

9.0 Identification of the Selected Remedy

The selection of the preferred remedy for remediation of groundwater, structures, and soil for the On-Post Operable Unit was based on the NCP evaluation criteria, which are described in Figure 8.0-1 and discussed with respect to each of the alternatives evaluated in Sections 8.1 through 8.3. As a result of these evaluations, the selected remedy for the On-Post Operable Unit consists of implementing Groundwater Alternative 4, Structures Alternative 2, and Soil Alternative 4. These selected alternatives are described in detail in Section 7. Remediation goals for the selected remedy satisfies the evaluation of statutory requirements under CERCLA as described in Section 10.

9.1 Groundwater Alternative 4 – Boundary Systems/IRAs/Intercept Systems

The selected groundwater alternative is Alternative 4. This alternative includes operation of all existing boundary systems and on-post groundwater IRA systems, installation of a new extraction and piping system, and development of an extended monitoring program. The specific components of the alternative are as follows:

- Operation of the three boundary systems, the NBCS, NWBCS, and ICS, continues. These systems include extraction and recharge systems, slurry walls (NBCS and NWBCS) for hydraulic controls, and carbon adsorption for removal of organics. The systems will be operated until shut-off criteria, as described below, are met.
- Operation of existing on-post groundwater IRA systems continues. The Motor Pool and Rail Yard IRA systems, which pipe water to ICS for treatment, will be shut down when shut-off criteria, as described below, are met. The Basin F extraction system continues to extract water that is treated at the Basin A Neck system and the Basin A Neck system continues to extract and treat water from Basin A until shut-off criteria are met.
- A new extraction system will be installed in the Section 36 Bedrock Ridge area. Extracted water will be piped to the Basin A Neck system for treatment (e.g., by air stripping or carbon adsorption).
- Water levels in Lake Ladora, Lake Mary, and Lower Derby Lake will be maintained to support aquatic ecosystems. The biological health of the ecosystems will continue to be monitored.

Lake-level maintenance or other means of hydraulic containment or plume control will be used to prevent South Plants plumes from migrating into the lakes at concentrations exceeding CBSGs in groundwater at the point of discharge. Groundwater monitoring will be used to demonstrate compliance.

- Confined aquifer wells are monitored in the South Plants, Basin A, and Basin F areas. Specific monitoring wells will be selected during remedial design.
- Those monitoring wells installed in the confined aquifer that may represent pathways for migration from the unconfined aquifer (approximately 30–40 wells) are closed and sealed; replacement wells will be installed if the Parties jointly determine that specific wells to be closed are necessary for future monitoring.
- Chloride and sulfate are expected to attenuate naturally to the CSRGs.
- Monitoring and assessment of NDMA contamination will be performed in support of design refinement/design characterization to achieve remediation goals specified for the boundary groundwater treatment systems.

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CSRGs were established for each containment/treatment system on the basis of ARARs and health-based criteria. The ARAR-based values were either Colorado Basic Standards for Groundwater (CBSGs), federal maximum contaminant levels (MCLs), or non-zero maximum contaminant level goals (MCLGs). The health-based values are to-be-considered criteria (TBCs) and were based on EPA health advisories and/or EPA Integrated Risk Information System database criteria. All of the boundary CSRGs are consistent with those derived for the ROD for the Off-Post Operable Unit (Harding Lawson Associates 1995). CSRGs were developed for each of the existing boundary and IRA systems, depending on the specific contaminants found upgradient of each system and whether the systems were on post or at the boundary. Tables 9.1-1, 9.1-2, 9.1-3, and 9.1-4 present the CSRGs for the three boundary systems, and the Basin A Neck system. Where the CSRG is below the detection limit, the detection limit is listed next to the CSRG. Except where technically impractical, the detection limit is less than the CSRG.

Criteria for shutting down boundary systems and internal systems have also been developed and are provided as follows:

- Existing wells within the boundary and off-post containment systems can be removed from production when concentrations of constituents detected in the well are less than the ARARs listed in Appendix A and/or it can be demonstrated that discontinuing operation of a well would not jeopardize the containment objective of the systems as identified by the remediation goals described above and the CSRGs listed in Tables 9.1-1, 9.1-2, and 9.1-3. Wells removed from production and monitoring wells upgradient and downgradient of the boundary and off-post containment systems will be monitored quarterly for a period of 5 years to determine whether contaminants have reappeared; however, those wells turned off for hydraulic purposes will not be subject to the quarterly monitoring requirements. Boundary and off-post containment system extraction wells removed from production for water-quality reasons will be placed back into production if contaminant concentrations exceed ARARs. Wells with concentrations less than ARARs can remain in production if additional hydraulic control is required.
- Existing wells within the internal containment systems can be removed from production when concentrations of constituents detected in the wells are less than ARARs listed in Appendix A and/or it can be demonstrated that discontinuing operation of a well would not jeopardize the containment objective of the systems as identified by the CSRGs listed in Table 9.1-4. Wells removed from production and monitoring wells upgradient and downgradient of the internal containment systems will be monitored quarterly for a period of 5 years to determine whether contaminants have reappeared; however, those wells turned off for hydraulic purposes will not be subject to the quarterly monitoring requirements. Internal containment system extraction wells removed from production for water-quality reasons will be placed back into production if contaminant concentrations exceed ARARs. Wells with concentrations less than ARARs can remain in production if additional hydraulic control is required.
- Shell and the Army will operate the ICS for 2 years or until the Rail Yard/Motor Pool plumes no longer require containment at the ICS.

Figure 9.1-1 illustrates the selected alternative. Additional detail on this alternative is provided in the Detailed Analysis of Alternatives report.

9.2 Structures Alternative 2 – Landfill/Consolidate

Structures Alternative 2 is the selected alternative for the structures medium. This alternative applies to all No Future Use structures, i.e., structures in the Other Contamination History, Significant Contamination History, and Agent History Groups. Under this alternative, the following activities will occur:

- All No Future Use structures will be demolished.
- Agent History structures will be monitored for the presence of Army chemical agent, and treated by caustic washing as necessary prior to disposal.
- Both Agent History and Significant Contamination History Group structural debris will be disposed in the on-site hazardous waste landfill.
- Other Contamination History Group structural debris will be used as grade fill in Basin A, which will subsequently be covered as part of the soil remediation.
- Structural assessments and review of ACM and PCB contamination status and disposition of ACM or PCB-contaminated materials will be performed as described in Section 7.3.3.
- Process-related equipment not remediated as part of the Chemical Process-Related Activities IRA will be disposed in the on-post hazardous waste landfill.

An inventory of structures in each medium group is presented in Tables 5.4-6, 5.4-7, 5.4-8, and 5.4-9. Refinement of the Future Use structures inventory will be completed during remedial design. Most of the demolition at RMA will consist of dismantling with standard dust-suppression measures. Remediation goals and standards have been identified for each medium group (see Table 9.5-1). The Other Contamination History Group structural debris is disposed by consolidation in Basin A. This procedure includes transporting the debris to the consolidation area and using it as a portion of the gradefill required by the soil remediation. When the consolidation area has been regraded, it will be covered as part of the soil remediation. Significant Contamination History Group and Agent Contamination History Group structural debris is disposed in the on-post hazardous waste landfill. The slabs and foundations of structures located in the South Plants Central Processing Area within principal threat or human health soil exceedance excavation areas are removed to a depth of 5 ft. In most cases, floor slabs and foundations for the Other Contamination History and Significant Contamination History Groups are left behind after demolition (unless contaminated soil is to be excavated from beneath the slabs or foundations). Floor slabs are broken to prevent water ponding. Additional detail on this alternative is provided in the Detailed Analysis of Alternatives Report.

9.3 Soil Alternative 4 – Consolidation/Caps/Treatment/Landfill

The selected soil alternative is Alternative 4. This alternative includes consolidation of 1.5 million BCY of soil with low levels of contamination into Basins A and F and the South Plants Central Processing Area; capping or soil cover of contaminated soil in the Basins, South Plants, North Plants, and Section 36 sites (including Shell and Complex Trenches); treatment (primarily by in situ solidification/stabilization) of 207,000 BCY of

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principal threat soil; and on-post landfilling of 1.7 million cubic yards of soil and debris, including the Basin F Wastepile. The specific components of this alternative are listed below and are summarized in Table 9.3-1:

- **On-Post Hazardous Waste Landfill** – Construction of a RCRA- and TSCA-compliant hazardous waste landfill on post.
- **Former Basin F** – Treatment of approximately 180,000 BCY of principal threat soil in the Former Basin F to a depth of 10 ft (measured from below the base of the overburden) using in situ solidification/stabilization to reduce the mobility of the contaminants and minimize further contamination of groundwater. The mixture of solidification agents will be determined during remedial design by treatability testing. This treatability testing will be used to verify the effectiveness of the treatment process and establish operating parameters for the design of the full-scale operation. The entire site is capped (including the Basin F Wastepile footprint) with a RCRA-equivalent cap that includes a biota barrier.
- **Basin F Wastepile** – Excavation of approximately 600,000 BCY of principal threat soil and liner materials from the wastepile and containment in dedicated triple-lined landfill cells at the on-post hazardous waste landfill facility. Excavation is conducted using vapor- and odor-suppression measures as necessary. If the wastepile soil fails EPA's paint filter test, the moisture content of the soil will be reduced to acceptable levels by using a dryer in an enclosed structure. Any volatile organics (and possibly some semivolatile organics) released from the soil during the drying process are captured and treated; however, the main objective of this process is drying. Prior to excavation of the wastepile, overburden from the existing cover is removed and set aside. The excavation area is backfilled with on-post borrow material and stockpiled overburden.
- **Basin A** – Construction of a soil cover consisting of a 6-inch-thick layer of concrete and a 4-ft-thick soil/vegetation layer over the principal threat and human health exceedance soil and soil posing a potential risk to biota, and consolidation of debris and soil posing a potential risk to biota and structural debris from other sites. No RCRA-listed or RCRA-characteristic waste from outside the AOC will be placed in Basin A. Any UXO encountered will be removed and transported off post for detonation (unless the UXO is unstable and must be detonated on post) or other demilitarization process.
- **South Plants Central Processing Area** – Excavation and landfill of principal threat and human health exceedance soil to a depth of 5 ft and caustic washing and landfill of any agent-contaminated soil found during monitoring. Backfill excavation and placement of a soil cover consisting of a 1-ft-thick biota barrier and a 4-ft-thick soil/vegetation layer over the entire site to contain the remaining human health exceedance soil and soil posing a potential risk to biota. Soil posing a potential risk to biota from other portions of South Plants may be used as backfill and/or gradefill prior to placement of the soil cover.
- **South Plants Ditches** – Excavation and landfill of principal threat and human health exceedance soil. Excavation of soil posing a potential risk to biota and consolidation under the South Plants Central Processing Area soil cover. Backfill excavated area with on-post borrow material. These sites are contained under the South Plants Balance of Areas soil cover.
- **South Plants Balance of Areas** – Excavation (maximum depth of 10 ft) and landfill of principal threat and human health exceedance soil and caustic washing and landfill of any agent-contaminated soil found during monitoring. Any UXO encountered will be excavated and transported off post for detonation (unless the UXO is unstable and must be detonated on post) or other demilitarization process. Excavation of soil posing a potential risk to biota and consolidation as backfill and/or gradefill under the South Plants Central Processing Area soil cover and/or for use as backfill for excavated areas within this medium group. The former human health exceedance area is covered with a 3-ft-thick soil cover and the former potential risk to biota area is covered with a 1-ft-thick soil cover. Prior to placing this cover, two composite samples per acre will be collected to verify that the soil under the 1-ft-thick soil cover does not exceed human health or principal threat criteria. If the residual soil is found to exceed these levels, the 3-ft-thick cover will be extended over these areas or the

exceedance soil will be excavated and landfilled. The top 1 ft of the entire soil cover area will be constructed using soil from the on-post borrow areas.

- **Section 36 Balance of Areas – Excavation and landfill of human health exceedance soil and UXO debris and excavation and consolidation to Basin A of soil posing a potential risk to biota.** The consolidated material is contained under the Basin A cover and the human health excavation area is backfilled with on-post borrow material. Prior to excavation, a geophysical survey is conducted to locate potential UXO. Any UXO encountered will be excavated and transported off post for detonation (unless the UXO is unstable and must be detonated on post) or other demilitarization process. Caustic washing and landfill of any agent-contaminated soil found during monitoring. The former human health exceedance area is covered with a 2-ft-thick soil cover and the former potential risk to biota area is covered with a 1-ft-thick soil cover.
- **Secondary Basins – Excavation and landfill of human health exceedance soil.** The excavated area is backfilled with on-post borrow material. A 2-ft-thick soil cover is placed over the entire area of Basins B, C, and D, including the potential biota risk area.
- **Complex Trenches – Construction of a RCRA-equivalent cap, including a 6-inch-thick layer of concrete, over the entire site.** Installation of a slurry wall into competent bedrock around the disposal trenches. Dewatering within the slurry wall is assumed for purposes of conceptual design and will be reevaluated during remedial design. Soil excavated for the slurry wall trench is graded over the surface of the site and is contained under the cap. Prior to installing the slurry wall and cap, a geophysical survey is conducted to locate potential UXO within construction areas. Any UXO encountered will be removed and transported off post for detonation (unless the UXO is unstable and must be detonated on post) or other demilitarization process.
- **Shell Trenches – Modification of the existing soil cover to be a RCRA-equivalent cap with a biota barrier.** Expansion of the existing slurry wall around the trenches. Dewatering within the slurry wall is assumed for purposes of conceptual design and will be re-evaluated during remedial design. Soil excavated for the slurry wall trench is graded over the surface of the site and is contained under the cap.
- **Hex Pit – Treatment of approximately 1,000 BCY of principal threat material using an innovative thermal technology.** The remaining 2,300 BCY are excavated and disposed in the on-post hazardous waste landfill. Remediation activities are conducted using vapor- and odor-suppression measures as required. Treatability testing will be performed during remedial design to verify the effectiveness of the innovative thermal process and establish operating parameters for the design of the full-scale operation. The innovative thermal technology must meet the treatability study technology evaluation criteria described in the dispute resolution agreement (PMRMA 1996). Solidification/stabilization will become the selected remedy if all evaluation criteria for the innovative thermal technology are not met. Treatability testing for solidification will be performed to verify the effectiveness of the solidification process and determine appropriate solidification/stabilization agents. Treatability testing and technology evaluation will be conducted in accordance with EPA guidance (OSWER-EPA 1989a) and EPA's "Guide for Conducting Treatability Studies under CERCLA" (1992).
- **Section 36 Lime Basins – Excavation and containment of principal threat and human health exceedance soil in a triple-lined landfill cell at the on-post hazardous waste landfill facility.** Prior to excavation of exceedance soil, overburden from the existing cover is removed and set aside. The excavated area is backfilled with clean borrow and the soil cover is repaired. Caustic washing and landfill of any agent-contaminated soil found during monitoring.
- **Buried M-1 Pits – Approximately 26,000 BCY of principal threat and human health exceedance soil is treated by solidification/stabilization and then landfilled.** The mixture of solidification/stabilization agents will be determined during remedial design by treatability testing. This treatability testing will be used to verify the effectiveness of the treatment process and establish operating parameters for the design of the full-scale operation. Excavation is conducted using vapor- and odor-suppression

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measures. Caustic washing and landfill of any agent-contaminated soil found during monitoring. The excavated area is backfilled with clean borrow.

- **Burial Trenches** – UXO in these sites is located using a geophysical survey, excavated, and transported off post for detonation (unless the UXO is unstable and must be detonated on post) or other demilitarization process. Excavation and landfill of human health exceedance soil and backfill with on-post borrow material. Caustic washing and landfill of any agent-contaminated soil found during monitoring. Removal and landfill of munitions debris and nearby soil in excess of TCLP.
- **Chemical Sewers** – For sewers located within the South Plants Central Processing Area and Complex Trenches area, the sewer void space is plugged with a concrete mixture to prohibit access to these lines and eliminate them as a potential migration pathway for contaminated groundwater. The plugged sewers are contained beneath the soil cover or cap in their respective sites. For sewers located outside the South Plants Central Processing Area and Complex Trenches areas, sewer lines and principal threat and human health exceedance soil are excavated and landfilled. Any agent-contaminated soil found during monitoring is caustic washed and landfilled. Prior to excavation of exceedance soil, overburden is removed and set aside. The excavated area is backfilled with on-post borrow material and the overburden replaced.
- **Sanitary/Process Water Sewers** – Void space inside sewer manholes is plugged with a concrete mixture to prohibit access and eliminate the manholes as a potential migration pathway for contaminated groundwater. Aboveground warning signs are posted every 1,000 ft along the sewer lines to indicate their location underground.
- **North Plants** – Excavation and landfill of human health exceedance soil. Any agent-contaminated soil found during monitoring is caustic washed and landfilled. The excavated area is backfilled with on-post borrow material. A 2-ft-thick soil cover is placed over the soil posing a potential risk to biota and the footprint of the North Plants processing area.
- **Toxic Storage Yards** – Excavation and landfill of human health exceedance soil. Any agent-contaminated soil found during monitoring is caustic washed and landfilled. The excavated area is backfilled with on-post borrow material. The New Toxic Storage Yards are used as a borrow area for both low-permeability soil and structural fill.
- **Munitions Testing** – UXO in these sites is located using a geophysical survey, excavated, and transported off post for detonation (unless the UXO is unstable and must be detonated on post) or other demilitarization process. Removal and landfill of munitions debris and nearby soil in excess of TCLP.
- **Lake Sediments** – Excavation and landfill of human health exceedance soil and excavation and consolidation of soil posing risk to biota from Upper Derby Lake to Basin A. The excavated human health exceedance area is backfilled with on-post borrow material and the consolidated material is contained under the Basin A cover. Aquatic sediments are left in place and the area is monitored to ensure that the sediments continue to pose no unacceptable risk to aquatic biota.
- **Ditches/Drainage Areas** – Excavation and consolidation to Basin A of soil posing a potential risk to biota. The consolidated material is contained under the Basin A cover. The excavated area is backfilled with on-post borrow material.
- **Sanitary Landfills** – Excavation and landfill of human health exceedance soil and excavation and consolidation to Basin A of landfill debris and soil posing a potential risk to biota. The consolidated material is contained under the Basin A cover. The excavated area is backfilled with on-post borrow material.
- **Buried Sediments** – Excavation and landfill of human health exceedance soil. The excavated area is backfilled with on-post borrow material.

- Sand Creek Lateral – Excavation and landfill of human health exceedance soil and excavation and consolidation to Basin A of soil posing a potential risk to biota. The consolidated material is contained under the Basin A cover. The excavated area is backfilled with on-post borrow material.
- Surficial Soil – Excavation and landfill of human health exceedance soil and excavation and consolidation to Basin A or Former Basin F of soil posing a potential risk to biota from this medium group and excavation and landfill of soil from the pistol and rifle ranges. The consolidated material is contained under the Basin A cover or Basin F cap, and the human health exceedance area is backfilled.
- Excavation and disposal in the on-post TSCA-compliant landfill of PCB-contaminated soil (three areas identified by the PCB IRA with concentrations of 250 ppm or greater). Soil identified with concentrations ranging from 50 to 250 ppm will be covered with at least 3 ft of soil (five areas identified by the PCB IRA).
- Contingent Volume – Excavation and landfill of up to 150,000 BCY of additional volume to be identified based on visual field observations. An additional 14 samples from North Plants, Toxic Storage Yards, Lake Sediments, Sand Creek Lateral, and Burial Trenches and up to 1,000 additional confirmatory samples may be used to identify the contingent soil volume requiring excavation.
- Remedy components for all sites include reconditioning the surface soil and revegetating areas disturbed during remediation with locally adapted perennial vegetation.

Exceedance volumes for all medium groups are listed in Table 7.1-5. For sites with excavation as part of the selected remedy, the exceedance volume is considered the volume to be excavated and no confirmatory sampling will occur during implementation, other than to identify contingent volume.

Additional detail on this alternative is provided in the Detailed Analysis of Alternatives report. Figure 9.3-1 shows the selected sitewide soil remedy; Figures 9.3-2, 9.3-3, and 9.3-4 show the major excavation areas and cap or cover components of the selected soil remedy; and Figure 9.3-5 shows the areas where exceedance volumes are left in place and the type of containment systems used in those areas following implementation of the selected remedy. Tables 9.3-2 and 9.3-3 show the disposition of exceedance volumes and Table 9.3-4 details the capped/covered areas for the selected soil remedy. A process will be presented in future implementation documents that will allow for independent confirmation that volumes (defined spatially) are removed. The process will allow for verification by the state or EPA during remedial action.

9.4 Additional Components of the Selected Remedy

The Army, Shell, EPA, USFWS, and state of Colorado have agreed to several additional components that will be included in the overall on-post remedy. These components have been considered in the selection of the preferred alternatives and are as follows:

- Provision of \$48.8 million held in trust to provide for the acquisition and delivery of 4,000 acre-feet of potable water to SACWSD and the extension of the water-distribution lines from an appropriate water supply distribution system to all existing well owners within the DIMP plume footprint north of RMA as defined by the detection limit for DIMP of 0.392 parts per billion (ppb). In the future, owners of any domestic wells, new or existing, found to have DIMP concentrations of 8 ppb (or other relevant CBSG at the time) or greater will be connected to a water-distribution system or provided a deep well

or other permanent solution. The Army and Shell have reached an Agreement in Principle with SACWSD, enclosed as Appendix B of this ROD, regarding this matter.

- In compliance with NEPA, PMRMA will separately evaluate the potential impacts to the environment of both the acquisition of a water supply for SACWSD and for extension of water-distribution lines.
- The Army and Shell will fund ATSDR to conduct an RMA Medical Monitoring Program in coordination with CDPHE. The program's nature and scope will include baseline health assessments and be determined by the on-post monitoring of remedial activities to identify exposure pathways, if any, to any off-post community.

A Medical Monitoring Advisory Group (MMAG) has been formed to evaluate information concerning exposure pathways and identify and recommend appropriate public health actions to CDPHE and ATSDR and to communicate this information to the community. CDPHE and ATSDR will use the recommendations of the MMAG to jointly develop an appropriate medical monitoring plan and jointly define the trigger for when such a plan will take effect. Any human health assessment completed by CDPHE and ATSDR will be formally reviewed by the Parties and the MMAG prior to issuance to the public. The MMAG includes representatives from the affected communities, regulatory agencies, local governments, Army, Shell, USFWS, and independent technical advisors. Any necessary technical advisors will be identified in coordination with CDPHE and funded through ATSDR.

The primary goals of the Medical Monitoring Program are to monitor any off-post impact on human health due to the remediation and provide mechanisms for evaluation of human health on an individual and community basis, until such time as the soil remedy is completed. On behalf of the communities surrounding RMA, the MMAG will develop and submit to CDPHE and ATSDR specific recommendations defining goals, objectives, and the methodology of a program designed to respond effectively to RMA-related health concerns of the community.

Elements of the program could include medical monitoring, environmental monitoring, health/community education or other tools. The program design will be determined through an analysis of community needs, feasibility, and effectiveness.

- Trust Fund – During the formulation and selection of the remedy, members of the public and some local governmental organizations expressed keen interest in the creation of a Trust Fund to help ensure the long-term operation and maintenance of the remedy once the remedial structures and systems are installed. In response to this interest, the Parties have committed to good-faith best efforts to establish a Trust Fund for the operation and maintenance of the remedy, including habitat and surficial soil. Such operation and maintenance activities will include those related to the new hazardous waste landfill; the slurry walls, caps, and soil and concrete covers; all existing groundwater pump-and-treat systems; the groundwater pump-and-treat system to intercept the Section 36 Bedrock Ridge Plume; the maintenance of lake levels or other means of hydraulic containment; all monitoring activities required for the remedy; design refinement for on-post surficial soil as described in Section 9.4; and any revegetation and habitat restoration required as a result of remediation.

These activities are estimated to cost approximately \$5 million per year (in 1995 dollars). The principal and interest from the Trust Fund would be used to cover these costs throughout the lifetime of remedial program.

The Parties recognize that establishment of such a Trust Fund may require special legislation and that there are restrictions on the actions federal agencies can take with respect to proposing legislation and supporting proposed legislation. In addition to the legislative approach, the Parties are also examining possible options that may be adapted from trust funds involving federal funds that exist at other remediation sites. Because of the uncertainty of possible legislative requirements and other options, the precise terms of the Trust Fund cannot now be stated.

A trust fund group will be formed to develop a strategy to establish the Trust Fund. The strategy group may include representatives of the Parties (subject to restrictions on federal agency

participation), local governments, affected communities, and other interested stakeholders, and will be convened within 90 days of the signing of the ROD.

Notwithstanding these uncertainties, it is the intent of the Parties that if the Trust Fund is created it will include the following:

A clear statement that will contain the reasons for the creation of the Trust Fund and the purposes to be served by it.

A definite time for establishing and funding the Trust Fund, which the Parties believe could occur as early as 2008, when the remedial structures and systems may have been installed.

An appropriate means for competent and reliable management of the Trust Fund, including appropriate criteria for disbursements from the Trust Fund to ensure that the money will be properly used for the required purposes.

- Continued operation of the CERCLA Wastewater Treatment Plant to support the remediation activities.
- Stored, drummed waste identified in the waste management element of the CERCLA Hazardous Waste IRA may be disposed in the on-post hazardous waste landfill in accordance with the CDD (Harding Lawson Associates 1996).
- Continued monitoring, as part of design refinement, for areas that may pose a potential risk to biota as outlined in the following process:
 - The BAS of technical experts (such as ecotoxicologists, biologists, and range/reclamation specialists) from the Parties will focus on the planning and conduct of both the USFWS biomonitoring programs and the SFS/risk assessment process. The BAS will provide interpretation of results and recommendations for design refinements to the Parties' decision makers.
 - The ongoing USFWS biomonitoring programs and the SFS/risk assessment process will be used to refine design boundaries for surficial soil and aquatic contamination to be remediated.
 - Phase I and the potential Phase II of the SFS will be used to refine the general areas of surficial soil contamination concern. The field BMFs will be used to quantify ecological risks in the Area of Dispute, identify risk-based soil concentrations considered safe for biota, and thus refine the area of excess risks (Figure 6.2-6).
 - Pursuant to the FFA process, USFWS will conduct detailed site-specific exposure studies of contaminant effects and exposure (tissue levels and Army-provided abiotic sampling) on sentinel or indicator species of biota (including the six key species identified in the IEA/RC report as appropriate). These studies will address both the aquatic resources and at least the surficial soil in and around the Area of Dispute. These site-specific studies will be used in refining contamination impact areas in need of further remediation.
 - Results from both the SFS/risk assessment process and the site-specific studies will be considered in risk-management decisions, which may further refine the areas of surficial soil and aquatic contamination to be remediated. (In the event of a conflict between management of RMA as a wildlife refuge and performance of remedial response actions, the Rocky Mountain Arsenal National Wildlife Refuge Act indicates that response actions will take priority.)
 - The BAS will serve as a technical resource to the Parties' decision makers by using technical expertise in analyzing, and potentially collecting, data sufficient to support design refinement for surficial soil areas and aquatic resources that will break unacceptable exposure pathways in consideration of minimizing habitat disturbance. Further, it will assess through monitoring the efficacy of remedies in breaking unacceptable pathways to biota. If any additional sites are identified, the remedy will be implemented as follows:

- It will be staged to allow habitat recovery.
- It will be performed first on locations selected through a balance of factors such as:
 - The Parties agree an area has a negative impact on or excessive risk to fish or wildlife.
 - The effort will not be negated by recontamination from other remediation activities.
 - The existing fish and wildlife resource value.
- It will include revegetation of a type specified by USFWS; if the initial revegetation is not successful, the appropriate adjustments will be made and revegetation again implemented.
- It will provide that the locations and timing of remediation are to be determined with consideration of and in coordination with USFWS refuge management plans and activities.
- The SFS, biomonitoring programs, and recommendations of the BAS will be used to refine the areas of remediation during remedial design.
- Any UXO encountered during remediation will be excavated and transported off post for detonation (unless the UXO is unstable and must be detonated on post) or other demilitarization process.
- Within 180 days after issuance of the Notice of Availability for the ROD, the Army will append to the ROD a complete, detailed schedule for completion of activities associated with the selected remedy. The schedule will identify the enforceable project milestone dates for design activities. Future design documents will detail milestone dates for implementation activities. Revisions to this schedule will be initiated prior to the start of each fiscal year to allow adequate time for review and concurrence by the Parties.

9.5 Remediation Goals and Standards

The treatment components of the selected groundwater remedy will meet the CSRGs presented in Tables 9.1-1 through 9.1-4, and the components of the selected soil and structures remedy will meet the remediation goals and standards presented in Table 9.5-1. The selected remedies will comply with the performance standards as provided in Appendix A (ARARs).

9.6 Cost of the Selected Remedy

The total estimated cost (in 1995 dollars) for the selected remedy is \$2.2 billion (present worth \$1.8 billion). Table 9.6-1 presents the capital and O&M costs for the selected alternatives. The time required for implementation is approximately 17 years, with groundwater system operations continuing for at least 30 years. The implementation of the remedy could be accelerated if funding is available that exceeds \$100 million/year.

9.7 Long-Term Operations

Long-term operations are those ongoing activities that will be performed after the initial remediation work is completed and that will continue after EPA releases the site to USFWS as a wildlife refuge. These include monitoring and maintaining containment systems, such as the caps and the landfill, and continuing the operation of groundwater treatment systems.

Soil sites where covers or caps are constructed will be inspected on a regular basis, and damage to the vegetative cover or any eroded soil will be repaired. Long-term management also includes access restrictions to capped and covered areas to ensure the integrity of the containment systems. Where human health exceedances are left in place at soil sites, groundwater will be monitored, as necessary, to evaluate the effectiveness of the remedy. The on-site hazardous waste landfill will be closed and monitored according to RCRA and TSCA requirements. Long-term activities at this facility will include leachate collection and disposal, regular cover inspections with repair of vegetative cover damage or erosion, and sampling of upgradient and downgradient wells to monitor for migration of landfill contaminants into the groundwater. Monitoring activities for biota will continue by USFWS in support of evaluating the effectiveness of the selected remedy.

Long-term activities for the water medium include continued operation of the NWBCS, NBCS, ICS, the Basin A Neck and North of Basin F Groundwater IRA systems, and the new Section 36 Bedrock Ridge groundwater Extraction System. Operation of wells within these systems may be discontinued according to the shutdown criteria listed in Section 9.1. Maintenance of lake levels and groundwater monitoring will be continued as described in Section 9.1.

A network of monitoring wells will be sampled to evaluate the effectiveness of the remedy. A select number of deep wells will also be sampled to monitor any contamination in the confined aquifer. Surface water will be monitored and managed in a manner consistent with the selected remedy.

There are no long-term activities directly associated with the structures medium groups as all potentially contaminated structures will be demolished and the structural debris placed into the on-post hazardous waste landfill or used as fill under the Basin A cover. These sites will be monitored and maintained as described above.

Technical working groups or subcommittees will combine their efforts to evaluate the effectiveness of the remedy and make recommendations to the Parties' decision makers. In addition, site reviews will be conducted at least every 5 years (following the signing of the ROD) for all sites where contaminants that exceed remediation goals are left in place. The effectiveness of containment remedies will be evaluated to determine what additional remedial actions may be required if containment is found to be inadequate. In the event other contaminants not included as COCs are identified as a concern (e.g., dioxin) during or after design or implementation, an evaluation will be conducted as required by EPA guidance (OSWER-EPA 1989a) to ensure that the remedial action is protective of human health and the environment. At a minimum, evaluations will be part of the 5-year site review.

Record of Decision for the On-Post Operable Unit



LEGEND

- Boundary System
- Treatment System
- Existing IRA
- Slurry Wall
- Groundwater extraction well
- Capped/Covered Area

- North Boundary Plume Group
 - ① Basins C and F Plume
 - ② North Plants Plume
- Northwest Boundary Plume Group (Outlined in blue:)
 - ③ Basin A Neck Plume
 - ④ & ⑤ Sand Creek Lateral Plumes
- Western Plume Group
 - ⑥ Western Plume (Outlined in yellow:)
 - ⑦ Motor Pool Plume
 - ⑧ Rail Yard Plume
- Basin A Plume Group
 - ⑨ South Plants North Plume
 - ⑩ Basin A Plume
 - ⑪ Section 36 Bedrock Ridge Plume
- South Plants Plume Group
 - ⑫ South Plants North Source Plume
 - ⑬ South Plants Southeast Plume
 - ⑭ South Plants Southwest Plume
 - ⑮ South Tank Farm Plume

† Colored portions of plumes indicate summed total organic concentrations above 100 ug/L.



0 3000
Scale in Feet

Prepared for:
Office of the Program Manager
for Rocky Mountain Arsenal
June 1998

FIGURE 9.1-1
Alternative 4: Continued Operation of Existing
Boundary Systems and 30a and Extraction from
Section 36 Bedrock Ridge

Prepared by:
Foster Wheeler Environmental Corporation



Legend

- RMA Boundary
 - SAR Site Boundary¹
 - In-situ Solidification of Principal Threat Volume; RCRA—Equivalent Cap
 - RCRA—Equivalent Caps
 - Direct Solidification/Stabilization
 - Innovative Thermal Treatment (Hex Fin)
 - Basin A Consolidation Area
 - Landfill Human Health Soil,² Consolidation of Biota Soil
 - Landfill Human Health Soil³
 - Landfill Site
 - Soil Covers
 - Agent Screening Area (Caustic wash/landfill)
 - UXO Screening Area (Detonation/landfill)
 - Surficial Soil Consolidation
 - Access Restrictions
 - Section Number
- ¹ Study Area Report (see Remedial Investigation Summary Report, Ebasco 1992a)
- ² Debris from the Sanitary Landfills Medium Group will be consolidated.
- ³ Wastepile material will be dried prior to landfilling, if necessary, to pass EPA paint filter test.
- 1000 0 1000 3000 Feet

Prepared for: U.S. Army Program Manager for
Rocky Mountain Arsenal

Figure 9.3-1

Selected Soil Remedy
Consolidation/Caps/Treatment/Landfill

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June 1998



Legend

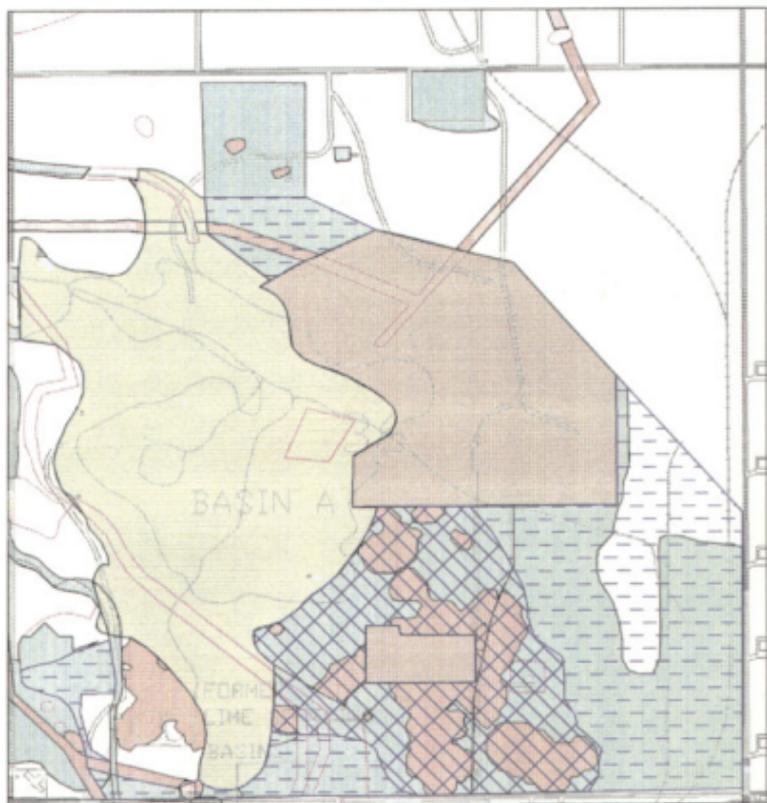
- | | | | |
|---|--|---|--|
|  | Former Basin F Solidification Area |  | SAR Site Boundary
(Study Area Report; see
Remedial Investigation Summary
Report, Ebasco 1992a.) |
|  | RCRA-Equivalent Cap |  | Section Number |
|  | Human Health and Principal
Threat Excavation Area |  | Section Line |
|  | Biota Excavation Area |  | Drainage |
|  | Basin F Wastepile Excavation |  | Road |
|  | 2-Foot Soil Cover Area |  | Railroad |



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Prepared June 1996

Figure 9.3-2
Section 26 Excavation Areas and
Cap/Cover Components

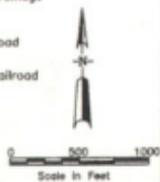
Rocky Mountain Arsenal
Prepared by: Foster Wheeler Environmental Corp.



Legend

-  Basin A Consolidation Area with 4-Foot Soil Cover/6-Inch Concrete Layer
-  RCRA-Equivalent Caps
-  Human Health and Principal Threat Excavation Area
-  Biota Excavation Area
-  2-Foot Soil Cover Area
-  1-Foot Soil Cover Area

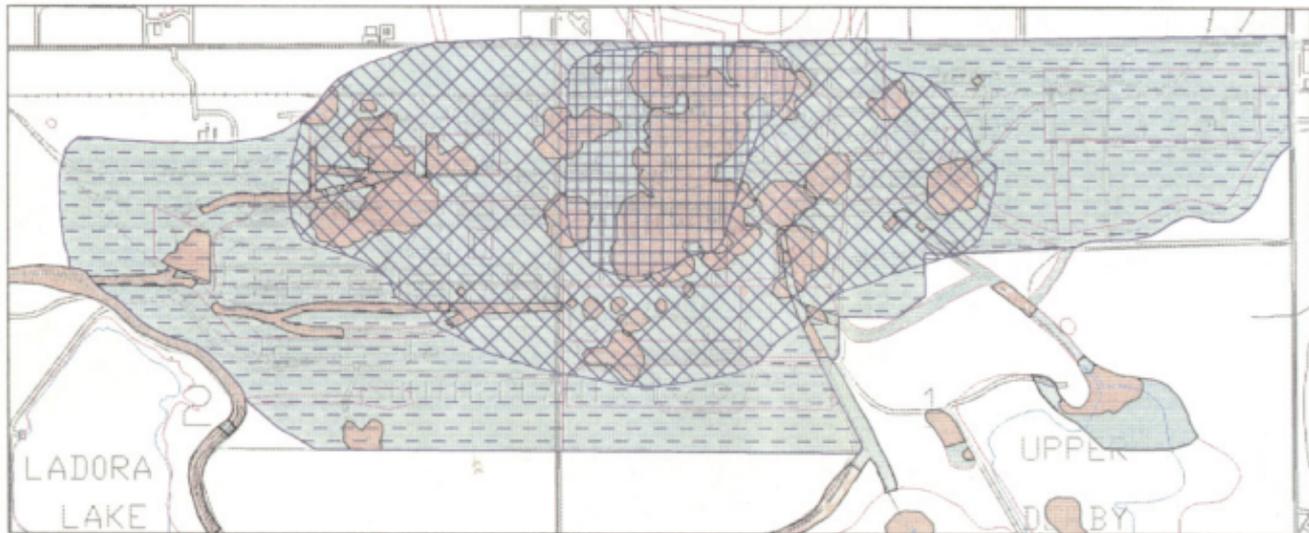
-  SAR Site Boundary (Study Area Report; see Remedial Investigation Summary Report, Ebasco 1992a.)
-  31 Section Number
-  Section Line
-  Drainage
-  Road
-  Railroad



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Prepared June 1996

Figure 9.3-3
Section 36 Excavation Areas and
Cap/Cover Components

Rocky Mountain Arsenal
Prepared by: Foster Wheeler Environmental Corp.



Legend

-  Human Health and Principal Threat Excavation Area
-  Biota Excavation Area
-  South Plants Central Processing Area Cover (4-foot soil cover with biota barrier)
-  3-Foot Soil Cover Area
-  1-Foot Soil Cover Area

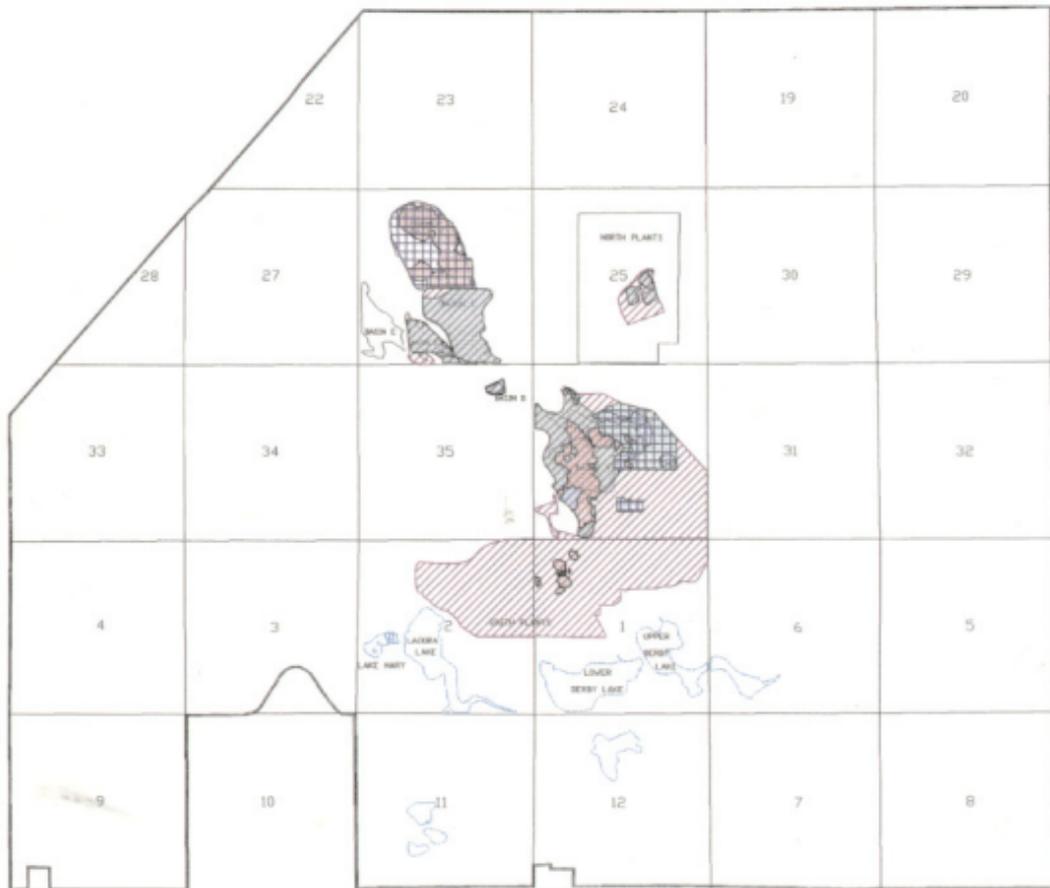
-  SAR Site Boundary (Study Area Report; see Remedial Investigation Summary Report, Ebasco 1992a.)
-  Section Number
-  Section Line
-  Drainage
-  Road
-  Railroad



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 Prepared June 1996

Figure 9.3-4
 South Plants Excavation Areas and
 Cover Components

Rocky Mountain Arsenal
 Prepared by: Foster Wheeler Environmental Corp.



Legend

-  Principal Threat Exceedance Area
-  Human Health Exceedance Area¹
-  Biotox Exceedance Area
-  RCRA-Equivalent Cap²
-  Soil Cover^{2, 3}
- 31 Section Number
- Section Line

¹ Exceedance soil in South Plants Central Processing Area remains below the 5-ft depth of excavation.

² RCRA-equivalent caps and Basin A and South Plants Central Processing Area soil covers include a biotox-intrusion layer.

³ Soil covers vary in thickness from 1 to 4 ft.



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Prepared June 1996

Figure 9.3-5
Containment Systems for Exceedances
Remaining in Place following Remediation

Rocky Mountain Arsenal
Prepared by: Foster Wheeler Environmental Corp.

Table 9.1-1 CSRGs for the Northwest Boundary Containment System

Chemical Group/Compound	Containment System Remediation Goals (µg/l)	
VHOs (Volatile Halogenated Organics)		
Trichloroethylene	3 ¹	
Chloroform	6 ²	
OPHBGs (Organophosphorous Compounds; Isopropylmethyl Phosphonofluoridate (GB) Agent Related)		
DIMP (Diisopropylmethyl phosphonate)	8 ²	
Other Organics		
NDMA (n-Nitrosodimethylamine)	0.007 ⁴	(0.033) ³
OCPs (Organochlorine Pesticides)		
Dieldrin	0.002 ²	(0.05) ³
Endrin	0.2 ²	
Isodrin	0.06 ¹	
Arsenic	2.35 ¹	

¹ Health-based value from the ROD for the Off-Post Operable Unit (Harding Lawson Associates 1995).

² Colorado Basic Standards for Groundwater. The Basic Standards for Groundwater, 5 CCR 1002.8, Section 3.11.

³ Current certified reporting limit or practical quantitation limit readily available from a certified commercial laboratory.

⁴ Risk-based value from Integrated Risk Information System (OHEA-EPA 1995).

Table 9.1-2 CSRGs for the Irondale Containment System

Chemical Group/Compound	Containment System Remediation Goals ($\mu\text{g/l}$)
VHOs (Volatile Halogenated Organics) Trichloroethylene	5 ^{1,2}
Other Organics DBCP (Dibromochloropropane)	0.2 ^{1,2}

Colorado Basic Standards for Groundwater. The Basic Standards for Groundwater, 5 CCR 1002.8, Section 3.11.
Federal maximum contaminant levels, 40 CFR 141.

Table 9.1-3 CSRGs for the North Boundary Containment System

Chemical Group/Compound	Containment System	Remediation Goals
	(µg/l)	
VHOs (Volatile Halogenated Organics)		
1,2-Dichloroethane	0.4 ¹	(1.0) ⁵
1,2-Dichloroethylene	70 ^{1,2}	
Carbon tetrachloride	0.3 ¹	(0.99) ⁵
Chloroform	6 ¹	
Methylene chloride	5 ^{1,2,6,7}	
Tetrachloroethylene	5 ^{1,2}	
Trichloroethylene	3 ³	
VHCs (Volatile Hydrocarbon Compounds)		
DCPD (Dicyclopentadiene)	46 ³	
VAOs (Volatile Aromatic Organics)		
Benzene	3 ³	
Xylenes	1,000 ³	
Toluene	1,000 ^{1,2}	
OSCMs (Organosulfur Compounds; Mustard Agent Related)		
1,4-Oxathiane	160 ³	
Dithiane	18 ³	
OSCHs (Organosulfur Compounds; Herbicide Related)		
Chlorophenylmethyl sulfide	30 ⁴	
Chlorophenylmethyl sulfone	36 ⁴	
Chlorophenylmethyl sulfoxide	36 ⁴	
OPHGBs (Organophosphorous Compounds; Isopropylmethyl Phosphonofluoridate (GB) Agent Related)		
DIMP (Diisopropylmethyl phosphonate)	8 ¹	
OPHPs (Organophosphorous Compounds; Pesticide Related)		
Atrazine	3 ^{1,2}	
Malathion	100 ³	

Table 9.1-3 CSRGs for the North Boundary Containment System

Chemical Group/Compound	Containment System	Remediation Goals (µg/l)
OCPs (Organochlorine Pesticides)		
Aldrin	0.002 ¹	(0.05) ⁵
Dieldrin	0.002 ¹	(0.05) ⁵
Endrin	0.2 ¹	
Isodrin	0.06 ³	
Other Organics		
DBCP (Dibromochloropropane)	0.2 ^{1,2}	
NDMA (N-Nitrosodimethylamine)	0.007 ⁶	(0.033) ⁵
Arsenic	2.35 ³	
Anions		
Fluoride	2,000 ^{1, 10}	
Chloride	250,000 ^{1, 8}	
Sulfate	540,000 ^{1, 8, 9}	

¹ Colorado Basic Standards for Groundwater. The Basic Standards for Groundwater, 5 CCR 1002.8, Section 3.11.
² Federal maximum contaminant levels, 40 CFR 141.
³ Health-based value from the ROD for the Off-Post Operable Unit (Harding Lawson Associates 1995).
⁴ EPA Region VIII Health Advisory value.
⁵ Current certified reporting limit or practical quantitation limit readily available from a certified commercial laboratory.
⁶ Risk-based level from the Integrated Risk Information System (OHEA-EPA 1995).
⁷ Methylene chloride is a common laboratory contaminant and analytical anomalies may be observed during compliance monitoring.
⁸ As described in Section 7.2.2, chloride and sulfate are expected to attenuate naturally, achieving remediation goals with time.
⁹ Inorganic CSRG for sulfate may be the natural background concentration.
¹⁰ The federal MCL for fluoride is 4,000 µg/l.

Table 9.1-4 CSRGs for the Basin A Neck IRA Treatment System

Chemical Group/Compound	Containment System Remediation Goals (µg/l)	
VHOs (Volatile Halogenated Organics)		
1,2-Dichloroethane	0.4 ¹	(1.1) ⁴
1,1,1-Trichloroethane	200 ^{1,2}	
1,1-Dichloroethylene	7 ^{1,2}	
Carbon tetrachloride	0.3 ¹	(1.0) ⁴
Chlorobenzene	100 ^{1,2}	
Chloroform	6 ¹	
Tetrachloroethylene	5 ^{1,2}	
Trichloroethylene	5 ^{1,2}	
VHCs (Volatile Hydrocarbon Compounds)		
Dicyclopentadiene	46 ³	
VAOs (Volatile Aromatic Organics)		
Benzene	5 ^{1,2}	
OPHPs (Organophosphorus Compounds; Pesticide Related)		
Atrazine	3 ^{1,2}	
SHOs (Semivolatile Halogenated Organics)		
Hexachlorocyclopentadiene	50 ¹	
OCPs (Organochlorine Pesticides)		
DDT (Dichlorodiphenyltrichloroethane)	0.1 ¹	
Dieldrin	0.002 ¹	(0.1) ⁴
Endrin	0.2 ¹	
OSCHs (Organosulfur Compounds; Herbicide Related)		
Chlorophenylmethylsulfide	30 ³	
Chlorophenylmethylsulfone	36 ³	
Chlorophenylmethylsulfoxide	36 ³	
Dicyclopentadiene	46 ³	
OSCMs (Organosulfur Compounds; Mustard Agent Related)		
1,4-Oxathiane	160 ³	
Dithiane	18 ³	

Table 9.1-4 CSRGs for the Basin A Neck IRA Treatment System

Chemical Group/Compound	Containment System Remediation Goals (µg/l)
Arsenic	50 ^{1,2}
Mercury	2 ^{1,2}

¹ Colorado Basic Standards for Groundwater. The Basic Standards for Groundwater, 5 CCR 1002.8, Section 3.11.

² Federal maximum contaminant levels, 40 CFR 141.

³ Health-based value from the ROD for the Off-Post Operable Unit (Harding Lawson Associates 1995).

⁴ Current practical quantitation limit or certified reporting limit.

Medium Groups/Subgroups	Remedial Action
Munitions Testing	Munitions screening; off-post detonation of UXO (450 BCY); landfill debris and soil above TCLP (89,000 BCY).
North Plants	Landfill human health exceedance (220 BCY); agent monitoring during excavation; caustic washing; construct soil cover over biota risk area and processing area footprint (160,000 SY).
Toxic Storage Yards	Landfill human health exceedance (2,700 BCY); utilize New Toxic Storage Yard for borrow area; agent monitoring during site excavation and preparation; caustic washing.
Lake Sediments	Landfill human health exceedances (19,000 BCY); consolidate soil posing risk to biota from Upper Derby Lake (19,000 BCY) into Basin A or South Plants; deferral to USFWS for aquatic sediment.
Surficial Soil	Landfill human health exceedances (87,000 BCY); consolidate soil posing risk to biota in Basin A/Former Basin F/South Plants (460,000 BCY).
Ditches/Drainage Areas	Consolidate soil posing risk to biota in Basin A (23,000 BCY).
Basin A	Construct soil cover with formed concrete layer over principal threat and human health exceedances and soil posing risk to biota (670,000 SY); consolidate debris and soil posing risk to biota (790,000 BCY) and structural debris (160,000 BCY) from other sites.
Basin F Wastepile	Landfill entire wastepile (principal threat exceedance) (600,000 BCY) in triple-lined cell (with vapor controls) after drying saturated materials.
Former Basin F	In situ solidification/stabilization of principal threat volume (180,000 BCY); construct RCRA-equivalent cap over entire site (including Basin F Wastepile footprint) (525,000 SY).
Secondary Basins	Landfill human health exceedances (32,000 BCY); construct soil cover over soil posing risk to biota (520,000 SY).
Sanitary/Process Water Sewers	Plug remaining manholes.
Chemical Sewers	Plug sewer lines in South Plants Central Processing Area and Complex Trenches; landfill remaining principal threat and human health exceedances (64,000 BCY).
Complex Trenches	Construct RCRA-equivalent cap with formed concrete layer over principal threat and human health exceedances and soil posing risk to biota (390,000 SY) and install a slurry wall around disposal trenches.
Shell Trenches	Modify existing cover to be a RCRA-equivalent cap (32,000 SY) and modify existing slurry wall around trenches.

Medium Groups/Subgroups	Remedial Action
Hex Pit	Treatment of buried material (1,000 BCY) using an innovative thermal technology (with vapor controls); landfill remaining volume (2,300 BCY). Solidification/stabilization will become the selected remedy if all evaluation criteria for the innovative thermal technology are not met.
Sanitary Landfills	Landfill human health exceedances (14,000 BCY); consolidate debris and soil posing risk to biota in Basin A (410,000 BCY).
Section 36 Lime Basins	Landfill principal threat and human health exceedances in triple-lined cell (54,000 BCY); repair existing soil cover. ¹
Buried M-1 Pits	Solidification of principal threat and human health exceedances (26,000 BCY) and landfill (with vapor controls). ¹
South Plants Central Processing Area	Landfill principal threat and human health exceedances (110,000 BCY); construct soil cover over entire site including soil posing risk to biota (220,000 SY); consolidate soil posing risk to biota from other sites (370,000 BCY). ¹
South Plants Ditches	Landfill principal threat and human health exceedances (33,000 BCY); consolidate soil posing risk to biota into excavated areas or South Plants Central Processing Area (22,000 BCY); construct soil cover over entire site (120,000 SY).
South Plants Balance of Areas	Landfill principal threat and human health exceedances (130,000 BCY); consolidate soil posing risk to biota into excavated areas or South Plants Central Processing Area (510,000 BCY); construct soil cover over entire site (1,700,000 SY). ^{1,2}
Buried Sediments	Landfill human health exceedances (16,000 BCY).
Sand Creek Lateral	Landfill human health exceedances (15,000 BCY); consolidate soil posing risk to biota into Basin A (90,000 BCY).
Section 36 Balance of Areas	Landfill human health exceedances and debris (140,000 BCY); consolidate soil posing risk to biota into Basin A (140,000 BCY); construct soil cover over entire site (850,000 SY). ^{1,2}
Burial Trenches	Landfill human health exceedances and debris (85,000 BCY). ^{1,2}
Contingent Volume	Landfill identified volume (up to 150,000 BCY).

¹ Agent monitoring during excavation and treatment of any soil containing agent by caustic solution washing.

² Munitions screening prior to excavation, off-post detonation of any munitions encountered, and landfill munitions debris/soil above TCLP.

Table 9.3-2 Final Disposition of Soil Exceedance Volumes¹

Medium Group/Subgroup	RCRA Landfill ²	Enhanced RCRA Landfill ²	Consolidation in Basin A	Consolidation in Basin F	Consolidation within South Plants	Treatment ³	Caustic Washing and Landfill	UXO Demilitarization Off Post
Munitions Testing	89,000							450
North Plants	220						61	
Toxic Storage Yards	2,700						220	
Lake Sediments	19,000		19,000					
Ditches/Drainage Areas			23,000					
Surficial Soil	87,000		109,000	351,000				
Basin A								5
Basin F Wastepile		600,000						
Secondary Basins	32,000							
Former Basin F ³						180,000		
Sanitary/Process Water Sewers								
Chemical Sewers	64,000						20	
Complex Trenches								130
Shell Trenches								
Hex Pit ³	2,300					1,000		
Sanitary Landfills	14,000		406,000					
Section 36 Lime Basins		54,000					91	
Buried M-1 Pits ³						26,000	29	
South Plants Central Processing Area	110,000						160	
South Plants Ditches	33,000				22,000			
South Plants Balance of Areas	135,000				510,000		160	50
Buried Sediments	16,000							
Sand Creek Lateral	15,000		90,000					
Section 36 Balance of Areas	142,000		140,000				300	160
Burial Trenches	85,000							550
Totals	847,000	654,000	787,000	351,000	532,000	207,000	1,040	1,340

¹ All volumes given in bank cubic yards. The soil volumes referenced in this table are summarized in Table 7.1-5, and are based on the TECHBASE software and other calculations. All soil volumes referenced in this table are subject to the addition of "contingent volumes" based on findings during implementation of remedial activities.

² Landfill volume does not include contingent soil volume (up to 150,000 BCY), structures demolition debris, treated material volume, or landfill daily cover.

³ Treatment detailed as follows: Former Basin F, in situ solidification; Hex Pit, innovative thermal; Buried M-1 Pits, solidification and landfill.

Table 9.3-3 Untreated Soil Exceedance Volumes Remaining In Place^{1,2}

Medium Group/Subgroup	Human Health	Principal Threat	Biota	Agent	UXO	UXO Debris	Consolidated Soil from Other Sites	Total Volume Remaining in Place
Munitions Testing								
North Plants			17,000					17,000
Toxic Storage Yards								
Lake Sediments								
Ditches/Drainage Areas								
Surficial Soil								
Basin A	160,000	32,000	88,000	710	89	47000 ³	787,000	1,080,000
Basin F Wastepile								
Secondary Basins			140,000					140,000
Former Basin F	560,000						351,000	911,000
Sanitary/Process Water Sewers								
Chemical Sewers	21,500	11,500		49				21,500
Complex Trenches	400,000	400,000		1,300	1,170	130,000 ⁴		532,000
Shell Trenches	100,000	100,000						100,000
Hex Pit								
Sanitary Landfills								
Section 36 Lime Basins								
Buried M-I Pits								
South Plants Central Processing Area	32,000 ⁵	17,000 ⁵	27,000				370,000	429,000
South Plants Ditches								
South Plants Balance of Areas							162,000	162,000
Buried Sediments								
Sand Creek Lateral								
Section 36 Balance of Areas								
Burial Trenches				12				
Totals	1,270,000	561,000	272,000	2,070	1,260	177,000	1,670,000	3,390,000

¹ All volumes given in bank cubic yards.² All volumes remaining in place are contained beneath soil covers or caps.³ Debris volume remaining includes 17,000 BCY human health exceedance volume and 30,000 BCY of biota risk volume.⁴ Debris volume remaining includes 43,000 BCY human health exceedance volume and 87,000 BCY of biota risk volume.⁵ Remaining volume at a depth greater than 5 ft.

Table 9.3-4 Cap and Soil Cover Components¹

Medium Group/Subgroup	RCRA-Equivalent Caps	Soil Covers			
		4 ft minimum thickness	3 ft minimum thickness	2 ft minimum thickness	1 ft minimum thickness
Munitions Testing					
North Plants				157,000	
Toxic Storage Yards					
Lake Sediments					
Ditches/Drainage Areas					
Surficial Soil					
Basin A ²		667,000			
Basin F Wastepile					
Secondary Basins				523,000	
Former Basin F	525,000				
Sanitary/Process Water Sewers					
Chemical Sewers					
Complex Trenches ²	390,000				
Shell Trenches	32,000				
Hex Pit					
Sanitary Landfills					
Section 36 Lime Basins					
Buried M-1 Pits					
South Plants Central Processing Area		230,000			
South Plants Ditches ³					
South Plants Balance of Areas			826,000		1,010,000
Buried Sediments					
Sand Creek Lateral					
Section 36 Balance of Areas				345,000	506,000
Burial Trenches					
Totals	947,000	897,000	826,000	1,030,000	1,520,000

¹ All areas given in square yards.² Cap or cover includes a 6-inch formed concrete layer.³ South Plants Ditches sites are included under the South Plants Balance of Areas cover area.

Table 9.5-1 Remediation Goals and Standards for the On-Post Operable Unit

Technology	Medium Group/Subgroup	Remediation Goals ¹ and Standards ²	Primary Components of Rationale ³
RCRA/TSCA Hazardous Waste Landfill	Munitions Testing; Secondary Basins; Chemical Sewers; Sanitary Landfills; South Plants Central Processing Area; South Plants Ditches; South Plants Balance of Areas; Buried Sediments; Sand Creek Lateral; Section 36 Balance of Areas; Burial Trenches; Buried M-1 Pits; Hex Pit; North Plants; Toxic Storage Yards; Lake Sediments; Surficial Soil; No Future Use Structures, Significant Contamination History; No Future Use Structures, Agent History	Landfill <ul style="list-style-type: none"> • Standard: Landfill principal threat and human health soil exceedance volumes, UXO debris, agent-contaminated material, and structural debris. • Standard: Design landfill to meet state 1,000-year siting criteria. • Standard: Ensure all material disposed in landfill passes EPA paint filter test. Cap <ul style="list-style-type: none"> • Standard: Minimize infiltration by limiting the hydraulic conductivity of the clay/synthetic composite barrier layer (1×10^{-7} cm/sec or less for clay layer). • Standard: Meet or exceed all RCRA, TSCA, and state requirements. Liner <ul style="list-style-type: none"> • Standard: Minimize percolation by limiting the hydraulic conductivity of the compacted clay layer to 1×10^{-7} cm/sec or less. • Standard: Install two composite liners, each consisting of 3 ft of compacted clay and a synthetic liner. • Standard: Meet or exceed all RCRA, TSCA, and state requirements. 	RCRA/TSCA regulations; State RCRA regulations; CAMU Designation Document

Table 9.5-1 Remediation Goals and Standards for the On-Post Operable Unit

Technology	Medium Group/Subgroup	Remediation Goals ¹ and Standards ²	Primary Components of Rationale ³
Enhanced RCRA Hazardous Waste Landfill	Basin F Wastepile; Section 36 Lime Basins	<p>Landfill</p> <ul style="list-style-type: none"> • Standard: Landfill principal threat and human health soil exceedance volumes and agent-contaminated material. • Standard: Design landfill to meet state 1,000-year siting criteria. • Standard: Ensure all material disposed in landfill passes EPA paint filter test. <p>Cap</p> <ul style="list-style-type: none"> • Standard: Minimize infiltration by limiting the hydraulic conductivity of the clay/synthetic composite barrier layer (1×10^{-7} cm/sec or less for clay layer). • Standard: Meet or exceed all RCRA, TSCA, and state requirements. <p>Enhanced liner</p> <ul style="list-style-type: none"> • Standard: Minimize percolation by limiting the hydraulic conductivity of the compacted clay layer to 1×10^{-7} cm/sec or less. • Standard: Install two composite liners, each consisting of 3 ft of compacted clay and a synthetic liner, and one additional composite liner. • Standard: Meet or exceed all RCRA and state requirements. 	RCRA regulations; State RCRA regulations; CAMU Designation Document

Table 9.5-1 Remediation Goals and Standards for the On-Post Operable Unit

Technology	Medium Group/Subgroup	Remediation Goals ¹ and Standards ²	Primary Components of Rationale ³
RCRA-Equivalent Cap	Former Basin F; Complex (Army) Trenches w/concrete layer; Shell Trenches	<ul style="list-style-type: none"> • Ensure cap performance is equivalent to RCRA landfill cap with these objectives: <ul style="list-style-type: none"> – Standard: Allow no greater range of infiltration through the cap than the range of infiltration that would pass through an EPA-approved RCRA cap. – Standard: Prevent contact between hazardous materials and humans/biota by using biota barriers and maintaining institutional controls. – Goal: Serve as effective long-term barriers. – Standard: Demonstrate cap performance equivalent to a RCRA landfill cap according to an EPA- and state-approved demonstration that will include comparative analysis and field demonstration. • Goal: Maximize runoff and minimize ponding. • Standard: Maintain cover percolation less than or equal to the percolation of the underlying native soil. • Goal: Minimize erosion by wind and water. • Goal: Prevent damage to integrity of cap by biota and humans. • Goal: Maintain cover of locally adapted perennial vegetation. 	State and federal RCRA regulations
UXO Clearance	Munitions Testing; Basin A; Section 36 Balance of Areas; Complex (Army) Trenches; Burial Trenches; South Plants Balance of Areas	<ul style="list-style-type: none"> • Standard: Identify, transport off post, neutralize, and destroy explosives/explosive residue. • Standard: Ensure excavation of all identified munitions-contaminated soil exceeding TCLP (Munitions Testing and Burial Trenches) and munitions debris and disposal in the on-post RCRA landfill. 	Army surety safety and UXO regulations

Table 9.5-1 Remediation Goals and Standards for the On-Post Operable Unit

Technology	Medium Group/Subgroup	Remediation Goals ¹ and Standards ²	Primary Components of Rationale ³
Agent Decontamination	North Plants; Toxic Storage Yard; Section 36 Balance of Areas; Buried M-1 Pits; Burial Trenches; South Plants Central Processing Area; South Plants Balance of Areas; Section 36 Lime Basins; Chemical Sewers; No Future Use Structures, Agent History	<ul style="list-style-type: none"> • Standard: Certify 3X decontamination or caustic wash of soil and structural debris to achieve 3X decontamination. • Standard: Ensure disposal of 3X-decontaminated soil and structural debris in the on-post RCRA landfill. 	Army surety safety regulations
Soil Cover (South Plants Consolidation Area)	South Plants Central Processing Area; South Plants Ditches; South Plants Balance of Areas	<ul style="list-style-type: none"> • Standard: Consolidate biota soil exceedance volume in South Plants Central Processing Area. • Standard: Maintain minimum cover thickness of 4 ft. • Goal: Minimize infiltration through cover. • Goal: Maximize runoff and minimize ponding. • Standard: Maintain cover percolation less than or equal to the percolation of the underlying native soil. • Goal: Minimize erosion by wind and water. • Goal: Prevent damage to integrity of cover by biota and humans. • Standard: Prevent biota and humans from accessing underlying contaminated soil by using biota barriers and maintaining institutional controls. • Goal: Maintain cover of locally adapted perennial vegetation. 	Detailed Analysis of Alternatives; EPA guidance

Table 9.5-1 Remediation Goals and Standards for the On-Post Operable Unit

Technology	Medium Group/Subgroup	Remediation Goals ¹ and Standards ²	Primary Components of Rationale ³
Soil Cover with Concrete Layer (Basin A Consolidation Area)	Basin A; Lake Sediments; Surficial Soil; Section 36 Balance of Areas; Sand Creek Lateral; Sanitary Landfills; Ditches/Drainage Areas; No Future Use Structures, Other Contamination History	<ul style="list-style-type: none"> • Standard: Consolidate biota soil exceedence volume and structural debris in Basin A. • Standard: Maintain minimum cover thickness of 4 ft. • Goal: Maximize runoff and minimize ponding. • Standard: Maintain cover percolation less than or equal to the percolation of the underlying native soil. • Goal: Minimize erosion by wind and water. • Goal: Prevent damage to integrity of cover by biota and humans. • Standard: Prevent biota and humans from accessing underlying contaminated soil by using biota barriers and maintaining institutional controls. • Goal: Maintain cover of locally adapted perennial vegetation. 	Detailed Analysis of Alternatives; EPA guidance
Soil Cover	Secondary Basins; North Plants; South Plants Ditches; South Plants Balance of Areas; Section 36 Balance of Areas	<ul style="list-style-type: none"> • Standard: Maintain minimum cover thicknesses specified in Section 9.3 of ROD. • Goal: Maximize runoff and minimize ponding. • Standard: Maintain cover percolation less than or equal to the percolation of the underlying native soil. • Goal: Minimize erosion by wind and water. • Goal: Prevent damage to integrity of cover by biota. • Standard: Prevent humans from accessing underlying contaminated soil by maintaining institutional controls. • Goal: Maintain cover of locally adapted perennial vegetation. 	Detailed Analysis of Alternatives; EPA guidance
Solidification/Stabilization	Former Basin F	<ul style="list-style-type: none"> • Standard: Comply with requirements of Basin F closure plan and design documents. 	State RCRA regulations; EPA guidance

Table 9.5-1 Remediation Goals and Standards for the On-Post Operable Unit

Technology	Medium Group/Subgroup	Remediation Goals ¹ and Standards ²	Primary Components of Rationale ³
Innovative Thermal Technology	Hex Pit	<ul style="list-style-type: none"> • Standard: Design to achieve 90% or greater destruction of contaminants. • Standard: Landfill all treatment residuals and untreated material in the on-post hazardous waste landfill. 	EPA guidance
Solidification/Stabilization	Buried M-1 Pits	<ul style="list-style-type: none"> • Standard: Design to reduce contaminant concentrations in leachate; a 90 to 99% reduction in contaminant concentrations in leachate is a general guidance and may be varied within a reasonable range considering the effectiveness of the technology and the cleanup goals for the site. • Goal: Design treatability testing to achieve a 90% reduction in contaminant concentrations in leachate. • Standard: Landfill all solidified material in the on-post RCRA landfill. • Standard: Provide adequate unconfined compressive strength after solidification/stabilization to meet disposal requirements. 	EPA guidance
Plugging	Sanitary/Process Water Sewers; Chemical Sewers	<ul style="list-style-type: none"> • Standard: Interrupt exposure pathway by permanently plugging all Sanitary Sewer manholes. • Standard: Interrupt exposure pathway by permanently plugging all chemical sewer lines and manholes not excavated. 	Detailed Analysis of Alternatives

Technology	Medium Group/Subgroup	Remediation Goals ¹ and Standards ²	Primary Components of Rationale ³
Slurry Wall	Complex (Army) Trenches; Shell Trenches	<ul style="list-style-type: none"> • Goal: Minimize groundwater flow across the slurry wall with a design goal 1×10^{-7} cm/sec hydraulic conductivity. • Goal: Construct slurry wall with sufficient thickness to withstand maximum hydraulic gradient. • Goal: Construct slurry wall with materials that are compatible with the surrounding groundwater chemistry. • Goal: Minimize migration by keying the slurry wall in an underlying low permeability strata. • Goal: Dewater as necessary to ensure containment. 	Detailed Analysis of Alternatives
Drying	Basin F Wastepile	<ul style="list-style-type: none"> • Standard: Ensure dried material passes EPA paint filter test. • Standard: Comply with requirements of Basin F closure plan and design documents. 	State regulations
Excavation	Munitions Testing; Secondary Basins; Chemical Sewers; Sanitary Landfills; South Plants Central Processing Area; South Plants Ditches; South Plants Balance of Areas; Buried Sediments; Sand Creek Lateral; Section 36 Balance of Areas; Burial Trenches; Hex Pit Buried M-1 Pits; North Plants; Toxic Storage Yards; Lake Sediments; Section 36 Lime Basins; Surficial Soil; Ditches/Drainage Areas; Basin F Wastepile	<ul style="list-style-type: none"> • Standard: Excavate all contaminated soil identified in the ROD for treatment, landfilling, or consolidation that corresponds to the areal and vertical extent detailed by the soil volume calculations in the administrative record. 	State regulations; EPA guidance

Table 9.5-1 Remediation Goals and Standards for the On-Post Operable Unit

Technology	Medium Group/Subgroup	Remediation Goals ¹ and Standards ²	Primary Components of Rationale ³
PCB Removal		<p>Equipment</p> <ul style="list-style-type: none"> • Standard: Remediate in accordance with PCB IRA requirements. <p>Structures</p> <ul style="list-style-type: none"> • Standard: Remove structural materials with PCB concentrations of 50 ppm or greater that exist above ground level, as well as contaminated parts of floor slabs and foundations identified for removal, and dispose in the on-post TSCA-compliant landfill. • Standard: PCB-contaminated sections of floor slabs or foundations that are not identified for removal, and that have PCB concentrations of less than 50 ppm, will be left in place. <p>Soil</p> <ul style="list-style-type: none"> • Standard: Interrupt exposure pathway with a minimum of 3 ft of soil in the five areas identified as having PCB contamination <250 ppm. • Standard: Removal of contamination >250 ppm in the three areas identified by the PCB IRA and disposal in on-post TSCA-compliant landfill. • Standard: If necessary, any suspected PCB soil contamination areas will be characterized further during remedial design. If additional PCB-contaminated soil is found with concentrations of 50 ppm or greater, the Army will determine any necessary remedial action in consultation with EPA. 	TSCA PCB regulations
Asbestos Removal		<ul style="list-style-type: none"> • Standard: Removal of asbestos and ACM to attain TSCA requirements. 	TSCA asbestos regulations; State regulations

Table 9.5-1 Remediation Goals and Standards for the On-Post Operable Unit

Technology	Medium Group/Subgroup	Remediation Goals ¹ and Standards ²	Primary Components of Rationale ³
Groundwater Treatment System	Groundwater	<ul style="list-style-type: none"> Standard: Capture and treat contaminated groundwater to meet or exceed CSRGs as specified in the ROD. 	CBSG, MCL, MCLG, Risk-based criteria
Structure Demolition	No Future Use Structures, Agent History	<ul style="list-style-type: none"> Standard: Certify 3X decontamination or caustic wash to achieve 3X decontamination. 	State regulations; Army surety safety regulations
Structure Demolition	No Future Use Structures, Significant Contamination History; No Future Use Structures, Other Contamination History	<ul style="list-style-type: none"> Standard: Demolish all structural material identified in the ROD for landfilling or consolidation. 	State regulations
Air Emissions Control	All medium groups	<ul style="list-style-type: none"> Goal: Control emissions, as necessary, during remediation. Standard: Control emissions and odors for Basin F Wastepile excavation and Former Basin F remediation, in accordance with Basin F closure plan and design documents. Standard: Meet air quality and odor standards that are ARARs. Goal: Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors. 	

¹ A broadly defined remediation objective supported by regulatory requirement, regulatory guidance, on agreement by the Parties. Typically, goals are less quantitative or measurable than standards.

² A quantitative or physical objective for remediation design that is based on a regulatory requirement, regulatory guidance, standard practice, or agreement by the Parties.

³ This column indicates only a reference to ARARs in Appendix A as a portion of the rationale used to support the remediation goal. It does not include ARARs, nor is it intended to replace any ARARs. A complete listing of ARARs is presented in Appendix A.

Table 9.6-1 Total Estimated Cost for the Selected Remedy^{1,2}

Cost Element	Capital		Operating and Maintenance		Total Cost	
	Total Cost ³	Present Worth Cost	Total Cost ³	Present Worth Cost	Total Cost ³	Present Worth Cost
Soil	\$530 million	\$380 million	\$41 million	\$17 million	\$570 million	\$400 million
Water	\$19 million	\$18 million	\$130 million	\$85 million	\$150 million	\$100 million
Structures ⁴	\$7 million	\$6.5 million	\$140 million	\$130 million	\$150 million	\$140 million
Pre-ROD Costs ⁵	\$750 million	\$750 million	—	—	\$750 million	\$750 million
PMRMA Mission Support	\$550 million	\$430 million	—	—	\$550 million	\$430 million
Total Cost	\$1.9 billion	\$1.6 billion	\$310 million	\$230 million	\$2.2 billion	\$1.8 billion

¹ Detailed cost information is provided in the Detailed Analysis of Alternative report.

² All costs presented in 1995 dollars.

³ Total cost does not account for inflation over the time frame for remediation.

⁴ Structures cost includes \$35 million to complete ongoing IRAs.

⁵ Pre-ROD costs include RI/FS and IRA costs and are listed to illustrate the total costs for complete remediation of RMA.