5. Evaluation of Remediation Modules

5.1. Criteria and Evaluation Process

This chapter presents an analysis of the remediation modules developed in Chapter 4 for each of the OUs at Site 300. U.S. EPA (1988) identified nine criteria to be used in detailed analyses:

1. Overall protection of human health and the environment.
2. Compliance with ARARs.
3. Long-term effectiveness and permanence.
4. Reduction of toxicity, mobility, and volume through treatment.
5. Short-term effectiveness.
6. Implementability.
7. Cost.
8. State acceptance.
9. Community acceptance.

In this chapter, we evaluate the modules against the first seven criteria to facilitate the detailed evaluation of alternative remedies in Chapter 7. The remedial action objectives stated in Chapter 2 and regulatory requirements are considered in the evaluation. The regulatory agencies will review and comment on this document, and their technical and administrative concerns will be addressed in the Interim Record of Decision (ROD). Public comments on the remedies will be addressed in the Responsiveness Summary of the ROD.

Table 5-1 summarizes the evaluation of each of the retained general response actions and technologies against these criteria.

5.2. Analysis of Modules for Remediation of Soil and Ground Water for Building 834 Operable Unit (OU2)

Table 5-2 summarizes the evaluation of each of the remediation modules for the Building 834 OU against the first seven EPA criteria.

5.2.1. Module A: No Further Action

No Further Action is included to provide a baseline for purposes of comparison to other modules. This will generally not compare favorably with other modules where contaminants are present that create any significant risks or potential risks.

5.2.2. Module B: Monitoring

In this OU, monitoring alone does not meet ARARs, nor does it provide long- or short-term effective actions for meeting the remedial objectives. Monitoring does not reduce toxicity, mobility, or volume of the contaminants.

The DOE will conduct monitoring at Building 834 in conjunction with other remedies. An extensive monitoring network is already in place, so the only actions would be the monitoring of existing monitor wells, and pump and well replacement, as necessary. Hence, this module is readily implementable. The monitoring itself does not reduce risk to human health or the environment, however, it provides a tool for following the progress of remediation and identifying any new risks. The results of monitoring can also trigger changes in a remediation strategy or assist in the optimization of an existing strategy. Monitoring results can demonstrate the existence and rate of natural degradation processes. Therefore, this module would likely be combined with other actions described in Modules C through E.

5.2.3. Module C: Risk and Hazard Management

The DOE can manage risk and hazard in the Building 834 area by limiting access to the area. The perched water-bearing zone affected by the contaminants is not a current (or likely) drinking water source. Because of the existing security system and control over the area, this module can easily be implemented to mitigate any risk to human health and the environment. As with monitoring, risk and hazard management will be applied in addition to any other remedies undertaken.

By themselves, these risk management actions do not meet ARARs, but they can be effective in preventing health impacts until ARARs are met, short and long term. Administrative control (limiting site access) is effective only while maintained and does not provide a permanent remedy. These management actions do not reduce toxicity, mobility, or volume.

5.2.4. Module D: Ground Water and Soil Vapor Extraction and Treatment of VOCs, TBOS/TKEBS, and nitrate

Ground water and soil vapor extraction employs presumptive technologies to effectively reduce the mass and concentration of contamination in the subsurface. Removal of contaminants would reduce risk to human health and the environment in the Building 834 area. Gravity separation techniques are available to separate LNAPLs (TBOS/TKEBS) and a number of treatment technologies are available for VOCs and nitrate. Engineering considerations, based on the characteristics of the extracted fluids, would dictate the final selection of technologies and specific design of the separation and treatment systems.

Overall protection of human health and the environment is maintained by removal of contaminants, proper handling of separated products and wastes, effluent controls, and operational safety procedures. Removal of contaminants from the subsurface reduces volume to the maximum extent feasible, and can achieve cleanup goals as rapidly as feasible. Surface treatment reduces mobility and toxicity of the VOCs and nitrate by immobilizing and/or converting them to non-hazardous components. In the short term, emission controls on the surface treatment facilities can prevent any impact on the general public. Worker exposure is limited by operational safety procedures. The extraction and treatment are permanent, hence effective in the long term.

A ground water and soil vapor extraction and treatment system exists at the Building 834 area, constructed and operated as a removal action. This existing system will be utilized, and expanded and/or modified, as necessary to meet the requirements of this module.

Rough terrain and the low permeability of subsurface soil and rock limit implementability somewhat. These factors primarily affect the speed with which remedial objectives can be attained, not the ability to make progress in removing contaminants or to maintain control over contaminant migration.

5.2.5. Module E: Enhanced *In Situ* Bioremediation

The injection of electron donors can enhance biodegradation of VOCs. In the Building 834 area, it would be possible to use this technique in the downgradient portion of the VOC plume to promote the same biodegradation attributable to TBOS/TKEBS in the source area.

Enhanced bioremediation alone would reduce risk to human health and the environment and meet State ground water chemical-specific ARARs by reducing contaminant concentrations to MCLs, or any more stringent WQOs. The rate of degradation is not yet known, but may reduce subsurface contaminant mass no faster than pump and treat technology. This process could also supplement extraction technologies, yielding a faster or more complete remediation than either alone.

Non-reversible chemical reactions involved in biodegradation assure long-term effectiveness and permanence for VOCs. Toxicity and volume of VOCs would be reduced. Nitrate (as NO_3)may be reduced to gaseous forms (N_2, NO_2), which would eventually escape from the subsurface, or be chemically bound in microorganisms. There would be no short term impact on the community, but biodegradation alone would slowly diminish existing risks.

Implementability is limited by (1) the ability to find suitable enhancing materials, (2) access to drill sites in the rough terrain, and (3) permitting requirements for injection of enhancing fluids. This technology is otherwise well established.

5.3. Analysis of Modules for Remediation of Ground Water for the Landfill Pit 6 Operable Unit (OU3)

Table 5-3 summarizes the evaluation of each of the remediation modules for Landfill Pit 6 OU against the first seven EPA criteria.

5.3.1. Module A: No Further Action

No Further Action is included to provide a baseline for purposes of comparison to other modules. This will generally not compare favorably with other modules where contaminants are present that create any significant risks or potential risks.

5.3.2. Module B: Monitoring

Monitoring alone does not meet ARARs, nor does it provide long or short term effectiveness in meeting the remedial objectives, or reduce toxicity, mobility, or volume of the contaminants.

The Landfill Pit 6 Post-Closure Plan (Ferry et al., 1998), includes monitoring which will continue regardless of other remedies undertaken. An extensive monitoring network is already in place, so the only actions would be monitoring of existing monitor wells, and pump and well replacement, as necessary. This module is readily implementable. Monitoring itself does not reduce risk to human health or the environment, however, it provides a tool for demonstrating the existence and rate of natural degradation processes, tracking the progress of other remedial actions, and assuring that no new releases have occurred. The results of monitoring can also trigger changes in a remediation strategy or assist in the optimization of an existing strategy. Therefore, this module would likely be combined with other actions described in Modules C through E.

5.3.3. Module C: Risk and Hazard Management

In the Landfill Pit 6 Area, risk and hazard can be easily managed by limiting access, maintaining the integrity of the cap, and making sure the shallow water is not used. The water-bearing zone affected by the contaminants is not currently a drinking water source. Because of the existing security system and control over the area, this module can easily be implemented to mitigate all risk to human health and the environment. As with monitoring, risk and hazard management will be applied in addition to any other remedies undertaken.

By themselves, these risk management actions do not meet ARARs for ground water, but they can be effective in preventing health impacts until ARARs are met, in the short and long term. Administrative controls (limiting site access and water use) are effective only while maintained and provide no permanence. These management actions do not reduce toxicity, mobility, or volume.

5.3.4. Module D: Monitored Natural Attenuation of Tritium and VOCs in Ground Water

Tritium naturally decays with a 12.3 year half-life. The 1998 maximum tritium activity measured in ground water at Landfill Pit 6 is 1600 pCi/L (compared to its MCL of 20,000 pCi/L). Because the affected ground waters are unlikely to have any exposure pathway for one or more half-lives, natural decay may be protective of human health and the environment. Tritium in the ground water should decay to below usual detection limits within a reasonable timeframe, and be fully in compliance with cleanup standards. The radioactive decay of tritium is irreversible and hence effective in the long term and permanent.

VOCs also naturally decay through effectively irreversible chemical reactions, largely brought about by microbial action. The only VOCs reported in the last two years of observations have been TCE (maximum 1998 concentration of 15 μg/L) and cis-1,2-DCE, a known breakdown product of TCE (maximum 1998 concentration 4.4 μg/L). TCE has exhibited a downward trend in concentration over time, with an initial increase in cis-1,2-DCE. As TCE concentrations have diminished, cis-1,2-DCE concentrations are now also declining. Although there is no defined half-life, such as with radioactive decay, the trend suggests that the maximum concentrations in monitor wells will be below MCLs and possibly detection limits within several years, well before any exposure pathways are encountered. Natural attenuation may be protective of human health and the environment, and will lead to full compliance with cleanup objectives in a reasonable time frame. Because VOC breakdown is not reversible in nature, natural attenuation is effective in the long term and permanent.

Although natural attenuation is a relatively slow process, not providing rapid short-term benefit, MNA can be effective when short-term risks are already low and diminishing. Toxicity and volume are reduced by natural decay and degradation, and there will be no impacts on the community from allowing these processes to take place. This module is readily implementable and the post-closure monitoring already in place would support the MNA approach.

5.3.5. Module E: Ground Water Extraction and Treatment of VOCs and perchlorate

Ground water extraction employs presumptive technologies to effectively reduce the mass and concentration of contamination in the subsurface. Removal of contaminants would reduce risks to human health and the environment in the Landfill Pit 6 area. A number of treatment technologies are available for VOCs and perchlorate. Engineering considerations, based on the characteristics of the extracted fluids, would dictate the final selection of technologies and specific design of the treatment system.

Overall protection of human health and the environment is ensured by removal of contaminants, proper handling of separated products and wastes, effluent controls, and operational safety procedures. Removal of contaminants from the subsurface reduces toxicity and volume to the maximum extent feasible, and can achieve cleanup goals as rapidly as possible. In the short term, emission controls on surface treatment facilities can prevent any impact on the general public. Worker exposure is controlled by operational safety procedures. Extraction and treatment are permanent, hence effective in the long term.

5.4. Analysis of Modules for Remediation of Ground Water for the HE Process Area (OU4)

Table 5-4 summarizes the evaluation of each of the remediation modules for the HE Process Area OU against the first seven EPA criteria.

5.4.1. Module A: No Further Action

No Further Action is included to provide a baseline for purposes of comparison to other modules. This will generally not compare favorably with other modules where contaminants are present that create any significant risks or potential risks.

5.4.2. Module B: Monitoring

Monitoring alone does not meet ARARs, nor does it provide long or short term effective actions for meeting the remedial objectives, or reduce toxicity, mobility, or volume of the contaminants.

The DOE will conduct monitoring at the HE Process Area in conjunction with other remedies. An extensive monitoring network is already in place, so the only actions would be monitoring of existing monitor wells, and pump and well replacement, as necessary. Hence, this module is readily implementable. Monitoring itself does not reduce risk to human health or the environment, however, it provides a tool for demonstrating the existence and rate of natural degradation processes, tracking the progress of other remedial actions, and assuring that no new releases have occurred. The results of monitoring can also trigger the changing of remediation strategy or assist in the optimization of an existing strategy. Therefore, this module would likely be combined with actions described in Modules C through F.

5.4.3. Module C: Risk and Hazard Management

In the HE Process Area, risk and hazard can be easily managed by limiting access to the area. The water-bearing zone affected by the contaminants is not currently a drinking water source. A nearby private supply well (GALLO-1) is screened across the $Tnbs_2$ water-bearing zone which is affected by contaminants onsite. However, GALLO-1 is used for irrigation purposes and not for human consumption. Because of the existing security system and control over the area, this module can be implemented to mitigate all risk to human health and the environment. As with monitoring, risk and hazard management will be applied in addition to any other remedies undertaken.

By themselves, these risk management actions do not meet ARARs, but they can be effective in preventing health impacts until ARARs are met, in the short and long term. Administrative control (limiting site access) is effective only while maintained and provides no permanence. These management actions do not reduce toxicity, mobility, or volume.

5.4.4. Module D: Ground Water Extraction and Treatment of VOCs and Nitrate at the Leading Edge of the Building 815 TCE Plume

Ground water extraction employs presumptive technologies to effectively reduce the mass and concentration of contamination in the subsurface. Removal of contaminants at the leading edge of the plume reduces risk to human health by arresting the advancement of the plume beyond its current boundaries. A number of treatment technologies are available for VOCs and nitrate. Engineering considerations, based on the characteristics of the extracted fluids, would dictate the final selection of technologies and specific design of the treatment system.

Overall protection of human health and the environment is aided by control of the contaminant plume, proper handling of separated products and wastes, effluent controls, and operational safety procedures. Removal of contaminants from the subsurface reduces volume to the maximum extent feasible, and can help achieve cleanup goals in a reasonable timeframe. In the short term, emission controls on surface treatment facilities can prevent any impact on the general public. Worker exposure is controlled by operational safety procedures. Extraction and treatment are permanent; however, long-term effectiveness is dependent on either removal of the source or maintaining extraction until the current contaminants in the system have migrated to this extraction well area and are withdrawn and treated.

Rough terrain and the low permeability of subsurface soil and rock limit implementability somewhat. These factors primarily limit the speed with which remedial objectives can be attained, not the ability to maintain control over contaminant migration or to remove contaminants.

5.4.5. Module E: Ground Water Extraction and Treatment of VOCs, HE Compounds, Nitrate, and Perchlorate Released from Building 815 and HE Rinsewater Lagoons

Ground water extraction employs presumptive technologies to effectively reduce the mass and concentration of contamination in the subsurface. Ground water extraction in the core area of the plume would diminish the source term, but would not, by itself, prevent short-term migration of the distal portions of the plume. In the long-term, distal portion so the plume will diminish with no new source flux. Removal of contaminants from the source area would reduce risk to human health and the environment in the HE Process Area. Because of the communication between shallow ground water and the surface feature called Spring 5 (no surface flow), ground water extraction in this area would also reduce VOC concentrations listed, for risk assessment purposes, as surface water in Tables 1-12 and 1-17. A number of treatment technologies are available for VOCs, HE compounds, nitrate, and perchlorate. Engineering considerations, based on the characteristics of the extracted fluids, would dictate the final selection of technologies and specific design of the separation and treatment systems.

Overall protection of human health and the environment is ensured by removal of the maximum mass of contaminants, proper handling of separated products and wastes, effluent controls, and operational safety procedures. Removal of contaminants from the subsurface reduces volume to the maximum extent feasible, limits further migration, and can achieve cleanup goals as rapidly as possible. In the short term, emission controls on surface treatment facilities can prevent any impact on the general public. Worker exposure is controlled by operational safety procedures. Extraction and treatment are permanent, hence effective in the long term.

Rough terrain and the low permeability of subsurface soil and rock limit implementability somewhat. These factors primarily limit the speed with which remedial objectives can be attained, not the ability to remove contaminants or to maintain control over contaminant migration.

5.4.6. Module F: Ground Water Extraction and Treatment of VOCs, Nitrate, and Perchlorate Released from the HE Burn Pit

Ground water extraction employs presumptive technologies to effectively reduce the mass and concentration of contamination in the subsurface. Removal of contaminants from this additional, isolated, source area would further reduce risk to human health and the environment. A number of treatment technologies are available for VOCs, nitrate, and perchlorate. Engineering considerations, based on the characteristics of the extracted fluids, would dictate the final selection of technologies and specific design of the separation and treatment systems.

Overall protection of human health and the environment is ensured by removal of the maximum mass of contaminants, proper handling of separated products and wastes, effluent controls, and operational safety procedures. Removal of contaminants from the subsurface reduces volume to the maximum extent feasible, limits further migration, and can achieve cleanup goals as rapidly as possible. In the short term, emission controls on surface treatment facilities can prevent any impact on the general public. Worker exposure is controlled by operational safety procedures. Extraction and treatment are permanent, hence effective in the long term.

Rough terrain and the low permeability of subsurface soil and rock limit implementability somewhat. These factors primarily limit the speed with which remedial objectives can be attained, not the ability to remove contaminants or to maintain control over contaminant migration.

5.5. Analysis of Modules for Remediation of Soil and Ground Water for the Building 850/Landfill Pits 3 and 5 Operable Unit (OU5)

Tables 5-5a through 5-5c summarize the evaluations of each of the remediation modules for the Building 850/Pits 3 and 5 OU against the first seven EPA criteria. The tables divide the OU into 3 distinct and separable geographic areas; the Landfill Pit 7 Complex (which includes Pits 3, 4, 5, and 7), the Building 850 Firing Table area, and Landfill Pit 2. Some modules apply to only one or two specific sub regions within this OU and are labeled below.

5.5.1. Module A: No Further Action

No Further Action is included to provide a baseline for purposes of comparison to other modules. This will generally not compare favorably with other modules where contaminants are present that create any significant risks or potential risks.

5.5.2. Module B: Monitoring

Monitoring alone does not meet ARARs, nor does it provide long or short term effective actions for meeting the remedial objectives. Monitoring does not reduce toxicity, mobility, or volume of the contaminants.

The DOE will conduct monitoring in this area in conjunction with other remedies. An extensive monitoring network is already in place (including the post-closure monitoring for the RCRA-closed Landfill Pits 1 and 7). The only actions would be monitoring of existing monitor wells, and pump and well replacement, as necessary. Hence, this module is readily implementable. The monitoring itself does not reduce risk to human health or the environment, however, it provides a tool for following the progress of natural decay/degradation and remediation, and for assessing changes in risk. The results of monitoring can also trigger changes in remediation strategy or assist in optimizing an existing strategy. Therefore, this module would likely be combined with other activities described in Modules C through H.

5.5.3. Landfill Pit 7 Complex and Building 850 Firing Table Module C: Risk and Hazard Management

In the Building 850 and Pits 3 and 5 areas, risk and hazard can be managed by limiting access to prevent contact with contaminated surface soils. The water-bearing zone affected by the contaminants is not currently a drinking water source. Because of the existing security system and control over the area, this module can easily be implemented to mitigate risk to human health and the environment. As with monitoring, risk and hazard management will be applied in addition to any other remedies undertaken.

By themselves, these risk management actions do not meet ARARs, but they can be effective in preventing health impacts until ARARs are met, in the short and long term. Administrative control (limiting site access) is effective only while maintained and provides no permanence. These management actions do not reduce toxicity, mobility, or volume.

5.5.4. Landfill Pit 7 Complex and Building 850 Firing Table Module D: Monitored Natural Attenuation of Tritium in Ground Water and Surface Water

Tritium naturally decays with a 12.3 year half-life. The maximum ground water tritium activity ever measured at in this OU is 2.7 million pCi/L; and the recent sampling has found activities up to this maximum. Because the affected ground waters are unlikely to have any exposure pathway for many half-lives, natural decay may be protective of human health and the environment. Tritium in the ground water should decay to below usual detection limits before off-site migration occurs (Taffet et al., 1996), and meet cleanup standards. The radioactive decay of tritium is irreversible and hence effective in the long term and permanent.

Natural attenuation (decay of tritium) is a relatively slow process, not providing a short-term benefit, and should be coupled with other actions that prevent actual exposures with significant risk. Tritium volume is reduced by natural decay, and there will be no impacts on the community from allowing this process to take place. Modules that bring tritiated ground water to the surface increase the risk of exposure. This module is readily implementable and compatible with the post-closure monitoring already in place at the Landfill Pit 7 Complex.

5.5.5. Landfill Pit 7 Complex Module E: Ground Water Extraction and Treatment of VOCs

Ground water extraction employs presumptive technologies to effectively reduce the mass and concentration of contamination in the subsurface. However, efficiency is impaired at the low concentrations of VOCs now present. Removal of VOCs would reduce risks from VOCs to human health and the environment. Special concerns regarding tritium as a co-contaminant must be addressed. A number of treatment technologies are available for VOCs. Engineering considerations, based on the characteristics of the extracted fluids, would dictate the final selection of technologies and specific design of the treatment system. In particular, there is a concern that extracted water may contain high tritium activities.

Overall protection of human health and the environment is maintained by removal of contaminants; proper handling of co-contaminants, separated products, and wastes; effluent controls; and operational safety procedures. Removal of VOCs from the subsurface reduces volume and can achieve cleanup goals for VOCs as rapidly as possible, but may present new issues with tritium extraction. In the short term, emission controls on surface treatment facilities can prevent any significant impact on the general public. Worker exposure is controlled by operational safety procedures; however, some risk exists in bringing tritiated water to the surface. The extraction and treatment are permanent, hence effective in the long term.

5.5.6. Building 850 Firing Table Module E, Landfill Pit 7 Complex Module F: Ground Water Extraction and Treatment of Uranium and Nitrate

Ground water extraction is a demonstrated technology to effectively reduce the mass and concentration of contamination in the subsurface. Removal of contaminants would reduce risks from uranium or nitrate to human health and the environment. Separation techniques are available to separate uranium from other components of the effluent and a number of licensed repositories are available for disposal of any resulting low-level radioactive waste. A number of technologies are available for nitrate removal. Engineering considerations, based on the characteristics of the extracted fluids, would dictate the final selection of the separation technologies and specific design of the water treatment system. Again, the extracted water may contain high tritium activities.

Overall protection of human health and the environment is maintained by removal of contaminants, proper handling of separated products, and wastes; effluent controls; and operational safety procedures. Removal of contaminants from the subsurface reduces volume to the maximum extent feasible, and can achieve cleanup goals as rapidly as possible. In the short term, emission controls on surface treatment facilities can prevent any impact on the general public. Worker exposure is controlled by operational safety procedures. The extraction and treatment are permanent, hence effective in the long term.

5.5.7. Building 850 Firing Table Module F, Landfill Pit 7 Complex Module G: Control of Migration of Uranium-238 in Ground Water by using *In Situ* Reactive Permeable Barriers

Permeable reactive barriers of iron filings can potentially immobilize uranium. These actions would reduce the risk to human health and the environment by controlling the migration of the uranium, as an alternative to ground water extraction. An effective barrier will protect ground waters beyond the barrier, but will accumulate uranium within the barrier. Long-term effectiveness comes about through the formation of less mobile species. Because the permanence of uranium immobilization is not yet proven, uranium-laden iron filings would be replaced in years 10 and 20 and disposed of in an acceptable landfill.

Reactive barriers do not reduce the toxicity and volume of uranium, which decays naturally at an extremely slow rate. In the short term, in situ barriers create no impact on the community or exposure to workers. The time to meet remedial goals is limited by natural flow velocities and re-solution of new chemical species. Implementability may be difficult because of major engineering requirements on difficult terrain.

5.5.8. Building 850 Firing Table Module G: Excavation of Contaminated Soil and Bedrock Underlying the Building 850 Firing Table, Removal of the Contaminated Sandpile, and Removal of Contaminated Soil Adjacent to Firing Table

Where surface soils contain unacceptable contamination, excavation presents a possible means of providing long-term protection of human health and the environment. Remedial objectives can be met by removing soil and rock containing COCs and properly disposing of them. Licensed facilities exist for disposal of hazardous, low-level, or mixed wastes potentially generated.

Excavation and disposal provide long-term effective elimination of a potential source of risk, by reducing the volume of contaminants present. In the short term, worker exposure is controlled by operational safety procedures. The removal and off-site disposal/treatment are permanent, hence effective in the long term. Implementability is limited primarily by cost, related to the volume of materials requiring disposal.

5.5.9. Landfill Pit 7 Complex Module H: Waste Characterization with Contingent Monitoring or Excavation of Landfill Pits 3 and 5

Where landfills contain wastes that are unacceptable because of landfill design or other constraints, excavation presents a potential means of providing long-term protection of human health and the environment. Monitoring may be adequate and cost effective, especially for contaminants that will either degrade or are naturally immobile. Cleanup goals may be achievable by either monitoring, or removing contaminated waste and properly disposing of it. Licensed facilities exist for disposal of hazardous, low-level, or mixed wastes generated. If large volumes of waste are excavated, placement of the waste in an on-site engineered containment unit may be more cost-effective than for off-site disposal. Siting, design, and approval issues, discussed in Section C-2.7 of Appendix C, could significantly impact the time, resources, and costs necessary to implement on-site containment.

Detailed source characterization and monitoring would be effective in the short term in providing information for preventing human health risks. Either monitoring or excavation/disposal may be more effective in the long term, depending upon the quantity and nature of contaminants in the landfills. Excavation can provide long-term elimination of a potential source of risk, by reducing the volume of contaminant present. In the short term, worker exposure can be controlled by operational safety procedures; however, excavation and transport entail other risks. Removal and off-site disposal/treatment are permanent, hence effective in the long term. Implementability may be limited by cost, related to the volume of materials requiring disposal. If large volumes of waste are excavated, placement of the waste in an on-site engineered containment unit may be more cost-effective than for off-site disposal. Siting, design, and approval issues, discussed in Section C-2.7 of Appendix C, could significantly impact the time, resources, and costs necessary to implement on-site containment.

5.5.10. Landfill Pit 2 Module C: Waste Characterization with Contingent Monitoring, Capping, or Excavation of Landfill Pit 2

Where landfills contain wastes that are unacceptable because of landfill design or other constraints, excavation presents a potential means of providing long-term protection of human health and the environment. The decision to excavate, however, should depend on a clear understanding of the landfill contents and risks they present. Capping or monitoring may be adequate and cost effective, especially for contaminants that will either degrade or naturally become immobile under stagnant conditions. Cleanup goals may be achievable by either monitoring, capping, or removing any contaminated waste and properly disposing of it. Licensed facilities exist for disposal of hazardous, low-level, or mixed wastes potentially generated. If large volumes of waste are excavated, placement of the waste in an on-site engineered containment unit may be more cost-effective than for off-site disposal. Siting, design, and approval issues, discussed in Section C-2.7 of Appendix C, could significantly impact the time, resources, and costs necessary to implement on-site containment.

Detailed source characterization and monitoring would be effective in the short term in providing information for preventing human health risks. Either monitoring, capping, or excavation/disposal may be effective in the long term, depending upon the quantity and nature of contaminants in the landfill. Capping Landfill Pit 2 can reduce the migration potential for any contaminants contained in the landfill. Excavation can provide long-term elimination of risk by reducing the volume of contaminants present. In the short term, worker exposure can be controlled by operational safety procedures; however, excavation and transport entail other risks. Removal and off-site disposal/treatment are permanent, hence effective in the long term. Implementability may be limited by cost, related to the volume of materials requiring disposal.

5.6. Analysis of Modules for Remediation of Soil and Ground Water for the Building 854 Operable Unit (OU6)

Table 5-6 summarizes the evaluation of each of the remediation modules for the Building 854 OU against the first seven EPA criteria.

5.6.1. Module A: No Further Action

No Further Action is included to provide a baseline for purposes of comparison to other modules. This will generally not compare favorably with other modules where contaminants are present that create any significant risks or potential risks.

5.6.2. Module B: Monitoring

In this OU, monitoring alone does not meet ARARs, nor does it provide long or short term effective actions for meeting the remedial objectives. Monitoring does not reduce toxicity, mobility, or volume of the contaminants.

The DOE will conduct monitoring at the Building 854 area in conjunction with other remedies. A monitoring network is already in place and is currently being expanded, so the only actions would be monitoring of existing monitor wells, and pump and well replacement, as necessary. Hence, this module is readily implementable. The monitoring itself does not reduce risk to human health or the environment, however, it provides a tool for following the progress of remediation and identifying any new risks. The results of monitoring can trigger changes in remediation strategy or assist in optimizing an existing strategy. Monitoring results also help demonstrate the existence and rate of natural degradation processes. Therefore, this module would likely be combined with other activities described in Modules C and D.

5.6.3. Module C: Risk and Hazard Management

Risk and hazard can be managed in this area by limiting access to the area. The water-bearing zone affected by the contaminants is not currently a drinking water source. Because of the existing security system and control over the area, this module could easily be implemented to mitigate all significant risk to human health and the environment. As with monitoring, risk and hazard management will be applied in addition to any other remedies undertaken.

By themselves, these risk management actions will not meet ARARs, but they can be effective in preventing health impacts until ARARs are met, in the short and long term. Administrative control (limiting site access) is effective only while maintained and provides no permanence. These management actions do not reduce toxicity, mobility, or volume.

5.6.4. Module D: Ground Water and Soil Vapor Extraction and Treatment of VOCs and Nitrate

Ground water and soil vapor extraction employs presumptive technologies to effectively reduce the mass and concentration of contamination in the subsurface. Removal of contaminants would reduce risk to human health and the environment in the Building 854 area. A number of treatment technologies are available for VOCs and nitrate. Engineering considerations, based on the characteristics of the extracted fluids, would dictate the final selection of technologies and specific design of the treatment system.

Overall protection of human health and the environment can be maintained by removal of contaminants, proper handling of wastes, effluent controls, and operational safety procedures. Removal of contaminants from the subsurface reduces volume to the maximum extent feasible, and can achieve cleanup goals as rapidly as possible. In the short term, emission controls on surface treatment facilities can prevent any impact on the general public. Worker exposure is controlled by operational safety procedures. The extraction and treatment are permanent, hence effective in the long term.

Rough terrain and the low permeability of subsurface soil and rock limit implementability somewhat. These factors primarily limit the speed with which remedial objectives can be attained, not the ability to make progress in removing contaminants or to maintain control over contaminant migration.

5.7. Analysis of Modules for Remediation of Soil and Ground Water for the Building 832 Canyon Operable Unit (OU7)

Table 5-7 summarizes the evaluation of each of the remediation modules for the Building 832 Canyon OU against the first seven EPA criteria.

5.7.1. Module A: No Further Action

No Further Action is included to provide a baseline for purposes of comparison to other modules. This will generally not compare favorably with other modules where contaminants are present that create any significant risks or potential risks.

5.7.2. Module B: Monitoring

In this OU, monitoring alone does not meet ARARs, nor does it provide long or short term effective actions for meeting the remedial objectives. Monitoring does not reduce toxicity, mobility, or volume of the contaminants.

The DOE will conduct monitoring in this area in conjunction with other remedies. An extensive monitoring network is already in place, so the only actions would be monitoring of existing monitor wells, and pump and well replacement, as necessary. Hence, this module is readily implementable. The monitoring itself does not affect risk to human health or the environment, however, it provides a tool for following the progress of remediation and identifying any new risks. The results of monitoring can trigger changes in remediation strategy or assist in optimizing an existing strategy. Monitoring results also help demonstrate the existence and rate of natural degradation processes. Therefore, this module would likely be combined with other activities described in Modules C through F.

5.7.3. Module C: Risk and Hazard Management

In the Building 832 Canyon area, risk and hazard can be managed by limiting access and controlling use of contaminated ground water. The subsurface water-bearing zone affected by the contaminants is not currently a drinking water source. The Spring 3 zone in the lower Building 832 Canyon area may be a seasonal source of surface water for animals. Because of the existing security system and control over the area, this module can easily be implemented to mitigate all significant risk to human health and the environment. As with monitoring, risk and hazard management will be applied in addition to any other remedies undertaken.

By themselves, these risk management actions will not meet ARARs, but they can be effective in preventing health impacts until ARARs are met, in the short and long term. Administrative controls (limiting site access and ground water use) are effective only while maintained and provide no permanence. These management actions do not reduce toxicity, mobility, or volume.

5.7.4. Module D: Ground Water and Soil Vapor Extraction and Treatment of VOCs, Perchlorate and Nitrate at Building 832

Ground water and soil vapor extraction employ presumptive technologies to effectively reduce the mass and concentration of contamination in the subsurface. Removal of contaminants would reduce risk to human health and the environment. A number of treatment technologies are available for VOCs, nitrate, and perchlorate. Engineering considerations, based on the characteristics of the extracted fluids, will dictate the final selection of technologies and specific design of the separation and treatment systems.

Overall protection of human health and the environment can be maintained by removal of contaminants, proper handling of separated products and wastes, effluent controls, and operational safety procedures. Removal of contaminants from the subsurface reduces volume to the maximum extent feasible, and can achieve cleanup goals as rapidly as possible. In the short term, emission controls on surface treatment facilities can prevent any impact on the general public. Worker exposure is controlled by operational safety procedures. The extraction and treatment are permanent, hence effective in the long term.

Rough terrain and low permeability of subsurface soil and rock limit implementability somewhat. These factors primarily limit the speed with which remedial objectives can be attained, not the ability to make progress in removing contaminants or to maintain control over contaminant migration.

5.7.5. Module E: Ground Water and Soil Vapor Extraction and Treatment of VOCs, Perchlorate, and Nitrate at Building 830

As in the Building 832 area, ground water and soil vapor extraction using presumptive technologies provides an effective way to reduce contamination in the subsurface. Removal of contaminants would reduce risk to human health and the environment. A number of treatment technologies are available for VOCs, perchlorate, and nitrate. Engineering considerations, based on the characteristics of the extracted fluids, would dictate the final selection of technologies and specific design of the separation and treatment systems.

Overall protection of human health and the environment can be maintained by removal of contaminants; proper handling of separated products and wastes, effluent controls, and operational safety procedures. Removal of contaminants from the subsurface reduces volume to the maximum extent feasible, and can achieve cleanup goals as rapidly as possible. In the short term, emission controls on surface treatment facilities can prevent any impact on the general public. Worker exposure is controlled by operational safety procedures. The extraction and treatment are permanent, hence effective in the long term.

Rough terrain and low permeability of subsurface soil and rock limit implementability somewhat. These factors primarily limit the speed with which remedial objectives can be attained, not the ability to make progress in removing contaminants or to maintain control over contaminant migration.

5.7.6. Module F: Downgradient Ground Water Extraction Using a Siphon, with *Ex Situ* Treatment of VOCs by Iron Filings

In the Building 832 Canyon, siphons may be a viable technology to extract ground water because of topography and resulting hydraulic head differences, potentially saving energy and cost during the extraction process. Iron filing can catalyze the breakdown of VOCs and either chemically change or immobilize nitrate. These actions can achieve cleanup goals for ground water beyond the extraction wells and reduce the potential for off-site contaminant migration. Long-term effectiveness comes about through essentially non-reversible chemical reactions. The effects on nitrate are not yet fully established, but technologies exist to assure that nitrate is adequately removed from the treatment system effluent.

Ground water extraction and treatment reduce the volume of VOCs and nitrate. In the short term, this system would create no impact on the community or exposure to workers. The time to meet remedial goals is limited by natural flow velocities. Implementability is limited somewhat by the difficult terrain and low permeability of subsurface soil and rock. These factors primarily limit the speed with which remedial objectives can be attained, not the ability to make progress in removing contaminants or to maintain control over contaminant migration.

5.8. Analysis of Modules for Remediation of Soil and Ground Water at Building 801 and Landfill Pit 8 (within OU8)

Table 5-8 summarizes the evaluation of each of the remediation modules for the Building 801 Dry Well and Landfill Pit 8 area against the first seven EPA criteria.

5.8.1. Module A: No Further Action

No Further Action is included to provide a baseline for purposes of comparison to other modules. This will generally not compare favorably with other modules where contaminants are present that create any significant risks or potential risks.

5.8.2. Module B: Monitoring

Monitoring alone may not meet ARARs, or provide long- or short-term effective actions for meeting the remedial objectives. Monitoring does not reduce toxicity, mobility, or volume of the contaminants.

The DOE will conduct monitoring in this area alone or in conjunction with other remedies. A monitoring network is already in place, so the only actions would be monitoring existing monitor wells, and pump and well replacement, as necessary. Hence, this module is readily implementable. The monitoring itself does not reduce risk to human health or the environment; however, it provides a tool for following the progress of natural degradation and/or remediation, and for assessing changes in risk. The results of monitoring can also trigger changes in remediation strategy or assist in optimizing an existing strategy. Therefore, this module could be combined with other activities described in Module C.

5.8.3. Module C: Waste Characterization with Contingent Monitoring, Capping, or Excavation of Landfill Pit 8

Where landfills contain wastes that are unacceptable because of landfill design or other constraints, excavation presents a means of providing long-term protection of human health and the environment. Capping or monitoring may be adequate and cost effective, especially for contaminants that either decay/degrade or are naturally immobile. Environmental quality goals may be achievable by either monitoring, capping, or removing any contaminated wastes and properly disposing of them. Licensed facilities exist for disposal of any hazardous, low-level, or mixed wastes potentially generated. If large volumes of waste are excavated, placement of the waste in an on-site engineered containment unit may be more cost-effective than for off-site disposal. Siting, design, and approval issues, discussed in Section C-2.7 of Appendix C, could significantly impact the time, resources, and costs necessary to implement on-site containment.

Detailed source characterization and monitoring would be effective in the short term in providing information for preventing human health risks. Either monitoring, capping, or excavation/disposal may be effective in the long-term, depending upon the quantity and nature of contaminants in the landfill. Capping Landfill Pit 8 can reduce the migration potential for any contaminants contained in the landfill. Excavation can provide long-term elimination of a potential source of risk, by reducing the volume of contaminants present. In the short term, worker exposure can be controlled by operational safety procedures; however, excavation and transport entail other risks. Removal and off-site disposal/treatment are permanent, hence effective in the long term. Implementability may be limited by cost, related to the volume of materials requiring disposal.

5.9. Analysis of Modules for Remediation of Soil and Ground Water for the Building 833 Area (within OU8)

Table 5-9 summarizes the evaluation of each of the remediation modules for the Building 833 Area against the first seven EPA criteria.

5.9.1. Module A: No Further Action

No Further Action is included to provide a baseline for purposes of comparison to other modules. This will generally not compare favorably with other modules where contaminants are present that create any significant risks or potential risks.

5.9.2. Module B: Monitoring

A monitoring only remedy was accepted by the regulatory agencies at a December 1993 meeting of Remedial Project Managers. Monitoring by itself does not reduce toxicity, mobility, or volume of the contaminants.

The DOE will conduct monitoring at this area in conjunction with any other remedies. An extensive monitoring network is already in place, so the only actions will be monitoring existing monitor wells, and pump and well replacement, as necessary. Hence, this module is readily implementable. The monitoring itself does not affect risk to human health or the environment, however, it provides a tool for following the progress of natural degradation and remediation, and for assessing changes in risk. The results of monitoring could also trigger a change in the remediation strategy.

5.9.3. Module C: Risk and Hazard Management

Risk and hazard in this area can be easily managed by controlling access to the area. The water-bearing zone affected by the contaminants is not currently a drinking water source. Because of the existing security system and control over the area, this module can easily be implemented to mitigate all significant risk to human health and the environment. Risk and hazard management will be applied in addition to any other remedies undertaken.

By themselves, these risk management actions do not meet ARARs, but they can be effective in prevention of health impacts until ARARs are met, short and long term. Administrative control (limiting site access) is effective only while maintained and provides no permanence. These management actions do not reduce toxicity, mobility, or volume.

5.9.4. Module D: Ground Water and Soil Vapor Extraction and Treatment of VOCs

Ground water and soil vapor extraction employs presumptive technologies to effectively reduce the mass and concentration of contamination in the subsurface. Removal of contaminants would reduce risk to human health and the environment in the Building 833 area. A number of treatment technologies are available for VOCs. Engineering considerations, based on the characteristics of the extracted fluids, would dictate the final selection of technologies and specific design of the treatment system.

Overall protection of human health and the environment can be maintained by removal of contaminants, proper handling of wastes, effluent controls, and operational safety procedures. Removal of contaminants from the subsurface reduces volume to the maximum extent feasible, and can achieve cleanup goals as rapidly as possible. In the short term, emission controls on surface treatment facilities can prevent any impact on the general public. Worker exposure is controlled by operational safety procedures. The extraction and treatment are permanent, hence effective in the long term.

Rough terrain and the low permeability of subsurface soil and rock limit implementability somewhat. These factors primarily limit the speed with which remedial objectives can be attained, not the ability to make progress in removing contaminants or to maintain control over contaminant migration.

5.10. Analysis of Modules for Remediation of Soil at the Building 845 Firing Table and Landfill Pit 9 (within OU8)

Table 5-10 summarizes the evaluation of each of the remediation modules for Building 845 Firing Table and Landfill Pit 9 against the first seven EPA criteria.

5.10.1. Module A: No Further Action

No Further Action is included to provide a baseline for purposes of comparison to other modules. This will generally not compare favorably with other modules where contaminants are present that create any significant risks or potential risks.

5.10.2. Module B: Monitoring

Monitoring alone may not meet ARARs, or provide long- or short-term effective actions for meeting the remedial objectives. Monitoring does not reduce toxicity, mobility, or volume of the contaminants.

The DOE will conduct monitoring in this area alone or in conjunction with other remedies. A monitoring network is already in place, so the only actions would be monitoring existing monitor wells, and pump and well replacement, as necessary. Hence, this module is readily implementable. The monitoring itself does not reduce risk to human health or the environment; however, it provides a tool for following the progress of natural degradation and remediation, and for assessing changes in risk. The results of monitoring can also trigger changes in remediation strategy or assist in optimizing an existing strategy. Therefore, this module could be combined with other activities described in Module C.

5.10.3. Module C: Waste Characterization with Contingent Monitoring, Capping, or Excavation of Landfill Pit 9

Where landfills contain wastes that are unacceptable because of landfill design or other constraints, excavation presents a potential means of providing long-term protection of human health and the environment. Capping or monitoring may be adequate and cost effective, especially for contaminants that will either decay/degrade or naturally become immobile under stagnant conditions. Environmental quality goals may be achievable by either monitoring, capping, or removing any contaminated waste and properly disposing of it. Licensed facilities exist for disposal of any hazardous, low-level, or mixed wastes potentially generated. If large volumes of waste are excavated, placement of the waste in an on-site engineered containment unit may be more cost-effective than for off-site disposal. Siting, design, and approval issues, discussed in Section C-2.7 of Appendix C, could significantly impact the time, resources, and costs necessary to implement on-site containment.

Detailed source characterization and monitoring would be effective in the short term in providing information for preventing human health risks. Either monitoring, capping, or excavation/disposal may be effective in the long term, depending upon the quantity and nature of contaminants in the landfill. Capping Landfill Pit 9 could reduce the migration potential for any contaminants contained in the landfill. Excavation can provide long-term elimination of a potential source of risk, by reducing the volume of contaminants present. In the short term, worker exposure can be controlled by operational safety procedures. Removal and off-site disposal/treatment are permanent, hence effective in the long term. Implementability may be limited by cost, related to the volume of materials requiring disposal.

5.11. Analysis of Modules for Remediation of Soil and Ground Water for the Building 851 Firing Table (within OU8)

Table 5-11 summarizes the evaluation of each of the remediation modules for the Building 851 Firing Table against the first seven EPA criteria.

5.11.1. Module A: No Further Action

No Further Action is included to provide a baseline for purposes of comparison to other modules. This will generally not compare favorably with other modules where contaminants are present that create any significant risks or potential risks.

5.11.2. Module B: Monitoring

Monitoring alone may not meet ARARs, or provide long or short term actions for meeting the remedial objectives. Monitoring does not reduce toxicity, mobility, or volume of the contaminants.

The DOE will conduct monitoring in this area alone or in conjunction with other remedies. A monitoring network is already in place, so the only actions would be monitoring existing monitor wells, and pump and well replacement, as necessary. Hence, this module is readily implementable. The monitoring itself does not reduce risk to human health or the environment, however, it provides a tool for assessing any new results that may change the current estimation of risk. The results of monitoring can also trigger changes in the remediation strategy or assist in optimizing an existing strategy. Therefore, this module could be combined with other activities described in Module C.

5.11.3. Module C: Ground Water Extraction and Treatment of Uranium

Ground water extraction is a demonstrated technology to effectively reduce the mass and concentration of contamination in the subsurface. Removal of uranium might reduce risk to human health and the environment. Separation techniques are available to separate uranium from other components of the effluent and a number of licensed repositories are available for disposal of any resulting low-level radioactive waste. Engineering considerations, based on the characteristics of the extracted fluids, would dictate the selection of the separation technology.

Overall protection of human health and the environment is maintained by removal of contaminants, proper handling of separated products and wastes, and operational safety procedures. Removal of uranium from the subsurface reduces volume to the maximum extent feasible, and can achieve cleanup goals as rapidly as possible. In the short term, emission controls on surface facilities can prevent any impact on the general public. Worker exposure is controlled by operational safety procedures. The extraction and offsite disposal are permanent, hence effective in the long term.

Rough terrain and low permeability of subsurface soil and rock limit implementability somewhat. These factors primarily limit the speed with which remedial objectives can be attained, not the ability to make progress in removing contaminants or to maintain control over contaminant migration. The low concentration of uranium limits the effectiveness of remediation.

5.12. Summary of Analyses of Remediation Modules

In this Chapter, we have evaluated each of the remediation modules developed in Chapter 4 against the first seven EPA criteria (Tables 5-2 through 5-11). Table 5-1 summarizes the results of those comparisons for ground water, the vadose zone, and surface soil. The preceding sections provide additional comments regarding those comparisons for each Operable Unit or, in the case of OU8, release site. Chapter 6 assembles these modules into alternative remedies and Chapter 7 evaluates the alternatives. The Proposed Plan will present preferred remedies. Much of the engineering design, including specific treatment technologies, will be provided in Remedial Design documents, based on specific applicability, implementability, cost-effectiveness, site-specific requirements, and best professional judgment.

If during future additional characterization, new or more significant contamination is discovered, the DOE will propose cleanup approaches similar to those described here. Conversely, if contaminants identified herein have naturally attenuated or are no longer considered to be a threat to human health or the environment, the Proposed Plan may recommend No Further Action, or Monitoring with appropriate Risk Management only.

Table 5-1. Comparative evaluation of General Response Actions and technologies.

General response action	Technologies	Overall protection of human health and the environment	Compliance with ARARs	Long-term effectiveness and permanence	Reduction in toxicity, mobility, and volume (TMV)	Short-term effectiveness	Implementability	Cost
<u>No further action</u>	None	Not protective where significant risks or hazards exist.	Non-compliant.	Not effective where significant risks or hazards exist.	Does not reduce TMV.	Not effective where significant risks or hazards exist.	Not applicable.	None
<u>Risk and hazard management</u>	Administrative controls. Control access and land/water use. Building ventilation controls. Operational safety procedures. Ecological hazard control.	Protective of human health by ensuring exposure does not exceed health-based standards.	Risk management, where appropriate, is compliant with ARARs.	Can be effective as long as risk management applied, or until risks no longer exceed standards.	Does not reduce TMV.	Short-term risks are mitigated by the site safety plan and SOPs.	Easily implemented.	Low
<u>Monitored Natural Attenuation</u>	Natural processes. Water sampling and analysis. Air sampling and analysis. Soil sampling and analysis. Soil vapor sampling and analysis. Modeling. Contingency Plans.	Monitoring ensures human health and environment protected. If not protective, other actions will be undertaken. In the right situations natural processes can reduce concentrations to cleanup standards.	Natural attenuation, where accepted to reach cleanup standards in a reasonable timeframe, is compliant with ARARs.	Dependent on time required for concentrations to go below cleanup standards.	Where applicable, permanently reduces contaminant volume by decay or degradation, toxicity by changes of chemical properties, and possibly mobility by precipitation or chemical changes.	Short-term risks must be mitigated by the site safety plan, SOPs, and/or risk management.	Easily implemented.	Low
<u>Extraction with *ex situ* treatment</u>								
Ground water extraction	Pumping ground water wells. Use of siphons. Electro-osmosis.	Protective of human health and the environment by reducing contaminant concentrations to cleanup standards.	Ground water extraction to reach cleanup goals is compliant with ARARs.	Mitigates future risks by preventing migration of contaminants in ground water, and by restoring beneficial uses of ground water. Permanent.	Reduces volume of contaminants in ground water by removal and may reduce mobility by hydraulic control.	Short-term risks are mitigated by the site safety plan and SOPs.	Implementable.	Moderate
Ex situ ground water treatment	Gravity separation of LNAPL. Aqueous-phase GAC. Air stripping/air sparging. Vapor phase GAC. Ion exchange. Coupled chemical/biological treatment. Bioremediation. Iron filing reaction chambers. Constructed wetlands. Treated ground water disposal. Spent treatment waste disposal.	Protective when treatment and discharge are performed in accordance with applicable procedures and regulations.	Compliant when treatment and discharge are performed in accordance with ARARs.	Permanent.	Treatment technologies may reduce volume or toxicity by chemical destruction, or mobility and volume by trapping and concentrating, allowing offsite disposal, destruction, or recycling.	Short-term risks are mitigated by the site safety plan and SOPs.	Implementable.	Moderate
Soil vapor extraction	Active soil vapor pumping. Passive (e.g., barometric) extraction. Simultaneous ground water GWE/SVE (ground water extraction/soil vapor extraction).	Protective of human health and the environment by reducing contaminant concentrations to cleanup standards.	Vapor extraction to reach cleanup goals is compliant with ARARs.	Mitigates future risks by preventing migration of contaminants to ground water, and by reducing potential vapor exposures. Permanent.	Reduces volume of contaminants in soil vapor by removal.	Short-term risks are mitigated by the site safety plan and SOPs.	Implementable.	Moderate

Table 5-1. Comparative evaluation of General Response Actions and technologies. (Cont. Page 2 of 2)

General response action	Technologies	Overall protection of human health and the environment	Compliance with ARARs	Long-term effectiveness and permanence	Reduction in toxicity, mobility, and volume (TMV)	Short-term effectiveness	Implementability	Cost
Extraction with *ex situ* treatment (cont.)								
Ex situ treatment of extracted soil vapor	Vapor-phase GAC. Regeneration of GAC and/or disposal of any wastes. Discharge of treated (clean) vapors.	Protective when treatment and discharge are performed in accordance with applicable procedures and regulations.	Compliant when treatment and discharge are performed in accordance with ARARs.	Permanent.	Treatment technologies may reduce volume or toxicity by chemical destruction, or mobility and volume by trapping and concentrating, allowing offsite disposal, destruction, or recycling.	Short-term risks are mitigated by the site safety plan and SOPs.	Implementable.	Moderate
In situ treatment	Enhanced *in situ* bioremediation. Subsurface permeable reactive barrier. *In situ* redox adjustment.	Protective.	Compliant.	Permanent where chemical breakdown occurs (e.g., VOCs).	Can reduce volume, toxicity, and/or mobility by chemical changes.	Short-term risks are mitigated by the site safety plan and SOPs.	Contaminant and site dependent.	Moderate-High
Containment	Surface covers. Capping.	Protective.	Compliant.	Effective long-term if maintained.	Reduces mobility by preventing further contaminant releases or preventing further migration. Does not reduce toxicity or volume.	Short-term risks are mitigated by the site safety plan and SOPs.	Implementable.	High
Removal and disposal	Excavation. Surface soil removal. Soil washing or disposal of wastes.	Protective.	Compliant.	Permanent with regard to removed waste.	Permanent reduction in volume on site. May shift problem elsewhere.	Short-term risks are mitigated by the site safety plan and SOPs.	Implementable where localized sources can be identified.	High

Table 5-2. Comparative evaluation of modules for the Building 834 Operable Unit (OU 2).

Module	Overall protection of human health and the environment	Compliance with ARARs	Long-term effectiveness and permanence	Reduction in toxicity, mobility, and volume (TMV)	Short-term effectiveness	Implementability	Net Present Worth Cost, $K
Module A: No Further Action	Potentially not.	No	No	No	No	NA	None
Module B: Monitoring	NA—Used in conjunction with active remedies.	Used in conjunction with active remedies.	Used in conjunction with active remedies.	No	No	Implementable—monitoring network already in place.	2,257
Module C: Risk and Hazard Management	Yes—Will also be used in conjunction with active remedies.	In conjunction with active remedies.	Effective in conjunction with other remedies. Must be actively maintained.	Not by itself.	Effective in preventing exposures.	Implementable—site control exists and accidental exposure prevented.	231
Module D: Ground water and soil vapor extraction and treatment of VOCs, TBOS/TKEBS, and nitrate	Risk to human health and the environment from the COCs substantially reduced. Negligible risk to employees and public from system operation. No toxic air emissions.	Treated effluent concentrations will meet ARARs, and ARARs for ground water potentially achievable.	Extraction and treatment systems operated until soil and ground water meet ARARs. Proper disposal of wastes and/or chemical changes constitute permanence.	Volume and toxicity of COCs reduced by ground water and soil vapor extraction and treatment. Mobility limited by hydraulic and pneumatic control, and treatment.	No impact on community during construction. Possible exposure to workers mitigated by appropriate safety procedures. Decades likely before remedial objectives reached.	Implementable—proven technologies available. Additional innovative technologies may be found implementable by the time of deployment.	9,607
Module E: Enhanced *in situ* bioremediation of VOCs	Risk to human health and the environment from the COCs reduced. Negligible risk to employees and public from system operation. No air emissions.	ARARs in ground water potential reachable with sufficient time. Can be used in conjunction with other remedies.	Effective and permanent for organics and via non-reversible chemical changes. Other COCs could potentially be remobilized if naturally persistent.	TMV of organics and nitrate reduced by biologically fostered chemical reactions. Other COCs may be little affected.	No impact on community during construction or exposure to workers. Decades likely before remedial objectives reached.	Implementable—technology proven for many organics. Research in progress to expand the applicability.	2,409

NA = Not applicable.

Table 5-3. Comparative evaluation of modules for the Pit 6 Landfill Operable Unit (OU 3).

Module	Overall protection of human health and the environment	Compliance with ARARs	Long-term effectiveness and permanence	Reduction in toxicity, mobility, and volume (TMV)	Short-term effectiveness	Implementability	Net Present Worth Cost, $K
Module A: No Further Action	Potentially not.	No	No	No	No	NA	None
Module B: Monitoring	NA—Used in conjunction with active remedies.	Used in conjunction with active remedies.	Used in conjunction with active remedies.	No	No	Implementable—monitoring network already in place.	1,692
Module C: Risk and Hazard Management	Yes—Will also be used in conjunction with active remedies.	In conjunction with other remedies.	Effective in conjunction with other remedies. Must be actively maintained.	Not by itself.	Effective in preventing exposures.	Implementable—site control exists and accidental exposure prevented.	209
Module D: Monitored natural attenuation of VOCs and tritium in ground water	Yes—Concentrations likely to be below hazard levels before reaching points of exposure. If not, active remedy can be initiated.	ARARs in ground water expected to be reached in a reasonable timeframe.	Effective and permanent due to irreversible chemical and radioactive decay.	Volume and toxicity will be reduced naturally with time.	No impacts on community during implementation. Remedial objectives expected to be met in reasonable timeframe.	Implementable—concentrations are low enough to make time to reach objectives reasonable.	476
Module E: Ground water extraction and treatment of VOCs and perchlorate	Risk to human health and the environment from the COCs rapidly reduced. Negligible risk to employees and public from system operation. No toxic air emissions.	Treated effluent concentrations will meet ARARs, and ARARs for ground water achieved in minimum time.	Extraction and treatment systems operated until ground water meets ARARs. Proper disposal of wastes and/or chemical changes constitute permanence.	Volume and toxicity of COCs reduced by ground water extraction and treatment. Mobility limited by hydraulic control and treatment.	No impact on community during construction. Possible exposure to workers mitigated by appropriate safety procedures.	Implementable—proven technologies available. Low concentrations and irregular occurrences of some contaminants will reduce efficiency.	4,038

NA = Not applicable.

Table 5-4. Comparative evaluation of modules for the HE Process Area Operable Unit (OU 4).

Module	Overall protection of human health and the environment	Compliance with ARARs	Long-term effectiveness and permanence	Reduction in toxicity, mobility, and volume (TMV)	Short-term effectiveness	Implementability	Net Present Worth Cost, $K
Module A: No Further Action	Potentially not.	No	No	No	No	NA	None
Module B: Monitoring	NA—Used in conjunction with active remedies.	Used in conjunction with active remedies.	Used in conjunction with active remedies.	No	No	Implementable monitoring network already in place.	3,297
Module C: Risk and Hazard Management	Yes—Will also be used in conjunction with active remedies.	In conjunction with other remedies.	Effective in conjunction with other remedies. Must be actively maintained.	Not by itself.	Effective in preventing exposures.	Implementable—site control exists and accidental exposure prevented.	181
Module D: Ground water extraction and treatment of VOCs and nitrate at the leading edge of the Building 815 TCE plume	Risk to human health and the environment from the COCs rapidly reduced. Negligible risk to employees and public from system operation. No toxic air emissions.	Treated effluent concentrations will meet ARARs, and ARARs for ground water achieved in minimum time.	Extraction and treatment systems operated until plume ground water meets ARARs. Proper disposal of wastes constitutes permanence.	Volume and toxicity of COCs reduced by ground water extraction and treatment. Mobility limited by hydraulic control.	No impact on community during construction. Possible exposure to workers mitigated by appropriate safety procedures.	Implementable—proven technologies available.	5,812
Module E: Ground water extraction and treatment of VOCs, HE compounds, nitrate, and perchlorate released from Building 815 and the high explosives rinsewater lagoons	Risk to human health and the environment from the COCs rapidly reduced. Negligible risk to employees and public from system operation. No toxic air emissions.	Treated effluent concentrations will meet ARARs, and ARARs for ground water achieved in minimum time.	Extraction and treatment systems operated until source area ground water meets ARARs. Proper disposal of wastes and/or chemical changes constitute permanence.	Volume and toxicity of COCs reduced by ground water extraction and treatment. Mobility limited by hydraulic control and treatment.	No impact on community during construction. Possible exposure to workers mitigated by appropriate safety procedures.	Implementable—proven technologies available.	14,397
Module F: Ground water extraction and treatment of VOCs, nitrate, and perchlorate released from HE Burn Pit	Risk to human health and the environment from the COCs rapidly reduced. Negligible risk to employees and public from system operation. No toxic air emissions.	Treated effluent concentrations will meet ARARs, and ARARs for ground water achieved in minimum time.	Extraction and treatment systems operated until source area ground water meets ARARs. Proper disposal of wastes and/or chemical changes constitute permanence.	Volume and toxicity of COCs reduced by ground water extraction and treatment. Mobility limited by hydraulic control and treatment.	No impact on community during construction. Possible exposure to workers mitigated by appropriate safety procedures.	Implementable—proven technologies available.	3,934

NA = Not applicable.

Table 5-5a. Comparative evaluation of modules for the Building 850/Pits 3 & 5 Operable Unit (OU 5), Landfill Pit 7 Complex.

Module	Overall protection of human health and the environment	Compliance with ARARs	Long-term effectiveness and permanence	Reduction in toxicity, mobility, and volume (TMV)	Short-term effectiveness	Implementability	Net Present Worth Cost, $K
Module A: No Further Action	Potentially not.	No	No	No	No	NA	None
Module B: Monitoring	NA—Used in conjunction with active remedies.	Used in conjunction with active remedies.	Used in conjunction with active remedies.	No	No	Implementable—monitoring network already in place.	2,173
Module C: Risk and Hazard Management	Yes—Will also be used in conjunction with active remedies.	In conjunction with active remedies.	Effective in conjunction with other remedies. Must be actively maintained.	Not by itself.	Effective in preventing exposures.	Implementable—site controls exist and prevent accidental exposure.	230
Module D: Monitored natural attenuation of tritium in ground water and surface water	Yes—Activities likely to be below hazard levels before reaching points of exposure. If not, active remedy can be initiated. No significant air emissions likely.	ARARs in ground water expected to be reached in a reasonable timeframe.	Effective and permanent due to irreversible radioactive decay.	Volume and toxicity will be reduced naturally with time.	No impacts on community during implementation, due to lack of an exposure pathway. Does not rapidly reduce activities in the ground. Remedial objectives expected to be met without off-site migration.	Implementable	283
Module E: Ground water extraction and treatment of VOCs	Risk to human health and the environment from the VOCs rapidly reduced. Negligible risk to employees and public from system operation. No toxic air emissions.	Treated effluent concentrations will meet ARARs, and ARARs for VOCs in ground water achieved in minimum time.	Extraction and treatment systems operated until ground water meets VOC ARARs. Proper disposal of wastes constitutes permanence.	Volume and toxicity of VOCs reduced by ground water extraction and treatment. Mobility limited by hydraulic control and treatment.	No impact on community during construction. Possible exposure to workers mitigated by appropriate safety procedures.	Implementable—proven technologies available.	3,749
Module F: Ground water extraction and treatment of uranium and nitrate	Risk to human health and the environment limited by safety procedures. Negligible risk to employees and public from system operation. No toxic air emissions.	Treated effluent activities will meet ARARs, and ARARs for uranium in ground water achieved in minimum time.	Extraction and treatment systems operated until ground water meets uranium ARARs. Proper disposal of wastes constitutes permanence.	Volume reduced by concentration at the surface. Mobility limited by hydraulic control and treatment.	No impact on community during construction. Possible exposure to workers mitigated by appropriate safety procedures.	Implementable—proven technology available.	5,376
Module G: Control migration of uranium-238 in ground water using *in situ* reactive permeable barriers	Yes—Immobilization in the subsurface prevents exposures.	Immobilization allows for natural processes to eventually meet ARARs, without human exposure.	Chemical reactions are essentially irreversible, providing permanence.	Volume reduced by concentration within the barrier. Change of chemical form limits mobility.	Effective in preventing exposures.	Significant engineering challenges, but theoretically implementable.	4,341
Module H: Waste characterization with contingent monitoring, capping, and/or excavation of Landfill Pits 3 and 5	Yes—Risk to human health and the environment considered in final decisions, and can be limited by proper safety procedures. Negligible risk to employees and public.	Yes—A portion of Pit 3 already under RCRA approved cap.	Removes or controls any significant sources identified, preventing future releases. Long-term effectiveness and permanence assured by proper disposal of any waste generated.	If excavation is warranted, proper disposal of wastes limits mobility. Volume of contaminants on site reduced.	Effective in assuring prevention of exposures and future releases.	Decision to excavate should be made with knowledge of potential source. Excavation may not be practical because of magnitude of project required.	503 to 47,596

NA = Not applicable.

Table 5-5b. Comparative evaluation of modules for the Building 850/Pits 3 & 5 Operable Unit (OU 5), Building 850 Firing Table.

Module	Overall protection of human health and the environment	Compliance with ARARs	Long-term effectiveness and permanence	Reduction in toxicity, mobility, and volume (TMV)	Short-term effectiveness	Implementability	Net Present Worth Cost, $K
Module A: No Further Action	Potentially not.	No	No	No	No	NA	None
Module B: Monitoring	NA—Used in conjunction with active remedies.	Used in conjunction with active remedies.	Used in conjunction with active remedies.	No	No	Implementable—monitoring network already in place.	2,294
Module C: Risk and Hazard Management	Yes—Will also be used in conjunction with active remedies.	In conjunction with active remedies.	Effective in conjunction with other remedies. Must be actively maintained.	Not by itself.	Effective in preventing exposures.	Implementable—site controls exist and prevent accidental exposure.	224
Module D: Monitored natural attenuation of tritium in ground water and surface water	Yes—Activities likely to be below hazard levels before reaching points of exposure. If not, active remedy can be initiated. No significant air emissions likely.	ARARs in ground water expected to be reached in a reasonable timeframe.	Effective and permanent due to irreversible radioactive decay.	Volume and toxicity will be reduced naturally with time.	No impacts on community during implementation, due to lack of an exposure pathway. Does not rapidly reduce activities in the ground. Remedial objectives expected to be met without offsite migration.	Implementable	283
Module E: Ground water extraction and treatment of uranium and nitrate	Risk to human health and the environment limited by safety procedures. Negligible risk to employees and public from system operation. No toxic air emissions.	Treated effluent activities will meet ARARs, and ARARs for uranium in ground water achieved in minimum time.	Extraction and treatment systems operated until ground water meets uranium ARARs. Proper disposal of wastes constitutes permanence.	Volume reduced by concentration at the surface. Mobility limited by hydraulic control and treatment.	No impact on community during construction. Possible exposure to workers mitigated by appropriate safety procedures.	Implementable—proven technology available.	4,475
Module F: Control of migration of uranium-238 in ground water using *in situ* reactive permeable barriers	Yes—Immobilization in the subsurface prevents exposures.	Immobilization allows for natural processes to eventually meet ARARs, without human exposure.	Chemical reactions are essentially irreversible, providing permanence.	Volume reduced by concentration within the barrier. Change of chemical form limits mobility.	Effective in preventing exposures.	Significant engineering challenges, but theoretically implementable.	3,376
Module G: Excavation of contaminated soil and bedrock underlying the Building 850 firing table, removal of the contaminated sandpile, and removal of contaminated soil adjacent to firing table	Yes—Risk to human health and the environment limited by proper safety procedures. Negligible risk to employees and public during excavation.	Yes	Long-term effectiveness and permanence assured by proper waste disposal. Removes potential source from area, preventing future releases.	Proper disposal of wastes limits mobility. Volume and toxicity generally not affected.	Effective in preventing exposures and future releases.	Implementable.	1,228 to 5,445

NA = Not applicable.

Table 5-5c. Comparative evaluation of modules for the Building 850/Pits 3 & 5 Operable Unit (OU 5), Landfill Pit 2.

Module	Overall protection of human health and the environment	Compliance with ARARs	Long-term effectiveness and permanence	Reduction in toxicity, mobility, and volume (TMV)	Short-term effectiveness	Implementability	Net Present Worth Cost, $K
Module A: No Further Action	Potentially not.	No	No	No	No	NA	None
Module B: Monitoring	NA—Used in conjunction with active remedies.	Used in conjunction with active remedies.	Used in conjunction with active remedies.	No	No	Implementable—monitoring network already in place.	515
Module C: Waste characterization with contingent monitoring, capping, or excavation of Landfill Pit 2	Yes—Risk to human health and the environment considered in final decision, and can be limited by proper safety procedures. Negligible risk to employees and public.	Yes	Removes or controls any significant sources identified, preventing future releases. Long-term effectiveness and permanence assured by proper disposal of any waste generated.	Capping could reduce mobility. If excavation is warranted, proper disposal of wastes limits mobility. Volume of contaminants on site reduced.	Effective in assuring prevention of exposures and future releases.	Decision to cap or excavate should be made with knowledge of potential source. Excavation may not be practical because of magnitude of project required.	252 to 21,735

NA = Not applicable.

Table 5-6. Comparative evaluation of modules for the Building 854 Operable Unit (OU 6).

Alternative	Overall protection of human health and the environment	Compliance with ARARs	Long-term effectiveness and permanence	Reduction in toxicity, mobility, and volume (TMV)	Short-term effectiveness	Implementability	Net Present Worth Cost, $K
Alternative A: No Further Action	Potentially not.	No	No	No	No	NA	None
Alternative B: Monitoring	NA—Used in conjunction with active remedies.	Not by itself—Used in conjunction with active remedies.	Not by itself—Used in conjunction with active remedies.	No	No	Implementable—monitoring network already in place.	945
Alternative C: Risk and Hazard Management	Yes—Will also be used in conjunction with active remedies.	In conjunction with other remedies.	Effective in conjunction with other remedies. Must be actively maintained.	Not by itself.	Effective in preventing exposures.	Implementable—site control exists and accidental exposure prevented.	239
Module D: Ground water and soil vapor extraction and treatment of VOCs and nitrate	Risk to human health and the environment from the COCs substantially reduced. Negligible risk to employees and public from system operation. No toxic air emissions.	Treated effluent concentrations will meet ARARs, and ARARs for ground water and soil achieved in minimum time.	Extraction and treatment systems operated until soil and ground water meet ARARs. Proper disposal of wastes and/or chemical changes constitute permanence.	Volume and toxicity of COCs reduced by ground water and soil vapor extraction and treatment. Mobility limited by hydraulic and pneumatic control, and treatment.	No impact on community during construction. Possible exposure to workers mitigated by appropriate safety procedures. Decades likely before remedial objectives reached.	Implementable—proven technologies available. Additional innovative technologies may be found implementable by the time of deployment.	7,966

NA = Not applicable.

Table 5-7. Comparative evaluation of modules for the Building 832 Canyon Operable Unit (OU 7).

Module	Overall protection of human health and the environment	Compliance with ARARs	Long-term effectiveness and permanence	Reduction in toxicity, mobility, and volume (TMV)	Short-term effectiveness	Implementability	Net Present Worth Cost, $K
Module A: No Further Action	Potentially not.	No	No	No	No	NA	None
Module B: Monitoring	NA—Used in conjunction with active remedies.	Used in conjunction with active remedies.	Used in conjunction with active remedies.	No	No	Implementable—monitoring network already in place.	2,462
Module C: Risk and Hazard Management	Yes—Will also be used in conjunction with active remedies.	In conjunction with active remedies.	Effective in conjunction with other remedies. Must be actively maintained.	Not by itself.	Effective in preventing exposures.	Implementable—site control exists and accidental exposure prevented.	203
Module D: Ground water and soil vapor extraction and treatment of VOCs, perchlorate, and nitrate at Building 832	Risk to human health and the environment from the COCs substantially reduced. Negligible risk to employees and public from system operation. No toxic air emissions.	Treated effluent concentrations will meet ARARs, and ARARs for ground water and soil achieved in minimum time.	Extraction and treatment systems operated until soil and ground water meet ARARs. Proper disposal of wastes and/or chemical changes constitute permanence.	Volume and toxicity of COCs reduced by ground water and soil vapor extraction and treatment. Mobility limited by hydraulic and pneumatic control, and treatment.	No impact on community during construction. Possible exposure to workers mitigated by appropriate safety procedures. Decades likely before remedial objectives reached.	Implementable—depending on unknown lateral extent of plume. Proven technologies available for treatment. Additional innovative technologies may be found implementable by the time of deployment.	10,293
Module E: Ground water and soil vapor extraction and treatment of VOCs, perchlorate, and nitrate at Building 830	Risk to human health and the environment from the COCs substantially reduced, Negligible risk to employees and public from system operation. No toxic air emissions.	Treated effluent concentrations will meet ARARs, and ARARs for ground water and soil achieved in minimum time.	Extraction and treatment systems operated until soil and ground water meet ARARs. Proper disposal of wastes and/or chemical changes constitute permanence.	Volume and toxicity of COCs reduced by ground water and soil vapor extraction and treatment. Mobility limited by hydraulic and pneumatic control, and treatment.	No impact on community during construction. Possible exposure to workers mitigated by appropriate safety procedures. Decades likely before remedial objectives reached.	Implementable—depending on unknown lateral extent of plume. Proven technologies available for treatment. Additional innovative technologies may be found implementable by the time of deployment.	10,638
Module F: Downgradient ground water extraction using a siphon, with *ex situ* treatment of VOCs by iron filings	Risk to human health and the environment from offsite migration of COCs substantially reduced, Negligible risk to employees and public from system operation. No toxic air emissions.	Treated effluent concentrations will meet ARARs, and ARARs for ground water achievable downgradient of extraction. Can be used in conjunction with other (source control) remedies.	Extraction and treatment system operated until ground water meets ARARs. Proper disposal of wastes and/or chemical changes constitute permanence.	Mobility beyond the site boundary limited by hydraulic control, and treatment. Volume and toxicity of COCs reduced by ground water extraction and treatment.	No impact on community during construction. Possible exposure to workers mitigated by appropriate safety procedures.	Implementable-- depending on unknown lateral extent of plume. Iron filing demonstrated for VOC and nitrate treatment.	3,170

NA = Not applicable.

Table 5-8. Comparative evaluation of modules for the Site 300 Release Sites Operable Onit (OU 8), Building 801 and Landfill Pit 8.

Alternative	Overall protection of human health and the environment	Compliance with ARARs	Long-term effectiveness and permanence	Reduction in toxicity, mobility, and volume (TMV)	Short-term effectiveness	Implementability	Net Present Worth Cost, $K
Module A: No Further Action	Potentially not.	Possibly not.	Possibly not.	No	Possibly not.	NA	None
Module B: Monitoring	Yes—Will protect human health and the environment.	Yes—Will assume compliance with ARARs.	Yes—Will provide warning if not protective in the long-term.	No	Possibly not.	Implementable—monitoring network already in place.	535
Module C: Waste characterization with contingent monitoring, capping, or excavation of Landfill Pit 8	Yes—risk to human health and the environment considered in final decision and can be limited by proper safety procedures. Negligible risk to employees and public during excavation.	Yes	Removes or controls any significant sources identified, preventing future releases. Long-term effectiveness and permanence assured by proper waste disposal of any waste generated.	Capping could reduce mobility. If excavation is warranted, proper disposal of wastes limits mobility. Volume of contaminants on site reduced—but volume at new disposal site may be greater.	Effective in assuring prevention of exposures and future releases.	Decision to cap or excavate should be made with knowledge of potential source. Exaction may not be practical because of magnitude of project required.	205 to 21,077

NA = Not applicable.

Table 5-9. Comparative evaluation of modules for the Site 300 Release Sites Operable Unit (OU 8), Building 833 Area.

Module	Overall protection of human health and the environment	Compliance with ARARs	Long-term effectiveness and permanence	Reduction in toxicity, mobility, and volume (TMV)	Short-term effectiveness	Implementability	Net Present Worth Cost, $K
Module A: No Further Action	Potentially not.	No	No	No	No	NA	None
Module B: Monitoring	NA—Used in conjunction with risk and hazard management.	Accepted as remedy by regulators.	NA	No	No	Implementable—monitoring network already in place.	661
Module C: Risk and Hazard Management	Yes—Will also be used in conjunction with monitoring.	In conjunction with monitoring.	Effective in conjunction with other remedies. Must be actively maintained.	Not by itself.	Effective in preventing exposures.	Implementable—site controls exist and prevent accidental exposure.	159
Module D: Ground water and soil vapor extraction and treatment of VOCs	Risk to human health and the environment from the COCs substantially reduced, Negligible risk to employees and public from system operation. No toxic air emissions.	Treated effluent concentrations will meet ARARs, and ARARs for ground water and soil achieved in minimum time.	Extraction and treatment systems operated until soil and ground water meet ARARs. Proper disposal of wastes and/or chemical changes constitute permanence.	Volume and toxicity of COCs reduced by ground water and soil vapor extraction and treatment. Mobility limited by hydraulic and pneumatic control, and treatment.	No impact on community during construction. Possible exposure to workers mitigated by appropriate safety procedures. Decades likely before remedial objectives reached.	Implementable—Proven technologies available for treatment. Additional innovative technologies may be found implementable by the time of deployment.	3,436

NA = Not applicable.

Table 5-10. Comparative evaluation of modules for the Site 300 Release Sites Operable Unit (OU 8), Building 845 Firing Table and Landfill Pit 9.

Module	Overall protection of human health and the environment	Compliance with ARARs	Long-term effectiveness and permanence	Reduction in toxicity, mobility, and volume (TMV)	Short-term effectiveness	Implementability	Net Present Worth Cost, $K
Module A: No Further Action	Potentially not.	Possibly not.	Possibly not.	No	Possibly not.	NA	None
Module B: Monitoring	NA—Used in conjunction with other remedies.	Used in conjunction with other remedies.	Used in conjunction with other remedies.	No	Possibly not.	Implementable—monitoring network already in place.	488
Module C: Waste characterization with contingent monitoring, capping, or excavation of Landfill Pit 9	Yes—Risk to human health and the environment considered in final decision and can be limited by proper safety procedures. Negligible risk to employees and public during excavation.	Yes	Removes or controls any significant sources identified, preventing future releases. Long-term effectiveness and permanence assured by proper waste disposal of any waste generated.	Capping could reduce mobility. If excavation is warranted, proper disposal of wastes limits mobility. Volume of contaminants on site reduced -- but volume at new site could be greater.	Effective in assuring prevention of exposures and future releases.	Decision to cap or excavate should be made with knowledge of potential source. Excavation may not be practical because of magnitude of project required.	205 to 6,577

NA = Not applicable.

Table 5-11. Comparative evaluation of modules for the Site 300 Release Sites Operable Unit (OU 8) Building 851 Firing Table.

Module	Overall protection of human health and the environment	Compliance with ARARs	Long-term effectiveness and permanence	Reduction in toxicity, mobility, and volume (TMV)	Short-term effectiveness	Implementability	Net Present Worth Cost, $K
Module A: No Further Action	Potentially not.	Possibly not.	Possibly not.	No	Possibly not.	NA	None
Module B: Monitoring	NA—Used in conjunction with other remedies.	Used in conjunction with other remedies.	Used in conjunction with other remedies.	No	Possibly not.	Implementable—monitoring network already in place.	530
Module C: Ground water extraction and treatment of uranium	Risk to human health and the environment limited by proper safety procedures. Negligible risk to employees and public from system operation. No toxic air emissions.	Treated effluent activities will meet ARARs, and ARARs for ground water achieved in minimum time.	Extraction and treatment systems operated until ground water meets ARARs. Proper disposal of wastes constitutes permanence.	No technology available to reduce toxicity. Volume of contaminants on site—mobility limited by hydraulic control, treatment, and disposal.	No impact on community during construction. Possible exposure to workers mitigated by appropriate safety procedures.	Implementable, but efficiency may be low because of the low concentrations or uranium present—proven technology available.	3,668

NA = Not applicable.