the risk of exposure to COC quickly, without significant potential for short-term impacts. Alternatives 9 and 10 would create negative impacts in the very short term, but they would result in the most thorough short-term remediation as well.

Alternative 2 has the highest rating for implementability. This alternative is the quickest and easiest to implement to reliably and effectively control the risk of exposure to COC. Alternative 3 is also easy to implement if the current property owner grants permission to implement it as designed.

Alternatives 2, 3, 4, 6A, 6D, 6E, 7A, 7D, and 7E are the least costly alternatives.

7.0 References

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APPENDIX F

Cost Estimates for Remedial Alternatives

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	Capital Cost						O, M, and M		
	Quantity	Unit	Unit Cost	Sub-Total Capital	Eng., CM, & Cont.	Total	Annual	Present Worth	Total Present Worth Cost
Alternative 6F:									
Excavation, stabilization, and backfill below the water table			$150						
Excavation, stabilization, and backfill above the water table	44,625	cy	$75			$3,346,875			$3,346,875
Biotreatment containment wall (excluding circulation wells)	1		$1,050,000	$1,050,000	$473,000	$1,523,000			$1,523,000
Continued Monitoring							$77,500	$1,519,000	$1,519,000
Institutional Controls	1		$100,000	$100,000		$100,000			$100,000
Totals				**$1,150,000**	**$473,000**	**$4,969,875**	**$77,500**	**$1,519,000**	**$6,488,875**
Alternative 6G:									
Excavation below the water table			$29						
Excavation above the water table	44,625	cy	$18			$815,000			$815,000
High-temperature thermal treatment of contaminated soil	44,625	cy	$300			$13,387,500			$13,387,500
Transportation from the site to the thermal treatment facility	44,625	cy	$200			$8,925,000			$8,925,000
Analytical costs	44,625	cy	$2			$89,250			$89,250
Backfill with clean soil/gravel	44,625	cy	$8			$334,688			$334,688
Biotreatment containment wall (excluding circulation wells)	1		$1,050,000	$1,050,000	$473,000	$1,523,000			$1,523,000
Continued Monitoring							$77,500	$1,519,000	$1,519,000
Institutional Controls	1		$100,000	$100,000		$100,000			$100,000
Totals				**$1,150,000**	**$473,000**	**$25,174,438**	**$77,500**	**$1,519,000**	**$26,693,438**
Alternative 7F:									
Excavation, stabilization, and backfill below the water table			$150						
Excavation, stabilization, and backfill above the water table	44,625	cy	$75			$3,346,875			$3,346,875
Continuous Containment Wall									
- Barrier Wall	1		$1,050,000	$1,050,000	$473,000	$1,523,000			$1,523,000
- Extraction Wells	1		$75,000	$75,000		$75,000			$75,000
Continued Monitoring							$77,500	$1,519,000	$1,519,000
Institutional Controls	1		$100,000	$100,000		$100,000			$100,000
Totals				**$1,225,000**	**$473,000**	**$5,044,875**	**$77,500**	**$1,519,000**	**$6,563,875**

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Alternative 7G:									
Excavation below the water table			$29						
Excavation above the water table	44,625	cy	$18			$815,000			$815,000
High-temperature thermal treatment of contaminated soil	44,625	cy	$300			$13,387,500			$13,387,500
Transportation from the site to the thermal treatment facility	44,625	cy	$200			$8,925,000			$8,925,000
Analytical costs	44,625	cy	$2			$89,250			$89,250
Backfill with clean soil/gravel	44,625	cy	$8			$334,688			$334,688
Continuous Containment Wall									
- Barrier Wall	1		$1,050,000	$1,050,000	$473,000	$1,523,000			$1,523,000
- Extraction Wells	1		$75,000	$75,000		$75,000			$75,000
Biotreatment containment wall (excluding circulation wells)	1		$1,050,000	$1,050,000	$473,000	$1,523,000			$1,523,000
Continued Monitoring							$77,500	$1,519,000	$1,519,000
Institutional Controls	1		$100,000	$100,000		$100,000			$100,000
Totals				**$2,275,000**	**$946,000**	**$26,772,438**	**$77,500**	**$1,519,000**	**$28,291,438**
Alternative 8F:									
Excavation, stabilization, and backfill below the water table			$150						
Excavation, stabilization, and backfill above the water table	44,625	cy	$75			$3,346,875			$3,346,875
Hot Water/Steam Treatment In Situ	306,375	cy	$50			$15,234,000			$15,234,000
Continued Monitoring							$77,500	$1,519,000	$1,519,000
Institutional Controls	1		$100,000	$100,000		$100,000			$100,000
Totals				**$100,000**	**$0**	**$18,680,875**	**$77,500**	**$1,519,000**	**$20,199,875**
Alternative 8G:									
Excavation below the water table			$29						
Excavation above the water table	44,625	cy	$18			$815,000			$815,000
High-temperature thermal treatment of contaminated soil	44,625	cy	$300			$13,387,500			$13,387,500
Transportation from the site to the thermal treatment facility	44,625	cy	$200			$8,925,000			$8,925,000
Analytical costs	44,625	cy	$2			$89,250			$89,250
Backfill with clean soil/gravel	44,625	cy	$8			$334,688			$334,688
Hot Water/Steam Treatment In Situ	306,375	cy	$50			$15,234,000			$15,234,000
Biotreatment containment wall (excluding circulation wells)	1		$1,050,000	$1,050,000	$473,000	$1,523,000			$1,523,000
Continued Monitoring							$77,500	$1,519,000	$1,519,000
Institutional Controls	1		$100,000	$100,000		$100,000			$100,000
Totals				**$1,150,000**	**$473,000**	**$40,408,438**	**$77,500**	**$1,519,000**	**$41,927,438**

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Totals				**$2,300,000**	**$946,000**	**$80,816,875**	**#######**	**$3,038,000**	**$83,854,875**
Alternative 9F:									
Excavation, stabilization, and backfill below the water table	210,250	cy	$150			$31,537,500			$31,537,500
Excavation, stabilization, and backfill above the water table	44,625	cy	$75			$3,346,875			$3,346,875
In Situ Treatment with Recirculating Wells	96,125	cy	$30			$2,873,000			$2,873,000
Continued Monitoring							$77,500	$1,519,000	$1,519,000
Institutional Controls	1		$100,000	$100,000		$100,000			$100,000
Totals				**$100,000**	**$0**	**$37,857,375**	**$77,500**	**$1,519,000**	**$39,376,375**
Alternative 9G:									
Excavation below the water table	210,250	cy	$29			$6,097,250			$6,097,250
Excavation above the water table	44,625	cy	$18			$815,000			$815,000
High-temperature thermal treatment of contaminated soil	254,875	cy	$300			$76,462,500			$76,462,500
Transportation from the site to the thermal treatment facility	254,875	cy	$200			$50,975,000			$50,975,000
Analytical costs	254,875	cy	$2			$509,750			$509,750
Backfill with clean soil/gravel	254,875	cy	$8			$1,911,563			$1,911,563
In Situ Treatment with Recirculating Wells	96,125	cy	$30			$2,873,000			$2,873,000
Continued Monitoring							$77,500	$1,519,000	$1,519,000
Institutional Controls	1		$100,000	$100,000		$100,000			$100,000
Totals				**$100,000**	**$0**	**$139,744,063**	**$77,500**	**$1,519,000**	**$141,263,063**
Alternative 10F:									
Excavation, stabilization, and backfill below the water table	210,250	cy	$150			$31,537,500			$31,537,500
Excavation, stabilization, and backfill above the water table	44,625	cy	$75			$3,346,875			$3,346,875
Biotreatment Containment Wall (excluding circulation wells)	1	cy	$290,000		$164,300	$454,300			$454,300
Contingency Circulation Wells	1	cy	$75,000			$75,000	$11,867	$233,000	$308,000
Continued Monitoring							$77,500	$1,519,000	$1,519,000
Institutional Controls	1		$100,000	$100,000		$100,000			$100,000
Totals				**$100,000**	**$164,300**	**$35,513,675**	**$89,367**	**$1,752,000**	**$37,265,675**

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Alternative 10G:									
Excavation below the water table	210,250	cy	$29			$6,097,250			$6,097,250
Excavation above the water table	44,625	cy	$18			$815,000			$815,000
High-temperature thermal treatment of contaminated soil	254,875	cy	$300			$76,462,500			$76,462,500
Transportation from the site to the thermal treatment facility	254,875	cy	$200			$50,975,000			$50,975,000
Analytical costs	254,875	cy	$2			$509,750			$509,750
Backfill with clean soil/gravel	254,875	cy	$8			$1,911,563			$1,911,563
Biotreatment Containment Wall (excluding circulation wells)	1	cy	$290,000		$164,300	$454,300			$454,300
Contingency Circulation Wells	1	cy	$75,000			$75,000	$11,867	$233,000	$308,000
Continued Monitoring							$77,500	$1,519,000	$1,519,000
Institutional Controls	1		$100,000	$100,000		$100,000			$100,000
Totals				**$100,000**	**$164,300**	**$137,400,363**	**$89,367**	**$1,752,000**	**$139,152,363**