PART IV CORRECTIVE ACTION UNIT 1 UNIT SPECIFIC CONDITIONS

100-NR-1

The 100-NR-1 includes solid waste management units and one-time spill sites, which are undergoing corrective action. As prescribed by Permit Conditions II.Y of this Permit, this Chapter sets forth the corrective action requirements for the 100-NR-1.

IV.1.A COMPLIANCE WITH APPROVED CORRECTIVE MEASURES STUDY

The Permittees shall comply with all requirements set forth in Corrective Action Unit 1. Enforceable portions are listed below; all subsections, figures, and tables included in these portions are also enforceable, unless stated otherwise.

CORRECTIVE ACTION UNIT 1:

Chapter 1.0 Comparative Analysis of Remedial Alternatives

Chapter 2.0 Recommended Corrective Measures

Chapter 3.0 Applicable or Relevant and Appropriate Requirements

Chapter 4.0 Cost Estimates

Chapter 5.0 Compliance with ARARS

Chapter 6.0 Recommended Alternative

Chapter 7.0 Integration Plan for Decontamination and Demolition and Remedial Action in the 100-N Area

Chapter 8.0 Hanford Generating Plant

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Chapter 1.0 Comparative Analysis of Remedial Alternatives

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1.0 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

This section presents the rationale and results of a comparison of remedial alternatives for the 100-NR-1 source OU and the 100-NR-2 groundwater OU. This comparison is based on five of the nine CERCLA evaluation criteria (EPA 1988) and NEPA values as discussed in DOE/RL-95-111, Rev. 0, Section 6.0. Source-site comparisons were done according to waste group types.

Key discriminators were selected within the evaluation criteria to compare the applicable remedial alternatives within each exposure scenario (i.e., rural-residential and modified CRCIA ranger/industrial) and are identified in Section 7.1. Based on key discriminators, this comparative analysis identifies the relative advantages and disadvantages of each alternative and provides a basis for selecting a remedial alternative for each exposure scenario.

1.1 EVALUATION CRITERIA AND KEY DISCRIMINATORS

To facilitate the evaluation of remedial alternatives, CERCLA prescribes nine specific evaluation criteria:

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.

The first two criteria, overall protection of human health and the environment and compliance with ARARs, are considered threshold criteria that, if not met, would eliminate an alternative from consideration. Though it fails to meet the threshold criteria, the No-Action Alternative is retained in this comparative analysis for the purposes of providing a baseline assessment. The Institutional Controls Alternative for the 100-NR-1 OU (source sites) also fails the first criterion for the waste site groups, and it is inconsistent with unrestricted land use. Both the Institutional Controls and No-Action Alternatives, by definition in DOE/RL-95-111, Rev. 0, Section 5.0, may become part of other alternatives should site-specific soils data dictate that these alternatives are appropriate for individual sites.

The Institutional Controls Alternative is retained as a viable option for the 100-NR-2 OU (groundwater) remedial actions.

The overall protection and ARAR compliance criteria are not included in the comparative analysis presented in this section because all alternatives retained meet these threshold criteria. In addition, certain key discriminators within the overall protection criterion (e.g., impacts to natural and cultural resources, and residual risk) are inherent to other evaluation criteria such as long-term effectiveness and permanence and short-term effectiveness.

The last two criteria, state and community acceptance, will not be evaluated until after the proposed plan has been issued; therefore, they are not part of the comparative analysis presented below. This leaves five CERCLA evaluation criteria that are addressed in this Comparative Analysis:

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume through treatment
- Short-term effectiveness
- Implementability
- Cost.

An evaluation of NEPA values also has been added so as to comply with the policy requiring integration of NEPA values into the CERCLA process.

Sections 7.1.1 through 7.1.6 discuss the five evaluation criteria and NEPA values, as well as the associated key discriminators used to compare alternatives.

1.1.1 Long-Term Effectiveness and Permanence

This criterion is concerned with the long-term consequences of the Remedial Alternative. Key discriminators for this criterion include the following:

- Residual risk (e.g., removal of the source contaminants eliminates site risk while the capping of wastes in place results in residual risk that limits land use and requires monitoring)
- Adequacy and reliability of controls (e.g., the Containment Alternative needs to address the reliability of the containment barrier, and the Remove/Dispose Alternative needs to address the reliability of the engineered disposal site)
- Long-term natural resource and environmental consequences (e.g., ability to manage residual risks, potential for habitat restoration, and influence on biodiversity).

1.1.1 Reduction of Toxicity, Mobility, or Volume through Treatment

The key discriminator for this criterion is the ability of the remedial alternative to reduce the mobility, toxicity, or volume of contaminants. Most alternatives considered would decrease contaminant mobility using containment or treatment technologies, but the effectiveness of the alternatives differs. Some remedial alternatives may also reduce waste volume (e.g., soil washing by using physical separation processes to segregate clean material from contaminated material). In situ and ex situ bioremediation are expected to reduce toxicity.

1.1.2 Short-Term Effectiveness

The EPA (1988) includes several discriminators (risk to the community, the worker, and the environment) in the short-term effectiveness criterion. This criterion also considers the time required to achieve protectiveness. Several NEPA values also relate to short-term effectiveness, including potential impacts to cultural resources, natural resources, socioeconomics, and transportation. The health risk to the community is considered insignificant for this evaluation because of the remote location of the 100-N Area. Socioeconomics was not considered a key discriminator because impacts of the remedial alternatives being considered probably would not make much difference on a regional level. Risk to the environment varies at each waste site. The impacts to vegetation and natural habitats would be minor as most of the waste sites have been previously disturbed. However, the capability to revegetate and restore wildlife habitats has been considered. Also, impacts to protected or sensitive species may be critical. The key discriminators for this criterion follow:

- Risk to workers
- Transportation impacts
- Risks to natural and cultural resources.

1.1.3 Implementability

Technical feasibility, administrative feasibility, and availability of services and materials are discriminators for implementability. Technical feasibility is important because it takes into account the technical aspects of implementing a remedial action. Administrative feasibility considers how consistent the remedial action is with the future land-use options. Administrative feasibility is also significant because it includes coordination with other agencies and parties (agencies, trustees, and tribes) that have regulatory responsibility or stakeholder interests. Availability of services and materials is significant when considering waste removal and disposal, in situ treatment, capping, subsurface barriers, hydraulic controls, and sources of fill material. The key discriminators follow:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials.

1.1.4 Cost

The estimated cost of each alternative is considered in all evaluations. The estimated costs available at this time should only be used to compare relative differences between remedial alternatives. These costs are not intended to be accurate estimates of total costs to remediate the sites.

1.1.5 NEPA Values

Key discriminators under this criterion include irreversible and irretrievable commitment of natural and cultural resources, cumulative impacts from implementation of the alternative, and environmental justice issues as they relate to Native American use of the land.

1.2 COMPARISON OF REMEDIAL ALTERNATIVES FOR SOURCE WASTE SITES

Comparative analyses were performed for the following four alternatives for both the rural- residential and modified CRCIA ranger/industrial exposure scenarios:

- No action (all waste groups types)
- Remove/dispose (all waste groups types)
- Remove/ex situ bioremediation/dispose (petroleum waste group)
- In situ bioremediation (petroleum waste group).

Comparative analyses of the following two alternatives were performed only for the modified CRCIA ranger/industrial exposure scenario:

- Containment (radioactive waste group)
- Solidification (radioactive waste group).

As discussed in DOE/RL-95-111, Rev. 0, Section 5.3, due to the lack of data on the extent of contamination in soil, all alternatives may potentially result in implementing no action or institutional controls upon obtaining further characterization data at a specific site within the 100-NR-1 OU.

Table 7.1 presents the remedial alternatives discussed in DOE/RL-95-111, Rev. 0, Sections 5.3, and 6.2.2 that are applicable to the rural-residential exposure scenario. If the rural-residential exposure scenario is selected, the remedial alternatives to meet unrestricted use are as shown in Table 7.1.

Table 7.2 presents the remedial alternatives considered to be applicable to the modified CRCIA ranger/industrial exposure scenario. In this case, land-use restrictions are appropriate and allow more options for remedial action.

The No-Action Alternative has been retained in this comparative analysis for both exposure scenarios as a basis for comparison with the other alternatives. However, as described in the detailed analysis presented in DOE/RL-95-111, Rev. 0, Section 6.0, the No-Action Alternative does not satisfy evaluation criteria for overall protection; long-term effectiveness and permanence; reduction of toxicity, mobility, and volume; or implementability. Therefore, the No-Action Alternative is not considered a viable alternative for the remediation of source sites at the 100-N Area.

Remedial alternatives compared under a rural-residential exposure scenario for all waste groups (Table 7.1) include the No-Action Alternative and the Remove/Dispose Alternative. The Remove/Dispose Alternative encompasses treatment that may be required for RCRA LDR compliance or for meeting waste acceptance criteria for disposal; however, the need to treat for land-disposal-restriction compliance and waste acceptance is not anticipated. The Remove/Dispose Alternative assumes that no contamination above cleanup levels will be encountered at depths below 4.6m (15 feet). However, should contamination be found below 4.6m (15 ft), a site specific determination will be required to define the appropriate remedial action options may include leaving some contamination in place. An evaluation will be conducted during the remedial action activities that will balance the extent of deep excavation with the following: protection of human health and the environment; disturbance of ecological and cultural resources; worker health and safety; remediation costs; O&M costs; radioactive decay of short-lived radionuclides; the use of institutional controls; and long-term monitoring costs.

Specific information on ex situ bioremediation that is pertinent to a comparison of alternatives has been outlined in the comparative analyses in Sections 7.2.1 and 7.2.2. It must be emphasized that ex situ bioremediation is dependent upon detailed, site-specific information to determine if it is a cost-effective remedy. Because this information is not available, the comparative analysis cannot definitively assess the appropriateness of this technology for individual sites relative to other technologies. In addition, the petroleum waste group includes the In Situ Bioremediation Alternative, which is considered appropriate for two TPH-contaminated sites where TPH contaminants were detected in the groundwater. DOE/RL-95-111, Rev. 0, Section 6.0 provides detailed information on ex situ bioremediation, in situ bioremediation, and a no-treatment option that supports the comparative analysis.

Remedial alternatives compared for the modified CRCIA ranger/industrial scenario (Table 7.2) include the No-Action Alternative and the Remove/Dispose Alternative for all waste groups. In addition, the radioactive waste group includes the Containment Alternative, applicable to 16 sites, and the Solidification Alternative, which is applicable to 21 sites. Similarly to the rural-residential exposure scenario, the petroleum waste group includes the In Situ Bioremediation Alternative and the Ex Situ Bioremediation Alternative.

The comparative analysis of alternatives for source sites is presented in two subsections, Section 7.2.1 for the rural-residential exposure scenario, and Section 7.2.2 for the modified CRCIA ranger/industrial exposure scenario. The reader should note the following organization in reading the comparative analysis for source sites:

- In the comparative analysis, no distinction is made among the five waste groups. During the detailed analysis process, it was determined that the responses to the CERCLA and NEPA evaluation criteria depended primarily on the type of remedial action to be taken rather than on the type of contaminant present at the site.
- No direct comparison is made in the modified CRCIA ranger/industrial scenario between in situ bioremediation and containment (or solidification) because these alternatives do not apply to the same sites. In situ bioremediation is presented as an alternative to remediate petroleum spills at two sites where petroleum was observed in the groundwater; containment and solidification are presented as alternatives to remediate certain sites within the radioactive waste group.

1.1.6 Rural-Residential Exposure Scenario

1.2.1.1 Long-Term Effectiveness and Permanence

The Remove/Dispose Alternative provides a high degree of long-term effectiveness and permanence. No sources of risk above approved cleanup levels would remain at the site. All removed soils would be treated, if needed and as appropriate, with treatment residuals being disposed at the ERDF. No additional long-term restrictions for residential use at the waste site would be required following remediation with this alternative, unless it is determined that wastes that could pose a direct exposure hazard may be left below 4.6 m (15 ft). In this case, restrictions on excavation below 4.6 m (15 ft) would be required. If appropriate, revegetation and restoration efforts could be implemented that have the potential to more rapidly restore ecological habitats to healthy, sustainable conditions than is currently possible through natural succession.

The Remove/Ex Situ Bioremediation/Dispose Alternative would compare similarly to the Remove/Dispose Alternative, but it would have the added advantage of returning all, or a significant part of the soil, to the site rather than sending it to the ERDF.

The In Situ Bioremediation Alternative would also provide a high degree of long-term effectiveness and permanence. No risks from TPH contamination would remain because the contaminants would be destroyed, assuming complete treatment. However, it may be impossible to determine whether the treatment reaches all of the contamination. Post-remediation monitoring would be required.

The No-Action Alternative does not offer long-term effectiveness and permanence. Contaminants would remain in near-surface and subsurface soils above levels protective of human health and the environment. Sources of contamination that could contribute to groundwater contamination would remain. No revegetation or restoration efforts would be performed with this alternative.

1.2.1.2 Reduction in Toxicity, Mobility, or Volume

The Remove/Dispose Alternative would potentially provide reduced toxicity, mobility, or volume through application of treatment technologies, as appropriate for LDR compliance and ERDF waste acceptance. This alternative would remove wastes from the site, thereby reducing waste volume there. The Remove/Ex Situ Bioremediation Dispose Alternative might be employed for TPH where soil characteristics are amenable to the success of such a treatment technology. Ex situ and in situ bioremediation would reduce or destroy the toxicity of petroleum constituents through destruction. The reliability of technology and controls for ensuring complete treatment is less certain for in situ bioremediation. The No-Action Alternative would not reduce toxicity, mobility, or volume of contaminants in soils.

1.2.1.3 Short-Term Effectiveness

For the Remove/Dispose Alternative, a large volume of contaminated soils would be generated relative to the other alternatives. As this would require handling through excavation, treatment, and transportation, it would have the potential for inherently greater short-term impacts. Petroleum sites, as well as others, may have contamination at depth. Excavation to greater depths may increase short-term impacts to natural resources. During implementation, risks to workers from exposure to contaminated soils and fugitive dust or from accidents may increase; however, these risks can be effectively minimized through appropriate engineering controls and through health and safety procedures. Certain types of treatment may generate residuals that will require further management to meet LDR or ERDF waste acceptance criteria and, thus, would increase short-term risks to workers. Short-term impacts to vegetation and wildlife may be greatest with this alternative because it would disturb the largest land area. These impacts could be reduced through proper scheduling and implementation of the alternative. This alternative has the highest probability of impacting cultural resources in the short-term, simply due to the large land area impacted. Cultural resource locations are not precisely known; however, identification and mitigation of potential impacts would be addressed through the cultural resources mitigation plan.

Excavation impacts from the Remove/Ex Situ Bioremediation/Dispose Alternative would be similar to those of the Remove/Dispose Alternative. This alternative would take longer to be fully effective if determined to be appropriate. Therefore, at sites where treatment may be required, there may be more short-term disruption to the environment during this period. Transportation of wastes to ex situ bioremediation facilities may increase short-term impacts relative to the in situ treatment. Ex situ bioremediation, however, is expected to provide clean fill material to offset use of borrow material.

The In Situ Bioremediation Alternative is anticipated to require 5 to 25 years to complete at the two petroleum sites where it is applicable. Risks to workers from exposure to vented gases and fugitive dust or from accidents may be present during this time. However, these risks can be effectively minimized through appropriate engineering controls and through health and safety procedures. The potential for worker exposure to contaminated soils would be minimal during in situ treatment in contrast to the ex situ bioremediation option. Because little or no waste would be generated by in situ treatment, few transportation impacts are anticipated. Only equipment would be transported to and from the site. Risks to natural and cultural resources would be minimized. Short-term impacts to vegetation and wildlife may occur but could be avoided or reduced through appropriate design and implementation of the alternative.

Cultural resources, if present, should not be impacted. If potential impacts are identified, they would be addressed through the cultural resources mitigation plan.

The No-Action Alternative would not involve any remedial actions; therefore, risks to workers, transportation impacts, and short-term risks to natural and cultural resources would not be increased nor decreased.

1.2.1.4 Implementability

The Remove/Dispose Alternative performs most favorably for technical and administrative feasibility and the availability of services and materials. Technical problems in implementing excavation and disposal activities within this alternative are not expected.

Ex situ bioremediation implementability is dependent upon site specific information, much of which could be obtained using the observational approach during excavation. Equipment required for implementation is readily available. However, should contamination be found at great depths, it may become less feasible to excavate. Due to the lack of soil characterization data, this potential would have to be evaluated during the design phase of this alternative. It might also be necessary to treat soil constituents to meet LDRs for which there is no immediately available treatment technology. Should it be found upon characterization that petroleum contamination exists at depth or that radionuclide or inorganic contaminants are present, this alternative would not be considered readily implementable.

There is less certainty regarding reliable implementation of in situ bioremediation because completeness of treatment cannot be accurately monitored. Characterization to better determine the extent of remediation may be required. Equipment required for implementation is readily available.

The No-Action Alternative would be easy to implement but would not be consistent with DOE's long-range objective.

1.2.1.5 Cost

Cost estimates for the source sites in DOE/RL-95-111, Rev. 0 were developed using either the Micro Computer Aided Cost Estimating System (MCACES) or the Remedial Action Cost Engineering and Requirements (RACER) package. Total costs presented in this section do not include a 3 percent design cost and a 3 percent cost data collection cost that applies to all estimates. Details of the cost estimates are presented in Permit Attachment 47, Appendix G. It needs to be kept in mind that the quality of a cost estimate is directly related to the quality of the input data used in the models. As has been noted earlier in this report, data on site-specific contamination, site locations, and site dimensions were limited, and this introduces uncertainty in the cost estimates. Despite this uncertainty, it is believed that the cost estimates are of sufficient quality to fulfill the primary objective, which is to aid in selecting preferred remedial alternatives. How representative these estimates might be of actual remediation costs is more difficult to answer and will not be resolved until the uncertainties in the data are resolved.

The No-Action Alternative would require no additional cost and is not considered further in this comparative analysis.

Individual cost estimates for each waste site, exposure scenario, and remedial alternative are presented in Table 6.2. Three alternatives (Remove/Dispose, Remove/Ex situ Bioremediation/Dispose, and In Situ Bioremediation) are proposed for petroleum-contaminated sites under both exposure scenarios. Ex situ bioremediation is proposed for 14 sites that have near-surface contamination, and in situ bioremediation is proposed for two sites with deep contamination. Because all of the petroleum contamination will be removed, there is no cost difference between the two exposure scenarios for this alternative. The cost comparison in Table 7.3 shows that in situ bioremediation is 65 percent less expensive than the Remove/Dispose Alternative. The cost comparison in Table 7.4 shows that ex situ bioremediation is 12 percent more expensive than the Remove/Dispose Alternative. Because of the uncertainty in the data used to develop these estimates, cost should not be used as a factor in deciding between these two alternatives. This 12 percent difference is not considered significant.

A summary of these results is presented in Table 7.5. The least cost alternative for the rural-residential scenarios is to select the Remove/Disposal Alternative for all sites except the two deep petroleum sites. This produces a cost saving of 7 percent over the using the Remove/Dispose Alternative for all sites.

1.2.1.6 NEPA Values

Irreversible and irretrievable commitment of a significant number of natural resources would not occur with the Remove/Dispose Alternative. Contaminated soils would be removed from a site and transported to the ERDF; therefore, there would be a commitment to use portions of that disposal unit for long-term waste management. Excavated material would be replaced with clean fill and topsoil, then revegetated to mirror more closely the native plant community. (This may be an interim benefit should future rural-residential use of the land dictate another vegetative regime.) Future use of the river and adjacent lands would allow Native American use in concert with a modified CRCIA ranger/industrial exposure scenario in a relatively short time frame. Excavation could disturb cultural resources contained at a site, and careful adherence to cultural resource mitigation planning would be required. Cumulative impacts may occur at borrow sites and transportation routes.

The In Situ Bioremediation Alternative would not irreversibly or irretrievably commit significant amounts of natural resources. Using ERDF resources would not be required under this alternative in comparison to the Remove/Dispose Alternative. Potential impacts on future land use would be comparable to the Remove/Dispose Alternative. Disturbance of cultural resources could occur with this alternative, but not to the degree that would be required with the Remove/Dispose Alternative. Irreversible and irretrievable commitment of natural resources would occur with the No-Action Alternative because contaminants would remain on site, so human and ecological receptors would continue to be exposed. For radiological constituents, this exposure will remain until decay results in contaminant levels below concern. For nonradiological constituents, exposure may be very long term. There may be an impact on Native Americans because they are potentially more likely than other groups to use the area. No direct impacts would result from implementing this alternative.

1.1.7 Modified CRCIA Ranger/Industrial Exposure Scenario

1.2.1.7 Long-Term Effectiveness and Permanence

The Remove/Dispose Alternative provides a high degree of long-term effectiveness and permanence. No sources of risk above approved cleanup levels would remain at the site. All removed soils would be treated, if needed and if appropriate, with treatment residuals being disposed at the ERDF. No additional long-term restrictions for residential use at the waste site would be required following remediation with this alternative unless it is determined that wastes that could pose a direct exposure hazard may be left below 4.6 m (15 ft). In this case, restrictions on excavation below 4.6 m (15 ft) would be required. If appropriate, revegetation and restoration efforts could be implemented that have the potential to more rapidly restore ecological habitats to healthy, sustainable conditions than is currently possible through natural succession.

The Remove/Ex Situ Bioremediation/Dispose Alternative would compare similarly to the Remove/Dispose Alternative, but it would have the added advantage of returning all, or a significant part of the soil, to the site rather than sending it to the ERDF.

The In Situ Bioremediation Alternative would also provide a high degree of long-term effectiveness and permanence. No risks from TPH contamination would remain because the contaminants would be destroyed, assuming complete treatment. However, it may be impossible to determine whether the treatment reaches all of the contamination. Post-remediation monitoring would be required.

The Containment and In Situ Solidification Alternatives perform relatively equally on long-term effectiveness and permanence, but neither performs as well as the Remove/ Dispose Alternative. While contaminants are left in place under both alternatives, for the near term, human health and the environment are considered protected. Both alternatives have the potential for long-term failure (i.e., containment through failure of the barrier and in situ solidification through incomplete treatment or deterioration of the solidified matrix). Long-term post-closure monitoring, including maintenance of barriers, would be required with these alternatives. Revegetation is considered to have a good probability for success with these alternatives, but wastes would be left in place and would limit complete restoration.

The No-Action Alternative does not offer long-term effectiveness and permanence. Contaminants would remain in near-surface and subsurface soils above levels protective of human health and the environment. Sources of contamination that could contribute to groundwater contamination would remain. No revegetation or restoration efforts would be included with this alternative.

1.2.1.8 Reduction in Toxicity, Mobility, or Volume

The Remove/Dispose Alternative would potentially provide reduced toxicity, mobility, or volume through application of treatment technologies, as appropriate for LDR compliance and ERDF waste acceptance. This alternative would remove wastes from the site, thereby reducing waste volume at the site. The Remove/ Ex Situ Bioremediation/Dispose Alternative might be employed for TPH where soil characteristics are amenable to the success of such a treatment technology. Ex situ and in situ bioremediation would reduce or destroy the toxicity of petroleum constituents through destruction. The reliability of technology and controls for ensuring complete treatment is less certain for in situ bioremediation.

Containment does not include a treatment option; however, a properly constructed engineered barrier would reduce the mobility of contaminants by reducing infiltration. Neither a reduction in toxicity nor volume is provided by this alternative.

The in situ solidification would reduce mobility through stabilization in the near term but would not reduce toxicity or volume of contaminants. Remobilization of contaminants could occur if the stabilized media degraded through time. Incomplete mixing of contaminants with the stabilization media could interfere with reduction in contaminant mobility, and some contaminants might not be stabilized to the same degree as others.

The No-Action Alternative would not reduce toxicity, mobility, or volume of contaminants in soils.

1.2.1.9 Short-Term Effectiveness

For the Remove/Dispose Alternative, a larger volume of contaminated soils would be generated relative to the other alternatives. This would require handling through excavation, treatment, and transportation, which would have the potential for inherently greater short-term impacts. Petroleum sites, as well as others, may have contamination at depth. Excavation to greater depths may increase short-term impacts to natural resources. During implementation, risks to workers from exposure to contaminated soils and fugitive dust or from accidents may increase; however, these risks can be effectively minimized through appropriate engineering controls and through health and safety procedures. Short-term impacts to vegetation and wildlife may be greatest with this alternative because it would disturb the largest land area. These impacts could be reduced through proper scheduling and implementation of the alternative. This alternative has the highest probability of impacting cultural resources in the short term simply due to the large land area impacted. Cultural resource locations are not precisely known; however, identification and mitigation of potential impacts would be addressed through the cultural resources mitigation plan.

Excavation impacts from the Remove/Ex Situ Bioremediation/Dispose Alternative would be similar to that of the Remove/Dispose Alternative. This alternative would take longer to be fully effective if determined to be appropriate. Therefore, at sites where treatment may be required, there may be more short-term disruption to the environment during this period. Transportation of wastes to ex situ bioremediation facilities may increase short-term impacts relative to the in situ treatment. Ex situ bioremediation, however, is expected to provide clean fill material to offset the use of borrow material.

The In Situ Bioremediation Alternative is anticipated to require 5 to 25 years to complete at the two petroleum sites where it is applicable. Risks to workers from exposure to vented gases and fugitive dust or from accidents may be present during this time. However, these risks can be effectively minimized through appropriate engineering controls and through health and safety procedures. The potential for worker exposure to contaminated soils would be minimal during in situ treatment in contrast to the ex situ bioremediation option. Because little or no waste would be generated by in situ treatment, few transportation impacts are anticipated. Only equipment would be transported to and from the site. Risks to natural and cultural resources would be minimized. Short-term impacts to vegetation and wildlife may occur but could be avoided or reduced through appropriate design and implementation of the alternative. Cultural resources, if present, should not be impacted. If potential impacts are identified, they would be addressed through the cultural resources mitigation plan.

The Containment and In Situ Solidification Alternatives perform similarly with regard to short-term effectiveness. Both alternatives pose little risk to workers because they would not be exposed to contaminants during implementation. No contaminated soils would be transported. Transportation of materials and equipment for containment or solidification, and transportation of clean fill after containment, would increase traffic on haul roads. Short-term impacts to vegetation and wildlife could occur during the estimated 2- to 5-year restoration time frame, but these could be avoided or reduced through proper implementation of the alternative. Cultural resources, if present, should not be impacted. Identification and mitigation of these impacts would be addressed through the cultural resources mitigation plan.

The No-Action Alternative would not involve any remedial actions; therefore, risks to workers, transportation impacts, and short-term risks to natural and cultural resources would not occur.

1.2.1.10 Implementability

The Remove/Dispose Alternative performs most favorably for technical and administrative feasibility and the availability of services and materials. Technical problems in implementing excavation and disposal activities within this alternative are not expected.

Ex situ bioremediation implementability is dependent upon site-specific information, much of which could be obtained using the observational approach during excavation. Equipment required for implementation is readily available. However, should contamination be found at great depths, it may become less feasible to excavate. Due to the lack of soil characterization data, this potential would have to be evaluated during the design phase of this alternative. It might also be necessary to treat soil constituents to meet LDRs for which there is no immediately available treatment technology. Should it be found upon characterization that petroleum contamination exists at depth or that radionuclide or inorganic contaminants are present, this alternative would not be considered readily implementable.

There is less certainty regarding reliable implementation of in situ bioremediation because completeness of treatment cannot be accurately monitored. Characterization to determine the extent of remediation may be required. Equipment required for implementation is readily available.

Containment will be easy to implement; however, characterization of the extent of contamination will be required in order to properly locate the barrier. Technical problems causing delays are not anticipated. Large quantities of soil and rock material will be required for construction of the barrier; however, this material is considered available from sources within or near Hanford. The In Situ Solidification Alternative is considered less implementable than the Containment Alternative because of the potential for incomplete mixing of the treatment zone. Contaminants may be encountered that are not effectively treated through this technology. Problems in ensuring complete treatment could result in remediation delays. As with containment, further characterization of the extent of contamination will be required to determine proper treatment. Materials needed for implementation are considered readily available.

The No-Action Alternative would be easy to implement, but would not be consistent with DOE’s long-range objective.

1.2.1.11 Cost

Cost estimates for the source sites in DOE/RL-95-111, Rev. 0 were, in general, developed using either the MCACES or the RACER package. Total costs presented in this section include neither a 3 percent design cost nor a 3 percent data collection cost. Details of the cost estimates are presented in Permit Attachment 47, Appendix G.

As has been noted earlier in this report, data on site-specific contamination, site locations, and site dimensions were limited, and this introduces uncertainty in the cost estimates. The quality of a cost estimate is directly related to the quality of the input data used in the models. Despite this uncertainty it is believed that the cost estimates are of sufficient quality to fulfill the primary objective, which is to aid in selecting preferred remedial alternatives. How representative these estimates might be of actual remediation costs is more difficult to answer and will not be resolved until the uncertainties in the data are resolved.

The No-Action Alternative would require no additional cost and is not considered further in this comparative analysis.

Individual cost estimates for each waste site, exposure scenario, and remedial alternative are presented in Table 6.2. Five remedial alternatives (Remove/Dispose, Remove/Ex Situ Bioremediation/Dispose, In Situ Bioremediation, Capping, and In Situ Solidification) have been proposed for the modified CRCIA ranger/industrial exposure scenario. The evaluation of alternatives for the sites with petroleum contamination is the same as just presented for the rural-residential scenario and concludes that in situ bioremediation is the least expensive alternative for the two deep petroleum sites and remove/dispose for the near-surface petroleum sites.

Capping is considered for 5 clusters of waste sites to cover a total of 16 sites. As shown in Table 7.6, the cost of remediating 16 sites by capping is about $65,000,000 versus $2,400,000 for the Remove/Dispose Alternative for 20 sites. This is 27 times the cost of the Remove/Dispose Alternative. Additionally, the Remove/Dispose Alternative is less expensive than capping at all five cap sites. Although it may appear that some sites could be capped at less cost than the Remove/Dispose Alternative, this is deceptive. These costs reflect the cost of capping a cluster of sites and must be evaluated as a group because the costs are shared among the several sites within the cluster. When evaluating capping costs it is necessary to keep in mind that this cost estimate is based upon using a specific barrier, the Modified RCRA Subtitle C barrier. This is perhaps one of the most expensive barrier options. It was selected for use in DOE/RL-95-111, Rev. 0, because there was limited site-specific data with which to make a decision. As additional data is collected during the design process, other, less expensive cap designs may be appropriate.

In situ solidification is considered for the 16 capping sites and 4 additional ones. As shown in Table 7.6, the cost of remediating 20 sites by in situ solidification is about $6,600,000 as opposed to $3,100,000 for the Remove/Dispose Alternative. This is over two times the cost of the Remove/Dispose Alternative. Additionally, the In Situ Solidification Alternative was more expensive than the Remove/Dispose Alternative at all 20 sites.

A summary of these results is presented in Table 7.7. The least cost alternative for the modified CRCIA ranger/industrial scenario is to select the Remove/Disposal Alternative for all sites except the two deep petroleum sites. This produces a cost saving of 7 percent over using the Remove/Dispose Alternative for all sites.

There are many uncertainties dealing with developing cost estimate for sites with limited site-specific information. As already noted, for example, limited data lead to the selection of an expensive cap design.

1.2.1.12 NEPA Values

By definition, the modified CRCIA ranger/industrial scenario requires more of a commitment of onsite resources than does the residential exposure scenario. At the same time, there would be less commitment of ERDF resources because less soil may require excavation and disposal. There would also be less impact on cultural resources, and fewer cumulative impacts under a modified CRCIA ranger/industrial exposure scenario because of this. Restrictions on hunting and gathering are also inherent in the modified CRCIA ranger/industrial scenario defined in DOE/RL-95-111, Rev. 0.

An irreversible and irretrievable commitment of natural resources would occur with the Remove/Dispose Alternative. Contaminated soils would be removed and transported to the ERDF; therefore, there would be a commitment to use portions of that disposal unit for long-term waste management and the associated borrow pit commitment for ERDF cover. Excavated material would be replaced with clean fill topsoil (from the borrow pits), then revegetated to mirror more closely the native plant community existing prior to disturbance from 100-N Area activities. Future use of the river and adjacent lands would allow Native American use in concert with a modified CRCIA ranger/industrial exposure scenario in a relatively short time frame. Excavation could disturb cultural resources existing at a site, and careful adherence to cultural resource mitigation planning would be required. Cumulative impacts may occur at borrow sites and transportation routes.

The In Situ Bioremediation, Containment, and In Situ Solidification Alternatives perform similarly to the Remove/Dispose Alternative for key discriminators under this criterion with the exception that fewer ERDF resources would be utilized under these alternatives.

Irreversible and irretrievable commitment of natural resources would occur with the No-Action Alternative because contaminants would remain on site, and human and ecological receptors would continue to be exposed. For radiological constituents, this exposure would remain until decay results in contaminant levels below concern. For nonradiological constituents, exposure may be very long term. There may be an impact on Native Americans because they are potentially more likely to use the area than are other groups. No cumulative impacts would result from implementing this alternative.

1.3 COMPARISON OF REMEDIAL ALTERNATIVES FOR GROUNDWATER

Table 7.8 presents the seven alternatives described in DOE/RL-95-111, Rev. 0, Section 5.0 for the remediation of groundwater underlying the 100-N Area and for protection of the Columbia River. It indicates which technologies are used within each remedial alternative to address the four issues considered to be critical for remediating the contaminated groundwater system at the 100-N Area. These four issues follow:

- Protection of the river from tritium
- Protection of the river from Sr-90
- Reduction of Sr-90 in the aquifer
- Reduction of other contaminants in the aquifer.

In the comparative analysis of groundwater alternatives, no distinction is made between the rural-residential and modified CRCIA ranger/industrial exposure scenarios. No distinction is necessary because, under either exposure scenario, the existing beneficial uses of the Columbia River must be protected. The existing beneficial uses of the river include water supply, recreation, fish and wildlife habitat, hydroelectric power production, transportation, and agriculture. The remedial alternatives must meet the appropriate ARARs for these beneficial uses, regardless of whether the exposure scenario is rural-residential or modified CRCIA ranger/industrial. Also, under both scenarios, it is assumed that the goal is to restore groundwater for beneficial uses. Therefore, no distinction is required with respect to aquifer remediation.

The No-Action Alternative is not considered a viable alternative because it does not meet overall protectiveness or compliance with ARARs. The No-Action Alternative is retained as the baseline case for comparison with the other alternatives that incorporate some active response action.

1.1.8 Long-Term Effectiveness and Permanence

1.3.1.1 Protection of the River from Tritium

Alternative 5 and Alternative 7 (Table 7.8) describe technologies to reduce tritium flux to the river (hydraulic controls or barrier with hydraulic controls) and therefore are equally effective in preventing the tritium from entering the river at concentrations above the MCL for tritium. The added impermeable barrier in Alternative 7 may provide some degree of protection above hydraulic controls alone for tritium, but the differences are considered neither quantifiable nor great because tritium is easily controlled hydraulically. Both are considered comparable in their reliability of controls, as well. The other alternatives do not include any action to prevent tritium from entering the river except through decay (although Alternative 4 might coincidentally prevent tritium discharge through hydraulic controls placed on the Sr-90 plume). For alternatives 1, 2, 3, and 6, the tritium reaching the river will exceed MCLs for approximately 15 years.

1.3.1.2 Protection of the River from Sr-90

Alternatives 1 and 2 do not include any action to prevent Sr-90 from entering the river; therefore, they provide a basis for comparison to the other alternatives. Taking no physical action, the Sr-90 concentrations in the groundwater/river interface will decay to concentrations below MCLs over a 300-year period. The remaining five alternatives use three different technologies to reduce the Sr-90 flux to the river: a permeable barrier (Alternative 3), hydraulic controls (Alternatives 4 and 5), and impermeable barriers (Alternatives 6 and 7). These three technologies for reducing flux may be interchanged within the three alternatives to accomplish this objective.

Although these technologies reduce flux of Sr-90 discharging to the Columbia River (i.e., mass of Sr-90 per unit time moving through the aquifer into the river), none of the alternatives are expected to significantly reduce Sr-90 concentrations entering the river above MCLs because a section of aquifer next to the river would be essentially unaffected by the technologies, and the slow release of the Sr-90 adsorbed onto the aquifer soils in this section would continue. This is true with all alternatives because a section of land remains between the river and the barrier in all cases--either by a physical barrier (impermeable or permeable) or a hydraulic barrier. This phenomenon is due to the sorbing ability of Sr-90 on soils, which retard dissolution in the groundwater, as described in DOE/RL-95-111, Rev. 0, Sections 3.0, and 5.0. The impact of this Sr-90-contaminated area adjacent to the river on concentrations at the groundwater/river interface is not anticipated to decrease significantly faster than the decease that will occur solely because of natural decay. However, comparatively, hydraulic controls contained in Alternatives 4 and 5 may potentially reduce concentrations at the groundwater/river interface more effectively than the other alternatives, although not significantly, because of the net gradient effect. For example, the net groundwater flow in the aquifer immediately adjacent to the river is inland, with hydraulic controls in place, while the net groundwater flow with the barriers is toward the river. A permeable barrier (Alternative 3) is expected to be the next best alternative for reducing Sr-90 concentrations in the groundwater/river interface, with the impermeable barrier (Alternatives 6 and 7) being the least effective in reducing concentrations of Sr-90.

All alternatives (except 1 and 2) are expected to reduce flux of Sr-90 to the river by more than 90 percent. The Hydraulic Control Alternatives, because they reverse the groundwater flow near the river shoreline, are probably more effective than the other alternatives for reducing flux, and might be more effective in reducing concentrations of Sr-90. However, this increase in effectiveness has not been quantified. The Impermeable Barrier Alternatives would rank next in ability to reduce Sr-90 flux, with the Permeable Barrier Alternative ranking the least effective among Alternatives 3 through 7.

Relative to risk, reducing the flux of Sr-90 to the river may not be of great importance. Currently, the most stringent ARAR for Sr-90 is based on an MCL, which is established for the purposes of achieving human health protection from the use of surface or groundwater as a drinking water source. Decreasing the flux of Sr-90-contaminated waters to the river is inconsequential with respect to using the river as a drinking water supply, because of the near instantaneous reduction of Sr-90 concentrations that occurs near the groundwater/river interface. DOE/RL-95-111, Rev. 0, Section 3.3.5 describes Columbia River water quality relative to Sr-90, and it concludes that concentrations in the river are consistently below MCLs for Sr-90. However, the seeps located at N-Springs on the river bank adjacent to the 116-N-1 Crib do exceed MCLs, and institutional controls would be required to restrict this area of the river from use as a drinking water source.

With the exception of N-Springs, Sr-90 does not threaten the Columbia River as a drinking water source. In contrast, however, concentrations of Sr-90 in the sediments at the groundwater/river interface may be harming aquatic organisms. Site-specific data related to ecological effects may not be complete, and in any case, no alternatives are capable of substantially decreasing these concentrations or significantly reducing the time frame for achieving a protective concentration.

1.3.1.3 Reduction of Sr-90 in the Aquifer

Alternatives 1, 2, and 3 do not include any action to reduce the Sr-90 contamination in the groundwater, but Alternatives 2 and 3 include institutional controls to prevent exposure to humans from use of the groundwater until Sr-90 decays to acceptable levels, thereby providing a measure of long-term protectiveness. Alternative 3 does, however, immobilize large quantities of Sr-90 through capture in the permeable barrier. This capture does not change concentrations of Sr-90 in the groundwater upgradient of the barrier due to the equilibrium that will occur between soil and groundwater, but it will immobilize a large mass of Sr-90 from the aquifer. This immobilization action may not contribute much to reducing Sr-90 concentrations at the groundwater/river interface as described above.

Alternatives 4, 5, and 6 are more effective in reducing Sr-90 in the aquifer than the first three alternatives because these alternatives include pump-and-treat systems. They do not, however, have a significant increase in effectiveness because the alternatives only achieve a 10 percent reduction in the time to attain the remediation goal – 270 years versus 300 years. Alternative 7 (soil flushing) has the potential to be more effective and result in a shorter restoration time frame than any of the other alternatives. However, at this stage, it is considered an innovative technology for Sr-90 in the aquifer and for the site-specific conditions of the 100-NR-2 OU. A series of laboratory, bench, and field-scale tests would be required before a decision on the feasibility of soil flushing could be made. Because of this requirement, no objective comparison of soil flushing can be made against the other alternatives in DOE/RL-95-111, Rev. 0.

1.3.1.4 Reduction of Other Contaminants in the Aquifer

Alternatives 1 through 4 include no action to reduce the contamination in the aquifer from other contaminants; therefore, they are not compared against each other for long-term effectiveness and permanence. The other contaminants include nitrate, sulfate, manganese, chromium IV, and TPH. Some migration of those contaminants will occur over time. Utilizing travel-time predictions contained in DOE/RL-95-111, Rev. 0, Appendix D, gross predictions of natural migration can be made. These predictions are based on modeling assumptions that may not account for the heterogeneity inherent in the groundwater/river system over time. However, since groundwater at the 100-N Area flows into the river, the travel time for peak concentrations to reach the river roughly equates to the time required for natural migration of the contaminant from the aquifer (DOE/RL-95-111, Rev. 0, Appendix D).

Nitrate may migrate from groundwater to the river within 10 to 20 years. Sulfate may migrate from groundwater to the river in 5 to 15 years. Chromium VI may migrate to the river in 15 to 25 years. Manganese may take over 3,000 years to migrate from groundwater to the river. Migration times for TPH cannot be estimated because the product will continue to float on top of the aquifer for an indeterminate, but probably long, period of time.

It should be noted that chromium VI concentrations are based on data from a small number of wells and that there is no discernible plume. Also, since manganese and sulfate PRGs are based on secondary

MCLs, the need for remediating these two contaminants may not be as critical as for the other contaminants.

Alternatives 5, 6, and 7 all rely upon the same pump-and-treat technology for remediation of the other contaminants. Pump-and-treat technologies can be effective in the long term because they permanently remove contaminants from the environment. It is anticipated that pump-and-treat technologies will decrease restoration time frames for groundwater protection as follows: nitrates, 5 years; sulfates, 5 years; chromium VI, 1 year; manganese, 88 years; and TPH, 5 years.

Given these estimates, long-term effectiveness can be achieved earlier with pump-and-treat technology than with natural migration:

- Nitrates may be remediated in the aquifer 5 to 15 years earlier.
- Sulfates may not be remediated in the groundwater at a significantly faster rate than could be achieved by natural migration.
- Chromium VI may be remediated 15 to 25 years earlier.

Manganese may be remediated over 3,000 years earlier.

- TPH may be remediated many years earlier, but time frames cannot be estimated.

Groundwater monitoring after cleanup would be required for a time to ensure that all of the plumes have been captured.

1.3.1.5 Summary

Seven alternatives have been compared that meet (except for no action) all or part of the needs for long-term effectiveness and permanence. For tritium river protection, Alternatives 5 and 7 are anticipated to provide, most effectively, long-term protection. Other than the No-Action Alternative, all of the alternatives that could be implemented are comparable for long-term effectiveness and permanence for addressing the Sr-90 releases to the river. An estimated 90 percent reduction in the mass of Sr-90 entering the river will result through utilization of Alternatives 3, 4, 5, 6, or 7 as opposed to an Institutional Controls Alternative. However, reduction in mass is anticipated to have little human health or environmental benefit. Reduction in the restoration time of Sr-90 concentrations is not anticipated to be significantly different for any of the alternatives with the possible exception of Alternatives 4 and 5 due to the net gradient effect of bringing clean river water inland.

For Sr-90 reduction in the aquifer, no alternative will resulting in remediation of Sr-90 to groundwater protection standards more rapidly than will natural attenuation, with the possible exception of soil flushing. Alternative 7 has the potential to improve the long-term effectiveness by shortening the time to meet remedial goals, but it is an innovative technology for Sr-90-contaminated soils at Hanford, and it must be the subject of further testing and evaluation before a decision on its use can be made. Alternative 7 has the potential for risks to natural resources by expansion of the Sr-90 plume, potentially to the river, if soil flushing is not carefully implemented. Given the uncertainties at this time relative to safe implementation of this option, these risks remain unknown.

Alternatives with pump and treat will reduce nitrate, chromium VI, and manganese (the latter two if proven to be a COCs upon further results of monitoring) at a faster rate than would be achieved through natural migration of contaminants in the aquifer. However, this improvement may not be significant when it is considered that a significant portion of the aquifer will remain unusable during the period of Sr-90 contamination.

1.1.9 Reduction in Toxicity, Mobility, or Volume through Treatment

For protection of the river from tritium, Alternatives 1 through 4 contain no treatment element and therefore would not reduce toxicity, mobility, or volume (i.e., mass) of tritium. Alternatives 5 and 7 reduce the mobility of the tritium to the river by establishing barriers to the flow to the river.

For protection of the river from Sr-90, Alternatives 1 and 2 contain no treatment element for Sr-90 and therefore would not reduce toxicity, mobility, or volume (i.e., mass) of Sr-90. Alternatives 3 through 7 would decrease the flux of Sr-90 entering the river by around 90 percent. Differences between these alternatives (permeable barrier, impermeable barrier, and hydraulic controls) are considered neither quantifiable nor great.

Alternatives 1 through 3 do not contain a treatment element for Sr-90 reduction in the aquifer. Alternatives 4 through 6, which have barriers to the river and pump-and-treat systems, compare favorably with respect to Sr-90 reduction in the groundwater; however, reductions in mobility, and/or volume are neither quantifiable nor great. Alternative 7 has the greatest potential for mass reduction, but will require that a test program be implemented before this alternative could be adequately compared with other alternatives.

For reducing other constituents in the aquifer, Alternatives 5 through 7, which have pump-and-treat systems, will reduce contaminant toxicity, mobility, and/or volume, dependent upon the specific constituent, to a higher degree than Alternatives 1 through 4.

1.1.10 Short-Term Effectiveness

None of the alternatives is expected to have significant short-term impacts on the community during implementation. No alternative will remediate the river or aquifer for Sr-90 within 270 years. Alternative 1, followed by Alternative 2, has the lowest short-term impacts associated with worker risk, as well as the lowest ecological, cultural, and transportation impacts from system installation. The greatest potential impacts to natural and cultural resources are from installation of barriers. Alternatives 4 and 5, which use wells rather than barrier, have less short-term impact than the barrier alternatives (Alternatives 3, 6, and 7) that use excavation techniques or cryogenics. Alternative 7 has the potential for risks to natural resources by expansion of the Sr-90 plume, potentially to the river, if soil flushing is not carefully implemented. Given the uncertainties at this time relative to safe implementation of soil flushing, these risks remain unknown.

1.1.11 Implementability

All alternatives, with the exception of the No-Action Alternative, will require institutional controls that will require some maintenance for close to 300 years. The technical and administrative feasibility of maintaining these controls is uncertain, but it is a comparable implementability issue for every alternative.

All three barriers are expected to be implementable, but each presents a concern because they represent a new application at Hanford. A treatability test plan is being considered for evaluation of the construction of the permeable wall in Alternative 3. This would help to refine this determination. Alternative 6 introduces some concerns because of the need to freeze the ground near the river and because of the need to maintain its integrity over 300 years. Alternative 7 presents implementability concerns regarding sheet pile installation because of past problems in installing a sheet pile barrier at Hanford. However, the alternative sheet pile installation method proposed in Alternative 7 is expected to resolve past concerns. There is little basis to distinguish between these alternatives with respect to barrier construction; however, all of the construction alternatives will require collection of additional information at the design stage.

Alternatives 4, 5, and 7 are less implementable than institutional controls because they involve installation of a complicated hydraulic control system. Hydraulic controls are subject to breakdown, and, as such, would not be effective 100 percent of the time. However, these alternatives are still technically and administratively feasible. Hydraulic control systems like the one contemplated in these alternatives would be similar to a system already in place at Hanford; therefore, these alternatives are considered more implementable than barrier construction alternatives.

The soil flush portion of Alternative 7 is not considered implementable without first successfully completing a series of laboratory, bench-scale, and field tests.

Alternatives that involve pump-and-treat systems for Sr-90 and/or other contaminants are considered less implementable than Alternatives 1 or 2.

In all of the alternatives, there is a strip of land along the river shoreline that is contaminated with Sr-90. The soil in this strip does not meet PRG levels for the rural-residential scenario and may not meet them for the modified CRCIA ranger/industrial exposure scenario. Remediation of the shoreline area would be difficult. The remove and dispose remedial alternative proposed for source waste sites could be implemented along the river shoreline, but would require excavation and backfilling to 4.6 m (15 ft) or 3 m (10 ft) for the rural-residential and modified CRCIA ranger/industrial scenarios, respectively. Such remedial actions would destroy the ecology of this riparian zone and possibly undercut the bluff along the shore, causing further destruction. Such actions may only provide temporary relief because there will likely be recontamination from upgradient groundwater. Additionally, the area appears to be within the Columbia River flood plain and residential construction may be limited or prohibited. Institutional Controls has been recommended in all of the alternatives (except No-Action) to ensure limited access to this area.

1.1.12 Cost

A summary of the cost estimates for each groundwater remedial alternative is presented in Table 7.9, and information that is more detailed is presented in Permit Attachment 47, Appendix G2. A simple quantitative comparison, as shown in Table 7.9 is not sufficient for evaluating the alternatives, since the alternatives represent different levels of remediation. An incremental analysis would be more appropriate. In this type of analysis, each alternative (or each group of alternatives with a similar level of remediation) is compared to the alternative with the next lowest level of remediation.

Alternative 1 includes no remediation because it proposes to do nothing and it costs nothing. Alternative 2 is similar to Alternative 1 in that it includes no remediation, but it proposes institutional controls such as warning signs and land-use restrictions. The total cost of institutional controls is $762,826.

Alternative 3 includes a remedial technology to prevent Sr-90 from entering the river. Constructing a clinoptilolite barrier will not prevent all Sr-90 from entering the river, but it will substantially reduce the amount. Strontium-90 will decay to an acceptable level in about 300 years. This degree of remediation will cost $8,499,399 more than Alternative 2, for a total cost of about $9,262,125. The objectives of Alternative 3 could also be met by using the hydraulic controls technology from Alternative 4 or the impermeable barrier technology from Alternatives 6 or 7.

In Alternative 4, the clinoptilolite barrier is replaced by hydraulic controls, which further reduces the amount of Sr-90 that will reach the river (although with less certainty). Additional remediation is provided by Alternative 4 in that a pump-and-treat system is used to remediate the Sr-90 that is present in the groundwater. The pump-and-treat system will extract Sr-90 from the aquifer and thereby reduce the mass of the contaminant. Operating the pump-and-treat system will reduce the time it takes to remediate the groundwater by about 10 percent, from 300 to 270 years. The cost of shortening this period by 30 years is about $4,983,489 more than Alternative 3, for a total of about $14,245,714.

Alternative 5 provides additional remediation by extending the hydraulic controls to protect the river from tritium, as well as Sr-90, and by to remediating the other contaminants (nitrate, iron, sulfate, manganese, TPH, and chromium VI) in the groundwater. Meeting this last objective is accomplished by operating a pump-and-treat system for the other contaminants. This pump and treat would shorten the time for the concentrations of these contaminants to reach acceptable levels in the groundwater, but it would not shorten the time until the groundwater would be available for use. The concentrations of these contaminants would be at acceptable levels (with no action) well before the Sr-90 concentration reached an acceptable level. The cost of the additional remediation is about $24,920,116 more than Alternative 4, for a total cost of about $39,165,605.

Alternative 6 actually results in less remediation than Alternative 5 because it replaces the hydraulic controls for protecting the river from Sr-90 with a cryogenic barrier that will not provide total protection from tritium. This alternative is not as effective as hydraulic controls used in preventing the Sr-90 from reaching the river. In this alternative, the protection of the river from tritium is not included as it was in Alternative 5. These changes in remediation reduce the cost of Alternative 6 compared to Alternative 5 by about $17,492,921 to $56,658,526.

Alternative 7 has the potential to provide a greater degree of remediation than any of the other alternatives because it proposes to significantly shorten the time it will take for the Sr-90 concentration in the groundwater to reach acceptable levels. Because this alternative is still in the development and evaluation stage, a reliable estimate of what this reduction in time might be cannot be made. This alternative costs $79,872,099 more than Alternative 6, for a cost of $136,530,625. This alternative is in the development stage, and this cost estimate is not as reliable as the estimates for the other alternatives.

1.1.13 NEPA Values

An interim (270 to 300 years) irreversible and irretrievable commitment of the unconfined aquifer and river shoreline would result with all alternatives because none would effectively reduce Sr-90 concentrations in the aquifer or river bank seeps within a shorter time. Also, none are effective in reducing Sr-90 concentrations at the groundwater/river interface. Aquatic resources at the groundwater/river interface may be impacted; however, more information must be acquired before impacts can be quantified. Restrictions on the use of the shoreline by humans may be required for a long period of time, regardless of the alternative chosen. Use of the river as a downstream drinking water supply or for other uses such as fishing will not be impacted by implementation of any alternative. Restrictions on the use of the groundwater will be required for 300 years under Alternatives 1 through 3 and for 270 years under Alternatives 4 through 6. Alternative 7 may result in use of the groundwater in a shorter time frame if soil flushing can be successfully implemented, but reduction in years cannot be quantified at this time. Alternative 6 may require a large expenditure of energy in order to initially implement the cryogenic barrier. There may be an impact on Native Americans because they are potentially more likely than other groups to use the area.

1.4 INTERIM ACTION FOR REMEDIATION OF GROUNDWATER

1.1.14 Potential for Implementing an Interim Action

An interim action for the 100-NR-2 groundwater OU may be warranted. Within the detailed and comparative analyses of alternatives for remediation of the groundwater, certain analyses have been complicated by a lack of information in two critical areas: confirmation that an alternative can or cannot significantly shorten restoration time frames from that of natural attenuation (300 years), and quantification of current and future risk to aquatic receptors living in the river and in river bottom substrate. A summary of these information needs and their significance in making a remedy decision is presented below.

1.4.1.1 Groundwater Remediation for Sr-90

No Sr-90 groundwater remedial alternative has been identified in DOE/RL-95-111, Rev. 0 that would provide a significantly shorter restoration period than the estimated natural attenuation period of 300 years. Soil flushing was identified as an innovative technology that could potentially shorten groundwater remediation. However, the lack of information regarding its implementability, safety, and cost raises doubts as to its technical feasibility.

State and public acceptance of a 300-year groundwater remedial action may be very difficult to obtain. Maintenance of a long-term remedy and its associated institutional controls would also be difficult over such an extended time frame. Because of the problems inherent with a long-term remedy and because of the lack of information supporting innovative technologies such as soil flushing, an interim action on groundwater remediation may be warranted.

River Protection from Sr-90. Data on Sr-90 impacts to aquatic resources are incomplete. Should it be concluded that there are no impacts to aquatic resources from Sr-90 contamination, no remediation for protection of the river would be necessary. Conversely, should it be concluded that substantial impacts exist, actions that are more aggressive may be warranted.

The existing alternatives may remove or prevent 90 percent or more of the Sr-90 mass within the aquifer from entering the river. However, the fate of approximately 5 Ci of Sr-90 in the soil (aquifer sediments) in the strip of land adjacent to the river is not well understood. The ability of any of the selected technologies to remove the Sr-90 from the aquifer sediments adjacent to the river is unknown. As detailed in Section 7.3.1.2, it is the persistent Sr-90 concentrations in this area that will cause long restoration time frames for protection of the river even if the movement of contaminated groundwater to the river is significantly reduced. Further evaluation of these technologies and their capabilities in this area may be warranted.

The lack of information on technologies and receptors may be deemed by the regulatory agencies, the DOE, and the public to be of critical importance to the determination of a final remedy for the 100-NR-2 OU. Because of this, an interim action may be necessary in order to provide adequate time for investigations designed to support the selection of a final remedy. The length of the interim action will depend upon the type and scope of interim investigations needed. However, it is anticipated that an interim action would be planned and executed for approximately a 5-year period. At the conclusion of this period, the need to continue the interim action would be evaluated.

1.1.15 Remedial Action Objective for a Groundwater Interim Action

No alternative has been identified that can remediate the groundwater or protect the river in less than 270 years. The purpose for an interim action at this OU would be to:

- Prevent exposure to contaminated groundwater
- Provide protection of the river by limiting the Sr-90 movement to the river
- Obtain information to allow selection of a final remedial action
- Take action consistent with the likely final remedies.

Remedial alternatives would be chosen that would act in concert with these objectives and be capable of providing further information for use in making a final alternative determination. Because of the uncertainties associated with ecological risk in the area along the river, and in the river bottom substrate, an alternative that controls the movement of Sr-90 to the groundwater-river interface would be an added objective of the interim action.

1.1.16 Remedial Technology Descriptions for an Interim Action

Viable remedial alternatives to achieve the interim remedial action objective should provide the most efficient use of budgetary resources and be consistent with any potential final remedy. It is evident using this basis that none of the final action alternatives presented in Section 7.3 that include long-term physical barriers would be appropriate for an interim action. Construction costs for these barriers are estimated at $8,200,000 for a permeable barrier (Alternative 3), $16,500,000 for a cryogenic barrier (Alternative 6), and $8,600,000 for a soil flush system that incorporates a sheet pile barrier (Alternative 7). The soil flush system associated with Alternative 7 is considered to be too speculative and costly at this time to be considered for an interim use. The physical barriers could potentially preclude the implementation of final remedies that do not incorporate the chosen barrier in the final action, or conversely would require removal costs to implement a different final remedy. Therefore, all alternatives associated with these physical barriers have been screened from consideration as viable interim actions.

The objectives of the interim action could be met by implementing hydraulic controls using a pump-and-treat system such as described in Alternative 4, or just by implementing the hydraulic control portion of such a system. Since this is for an interim action, the full system described as Alternative 4 would not be needed. The existing N-Springs ERA (as modified to optimize costs) could be used to fulfill the interim action objectives, operated as either a hydraulic control or a pump-and-treat operation.

The remedial alternatives that would remain as possible interim actions are: No-Action; Institutional Controls; Hydraulic Controls; and, Pump and Treat. These alternatives are compared below against applicable interim action CERCLA criteria. This comparison has been performed for the purpose of supporting the selection of a remedial alternative should an interim action be recommended.

1.4.1.2 No-Action and Institutional Controls

Descriptions of the technologies included in these alternatives are contained in DOE/RL-95-111, Rev. 0, Sections 5.4.1 and 5.4.2, respectively. Components of the Institutional Controls Alternative specific to Sr-90 would apply during an interim action.

1.4.1.3 Pump-and-Treat Alternative

A full description of the pump-and-treat system and operating plan is described in (DOE-RL 1997). This system would consist of four extraction wells, an ion exchange treatment skid, two injection wells, and plant equipment such as piping, electrical equipment, and instrumentation. The extraction well network would include wells N-75, N-103A, N-105A, N-106A (although well N-105A is not being used), located downgradient of the 1301-N Crib. The pump-and-treat system would be operated continuously at a nominal rate of 228 L/min (60 gal/min) with an average removal of 90 percent for the volume of water treated over a given period. Water from the extraction wells would be pumped to a large influent tank located at the treatment facility. The influent tank acts as a surge tank and provides feed water to the treatment system.

The four ion exchange columns would each contain 1.4 m3 (50 ft3) of clinoptilolite, a natural zeolite. Contaminated water would be pumped from the influent tank through the four clino-containing ion exchange columns, where the Sr-90 would be removed from the water. The clino would be changed out on a cycle duration that results in an average removal rate greater than or equal to 90 percent. The treated water would be discharged into a large effluent tank. The effluent tank acts as a surge tank and provides feed water to the injection well network.

The injection well network would include wells N-29 and N-104A, which are located upgradient of the 1301-N Crib. The processed water would be injected into both wells.

1.4.1.4 Hydraulic Controls Alternative

The Hydraulic Controls Alternative would consist of the same extraction and injection systems as in the Pump-and-Treat Alternative described above. The flow of contaminated liquid would bypass the treatment system and be injected without treatment.

1.1.17 Detailed Analysis of Remedial Alternatives for Groundwater Interim Action

Alternatives applicable to an interim action are compared against the CERCLA criteria described in DOE/RL-95-111, Rev. 0, Section 6.0, which for the most part would apply to an interim action. However, the long-term effectiveness criterion would not be applicable to an interim action, and the costs presented in DOE/RL-95-111, Rev. 0, Section 6.0 would not be applicable for the interim period. Interim costs are presented in Table 7.10.

1.4.1.5 No-Action Alternative

The No-Action Alternative (Alternative 1) discussed in DOE/RL-95-111, Rev. 0, Section 6.3.2.1 is retained for interim action as a baseline for comparison. This alternative is, however, not realistic since DOE is maintaining Institutional Controls in this area in connection with other activities. No costs are associated with the No-Action Alternative.

1.4.1.6 Institutional Controls Alternative

The Institutional Controls Alternative (Alternative 2) is discussed in DOE/RL-95-111, Rev. 0, Section 6.3.2.2. The detailed analysis of CERCLA criteria for this alternative as it relates to Sr-90 final remediation would be applicable to an interim action as well, with the following exceptions: (1) the NEPA values define irreversible and irretrievable commitments for the long-term action, which would not be applicable in the short term; (2) impacts on Native American access to cultural resources would not be applicable in the short term; and (3) no additional costs would be associated with the Institutional Controls Interim Alternative because DOE would maintain its present system of site controls during the interim period. Other facilities and circumstances require institutional controls to continue; therefore, additional costs need not be considered for the interim action alternative.

1.4.1.7 Hydraulic Controls Alternative

A hydraulic controls system is discussed in DOE/RL-95-111, Rev. 0, Section 6.3.2.4 as a river protection technology within Alternative 4. The detailed analysis of CERCLA criteria relative to Sr-90 remediation that is presented in DOE/RL-95-111, Rev. 0, Section 6.3.2.4 would be applicable to an interim action, with the following exceptions: (1) the NEPA values define irreversible and irretrievable commitments for the long-term action, and this would not be applicable in the short term; (2) impacts on Native American access to cultural resources would not be applicable in the short term; and (3) a cost-effectiveness study (DOE-RL 1997) of operating the ERA pump-and-treat system at various treatment levels was recently completed. This study noted that no capital cost would be associated with operating this system since it is already in place. A cost analysis (Permit Attachment 47, Appendix G) based on that study shows that the hydraulic control system could operate at $261,900 per year. This cost includes an expanded well monitoring system but no treatment costs.

1.4.1.8 Pump-and-Treat Alternative

A pump-and-treat system is discussed in DOE/RL-95-111, Rev. 0, Section 6.3.2.4 as a groundwater remediation technology within Alternative 4. The detailed analysis of CERCLA criteria relative to Sr-90 remediation that is presented in that section would be applicable to an interim action, with the following exceptions: (1) the NEPA values define irreversible and irretrievable commitments for the long-term action, which would not be applicable in the short term; (2) impacts on Native American access to cultural resources would not be applicable in the short term; and (3) a cost-effectiveness study (DOE/RL-1997) of operating the ERA pump-and-treat system at various treatment levels was recently completed. This study noted that no capital cost would be associated with operating either system since the systems are already in place. A cost analysis (Permit Attachment 47, Appendix G) based on that study shows that the pump-and-treat system could operate at $329,100 per year. This cost includes a reduced well monitoring system and treatment costs.

1.1.18 Comparative Analysis of Remedial Alternatives for Groundwater Interim Action

The following information provides a comparison of the four interim action alternatives utilizing applicable CERCLA criteria. A discussion of how these alternatives compare for final remedy purposes is included in Sections 7.3.1 through 7.3.6. As stated in Section 7.1, the overall protection and ARAR compliance criteria have not been included in this comparative analysis because all alternatives retained (excluding the No-Action Alternative) meet these threshold criteria except for discharge limits for the discharge of groundwater MCLs, which would not be met. This, however, is an interim action. State and community acceptance will not be evaluated until after the proposed plan has been issued; therefore, they also are not part of this comparative analysis.

1.4.1.9 Long-Term Effectiveness and Permanence

This criterion would not apply to interim action.

1.4.1.10 Reduction of Toxicity, Mobility, or Volume through Treatment

Only the Pump-and-Treat Alternative would reduce Sr-90 mass in the groundwater through treatment. However, this reduction is not significant compared to what would occur by natural attenuation, or by implementing one of the other alternatives. The Hydraulic Controls and Pump-and-Treat Alternatives would significantly reduce the flux of Sr-90 towards the river, thus reducing the mobility of the major contaminant in the 100-N Area. None of the alternatives would provide for a shorter restoration time frame because none would remediate the groundwater or protect the river at the conclusion of the interim measure.

1.4.1.11 Short-term Effectiveness

The Pump-and-Treat and Hydraulic Control Alternatives are already in place as a result of the N-Springs ERA (DOE-RL 1996g, 1997). Therefore, short-term impacts from these alternatives would be small and associated primarily with worker risk from continued operation of these systems. Because pump-and-treat contains two operating systems, the hydraulic control system and the ion exchange treatment system, it would have a slightly higher potential for short-term worker risk during O&M than the Hydraulic Control Alternative. However, the short-term impacts would not be significantly different from the other interim action alternatives. Only minor, if any, short-term physical, biological, or cultural impacts would result from any of the alternatives.

1.4.1.12 Implementability

As a short-term action, all four of the alternatives would be considered technically and administratively feasible. Implementability would not be significantly different for any of the alternatives. No action would be the easiest alternative to implement; however, implementation of this alternative would not be viable because the DOE will continue to maintain restrictions and controls over the 100-N Area groundwater for purposes other than 100-NR-2 remediation. Institutional controls are already in place as part of the DOE operation of the Hanford Site. Hydraulic control implementation, required for both the Pump-and-Treat and Hydraulic Controls Alternatives, would be less implementable than the No-Action or Institutional Controls Alternatives due to the continued operation of a complicated hydraulic control system that could be subject to breakdown. Finally, because pump and treat contains another operating system, it would be slightly less implementable compared to hydraulic controls.

1.4.1.13 Cost

The detailed analysis in Section 7.4.4 showed that there were no additional costs associated with the No-Action and Institutional Controls Alternatives, because these interim action alternatives would not require actions beyond what is currently in place. A comparative cost analysis (Table 7-10) for a 5-year period shows that Hydraulic Controls, at a Present Worth cost of $1,153,109 is the second lowest cost alternative, after the No-Action and Institutional Controls Alternatives. The Pump-and-Treat Alternative is the most expensive alternative, at a Present Worth cost of $1,448,981.

1.4.1.14 NEPA Values

None of the alternatives would require construction of new systems. Impacts to wildlife from construction noise, and disturbance of the land area for construction of well systems, would therefore not occur from any alternative. Ecological, cultural, and natural resource reviews would not be required for any alternative. Impacts to aquatic resources are not anticipated to be significantly different for any of the four interim actions, because decreases in river-bottom and shoreline sediment concentrations during the interim period would not be appreciably different with any of the alternatives. Restrictions on the use of groundwater and river water in the vicinity of the 100-N Area would remain in the short-term regardless of which interim alternative is selected, due to continued DOE control over the Hanford Site in the time frame of the interim action.

Table 1.1. Applicable Remedial Alternatives for Source Waste Sites Assuming a Rural Residential Exposure Scenario.

Waste Group	No Action	Remove/ Dispose	In Situ Bioremediation
Radioactive	X	X	
Petroleum	X	X	X[a]
Inorganic	X	X	
Burn Pits	X	X	
Solid Waste	X	X	

[a] This alternative is only applicable to 2 out of 22 sites within the petroleum waste group.

Table 1.2. Applicable Remedial Alternatives for Source Waste Sites Assuming a Modified CRCIA Ranger/Industrial Exposure Scenario

Waste Group	No Action	Remove/Dispose	In Situ Bioremediation	Containment	Solidification
Radioactive	X	X		X[a]	X[b]
Petroleum	X	X	X[c]		
Inorganic	X	X			
Burn Pits	X	X			
Solid Waste	X	X			

[a] This alternative is only applicable to 16 out of 37 sites within the radioactive waste group.
[b] This alternative is only applicable to 20 out of 37 sites within the radioactive waste group.
[c] This alternative is only applicable to 2 out of 22 sites within the petroleum waste group.

Table 1.3. Cost Comparison of Remedial Action Alternatives for Deep Petroleum Source Sites[a]

(Applicable to both the Rural-Residential and Modified CRCIA Ranger/Industrial Exposure Scenarios)

Site	Remove/Dispose	In Situ Bioremediation	Percent Difference from Remove/ Dispose
UPR-100-N-17	$2,409,203	$ 903,509	
UPR-100-N-42	$2,842,571	$ 910,025	
Total Cost	$5,251,774	$1,813,534	-65%

[a] Costs do not include a 3 percent design cost and a 3 percent design data collection cost.
UPR = unplanned release

Table 1.4. Cost Comparison of Remedial Action Alternatives for Near-Surface Petroleum Source Sites[a]

(Applicable to both the Rural-Residential and Modified CRCIA/Ranger Industrial Exposure Scenarios)

Site	Remove/Dispose	Remove/Ex Situ Bioremediation/Dispose	Percent Difference from Remove/Dispose
UPR-100-N-18	$105,000	$107,994	
UPR-100-N-19	$105,944	$112,486	
UPR-100-N-20	$102,056	$105,660	
UPR-100-N-21	$97,168	$100,162	
UPR-100-N-22	$105,092	$108,696	
UPR-100-N-23	$103,593	$104,720	
UPR-100-N-24	$107,499	$121,304	
UPR-100-N-36	$96,816	$97,408	
UPR-100-N-43	$106,574	$116,719	
100-N-3	$254,529	$329,895	
100-N-12	$93,743	$94,334	
100-N-35	$98,242	$99,369	
100-N-36	$94,724	$98,254	
124-N-2	$149,807	$212,349	
Total Cost	$1,620,787	$1,809,350	+12

[a] Costs do not include a 3 percent design cost and a 3 percent design data collection cost.
UPR = unplanned release

Table 1.5. Present Worth Cost Comparison of Remedial Alternatives for Source Waste Sites for the Rural-Residential Exposure Scenario

Remedial Alternative	Number of Sites[a, b]	Remove/ Dispose	Remove/Ex Situ Bioremediation/ Dispose	In Situ Bioremediation	Percent Difference from Remove/ Dispose
Remove/Dispose	80	$52,030,513	N/A	N/A	NA
Remove/Dispose	63	$50,409,726	$50,409,726		
Remove/Ex Situ Bioremediation/ Dispose	17	$ 1,620,787	$ 1,809,350		+12
Cost	80	$52,030,513	$52,219,056		~ 0
Remove/Dispose	78	$46,777,739		$46,777,739	
In Situ Bioremediation[b]	2	$ 5,251,774	N/A	$ 1,813,350	-65
Cost	80	$52,030,513		$48,592,089	- 7

[a] There are four sites (100-N-28, 116-N-4, 118-N-1, UPR-100-N-35) where all of the waste is below 4.6 m (15 ft), and these sites may not be remediated under this scenario. See DOE/RL-95-111, Rev. 0, Appendix B for information regarding excavation depths.
[b] There are five sites (100-N-46, 100-N-50, 100-N-51a, 100-N-51b, and 100-N-65) for which costs or additional costs will be established during design.
[c] The cost shown in this table does not include a 3 percent design cost and a 3 percent cost for collecting design data in the field.
N/A = not applicable

Table 1.6. Costs for Source Units

Site Name	Remove/Dispose	Capping	In Situ Solidification
CAP 1-1			
UPR-100-N-10	$95,391	$653,884	$157,016
UPR-100-N-39	$99,297	$3,767,236	$415,600
Subtotal	$194,688	$4,421,120	$572,616
CAP 1-2			
UPR-100-N-29	$100,630	$41,563	$158,467
UPR-100-N-30	$112,776	$4,086,761	$349,849
UPR-100-N-32	$101,908	$389,430	$173,568
Subtotal	$315,314	$4,517,754	$681,884
CAP 4-1			
UPR-100-N-4	$97,464	$83,646	$192,295
UPR-100-N-5	$218,961		$651,238
UPR-100-N-6	$104,056	$190,527	$217,955
UPR-100-N-8	$95,391	$4,647	$157,016
UPR-100-N-25	$97,779	$106,881	$202,532
100-N-26	$101,593	$23,235	$163,047
124-N-4	$766,864	$38,909,260	$1,388,214
Subtotal	$1,482,108	$46,469,916	$2,972,297
CAP 4-2			
UPR-100-N-9	$104,307	$4,672,424	$345,617
UPR-100-N-14	$95,409	$82,740	$158,496
Subtotal	$199,716	$4,755,164	$504,113
CAP 4-3			
UPR-100-N-13	$88,873	$749,331	$181,321
UPR-100-N-26	$99,908	$3,674,112	$252,221
Subtotal	$188,781	$4,423,443	$433,542
Misc In Situ Solidification			
UPR-100-N-1	$150,214	N/A	$386,077
UPR-100-N-11	$95,835	N/A	$345,010
100-N-13	$98,242	N/A	$340,414
100-N-14	$98,242	N/A	$340,414
Subtotal	$442,533	N/A	$1,411,915
Total for Capping and Remove/ Dispose	$2,380,607	$64,587,397	
Total for In Situ Solidification and Remove/Dispose	$2,823,140	N/A	$6,576,367

[a] Costs based on the Modified CRCIA Ranger/Industrial Exposure Scenario.
NA = not applicable

Table 1.7. Present Worth Cost Comparison of Remedial Alternatives for Source Waste Sites for the Modified CRCIA Ranger/Industrial Exposure Scenario [a]

Remedial Alternative	Number of Sites[b,c]	Remove/ Dispose	Remove/ Ex Situ Bioremediation/ Dispose	In Situ Bioremediation	Containment	In Situ Solidification	Percent Difference from Remove/ Dispose
Remove/Dispose	80	$49,896,037					
Remove/Dispose	63	$48,275,250	$48,275,250	N/A	N/A	N/A	
Remove/Ex Situ Bioremediation/ Dispose	17	$ 1,620,787	$ 1,809,350	N/A	N/A	N/A	+12
Cost	80	$49,896,037	$50,084,600				0
Remove/Dispose	78	$44,644,263	N/A	$44,644,263	N/A	N/A	
In Situ Bioremediation	2	$ 5,251,774	N/A	$ 1,813,350	N/A	N/A	-65
Cost	80	$49,896,037		$46,457,613			-7
Remove/Dispose	64	$47,515,430	N/A	N/A	$ 47,515,430	N/A	
Containment	16	$2,380,607	N/A	N/A	$64,587,397	N/A	+2703
Cost	80	$49,896,037			$112,102,827		+ 125
Remove/Dispose	60	$46,820,831	N/A	N/A	N/A	$46,820,831	
In Situ Solidification	20	$3,075,206	N/A	N/A	N/A	$6,576,367	+114
Cost	80	$49,896,037				$53,397,198	+7

[a] The cost shown in this table does not include a 3 percent design cost and a 3 percent cost for collecting design data in the field.
[b] There are five sites for which costs or additional costs will be established during design.
[c] There are eleven sites for which all of the waste is below 3 m (10 ft), and these sites may not be remediated under this scenario.

Table 1.8. Remedial Alternatives for Groundwater Contamination at the 100-N Area

Alternative		**River Protection Technology**		**Aquifer Cleanup Technology**	
No.	Title	Protection of the River from Tritium	Protection of the River from Strontium	Reduce Strontium-90 Concentration/ Activity in the Aquifer[a]	Reduce Concentrations of Other Contaminants in the Aquifer[b]
1	No Action	No Action	No Action	No Action	No Action
2	Institutional Controls	Institutional Controls	Institutional Controls	Institutional Controls	Institutional Controls
3	Permeable Barrier for River Protection	Institutional Controls	Permeable Barrier Wall	Institutional Controls	Institutional Controls
4	Hydraulic Controls for River Protection and Pump and Treat for Strontium in the Aquifer	Institutional Controls	Hydraulic Control (270 years)	Pump and Treat	Institutional Controls
5	Hydraulic Controls for River Protection and Pump and Treat for Aquifer Remediation	Hydraulic Control (15 years)	Hydraulic Control (270 years)	Pump and Treat	Pump and Treat
6	Cryogenic Barrier for River Protection and Pump and Treat for Aquifer Remediation	Institutional Controls	Impermeable Barrier Wall (cryogenic wall)	Pump and Treat	Pump and Treat
7	Sheet Pile Barrier for River Protection and Soil Flushing/Pump and Treat for Aquifer Remediation	Impermeable Barrier Wall (with hydraulic control for tritium)	Impermeable Barrier Wall (sheet pile wall with pre-excavation)	Soil Flush System	Pump and Treat

[a] Strontium-90 remediated by removing strontium from the aquifer (concentration) and by providing time for natural radioactive decay (activity).
[b] Other contaminants include nitrate, sulfate, hexavalent chromium VI, TPH, and manganese.

Table 1.9. Cost of Remedial Alternatives for Groundwater

No.	Remedial Alternatives	Initial Capital Cost ($)	Present Worth of Future Costs ($)	Total Present Worth Cost ($)
1	No Action	0	0	0
2	Institutional Controls	63,558	699,468	762,826
3	Permeable Barrier for River Protection	8,240,697	1,021,528	9,262,225
4	Hydraulic Controls for River Protection and Pump and Treat for Strontium in the Aquifer	1,754,609	12,491,105	14,245,714
5	Hydraulic Controls for River Protection and Pump and Treat for Aquifer Remediation	4,580,204	34,585,401	39,165,605
6	Cryogenic Barrier for River Protection and Pump and Treat for Aquifer Remediation	20,389,389	36,269,137	56,658,526
7[a]	Sheet Pile Barrier for River Protection and Soil Flushing/ Pump and Treat for Aquifer Remediation	22,416,808	114,113,817	136,530,625

[a] This alternative is in the development and evaluation stage; therefore, a reliable cost estimate cannot be made.

Table 1.10. Comparative Cost Summary of the Interim Groundwater Remedial Alternatives

Alternative	Capital Cost ($)	One Year Operating Cost ($)	Present Worth Cost ($)
No Action	0	0	0
Institutional Controls	0	0	0
Hydraulic Controls	0	$261,900	$1,153,109
Pump and Treat	0	$329,100	$1,448,981

Chapter 2.0 Recommended Corrective Measures for 100-NR-1 Operable Unit

2.0 RECOMMENDED CORRECTIVE MEASURES FOR 100-NR-1 AND 100-NR-2 OPERABLE UNITS 2.1
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2.0 RECOMMENDED CORRECTIVE MEASURES FOR 100-NR-1 OPERABLE UNIT

According to EPA guidance, a RCRA corrective measures study should identify the recommended corrective measure. This section is included for consistency with EPA RCRA guidance, and the recommended corrective measures presented in this section correspond to the preferred remedial alternatives that will be identified in the integrated CERCLA Proposed Plan and RCRA Permit Modification proposal for the 100-NR-1 and 100-NR-2 Operable Units (OUs). The preferred alternative that will be presented in the Proposed Plan is only a preliminary recommendation, and changes to the preferred alternative, or a change from the preferred alternative to another alternative, may be made based on public comment. The recommended corrective measures presented in this section will be revised, if necessary, to reflect the remedy eventually selected by the CERCLA ROD.

In addition to identifying the recommended corrective measure, the RCRA process requires that the specific permit conditions associated with the recommendation be identified. This section includes detailed information to be referenced for purposes of establishing RCRA permit conditions. If, as a result of public comment, the preferred alternative is changed, then the permit conditions and information presented in this section will be modified accordingly.

The Tri-Party Agreement defines the 100-NR-1 and 100-NR-2 OUs as RCRA past-practice sites. RCRA corrective action authority applies to releases of dangerous[1] waste and dangerous constituents including releases from solid waste management units and to releases of mixed waste (mixtures of hazardous waste and radiological contaminants), but not to waste that only contains radiological contaminants. Since many of the waste sites in the operable units contain radiological contaminants, and because they are in the 100 Area, which is listed on the NPL, the adequacy of any action taken under another regulatory authority will be evaluated against CERCLA program criteria. The recommended RCRA corrective measures[2] that are discussed in this section have been developed to satisfy requirements for both RCRA corrective action and CERCLA remedial action. By applying CERCLA authority concurrently with RCRA corrective action requirements through an integrated plan, all regulatory and environmental obligations at the 100-NR-1 and 100-NR-2 OUs can be met as effectively and efficiently as possible. Also, by applying CERCLA authority jointly with that of RCRA, additional options for disposal of corrective action and remedial action wastes at the ERDF are possible. By allowing flexibility in final disposal options, disposal costs can be minimized while still being protective of human health and the environment.

The following discussion explains RCRA corrective action performance standards, which must be met by the recommended corrective measures.

2.1 RCRA CORRECTIVE ACTION PERFORMANCE STANDARDS

The RCRA corrective action performance standards found at WAC 173-303-646(2) state that the corrective measure:

1. *Shall protect human health and the environment from all releases of dangerous wastes and dangerous constituents, including releases from all solid waste management units at the facility.* For purposes of corrective action at the 100-NR-1 and 100-NR-2 Operable Units, protection is generally determined as follows:

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[1] RCRA authority with respect to hazardous waste management and corrective action has been delegated to the State of Washington. The State of Washington has published regulations for this authority at WAC 173-303, "Dangerous Waste Regulations." The State terms "dangerous waste" and "dangerous constituents" are generally equivalent to the RCRA terms "hazardous waste" and "hazardous constituents."

[2] RCRA corrective measures are essentially equivalent to CERCLA remedial actions.

a. Human health[3] will be protected by preventing exposure to contaminants above unacceptable levels (i.e., MTCA B with a residential land-use scenario for soil sites).

b. Protection of the Columbia River will be enhanced by removing contamination from the source sites and by utilizing the existing pump-and-treat system (via hydraulic controls) to reduce discharges of contaminated groundwater.

c. Ecological resources will be protected by minimizing impacts resulting from corrective measures, by cleaning up source sites (except the shoreline site) to levels that are protective of human health, and by continuing the existing pump-and-treat operations to reduce discharges of contaminated groundwater to the river.

d. Cultural resources will be protected by minimizing impacts resulting from corrective measures.

A discussion of how these performance standards will be achieved is provided in Permit Sections 9.2 and 9.3.

2. *Is required regardless of the time at which waste was managed at the facility or placed in such units, and regardless of whether such facilities or units were intended for the management of solid or dangerous waste;*

The 100 Area was evaluated to identify sites where waste was placed or handled. The results of this investigation are provided in a variety of documents listed in DOE/RL-95-111, Rev. 0, Section 2.2. Based on three principle resources (i.e., 100 Area Technical Baseline Report, RCRA Facility Investigation/Corrective Measure Study Work Plan, and WIDS), DOE/RL-95-111, Rev. 0 identifies 114 potentially contaminated source sites in the 100-NR-1 Operable Unit. Thirty three of these have been eliminated from further consideration in the evaluations of alternatives because either they were never contaminated, are not currently contaminated, or they fall under other regulatory jurisdictions and are not subject to RCRA regulations. The remaining 81 potentially contaminated waste sites would be subject to RCRA corrective measures because dangerous constituents were handled at and potentially released from the sites. Corrective measures recommended for the various categories of waste sites are described in Section 9.2.1 below.

3. *Must be implemented by the owner/operator beyond the facility property boundary, where necessary to protect human health and the environment.*

The recommended corrective measures are interim actions that address contaminated soils and groundwater within the 100-NR-1 and 100-NR-2 Operable Units. There have been releases of dangerous constituents to locations beyond the boundaries of the areas addressed by DOE/RL-95-111, Rev. 0 and the DOE is undertaking studies of the impacts of these releases and how they will need to be addressed in final actions for the Hanford Site. Although the recommended corrective measures will reduce the potential for future off site releases, this performance standard will be addressed during final remediation of the Hanford Site as discussed in Section 9.1 above.

In addition to the performance standards cited in the WAC, the following also applies:

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[3] It is assumed that protection of human health will also result in the protection of various ecological receptors (i.e., plants and animals) that could come into contact with the potentially contaminated sites as discussed in Section 4.3. It is also a basic assumption in recommendations for corrective measures that they will not preclude any future land use.

4. Corrective action must be conducted in compliance with training requirements established in 29 *CFR* 1910.120(e) and Permit Condition II.C.2.

Training to be implemented to meet this requirement is described in Section 9.2.5 below.

2.2 CORRECTIVE MEASURES FOR THE 100-NR-1 OPERABLE UNIT SOURCE SITES

The 100-NR-1 OU addresses contaminated soils and underground pipelines. It also includes the shoreline site, which is composed of the riverbank seeps in the 100-N Area (N-Springs) and the contaminated soil associated with waste site 100-N-65. The 100-NR-1 Operable Unit does not include the contaminated groundwater underlying this area. The groundwater is addressed in the 100-NR-2 OU.

Based on the types of contaminants that occur at the waste sites, the 81 waste sites included in the 100-NR-1 OU have been categorized into the following types:

- Radioactive waste sites (37)[4]
- Inorganic waste sites (6)
- Burn pits (6)
- Surface solid and miscellaneous waste sites (9)
- Surface petroleum sites (20)
- Deep petroleum sites (2)
- Shoreline site (1).

2.2.1 Recommended Actions and Justifications

Different corrective measures have been recommended for the various categories of waste sites in the 100-NR-1 OU. The recommended corrective measures are as follows:

- Remove/Dispose for the radioactive and inorganic waste sites, the burn pits, and the surface solid and miscellaneous waste sites. The Remove/Dispose corrective measure would consist of removing contaminated media that exceed cleanup levels; disposing media at the ERDF; backfilling, grading, and revegetation excavated areas; and land-use restrictions and access controls as described in detail in DOE/RL-95-111, Rev. 0, Section 5.3.4.

- Remove/Ex Situ Bioremediation/Dispose for near-surface petroleum sites. The Remove/ Ex Situ Bioremediation/Dispose corrective measure would consist of removing contaminated media that exceed cleanup levels; treating excavated soil through biodegradation to reduce toxicity (ex situ bioremediation); disposing residual, contaminated media at the ERDF; backfilling and revegetation excavated areas; and groundwater monitoring as described in detail in DOE/RL-95-111, Rev. 0, Section 5.3.5.

- In Situ Bioremediation for deep petroleum sites. The In Situ Bioremediation corrective measure would consist of treating contaminated soil in place through biodegradation to reduce toxicity (in situ bioremediation); revegetating disturbed areas; and groundwater monitoring as described in detail in DOE/RL-95-111, Rev. 0, Section 5.3.6.

- Institutional Controls under a modified CRCIA ranger/industrial scenario for the shoreline site. The Institutional Controls corrective measure would consist of land-use and/or access controls and groundwater monitoring as described in detail in DOE/RL-95-111, Rev. 0, Section 8.7.2.

In developing the recommended corrective measures, the various alternatives were compared against both the CERCLA evaluation criteria and the RCRA performance standards. Alternatives that met the two

[4] These sites are called radioactive waste sites because radioactive constituents are the primary concern; however, these sites are also potentially contaminated with dangerous constituents.

CERCLA threshold criteria (i.e., overall protection of human health and the environment and compliance with ARARs), would also meet the RCRA performance standards numbered 1 through 3 in Section 9.1. All the recommended corrective measures provide protection of human health (performance standard 1.a). The measures that include a removal or treatment component will be protective by removing and disposing of contaminated soil or treating contaminated soil to reach acceptable levels in accordance with ARARs. Similarly, the in situ component will treat contaminated soil to ARARs. The institutional controls recommendation will be protective of human health by preventing exposure through the use of access controls and land-use restrictions.

In addition, the recommended corrective measures, except for institutional controls, would be protective of the environment (performance standard 1.b). By removing or treating contaminated soils, no contaminants above acceptable cleanup levels would remain at the site. Therefore, the potential for contaminants to migrate to other environmental resources is minimized. Institutional controls would not be protective of the environment because they are not effective in preventing migration of contaminants to the groundwater or the river. However, the recommendation to implement institutional controls is viewed as only an interim measure pending availability of information that would support selection of a final remedy for the shoreline site. Attaining ARARs for final cleanup are beyond the scope of the recommended corrective measures, but they will be addressed as part of final cleanup of the site.

All of the recommended corrective measures would minimize impacts to ecological and cultural resources (performance standards 1.c and 1.d). For recommendations with removal components, impacts would be minimized through careful adherence to ecological and cultural resources mitigation planning. With the in situ treatment component, little disturbance of the site would be required, therefore impacts to ecological or cultural resources would be minimal. In addition, both the remove and treatment recommendations should have a beneficial impact on ecological and cultural resources by reducing the amount of contamination discharged to offsite sources. Institutional controls, which are already widely used at Hanford, would present no additional risk to ecological or cultural resources.

Performance standard 2 is being met with these recommended corrective measures because all of the sites that have been identified as being potentially contaminated in the 100-NR-1 are being addressed by one of the corrective measures.

By removing or treating contaminated soils to acceptable cleanup levels, and by controlling migration of contaminants to the groundwater, the potential for releases beyond the boundaries of the 100-NR-1 or 100-NR-2 Operable Units is greatly reduced. Therefore, the recommended corrective measures would satisfy performance standard 3, both in the near term and the future. In addition, this performance standard will be addressed during final remediation of the Hanford Site as discussed in Section 9.1 above.

Performance standard 4 pertaining to training is discussed in Section 9.2.5 below.

2.2.2 Cleanup Standards for the 100-NR-1 Operable Unit

The cleanup standards for the 100-NR-1 OU are MTCA Method B values identified for the contaminants of concern listed in DOE/RL-95-111, Rev. 0, Table 4-7. If there are sites where deep soil contamination (more than 4.6 m below surrounding grade) is in excess of the cleanup standards, several factors will be considered to determine the extent of additional corrective actions. These factors include protection of human health and the environment, remediation costs, size of the ERDF, worker safety, presence of ecological and cultural resources, the use of institutional controls, and long-term monitoring costs. The extent of remediation must also ensure that contaminant levels in the soil are protective of groundwater and the Columbia River. The decision of whether to proceed with the Remove/Dispose recommendation below 4.6 m will be made by the regulators in consideration of the factors listed above.

2.2.3 Cost

The estimated cost for the various Remove/Dispose alternatives that are recommended for the 80 source sites (which excludes the shoreline site) is $48.7 million. The cost for the Institutional Controls under the Modified CRCIA Ranger/Industrial Alternative that would be applicable to the shoreline site is estimated to be $63,358. Detailed cost analyses for all the alternatives are contained in Permit Attachment 47, Chapter 7.0, §7.2.

2.2.4 Schedule

Corrective measures for the 100-NR-1 Operable Unit will begin upon completion of all the TSD units and will follow the duration schedule identified in the *Engineering Evaluation/Cost Analysis for the 100-N Area Ancillary Facilities and Integration Plan* (Permit Attachment 48).

2.2.5 Training

All personnel working at the Hanford Site, including at sites associated with the 100-NR-1 Operable Unit, will be provided with and will successfully complete general site training as specified in Permit Condition II.C.2 of the Hanford Facility Dangerous Waste Permit. The general requirements specified in Permit Condition II.C.2 are as follows:

All Hanford Facility personnel shall receive general training within 6 months of hire. This training shall provide personnel with orientation of dangerous waste management activities being conducted on the Hanford Facility. This training shall include:

- Description of emergency signals and appropriate personnel response
- Identification of contacts for information regarding dangerous waste management activities
- Introduction to waste minimization concepts
- Identification of contact(s) for emergencies involving dangerous waste
- Familiarization with the Hanford Facility Contingency Plan.

In addition to the training specified in the permit condition, personnel who work at or visit the 100-NR-1 OU sites and who have the potential for exposure to contaminants above permissible levels will be provided with training in accordance with 29 CFR 1910.120(e). All such personnel shall receive the required training before they are permitted to engage in hazardous waste operations that could expose them to hazardous substances, safety, or health hazards. The training shall consist of provision of the following information:

- Names of personnel and alternates responsible for site safety and health
- Safety, health, and other hazards present on the site
- Use of personal protective equipment
- Work practices by which the employee can minimize risks from hazards
- Safe use of engineering controls and equipment on the site
- Medical surveillance requirements, including recognition of symptoms and signs that might indicate overexposure to hazards
- Familiarization with the site safety and health plan.

This information shall be provided both initially and in annual refresher courses, and certifications shall be made as summarized in subsection 9.2.5.3.

2.2.5.1 Initial Training

- For general site workers, initial training shall consist of a minimum of 40 hours of instruction off the site, and a minimum of three days actual field experience under the direct supervision of a trained, experienced supervisor.

- For workers who are on site only occasionally for a specific limited task, or those who will work only in areas where no health hazards or the possibility of an emergency exists (i.e., are not required to wear respirators), initial training shall consist of a minimum of 24 hours of instruction off the site, and a minimum of 1 day of supervised field experience.
- For on-site managers and supervisors directly responsible for employees engaged in hazardous waste operations, initial training shall consist of a minimum of 40 hours of instruction and 3 days of field experience. This may be reduced to 24 hours of instruction and 1 day of field experience if supervision is limited to those workers who are on site only occasionally or work in areas where no health hazards exist. Managers and supervisors must also have 8 hours of specialized training on such topics as employer's safety and health program and associated employee training program, personal protective equipment program, spill containment program, and health hazard monitoring procedures and techniques.
- For trainers, they shall have academic credential and instruction experience in the subjects they are expected to teach, or must have satisfactorily completed a training program for teaching the subjects, and shall demonstrate competent instructional skills and knowledge of the subject matter.
- For those employees engaged in responding to hazardous emergency situations at hazardous waste cleanup sites that may expose them to hazardous substances shall be trained in how to respond to such expected emergencies.

2.2.5.2 Refresher Training

Employees and supervisors required to have completed the initial training as described above shall receive 8 hours annually of refresher training in the required topics and/or a critique of incidents that occurred during the previous year that could serve as training examples.

2.2.5.3 Certification

Employees and supervisors that have received and successfully completed the training and field experience shall be certified by their instructor as evidenced by a written certificate. Uncertified employees shall be prohibited from engaging in hazardous waste operations.

Chapter 3.0 Applicable or Relevant and Appropriate Requirements

3.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS 3.3

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3.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

3.1 INTRODUCTION

Applicable or relevant and appropriate requirements (ARAR) are standards, requirements, criteria, or limitations promulgated under federal or state environmental laws that must be met or waived for remedial actions as required by Section 121 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). Only the substantive provisions of ARARs must be met (or waived) for actions conducted entirely on site [CERCLA 121(d)(2)] because such onsite actions are exempted from obtaining federal, state, and local permits [CERCLA 121(e)(1)]. A component of an action's protectiveness is its ability to comply with ARARs. The to be considered (TBC) materials are other federal or state guidance, criteria, advisories, proposed regulations, or similar materials that, while not enforceable, provide additional standards that may be pertinent in selecting or designing a remedy.

Below is a listing of the major ARARs and TBCs pertinent to remediation of the 100-NR-1 and 100-NR-2 Operable Units. These ARARs and TBCs are further described and cited in Table 3.1 and are discussed relative to each remedial alternative in Sections 3.1.1 through 3.1.7.

- The Model Toxics Control Act (MTCA) Regulations
- The Safe Drinking Water Act (SDWA) Primary and Secondary Drinking Water Standards
- Draft EPA Radiation Site Cleanup Regulations
- The Resource Conservation and Recovery Act Hazardous Waste Regulations
- State of Washington Dangerous Waste Regulations
- The U.S. Environmental Protection Agency Transportation Regulations
- Nuclear Regulatory Commission Licensing Requirements for Land Disposal of Radioactive Wastes
- State of Washington Waste Discharge Permit Program
- State of Washington Underground Injection Control Program
- National Emissions Standards for Hazardous Air Pollutants
- State of Washington Radiation Protection Air Emissions
- State of Washington Control of New Sources of Toxic Air Pollutants
- The National Historic Preservation Act
- The Native American Graves Protection and Repatriation Act
- The Archeological and Historical Preservation Act
- The Endangered Species Act
- The Migratory Bird Treaty Act
- The Hanford Reach Preservation Act
- U.S. Department of Energy Occupational Radiation Protection Regulations
- Nuclear Regulatory Commission Standards for Protection Against Radiation
- U.S. Department of Energy Order - Radiation Dose Limit

3.1.1 Standards for Soil, Groundwater, and River Cleanup

The state MTCA is implemented by Chapter 173-340 of the Washington Administrative Code (WAC) and establishes cleanup standards (including cleanup levels and points of compliance) for nonradioactive contaminants in soil and groundwater. In setting standards, MTCA prescribes a methodology for calculating cleanup levels based on potential land use and exposure assumptions and draws on other standards, such as maximum contaminant levels (MCLs) established for drinking water under the SDWA. In addition, MTCA specifies that soil and groundwater cleanup must be accomplished so that other interconnected media, such as adjacent surface waters, are protected. The MTCA standards are relevant and appropriate and are incorporated into the remediation goals for all remedial alternatives evaluated in this CMS.

Few standards exist for the cleanup of radioactive constituents at waste sites. Standards for MCLs for certain radionuclides, based on an annual dose limit, are provided in 40 CFR 141 and are relevant and appropriate and are incorporated into the remediation goals for alternatives that address groundwater. Standards for remediation of radioactive constituents in soil have not been promulgated. Two agencies (the U.S. Environmental Protection Agency [EPA] and the U.S. Nuclear Regulatory Commission [NRC]) have proposed regulations for acceptable levels of residual radioactivity for cleanup of soil. These are TBC materials rather than ARARs, but in the absence of ARARs, they are incorporated into the remediation goals for soil cleanup.

The following information provides an analysis of how each source-site and groundwater alternative category is anticipated to comply with these ARARs and TBCs.

3.1.1.1 100-NR-1 Source Site Alternative Compliance with ARARs/TBCs

No-Action Alternative. The No-Action Alternative would not result in compliance with soil and groundwater protection ARARs or TBCs.

Institutional Controls Alternative. Because there is a general lack of data on soils within the 100-NR-1 source operable unit, it is unknown whether institutional controls would be adequate to meet standards for soil and groundwater cleanup. Should contaminant of concern concentrations be present at a site that would contribute to an increase in groundwater contamination (i.e., cause new or expanded areas of contamination above and beyond existing contaminant plumes) or a decrease in river protection, the ARARs and TBCs for this alternative would not be met. The type of institutional controls that may be necessary to preclude direct exposure to contaminants is also dependent upon the need for more information on constituent concentrations in the soil. It is assumed, however, that controls such as access controls (e.g., signs) and restrictions on groundwater usage would be adequate to meet soil and groundwater standards based on direct exposure in the short term. However, because this alternative will require that controls be in place for over 200 years due to Sr-90 decay, it becomes less certain that institutional controls would be able to provide compliance with soil and groundwater direct exposure standards. Institutional controls would preclude rural-residential use at sites where direct soil exposure levels are above residential standards. At the shoreline site, contaminants would be left in place above groundwater and river protection standards with this alternative until contaminated groundwater is remediated. Compliance would be attained at the end of the groundwater/river protection remediation, which may require 270 to 300 years.

Remove/Dispose Alternative. Removal, treatment where appropriate and subsequent disposal of contaminated soils will provide compliance with all soil and groundwater cleanup standards. However, due to the lack of data on constituent concentrations in the soil, the degree of removal that would be required at a site in order to reach compliance with soil and groundwater cleanup standards cannot be ascertained. A potential exists that it would become technically impracticable or cost prohibitive to excavate deep vadose zone soils if large, deep areas of contamination are discovered. Removal, treatment where appropriate, and subsequent disposal of contaminated shoreline site soils will provide compliance with all soil and groundwater cleanup standards if contaminated groundwater is prevented from recontaminating the soil through implementation of a hydraulic or physical barrier system.

In Situ Bioremediation of Petroleum Waste Group. In situ bioremediation is a proven technology that has achieved good results at other remedial action sites. It is anticipated to achieve compliance with soil and groundwater cleanup standards for total petroleum hydrocarbons (TPH). However, given the lack of data identifying the extent of contamination, there is a possibility that remediation using this alternative would not be practical.

Containment for Radioactive Waste Group. Although this alternative likely will not comply with the direct soil exposure numerical cleanup standards and possibly the groundwater protection numerical cleanup standards of MTCA. MTCA considers this a compliant alternative if the compliance monitoring program is designed to ensure the long-term integrity of the containment system

(WAC 173-340-740[4][6][d]). Without any removal of contaminants from soils, there is a potential that after failure of the cap, contaminants could still be in place in the soils that could exceed the soil cleanup standards and could cause exceedence of groundwater cleanup standards. Therefore, maintenance of the cover is critical to maintaining compliance with these ARARs and TBCs. For the shoreline site, a cover alternative would also be expected to comply with soil and groundwater cleanup standards during the design life of the cover. This alternative would be in conflict with unrestricted land use.

In Situ Solidification for Radioactive Waste Group and Shoreline Site. In situ solidification will provide compliance with soil and groundwater cleanup levels for constituents expected to be remaining in the soils for the radioactive waste group. It is possible that constituents might be present in the soil that cannot be immobilized through the chosen solidification technology, such as mobile inorganic constituents, but this possibility is considered unlikely.

3.1.1.2 100-NR-2 Groundwater Alternative Compliance with ARARs/TBCs

There is a general lack of data on the impacts of aquatic organisms from Sr-90 concentrations entering the river. Groundwater and river protection standards for Sr-90 are based on the MCL in this CMS. However, because ecological impacts are unknown and because concentrations of Sr-90 are anticipated to exceed MCL river-protection standards for 270 years for any of the alternatives, further study is warranted. (Note: Modeling efforts show that manganese will require over 3,000 years to meet cleanup standards based on its secondary MCL. Because of the uncertainties in modeling plume dispersion over this time frame and because the standard is based on a secondary MCL, Sr-90 remediation time frames are considered the primary focus.) One potential avenue for obtaining some information on impacts to aquatic organisms is the pending Columbia River Comprehensive Impact Assessment study (Tri-Party Agreement Milestone M-15-80, scheduled for submittal of a revised draft in March 1998). This study is planned to define further ecological impacts, including aquatic ecosystems potentially impacted by Sr-90 along the 100-NR-2 groundwater/river interface. When this information is obtained, it will become available to the public for consideration. In addition, reassessment of ecological impacts associated with remediation of 100-NR-2 will be made during the CERCLA five-year review (40 CFR 300.430(f)(4)(ii)).

No-Action Alternative. The No-Action Alternative would not result in compliance with soil and groundwater protection ARARs and TBCs.

Institutional Controls Alternative. Compliance with groundwater and river protection standards will be attained for all contaminants of concern (COC) at the end of remediation, which is estimated to require 300 years under this alternative. One exception will be manganese, which may exceed secondary MCLs for over 3,000 years.

Because of the length of time necessary to ensure that institutional controls are maintained, compliance with ARARs and TBCs becomes less certain. Access controls and groundwater use restrictions would restrict exposure to contaminants in groundwater until contaminant plumes decay and/or naturally attenuate to concentrations below groundwater protection standards. River protection standards would continue to be exceeded for Sr-90 for 270 years and would be exceeded for tritium for 10 to 15 years. Groundwater protection standards would be exceeded for Sr-90 and tritium for 300 years and 25 years, respectively. Except for manganese, inorganic contaminants will not meet MCLs in groundwater from a few to about 30 years, depending upon the specific contaminant. Nitrates will exceed MCLs at the groundwater/river interface in the future and manganese may exceed MCLs at a future date under this alternative.

Permeable Barrier for River Protection. Compliance with groundwater and river protection standards will be attained for all COCs at the end of remediation, which is estimated to require 300 years under this alternative. One exception will be manganese, which may exceed secondary MCLs for over 3,000 years.

The permeable wall would not allow compliance with groundwater protection standards at a significantly faster rate because this alternative does not actively treat the Sr-90. River protection standards are not met at a faster rate due to the continued flushing of Sr-90 into the groundwater/river interface from the contaminated soils that remain in the strip of land between the groundwater/river interface and the permeable wall. This alternative will reduce concentrations of Sr-90 entering the groundwater/river interface, thus allowing for greater overall protection of the river, but may have no effect on the time it will take to achieve compliance with groundwater and river protection standards due to the continued release of Sr-90 from this strip of land. River protection standards would continue to be exceeded for Sr-90 for 270 years and would be exceeded for tritium for 10 to 15 years. Tritium would continue to exceed groundwater protection standards until decay decreased concentrations below MCLs (25 years). "Other" inorganic contaminants will have restoration time frames for compliance with groundwater protection standards as identified in Section 5.0. Most significantly, manganese may exceed groundwater protection standards for over 3,000 years under this alternative.

Hydraulic Controls for River Protection and Pump and Treat for Sr-90 in the Aquifer. Compliance with groundwater and river protection standards will be attained for all COCs at the end of remediation, which is estimated to take 270 years under this alternative (except manganese, which may exceed secondary MCLs for over 3,000 years).

Hydraulic controls would not allow compliance with groundwater protection standards at a significantly faster rate because this alternative does not actively treat the Sr-90. The time necessary to achieve compliance with groundwater protection standards for Sr-90 would not be significantly shortened (from 300 years without treatment to 270 years with treatment). River protection standards would not be met in a significantly shorter time frame due to the continued flushing of Sr-90 into the groundwater/river interface from the Sr-90 that remains in the aquifer sediments adjacent to the river. This alternative will reduce concentrations of Sr-90 entering the groundwater/river interface, thus allowing for greater overall protection of the river, but may have no effect on the time it will take to achieve compliance with river protection standards due to the continued release of Sr-90 from the sediments. Tritium would not be actively remediated along the entire plume (although the hydraulic controls for Sr-90 would remediate much of the tritium plume), and, therefore, groundwater and river protection standards would not be met until decay and natural attenuation brought concentrations below the MCL (25 and 10 to 15 years, respectively). Other groundwater plumes would not be actively remediated with this alternative and, therefore, would not achieve compliance with groundwater or river protection standards until decay and/or natural attenuation resolved concentrations below the standards. "Other" inorganic contaminants will have restoration time frames for compliance with groundwater protection standards as identified in Section 5.0. Most significantly, manganese may exceed groundwater protection standards for over 3,000 years under this alternative.

Hydraulic Controls for River Protection and Pump and Treat for Aquifer Remediation. Compliance with groundwater and river protection standards will be attained for all COCs at the end of remediation, which is estimated to take 270 years under this alternative.

Hydraulic controls and pump-and-treat systems would not allow compliance with river protection standards at a significantly faster rate because this alternative would reduce the time frame for Sr-90 remediation from 300 to 270 years. Groundwater protection standards would be met for all COCs, other than tritium and Sr-90, in a much shorter time frame than could be achieved through decay and/or natural attenuation. Strontium-90 groundwater protection standards would not be met in a significantly shorter time frame (300 years without treatment and 270 years with treatment). Tritium would continue to exceed groundwater protection standards until decay decreased concentrations below MCLs (25 years) but would meet MCLs in the groundwater/river interface shortly after hydraulic controls are fully operational. This alternative is anticipated to be able to reduce concentrations of Sr-90 entering the groundwater/river interface, thus allowing for greater overall protection of the river (although the amount may not be significant), but would have no effect on the time it will take to achieve compliance with river protection standards due to the continued release of Sr-90 from the aquifer sediments near the river. Manganese will not meet MCLs in groundwater for close to 90 years using pump-and-treat technologies. Other inorganic contaminants will have shortened restoration time frames for compliance with groundwater protection standards as identified in Section 5.0.

Cryogenic Barrier for River Protection and Pump and Treat for Aquifer Remediation. Compliance with groundwater and river protection standards will be attained for all COCs at the end of remediation, which is estimated to take 270 years under this alternative.

The barrier and pump-and-treat systems would not allow compliance with river protection standards at a significantly faster rate because this alternative does not actively treat the Sr-90 in aquifer sediments immediately adjacent to the river. Strontium-90 would continue to cause exceedences of river protection standards due to continued flushing of sediments on the riverside of the barrier. Groundwater protection standards would be met with this alternative for all COCs, other than Sr-90 and tritium, in a much shorter time frame than could be attained through decay and/or natural attenuation. Strontium-90 groundwater protection standards would not be met in a significantly shorter time frame (300 years without treatment and 270 years with treatment), and tritium would continue to exceed groundwater protection standards until decay and natural attenuation decreased concentrations below MCLs (25 years). Manganese will not meet MCLs in groundwater for close to 90 years using pump-and-treat technologies. Other inorganic contaminants will have shortened restoration time frames for compliance with groundwater protection standards as identified in Section 5.0.

Sheet Pile Barrier for River Protection and Soil Flushing/Pump and Treat for Aquifer Remediation. Compliance with groundwater and river protection standards will be attained for all COCs at the end of remediation, which is estimated to take 270 years under this alternative.

The barrier and pump-and-treat systems would not allow compliance with river protection standards at a significantly faster rate because this alternative does not actively treat the Sr-90 in aquifer sediments immediately adjacent to the river. Groundwater protection standards would be met with this alternative for all COCs, other than Sr-90 and tritium, in a much shorter time frame than could be attained through decay and/or natural attenuation. It is unknown how rapidly soil flushing could remediate groundwater for Sr-90. Tritium would continue to exceed groundwater protection standards until decay decreased concentrations below MCLs (25 years) but would meet MCLs in the groundwater/river interface shortly after hydraulic controls are fully operational. Manganese will not meet MCLs in groundwater for close to 90 years using pump-and-treat technologies. Other inorganic contaminants will have shortened restoration time frames for compliance with groundwater protection standards as identified in Section 5.0.

3.1.2 Waste Management Standards

The Resource Conservation and Recovery Act of 1976 (RCRA) regulates the generation, transportation, storage, treatment, and disposal of solid and hazardous waste. Authority to implement much of RCRA has been delegated to the state and is implemented by WAC 173-303 (for dangerous waste) and WAC 173-304 (for solid waste that is not dangerous waste). Authority for land disposal restrictions (LDR), including standards for the treatment of wastes prior to land disposal, are retained at the federal level and implemented via 40 CFR 268. The Atomic Energy Act (AEA) establishes standards for the management of radioactive wastes. Regulations pertaining to the management and land disposal of low-level radioactive waste are contained in 10 CFR 61.

Alternatives that involve the removal of waste or contaminated media or in situ or ex situ treatment may generate solid, dangerous, or radioactive waste. The RCRA requirements are applicable to those alternatives that may generate, transport, treat, store, or dispose of solid or dangerous waste. Offsite shipment of hazardous materials must comply with EPA's 49 CFR transportation and packaging requirements. DOE Order 1540.1A is considered a TBC for onsite waste transport. It requires substantive compliance with 49 CFR unless other methods allow an equivalent degree of safety. The substantive requirements of 10 CFR 61 is relevant and appropriate to those alternatives that generate, treat, or dispose of radioactive waste. All waste generated under any alternative would be evaluated and managed in compliance with the appropriate waste designation. Waste disposal would be to the Environmental Restoration Disposal Facility (ERDF), which is designed to meet the requirements of both RCRA and the radioactive waste standards. For alternatives that involve leaving solid or dangerous waste in place, RCRA performance standards for landfill covers are applicable or relevant and appropriate (depending on the date when the waste was first placed at the site) and are incorporated into the design. Cover performance and boundary requirements, locators, and post-operational monitoring contained in 10 CFR 61.52 are relevant and appropriate to the in-place disposal of radioactive waste.

The following information provides an analysis of how each source-site alternative category is anticipated to comply with these ARARs and TBCs.

3.1.2.1 100-NR-1 Source Site Alternative Compliance with ARARs/TBCs

No-Action Alternative. Because the No-Action Alternative does not result in waste generation, information specific to compliance with ARARs and TBCs has not been provided.

Institutional Controls Alternatives. Institutional controls are not anticipated to generate waste.

Remove/Dispose Alternative. Potentially large quantities of soil and debris (piping, structures, and cleanup materials) may be generated under the alternatives requiring disposal. These wastes may or may not require treatment in order to be disposed to the ERDF. Shoreline site wastes may require dewatering. However, due to the lack of data on soils, the type and extent of waste treatment cannot be defined. It is anticipated, however, that compliance with waste management standards will be achievable. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in WAC 173-303. Because of the potential for much greater quantities of waste generated from this alternative, ARAR and TBC compliance will be more difficult than the other alternatives.

In Situ Bioremediation of Petroleum Waste Groups. Small quantities of waste may be generated from in situ bioremediation such as contaminated soils and cleanup debris during preparation of the soil surface for treatment. These wastes may or may not require treatment in order to be disposed to the ERDF. However, due to the lack of data on soils, the type and extent of waste treatment cannot be defined. It is anticipated, however, that compliance with waste-management standards will be achievable. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in WAC 173-303.

Containment for Radioactive Waste Group and Shoreline Site. Small quantities of waste may be generated from placement of a cap such as contaminated soils and cleanup debris during site preparation and construction. Operational wastes may include run-on and run-off waters. Wastes may also be generated during maintenance of the cap. These wastes may or may not require treatment in order to be disposed to the ERDF; however, due to the lack of data on soils, the type and extent of waste treatment cannot be defined. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in WAC 173-303. It is anticipated, however, that treatment and subsequent compliance with waste-management standards will be achievable.

In Situ Solidification for Radioactive Waste Group and Shoreline Site. Small quantities of waste may be generated from in situ solidification such as contaminated soils and cleanup debris during preparation of the soil surface for treatment. These wastes may or may not require treatment in order to be disposed to the ERDF. However, due to the lack of data on soils, the type and extent of waste treatment cannot be defined. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in WAC 173-303. It is anticipated, however, that compliance with waste-management standards will be achievable.

3.1.2.2 100-NR-2 Groundwater Alternative Compliance with ARARs/TBCs

No-Action Alternative. Because the No-Action Alternative does not result in waste generation, information specific to compliance with ARARs and TBCs has not been provided.

Institutional Controls Alternative. Institutional controls are not anticipated to generate waste.

Permeable Barrier for River Protection. Construction of a permeable wall is anticipated to generate waste in the form of contaminated soils and construction debris. These waste streams may or may not require treatment in order to meet waste acceptance criteria for the ERDF and/or LDR requirements. Compliance with waste management ARARs and TBCs are anticipated to be easily attained.

Hydraulic Controls for River Protection and Pump and Treat for Sr-90 in the Aquifer. Construction and operation of wells and a pump-and-treat system will generate small quantities of waste in the form of contaminated soils, groundwater, cleanup debris, treatment residuals, and resins. These waste streams may or may not require treatment in order to meet waste acceptance criteria for the ERDF and/or LDR requirements. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in WAC 173-303. Compliance with waste management ARARs and TBCs are anticipated to be easily attained.

Hydraulic Controls for River Protection and Pump and Treat for Aquifer Remediation. Construction and operation of wells and a pump-and-treat system will generate small quantities of waste in the form of contaminated soils, groundwater, cleanup debris, and resins. These waste streams may or may not require treatment in order to meet waste acceptance criteria for the ERDF and/or LDR requirements. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in WAC 173-303. Compliance with waste management ARARs and TBCs are anticipated to be easily attained.

Cryogenic Barrier for River Protection and Pump and Treat for Aquifer Remediation. Construction of a cryogenic barrier is anticipated to generate waste in the form of contaminated soils and construction debris. Construction and operation of wells and a pump-and-treat system will generate small quantities of waste in the form of contaminated soils, cleanup debris, treatment residuals, and adsorbents. These waste streams may or may not require treatment in order to meet waste acceptance criteria for the ERDF and/or LDR requirements. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in WAC 173-303. Compliance with waste management ARARs and TBCs are anticipated to be easily attained.

Sheet Pile Barrier for River Protection and Soil Flushing/Pump and Treat for Aquifer Remediation. Construction of a sheet pile barrier is anticipated to generate waste in the form of contaminated soils and construction debris. Construction and operation of wells and a pump-and-treat system will generate small quantities of waste in the form of contaminated soils, cleanup debris, treatment residuals, and adsorbents from treatment systems. These waste streams may or may not require treatment in order to meet waste acceptance criteria for the ERDF and/or LDR requirements. Compliance with waste management ARARs and TBCs are anticipated to be easily attained with the exception of the soil-flushing adsorbents. This waste stream is anticipated to contain extremely high concentrations of Sr-90, and treatment of this waste stream will be required in order to comply with the ERDF waste acceptance criteria. Management of this waste stream will require careful planning in order to comply with handling treatment, packaging, and transportation requirements. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in WAC 173-303.

3.1.3 Wastewater Management Standards

WAC 173-216 establishes requirements for discharges to waters of the state, other than discharges subject to an NPDES permit under the Clean Water Act, including effluent discharges to the soil column. WAC 173-218 establishes requirements for injection to the underground aquifer.

The following information provides an analysis of how each source-site alternative category is anticipated to comply with these ARARs and TBCs.

3.1.3.1 100-NR-1 Source-Site Alternative Compliance with ARARs/TBCs

All source-site alternatives, other than the No-Action and Institutional Controls Alternatives, could result in the generation of some quantity of decontamination or dewatering wastewaters. Depending upon volumes of soils, debris, and types and concentrations of contaminants, a number of treatment/disposal options may be used that may result in wastewater discharges to the ground or to groundwater. Treatment and disposal options that may invoke these standards include discharge of wastewaters to the ground after verification that contaminant concentrations are below the substantive requirements contained in WAC 173-216, transport of wastewaters to a pump-and-treat system in substantive compliance with WAC 173-218 and designed to treat COCs in wastewaters, and transport of wastewaters to a site water-treatment system in compliance, or substantive compliance depending upon operating authority, with WAC 173-216 or 40 CFR 122. Regardless of which alternative is used, compliance with these ARARs and TBCs can be accomplished.

Remove/Dispose Alternative. Some soil treatments will produce a wastewater stream that could require treatment at the end of the treatment phase. Treatment and disposal options would include trucking the wash waters to a water-treatment facility within the Hanford Site or testing the waters and, if they comply with ARARs associated with WAC 173-216, discharging them to the ground. The ARARs associated with wastewater management would be able to be complied with regardless of which treatment and disposal option is chosen.

3.1.3.2 100-NR-2 Groundwater Alternative Compliance with ARARs/TBCs

All alternatives other than the No-Action and Institutional Controls Alternatives will require construction and development of wells. This activity has the potential to require disposal of purge water from well installation and development activities. Purge-water management will be accomplished in accordance with the Hanford Site Purge Water Agreement. Injection of treated groundwater is considered in the groundwater removal and treatment alternatives. Reinjection would be subject to the provisions of WAC173-218. If this cannot be accomplished, a waiver would be required.

3.1.4 Standards for Protection of the Columbia River from Direct Discharges

40 CFR 122 addresses technology-based limitations and standards, control of toxic pollutants, and monitoring for direct discharges to waters of the United States, including storm water.

No direct wastewater discharges to the Columbia River are planned under any of the alternatives. Use of National Pollutant Discharge Elimination System-permitted water-treatment units for treatment of wastewaters from source-unit cleanup may be utilized as identified above. Erosion and storm water controls would be used as necessary while working near the river. A storm water management plan would be prepared to prevent discharges of contaminated storm water to the Columbia River.

Two alternatives with remediation of the shoreline site, the Remove/Dispose and the Containment Alternatives, could trigger ARARs associated with river construction activities. These ARARs include the U.S. Army Corp of Engineers permitting requirements contained in 33 CFR 320-330, which contain provisions for dredging and filling material to the Columbia River. Because the Columbia River may be included in the Wild and Scenic River System, the substantive requirements associated with a Section 10 permit under 33 CFR 322 may be an ARAR for these alternatives. State ARARs associated with river construction include the Shoreline Development Permits contained in WAC 173-14, and Hydraulic Projects Permits contained in WAC 220-110.

3.1.5 Air Standards

The Clean Air Act (CAA) establishes standards for the control of air emissions. Authority has partially been delegated to the state. Under 40 CFR 61, Subpart H, and WAC 246-247 , radionuclide airborne emissions from all combined operations at the Hanford Site may not exceed 10-mrem/yr effective dose equivalent to the hypothetical offsite maximally exposed individual (MEI). For an emission unit with a potential to emit less than 0.1 mrem/yr total effective dose equivalent to the MEI, WAC 246-247 allows for an estimate of those emissions in lieu of monitoring and requires verification of compliance through periodic confirmatory measurements. An emission unit is defined as a point source, nonpoint source, or source of fugitive emissions. WAC 246-247 requires verification of compliance through monitoring. WAC 173-400 establishes requirements for the control and/or prevention of the emission of air contaminants, including particulates. WAC 173-460 establishes acceptable source impact levels for more than 500 carcinogenic acutely toxic air pollutants. In addition, WAC 173-480-050 requires that emissions be kept as low as reasonably achievable (ALARA).

The radionuclide emission limits would apply to all fugitive, diffuse, and point source air emissions of radionuclides generated by any of the removal or treatment (in situ or ex situ) alternatives. If there were the potential for any non-zero radioactive emissions, best available radionuclide control technology (BARCT) would be required. If the alternative would generate an increase of toxic air pollutants to the atmosphere above the small-quantity emission rates, implementation of BARCT for toxics would be required.

The following information provides an analysis of how each source-site alternative category is anticipated to comply with these ARARs and TBCs.

3.1.5.1 Source-Site Alternative Compliance with ARARs/TBCs

No-Action Alternative. Because the No-Action Alternative would have contaminants in place, compliance with ARARs and TBCs would not be achieved.

Institutional Controls Alternative. Institutional controls are not anticipated to generate airborne emissions of radionuclides.

Remove/Dispose Alternative. Remove, treatment, and disposed activities have the potential to increase emissions of radionuclides. If radionuclides are present in the soil at the site and there is the potential for any non-zero emissions, BARCT would be required as specified in WAC 246-247. No toxic emissions are expected.

Remove/Ex Situ Bioremediation/Dispose for Petroleum Waste Group. Remove, aboveground bioremediation, and dispose activities have the potential to increase emissions of radionuclides if radionuclides are present in the soil. However, ex situ bioremediation would not be used if radionuclides were present along with petroleum hydrocarbons. Bioremediation is not expected to increase any emissions of TPH; therefore, no additional controls are required.

In Situ Bioremediation of Petroleum Waste Group. Preparation for in situ bioremediation may require limited surface disturbance of a surface radiation area. If radionuclides are present in the surface soil at the site and there is the potential for any non-zero emissions, BARCT would be required, as specified in WAC 246-247. Once preparation is completed, no additional emissions are expected from the activity. If radionuclides were present in deep soil, then in situ bioremediation would not be selected as an alternative. In addition, bioremediation is not expected to increase any emissions of TPH; therefore, no additional controls are required.

Containment for Radioactive Waste Group and Shoreline Site. Containment is a standard practice on the Hanford Site for surface contaminants. The Radiation Area Remedial Action program uses clean fill to cover and stabilize surface contamination. The placement of a cover to contain radiation units is not anticipated to generate airborne emissions of radionuclides. The BARCT will be required, as specified in WAC 246-247, to prevent the release of particulates during placement of the cover.

In Situ Solidification for Radioactive Waste Group and Shoreline Site. Preparation for in situ solidification may require limited surface disturbance of the surface radiation area. If radionuclides are present in the surface soil at the site and there is the potential for any non-zero emissions, BARCT would be required as specified in WAC 246-247. Once preparation is competed, no additional emissions are expected from the activity.

3.1.5.2 100-NR-2 Groundwater Alternative Compliance with ARARs

No-Action Alternative. Because the No-Action Alternative would not actively cause airborne emissions, compliance with ARARs and TBCs will be achieved.

Institutional Controls Alternative. Institutional controls are not anticipated to generate airborne emissions of radionuclides.

Permeable Barrier for River Protection. Installation of the permeable wall has the potential to encounter radionuclide contaminated soil. If radionuclides are present in the soil at the site and there is the potential for any non-zero emissions, BARCT would be required as specified in WAC 246-247.

Hydraulic Controls for River Protection and Pump and Treat for Sr-90 in the

Aquifer. Installation of the pump-and-treat system should not generate radionuclide emissions. However, if radionuclides are present in the soil at the site and there is the potential for any non-zero emissions, BARCT would be required as specified in WAC 246-247.

Hydraulic Controls for River Protection and Pump and Treat for Aquifer Remediation. Installation of the pump-and-treat system should not generate radionuclide emissions. However, if radionuclides are present in the soil at the site and there is the potential for any non-zero emissions, BARCT would be required as specified in WAC 246-247.

Cryogenic Barrier for River Protection and Pump and Treat Aquifer Remediation. Installation of the cryogenic barrier has the potential to generate emissions of radionuclides while the installation of the pump-and-treat system should not generate radionuclide emissions. However, if radionuclides are present in the soil at the site and there is the potential for any non-zero emissions, BARCT would be required as specified in WAC 246-247.

Sheet Pile Barrier for River Protection and Soil Flushing/Pump and Treat for Aquifer Remediation. Installation of the sheet pile barrier has the potential to generate emissions of radionuclides while the installation of the pump-and-treat system should not generate radionuclide emissions. However, if radionuclides are present in the soil at the site and there is the potential for any non-zero emissions, BARCT would be required as specified in WAC 246-247.

3.1.6 Standards for the Protection of Cultural and Ecological Resources

The National Historic Preservation Act of 1966 (16 USC 470 et seq, implemented in regulation by 36 CFR 800) requires federal agencies to take into account the effect of an activity on any significant cultural resource, including properties listed, or eligible for inclusion, on the National Register of Historic Places. The Native American Graves Protection and Repatriation Act establishes statutory provisions for the treatment of inadvertent discoveries of Native American remains and cultural objects. The Archeological and Historical Preservation Act of 1974 (16 USC 469a) requires action to recover and preserve archaeologic or historic data in areas where activity may cause irreparable harm, loss, or destruction of significant data.

The Endangered Species Act of 1973 (16 USC 1531) is implemented by 50 CFR 402 and WAC 232-12-297 WAC and prohibits activities that threaten the continued existence of listed species or destroys critical habitat. The Migratory Bird Treaty Act makes it illegal to take, capture, or kill, as applicable, any migratory bird or any part, nest, or egg of any such birds.

All National Register evaluations have been performed to determine whether the buildings in the 100-N Area are eligible for inclusion on the National Register of Historic Places, and this determination may affect alternatives for nearby waste sites. The cultural resource protection requirements are applicable for those properties in the 100-N Area that have been determined to be historically significant. In addition, the 100 Area in general is rich in cultural resources related to Native Americans, and several of the alternatives involve ground-disturbing activities. If any discoveries related to Native American remains or cultural objects are made during such activities, activity in the area will cease, and appropriate notifications and negotiations regarding further actions will be made.

Threatened and endangered species are known to be present in the 100 Area, and the area is within an established migration route; however, no adverse impacts on protected species or sensitive habitat from any of the alternatives are anticipated. Area-specific ecological reviews will be conducted prior to implementing any alternative to identify potential adverse impacts. Mitigation plans will be prepared, as necessary, and implemented.

The Hanford Reach Preservation Act (PL 100-605) provides for a comprehensive river conservation study and prohibits the construction of any dam, channel, or navigation project by a federal agency for 8 years from enactment. Projects are required to be performed under the consultation and coordination of the National Park Service on any proposed remediation alternative.

The following information provides an analysis of how each source-site alternative category is anticipated to comply with these ARARs and TBCs.

3.1.6.1 100-NR-1 Source-Site Alternative Compliance with ARARs/TBCs

No-Action Alternative. Because the No-Action Alternative leaves waste in place, ARARs and TBCs relative to these standards may not be complied with, due to threat of contamination to the resources, or relative to the use of resources.

Institutional Controls Alternative. Minimal or no surface disturbances are anticipated to occur utilizing this alternative; therefore, ARARs/TBCs associated with preservation of cultural and ecological resources would be easily followed in the short term. This alternative will also afford continued protection of cultural and historical resources from public use. However, this alternative irreversibly or irretrievably commits natural resources during the remediation time frame, which can be for a very long time particularly, for the shoreline site. This alternative also has the potential for contaminating resources adjacent to the sites from contaminants remaining in place. Therefore, long-term compliance with these ARARs and TBCs cannot be ensured.

Remove/Dispose Alternative. This alternative will comply with all cultural and ecological resource ARARs and TBCs. However, this alternative has a high potential to impact cultural, historical, or traditional-use areas due to the need for extensive excavation of areas at and adjacent to the waste sites (e.g., shoring side walls for worker safety) particularly at the shoreline site. Much more care will be required with this alternative for completion of preconstruction surveys and development of mitigative measures should cultural or natural resources be encountered. Recontouring and revegetation of the disturbed areas will be required to ensure restoration of the natural resources. A benefit of this option is that no future threat of recontamination of the site or contamination of adjacent areas will occur once the contaminants are removed and appropriately disposed.

Remove/Ex Situ Bioremediation/Dispose for Petroleum Waste Group. This alternative will comply with all cultural and ecological resource ARARs and TBCs. However, this alternative has a high potential to impact cultural, historical, or traditional-use areas due to the need for extensive excavation of areas at and adjacent to the waste sites (e.g., shoring side walls for worker safety). Much more care will be required with this alternative for completion of preconstruction surveys and development of mitigative measures should cultural or natural resources be encountered. Recontouring and revegetation of the disturbed areas will be required to ensure restoration of the natural resources. A benefit of this option is that no future threat of recontamination of the site or contamination of adjacent areas will occur once the contaminants are removed and appropriately disposed. The treatment action, aboveground bioremediation, should not require additional actions in order to comply with these standards.

In Situ Bioremediation for Petroleum Waste Group. This alternative will comply with all cultural and ecological resource ARARs and TBCs. This alternative is anticipated to cause minimal or no impacts to cultural resources since the area of concern has already been previously disturbed because of operations.

Compliance with these standards can readily be achieved through proper preconstruction surveys and mitigative measures should resources be encountered.

Containment for Radioactive Waste Group and Shoreline Site. This alternative will comply with all cultural and ecological resource ARARs and TBCs. Placement of a cap is anticipated to cause minimal or no impacts to cultural resources since the area of concern has already been previously disturbed because of operations. This alternative will protect adjacent cultural resources from becoming contaminated by retaining contaminants in place. Compliance with these standards can readily be achieved during construction of the cap through proper preconstruction surveys and mitigative measures should resources be encountered. Implementation of this alternative will most likely enhance ecological resources by eliminating the exposure of contaminants and by providing an opportunity to revegetate the surface of the cap with plant species that provide for a viable and sustainable ecological environment.

In Situ Solidification for Radioactive Waste Group and Shoreline Site. This alternative will comply with all cultural and ecological resource ARARs and TBCs. This alternative is anticipated to cause minimal or no impacts to cultural resources since the area of concern has already been previously disturbed because of operations. Because this alternative will immobilize contaminants, protection of adjacent cultural resources will be ensured by contaminants remaining in place. Recontouring and revegetation efforts that could impact cultural resources would require mitigative measures. Compliance with these standards can readily be achieved through proper preconstruction surveys and mitigative measures should resources be encountered.

3.1.6.2 100-NR-2 Groundwater Alternative Compliance with ARARs/TBCs

All 100-NR-2 groundwater alternatives require very long restoration time frames for river protection (270 to 300 years for Sr-90 cleanup). Note: Based on modeling of current well data, manganese would require over 3,000 years to meet secondary MCL standards. Because of the uncertainties with modeling to this length of time and because the manganese MCL is based on a secondary drinking water standard, the Sr-90 remediation time frame is considered the primary focus). Due to the length of remediation, waivers from ecological resource ARARs may be required. Impacts to aquatic organisms from Sr-90 and tritium contamination have not been fully defined. In order to determine whether these constituents are damaging aquatic resources to the extent that they are irretrievable and irreversible, more data will need to be gathered and assessed. One potential avenue for obtaining this information is the pending Columbia River Comprehensive Impact Assessment study (Tri-Party Agreement Milestone M-15-80, scheduled for submittal of a revised draft in March of 1998). This study is planned to define further ecological impacts, including aquatic ecosystems potentially impacted by Sr-90 along the 100-NR-2 river interface. When this information is obtained, it will become available to the public for consideration. In addition, all 100-NR-2 groundwater alternatives other than the No-Action Alternative, may temporarily (for up to 300 years) restrict use of the shoreline, particularly at N-Springs.

No-Action Alternative. ARARs and TBCs would be complied with because no surface disturbances would occur with this alternative.

Institutional Controls Alternative. Minimal or no surface disturbances are anticipated to occur using this alternative; therefore, ARARs and TBCs associated with preservation of cultural and ecological resources would be easily complied with.

Permeable Barrier for River Protection. This alternative will cause major surface disturbances in an area near the river shoreline and unrestricted land use would conflict with this option, but it is anticipated that ARARs and TBCs will be complied with during implementation and after completion of this alternative. Because this area is particularly sensitive from both an ecological and cultural perspective, particular attention to ecological reviews will be necessary, as well as development of mitigative measures during construction activities, to ensure compliance with these ARARs and TBCs.

Hydraulic Controls for River Protection and Pump and Treat for Sr-90 in the Aquifer. This alternative will cause minimal surface disturbance through construction and operation of well systems and the pump-and-treat facility. These activities are anticipated to cause minimal disturbance to cultural and ecological resources, and compliance with ARARs and TBCs is anticipated to be easily met through standard Hanford practices for cultural and ecological surveys and mitigative measures.

Hydraulic Controls for River Protection and Pump and Treat for Aquifer Remediation. This alternative will cause minimal surface disturbance through construction and operation of well systems and the pump-and-treat facilities. These activities are anticipated to cause minimal disturbance to cultural and ecological resources, and compliance with ARARs and TBCs is anticipated to be easily met through standard Hanford practices for cultural and ecological surveys and mitigative measures.

Cryogenic Barrier for River Protection and Pump and Treat for Aquifer Remediation. This alternative will cause major surface disturbances in an area near the river shoreline due to construction of a cryogenic barrier, but it is anticipated that ARARs and TBCs will be able to be complied with during implementation and after completion of this alternative. Because this area is particularly sensitive from both an ecological and cultural perspective, particular attention to ecological reviews will be necessary, as well as development of mitigative measures during construction activities to ensure compliance with these ARARs and TBCs. Minimal surface disturbance through construction and operation of well systems and the pump-and-treat facilities can be expected. These activities are anticipated to cause minimal disturbance to cultural and ecological resources, and compliance with ARARs and TBCs is anticipated to be easily met through standard Hanford practices for cultural and ecological surveys and mitigative measures.

Sheet Pile Barrier for River Protection and Soil Flushing/Pump and Treat for Aquifer Remediation. This alternative will cause minimal surface disturbance through construction and operation of well systems and the pump-and-treat facilities. These activities are anticipated to cause minimal disturbance to cultural and ecological resources, and compliance with ARARs and TBCs is anticipated to be easily met through standard Hanford practices for cultural and ecological surveys and mitigative measures.

3.1.7 Radiation Protection Standards

The Atomic Energy Act establishes radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation resulting from the conduct of DOE activities. Title 10 CFR 835 establishes limits for doses to occupational workers and visitors and requires that measures be taken to maintain radiation exposure as low as reasonably achievable. Regulations regarding radiation protection of the public and the environment have been promulgated by the NRC in 10 CFR 20 and 10 CFR 61.

A combination of personal protective equipment, personnel training, physical design features (e.g., confinement and remote handling), and nonengineered controls (e.g., limiting time in radiation zones), for example, would be used to ensure that the requirements of 10 CFR 835 and DOE Order 5400.5 are met for all alternatives.

The following information provides an analysis of how each source-site alternative category is anticipated to comply with these ARARs and TBCs.

3.1.7.1 100-NR-1 Source-Site Alternative Compliance with ARARs/TBCs

No-Action Alternative. ARARs and TBCs associated with radiation protection standards may not be complied with because the No-Action Alternative would leave contamination in place.

Institutional Controls Alternative. Compliance with radiation worker exposure standards would be easily met with this alternative because it is anticipated that very little field-maintenance activities would be required with this alternative. Compliance with radiation protection standards for the public can be achieved with this alternative through continued control of the site under the DOE or an equivalent agency. Compliance would be achieved through access prevention to areas that would result in doses that exceed radiation protection standards for the public. However, because this alternative will require that controls be in place for over 200 years due to Sr-90 decay, it becomes less certain that institutional controls would be able to provide compliance with radiation protection standards. A decision for rural residential use at sites within 100-NR-1 is most probably precluded with the sole use of institutional controls where radiation protection standards are exceeded.

Remove/Dispose Alternative. Compliance with radiation worker exposure standards can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during site preparation and excavation of soils in radiologically contaminated areas. Radiation protection standards for the public will be complied with during excavation of radiologically contaminated soils through adequate planning and design of the excavation and disposal activities. Upon removal of soils, these requirements will cease to be applicable at the site.

Remove/Ex Situ Bioremediation/Dispose for Petroleum Waste Group. Radiation protection standards are not anticipated to be applicable to this alternative; however, due to the lack of data on soil sites, there is a potential for these standards to apply should radionuclides be discovered within petroleum-contaminated soils.

In Situ Bioremediation of Petroleum Waste Groups. Radiation protection standards for the public are not anticipated to be applicable to this alternative; however, because of the lack of data on soil sites, there is a potential for these standards to apply should radionuclides be discovered within petroleum-contaminated soils.

Containment for Radioactive Waste Group and Shoreline Site. Compliance with radiation worker exposure standards can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during site preparation and construction of a cap in radiologically contaminated areas. Compliance with radiation protection standards for the public can be achieved throughout construction and during operation and maintenance of the cap. Compliance would be achieved through access prevention to areas that would result in doses that exceed radiation protection standards for the public.

In Situ Solidification for Radioactive Waste Group and Shoreline Site. Compliance with radiation worker exposure standards can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during site preparation, construction activities, and implementation of the treatment activities in radiologically contaminated areas. In situ solidification by itself may not be able to ensure compliance with radiation protection standards for the public. Institutional controls would be required to prevent intrusion into the solidified mass and to prevent access should radiation protection standards be exceeded after solidification. In this manner, compliance with these standards can be achieved.

3.1.7.2 100-NR-2 Groundwater Alternative Compliance with ARARs/TBCs

No-Action Alternative. Because groundwater would remain accessible and contaminated, compliance with ARARs and TBCs may not be achieved.

Institutional Controls Alternative. Compliance with radiation worker exposure standards would be easily met with this alternative because it is anticipated that very little field maintenance activities would be required with this alternative. Compliance with radiation protection standards for the public can be achieved with this alternative through continued control of the site under the DOE or an equivalent agency. Compliance would be achieved through restrictions on groundwater use. At the end of remediation, radionuclide activity in the groundwater would have decayed to levels that would allow for unrestricted use.

Permeable Barrier for River Protection. Compliance with radiation worker exposure standards can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during site preparation and construction of the permeable barrier in radiologically contaminated areas. Compliance with radiation protection standards for the public can be achieved with this alternative through continued control of the site under the DOE or an equivalent agency. Compliance would be achieved through restrictions on groundwater use. At the end of remediation, radionuclide activity in the groundwater would have decayed to levels that would allow for unrestricted use.

Hydraulic Controls for River Protection and Pump and Treat for Sr-90 in the Aquifer. Compliance with radiation worker exposure standards can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during construction and operation of wells and the pump-and-treat facility. Compliance with radiation protection standards for the public can be achieved with this alternative through continued control of the site under the DOE or an equivalent agency. Compliance would be achieved through restrictions on groundwater use. At the end of remediation, radionuclide activity in the groundwater would have decayed to levels that would allow for unrestricted use.

Hydraulic Controls for River Protection and Pump and Treat for Aquifer Remediation. Compliance with radiation worker exposure standards can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during construction and operation of wells and the pump-and-treat facilities. Compliance with radiation protection standards for the public can be achieved with this alternative through continued control of the site under the DOE or an equivalent agency. Compliance would be achieved through restrictions on groundwater use. At the end of remediation, radionuclide activity in the groundwater would have decayed to levels that would allow for unrestricted use.

Cryogenic Barrier for River Protection and Pump and Treat for Aquifer Remediation. Compliance with radiation worker exposure standards can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during construction and operation of wells and the pump-and-treat facilities. Compliance with radiation protection standards for the public can be achieved with this alternative through continued control of the site under the DOE or an equivalent agency. Compliance would be achieved through restrictions on groundwater use. At the end of remediation, radionuclide activity in the groundwater would have decayed to levels that would allow for unrestricted use.

Sheet Pile Barrier for River Protection and Soil Flushing/Pump and Treat for Aquifer Remediation. Compliance with radiation worker exposure standards can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during construction and operation of wells and the pump-and-treat facilities. Compliance with radiation protection standards for the public can be achieved with this alternative through continued control of the site under the DOE or an equivalent agency. Compliance would be achieved through restrictions on groundwater use. At the end of remediation, radionuclide activity in the groundwater would have decayed to levels that would allow for unrestricted use.

Table 3.1. Applicable or Relevant and Appropriate Requirements (ARAR) and To Be Considered (TBCs)

Description	Citation	Requirements	Remarks	Operable Unit Affected
Atomic Energy Act of 1954, as amended	42 U.S.C. 2011 et seq.	Authorizes DOE to set standards and restrictions governing facilities used for research, development, and use of atomic energy.		100-NR-2
Department of Energy Occupational Radiation Protection (Final Rule)	10 CFR 835	Establishes occupational and visitor radiological exposure limits.	DOE Radiological Control Manual DOE/EH-02561, which is encompassed within the Hanford Site Radiological Control Manual adheres to these requirements.	100-NR-1 100-NR-2
Nuclear Regulatory Commission Standards for Protection Against Radiation	10 CFR 20, Subpart C and D	Sets occupational dose limits for adult workers. Total effect dose equivalent equal to 5 rem/year. Sets dose limits to members of the public.	Occupational dose limits will be followed during remediation in radiological areas.	100-NR-1 100-NR-2
Nuclear Regulatory Commission Licensing Requirements for Land Disposal of Radioactive Wastes	10 CFR 61	Provides regulations for the management and land disposal of radioactive wastes.	Cover performance standards are contained in this regulation.	100-NR-1
Uranium Mill Tailings Radiation Control Act of 1978	Public Law 95-604, as amended			
Standards for Uranium and Thorium Mill Tailings	40 CFR 192	Establishes standards for control, cleanup, and management of radioactive materials from inactive uranium processing sites.	May be relevant and appropriate if any radium-226 is encountered.	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Land Cleanup Standards	40 CFR 192.10-192.12	Requires remedial actions to provide reasonable assurance that, as a result of residual radioactive materials from any designated processing site, the concentration of radium-226 in land averaged over any area of 100 m2 shall not exceed the background level by more than 5 pCi/g, averaged over the first 15 cm of soil below the surface and 15 pCi/g, averaged over 150-cm-thick layers of soil more than 15 cm below the surface. In any habitable building, a reasonable effort shall be made during remediation to achieve an annual average (or equivalent) radon decay product concentration (including background not to exceed 0.02 Working Level (WL). In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL and the level of gamma radiation shall not exceed the background level by more than 20 microroentegens per hour.	May be relevant and appropriate if any above-background radium-226 or radon-222 is encountered during remediation. Radium-226 did not result from uranium processing; therefore, regulation is not applicable.	100-NR-1 100-NR-2
Implementation	40 CFR 192.20-192.23	Requires that when radionuclides other than radium-226 and its decay products are present in sufficient quantity and concentration to constitute a significant radiation hazard from residual radioactive materials, remedial action shall reduce other residual radioactivity to levels as low as reasonably achievable (ALARA).	May be relevant and appropriate if any radium-226 is encountered during remediation.	100-NR-1 100-NR-2
Archaeological and Historical Preservation Act of 1974	26 U.S.C. 469	Requires action to recover and preserve artifacts in areas where activity may cause irreparable harm, loss, or destruction of significant artifacts.	Applicable when remedial action threatens significant scientific, prehistorical, historical, or archeological data.	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Archaeological Resources Protection Act of 1979	16 U.S.C. 4l70aa mm (1990)	Protects archaeological and traditional cultural properties associated with archaeological sites. Requires notification of Indian Tribes of possible harm to or destruction of sites having religious or cultural significance.	Applicable when remedial action threatens archaeological and traditional cultural properties.	100-NR-1 100-NR-2
Protection of Archaeological Resources	43 CFR 7	Establishes procedures to be followed by federal land managers to protect archaeological resources on federal lands. Sets civil and criminal penalties for violations; protects confidentiality of archaeological resource information.	Applicable when remedial action threatens archaeological resources.	100-NR-1 100-NR-2
American Indian Religious Freedom Act of 1978	42 U.S.C. 1996	Provides for access by Native Americans to religious sites and development of migration measures if actions will deny such access. Requires agency to consult with traditional religious leaders regarding activities that might affect religious sites.	Applicable when remedial action threatens Native American religious sites.	100-NR-1 100-NR-2
The Religious Freedom Restoration Act of 1993	42 U.S.C. 2000bb; P.L. 103-141	Requires agency to demonstrate compelling need for a project that will deny the free exercise of religion by Native Americans. If activities threaten access to religious site, consultation with tribes will be necessary.	Applicable when remedial action threatens Native American religious sites.	100-NR-1 100-NR-2
Antiquities Act of 1906	16 U.S.C. 431-433	Protects all historic and prehistoric ruins and objects of antiquity located on federal lands. Provides for criminal sanctions against excavation, injury, or destruction of such resources.	Applicable when remedial action threatens historic or prehistoric ruins.	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Migratory Bird Treaty Act	16 U.S.C. 703 et seq. 50 CFR 10-24	Makes it illegal to pursue, hunt, take, capture, kill, possess, trade, or transport any migratory bird, part, nest, or egg included in the terms of the conventions between the U.S. and Great Britain, the U.S. and Mexico, and the U.S. and Japan. Although this Act does not require ecological assessments, be done for federal agency projects, if a disturbance is expected in an area where migratory birds may be affected, such an assessment should be done to ensure the law's intent.	If remedial actions potentially impact migrating birds, this Act is applicable.	100-NR-1 100-NR-2
Endangered Species Act of 1973	16 U.S.C. 1531 et seq.	Prohibits federal agencies from jeopardizing threatened or endangered species or adversely modifying habitats essential to their survival. If waste site remediation is within sensitive habitat or buffer zone surrounding threatened and endangered species, migration measures must be taken to protect this resource.	This law is applicable, as threatened or endangered species have been identified within the 100 Area.	100-NR-1 100-NR-2
Fish and Wildlife Services List of Endangered and Threatened Wildlife and Plants	50 CFR 17, 22, 225, 226, 227, 402 and 424	Requires identification of activities that may affect listed species. Actions must not threaten the continued existence of a listed species or destroy critical habitat. Requires consultation with the Fish and Wildlife Service to determine if threatened or endangered species could be impacted by activity.	This law is applicable, as threatened or endangered species have been identified within the 100 Area.	100-NR-1 100-NR-2
Historic Sites, Buildings, and Antiques Act	16 U.S.C. 461	Establishes requirements for preservation of historic sites, buildings, or objects of minimal significance. Undesirable impacts to such resources must be mitigated.	Applicable to properties listed in the National Register of Historic Places, or eligible for such listing.	100-NR-1 100-NR-2
National Historic Preservation Act of 1966, as amended	16 U.S.C. 470 et seq.	Prohibits impacts on cultural resources. Where impacts are unavailable, requires impact migration through design and data recovery.	Applicable to properties listed in the National Register of Historic Places, or eligible for such listing.	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Protection of Historic Properties	36 CFR 800	Sets criteria to assess effects, to develop migration measures to address unavoidable adverse impacts, and to address properties discovered during implementation of an undertaking.	Applicable when remedial action threatens a historic property discovered during remedial activity.	100-NR-1 100-NR-2
Historic Sites Act of 1935	16 U.S.C. 461-467 36 CFR 65	Requires action to undertake the recovery, protection, and preservation of sites, buildings, objects, and antiquities of National significance.	Applicable when remedial action threatens sites, buildings, objects, and antiquities of National significance.	100-NR-1 100-NR-2
Native American Graves Protection and Repatriation Act of 1990	25 U.S.C. 3001-3013 Public Las 101-601 (1993)	Requires action by federal agency when Native American human remains and associated funerary objects are inadvertently discovered during excavation. Requires work stoppage, protection of items, and notification to appropriate Indian Tribes.	Applicable if, during remedial action, Native American human remains or burial objects are discovered. Construction activities may resume 30 days after certification that agency head and Indian tribes have been notified.	100-NR-1 100-NR-2
Hanford Reach Study Act	P.L. 100-605	Provides for a comprehensive river conservation study. Prohibits the construction of any dam, channel, or navigation project by a federal agency for 8 years after enactment. New federal and nonfederal projects and activities are required, to the extent practicable, to minimize direct and adverse effects on the values for which the river is under study and to use existing structures.	This law as enacted November 4, 1988. Consultation and coordination with the National Park Service will be done to minimize and provide mitigation for any direct and adverse effects on the river.	100-NR-1 100-NR-2
Flood Plains/Wetlands Environmental Review	10 CFR 1022	Requires federal agencies to avoid, to the extent possible, adverse effects associated with the development of a floodplain or the destruction or loss of Wetlands.	Applicable if remedial activities take place in a floodplain or Wetlands.	100-NR-1 100-NR-2
Clean Air Act, as amended	42 U.S.C. 7401 et seq.	A comprehensive environmental law designed to regulate any activities that affect air quality, providing the national framework for controlling air pollution.		

Description	Citation	Requirements	Remarks	Operable Unit Affected
National Emissions Standards for Hazardous Air Pollutants (NESHAP)	40 CFR 61	Establishes numerical standards for hazardous air pollutants.		
Radionuclide Emissions from DOE Facilities (except Airborne radon-222, and radon-230	40 CFR 61.92	Prohibits emissions of radionuclides to the ambient air exceeding an effective dose equivalent of 10 mrem/year.	Applicable to point and diffuse sources.	
Emission Standards for Asbestos for Waste Disposal Operations for Demolition and Renovation	40 CFR 61.150	States there must be no visible emissions to the outside air during either the collection, processing (including incineration), packaging, or transporting of any asbestos-containing waste material generated by the source, or specified waste treatment methods must be used.	Applicable to recovery and handling of asbestos wastes.	100-NR-1
Asbestos Standard for Active Waste Disposal Sites	40 CFR 61.154	States there must either be no visible emissions to the outside air during the collection, processing (including incineration), packaging, or transporting of any asbestos-containing waste material generated by the source, or specified waste treatment methods must be used.	Applicable to landfill disposal of asbestos.	100-NR-1
Protection of Stratospheric Ozone	40 CFR 82	Management of refrigerant systems	Applicable to all buildings/ facilities containing refrigerant systems	100-NR-1
Federal Water Pollution Control Act (FWPCA), as amended by the Clean Water Act of 1988 (CWA)	33 U.S.C. 1251 et seq.	Creates the basic national framework for water pollution control and water quality management in the United States	Applicable to discharges of pollutants to navigable waters	
Water Quality Standards	40 CFR 131	Provides federal ambient water quality criteria for use in surface water cleanup	Also provides requirements for approving State water quality standards.	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
NPDES Criteria and Standards	40 CFR 125.104	Best management practices program shall be developed in accordance with good engineering practices.	Applicable if remediation includes wastewater discharge; also applies to storm water runoff associated with industrial activities. Effluent limitations established by EPA are included in NPDES permit.	
Discharge of Oil	40 CFR 110	Prohibits discharge of oil that violates applicable water quality standards or causes a sheen of oil on water surface. Runoff from site will need control for oily water discharge to waters of the United States.		
Safe Drinking Water Act (SDWA)	42 U.S.C. 300 et seq.	Creates the basic framework for protection of drinking water supplies from pollutants	Applicable to remedial action objectives for soil and groundwater	100-NR-1 100-NR-2
National Primary Drinking Water Regulations	40 CFR 141	Identifies primary contaminants and concentration levels protective of drinking water supplies	Provides MCLs for medial action objective consideration	100-NR-1 100-NR-2
National Secondary Drinking Water Regulations	40 CFR 143	Identifies contaminants and concentration levels for aesthetic quality of drinking water supplies	Provides secondary MCLs for remedial action objective consideration	100-NR-1 100-NR-2
U.S. Army Corp of Engineers Permit Regulations	33 CFR 320-330	Establishes procedural and permit requirements of construction activities within the Columbia River. Permit programs include Section 10 Permits.	Substantive requirements are applicable if river construction activities will take place and would qualify under these permit programs.	NR-1 NR-2
Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (RCRA)	40 U.S.C. 6901 et seq.	Establishes the basic framework for federal regulation of solid waste. Subpart C of RCRA controls the generation, transportation, treatment, storage, and disposal of hazardous waste through a comprehensive "cradle to grave" system of hazardous waste management techniques and requirements. Subtitle D of RCRA controls the disposal of solid waste.	The State has been authorized to implement most of Subtitle C, although certain HSWA provisions (e.g., LDR requirements) have not yet been delegated. Additionally, EPA has approved the State Subtitle D Program.	

Description	Citation	Requirements	Remarks	Operable Unit Affected
Identification and Listing of Hazardous Waste	40 CFR 261 [WAC 173-303-016]	Identifies by listing and characterization, those solid wastes subject to regulation as hazardous wastes under Parts 261-265, 268, 270, 271, and 124.	Applicable if remediation techniques result in generation of hazardous wastes, Environmental media (e.g., soil and groundwater) contaminated with RCRA listed waste must be managed as RCRA listed waste unless the regulatory agencies determine that the media no longer contains the listed waste.	100-NR-1 100-NR-2
Standards Applicable to Generators of Hazardous Waste	40 CFR Part 262 [WAC 173-303]	Describes the regulatory requirements imposed on generators of hazardous wastes who treat, store, or dispose of the waste onsite.	Applicable if remediation techniques result in generation of hazardous waste.	100-NR-1 100-NR-2
Designation & Determination of LDR Status	40 CFR 262.11 (WAC 173-303-070)	Requires generator to determine waste designation and LDR Status.	Applicable if remediation techniques result in generation of solid waste.	100-NR-1 100-NR-2
Accumulation Time	40 CFR 262.34 [WAC 173-303-200]	Allows a generator to accumulate hazardous waste on site for 90 days or less without a permit, if all waste is containerized and labeled.	Hazardous waste removed from the operable units, and waste treatment residues, are subject to the 90 day generator accumulation requirements if the waste is stored on site for 90 days or less. If hazardous waste is stored on site for more than 90 days, the substantive provisions of permitting standards for TSD facilities are applicable.	100-NR-1 100-NR-2
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	40 CFR 264 WAC 173-303]	Establishes requirements for operating hazardous waste treatment, storage, and disposal facilities. Applies to facilities put in operation since November 19, 1980. Facilities in operation before that date and existing facilities handling newly regulated wastes must meet similar requirements in 40 CFR 265.	Applicable if remediation technique results in onsite treatment, storage, or disposal of hazardous waste.	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Closure	40 CFR 264.111-264.116 [WAC 173-303-610] Subpart G	Performance standard that controls, minimizes, or eliminates, to the extent necessary to protect human health and the environment, post closure escape of chemicals, disposal, or decontamination of equipment, structures, and soils. All contaminated equipment, structures, and soils must be properly disposed.	Substantive requirements may be relevant and appropriate during remediation activities.	100-NR-1 100-NR-2
Post closure	40 CFR 264-117-264-120 [WAC 173-303-610] Subpart G	Post closure care must begin after completion of closure and continue for 30 years. During this period, the owner or operator must comply with all post closure requirements, including maintenance of cover, leachate monitoring, and groundwater monitoring.	Applicable to waste remaining in place after closure. Requires post closure care and monitoring to ensure elimination of escape of hazardous constituents, leachate, and contaminated runoff.	100-NR-1 100-NR-2
Container Storage	40 CFR 264.170-264-178 [WAC 173-3-3-160-173-303-161] Subpart I	Condition of containers, comparability of waste with containers, container management, containment, special requirements for ignitable or reactive wastes.	May be applicable if container storage is to occur. Inspection requirements may be in potential conflict with ALARA requirements.	100-NR-1 100-NR-2
Miscellaneous Unit	40 CFR 264-600-603 (WAC 173-303-680) Subpart X	Requires general environmental performance standards for operations including monitoring and inspections.	May be applicable if miscellaneous units occur, i.e., thermal treatment is used.	100-NR-1 100-NR-2
Waste Piles	40 CFR 264.250-259 (WAC 173-303-660) Subpart L	Design in operating requirements: monitoring, leachate system and lines.	May be applicable if waste piles occur outside area of contamination.	100-NR-1 100-NR-2
Tanks	40 CFR 264.190-199 (WAC 173-303-640)	Design operating standards for tanks including secondary containment and leak detection systems; tank management; containment; special requirements for ignitable or reactive wastes.	May be applicable if tank storage is to occur. Inspection requirements may be potential conflict with ALARA requirements. May be applicable for soil washing process.	100-NR-1 100-NR-2
Temporary Units	40 CFR 264-553 (WAC 173-3-3-645(7)	Establishes alternative performance standards for temporary tanks and containers used for treatment or storage of hazardous remediation wastes for up to one year.	Applicable if temporary unit is used.	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Land Disposal Restrictions (LDR)	40 CFR 268 [WAC 173-303-140 WAC 173-303-141]	Generally prohibits placement of restricted RCRA hazardous wastes in land-based units such as landfills, surface impoundments, and waste piles.	Applicable unless waste has been treated, treatment has been waived, a treatment variance has been set for the waste, and equivalent treatment method has been established, or waste qualifies for delisting.	100-NR-1 100-NR-2
Dilution Prohibition	40 CFR 268.3 Subpart A	Requires remediation waste to be appropriately treated, which does not include dilution. Generators are required to identify applicable treatment standards at the point of generation and prior to mixing with other remediation wastes.	Applicable if RCRA hazardous waste.	100-NR-1 100-NR-2
Debris Rule	40 CFR 268.45	Establishes the alternative treatment standards of hazardous waste debris by using technologies specified in 40 CFR 268.45, Table 1.	Applicable if RCRA hazardous waste.	100-NR-1 100-NR-2
Prohibition and Treatment Standards	40 CFR 268-30-268.48 [WAC 173-303-140]	Establishes treatment standards that must be met prior to land disposal	Applicable if RCRA hazardous waste	100-NR-1 100-NR-2
Prohibition on Storage	40 CFR 268.50 [WAC 173-303-141]	The storage of nonradioactive hazardous waste restricted from land disposal under RCRA Section 3004 and 40 CFR 268, Subpart C, is prohibited unless wastes are stored in tanks and containers by a generator or the onsite operator of a TSD facility solely for the purpose of accumulation of such quantities as to facilitate proper treatment or disposal. TSD facility operators may store wastes for up to one year under these circumstances. Radioactive mixed waste is not prohibited from storage pursuant to the Tri-Party Agreement.	Applicable only to nonradioactive hazardous waste	100-NR-1 100-NR-2
Transportation	49 CFR 100-199	Establishes standards applicable to the offsite transportation and packaging of hazardous materials	Applicable requirement for offsite shipments	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Toxic Substances Control Act (TSCA), as amended	15 U.S.C. 2601 et seq.	Provides EPA with authority to regulate the production, use, distribution, and disposal of toxic substances		
Regulation of Polychlorinated Biphenyls (PCBs)	40 CFR 761	For spills, occurring after May 4, 1987, spillage or disposal must be reported to EPA. Unless otherwise approved, PCBs as concentrations of 50 ppm or greater must be treated in an incinerator. Spills that occurred before May 4, 1987, are to be decontaminated o requirements established at the discretion of the EPA.		100-NR-1 100-NR-2
Model Toxics Control Act (MTCA)	70.105 RCW	Requires remedial actions to attain a degree of cleanup protective of human health and the environment		
Cleanup Regulations	WAC 173-340	Establishes cleanup levels and prescribes methods to calculate cleanup levels for soils, groundwater, surface water, and air.	Relevant and appropriate to remediation actions where hazardous substances have been released.	100-NR-1 100-NR-2
Soil Cleanup Standards	WAC 173-340-700-760	Establishes cleanup standards for contaminated media. These levels must be protective of the groundwater if groundwater is considered a pathway of exposure.	Applicable to remediation actions where hazardous substances have been released. Levels will be calculated based on final land use decision.	100-NR-1 100-NR-2
Selection of Cleanup Actions	WAC 173-340-360	Establishes h criteria for selection of cleanup actions	Must be considered within feasibility of corrective measures studies	100-NR-1 100-NR-2
Cleanup Actions	WAC 173-340-400	Ensures that the cleanup action is designed, constructed, and operated in accordance with the cleanup plan and other specified requirements.	Cleanup must follow remedial design document and remedial action work plans.	100-NR-1 100-NR-2
Institutional Controls	WAC 173-340-440	Requires physical measures, such as fences and signs, to limit interference with cleanup.	Physical measures may be applicable if institutional controls are used.	100-NR-1 100-NR-2
Cleanup Standards	WAC 173-340-700-750	Establishes cleanup standards for remedial and corrective actions	Soil, groundwater, and surface water standards are contained in these requirements.	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Radiation Protection--Air Emissions	WAC 246-247	Establishes procedures to monitor and control airborne radionuclide emissions.	Applicable if airborne radionuclide emissions are anticipated during remedial action.	100-NR-1 100-NR-2
New and Modified Sources	WAC 246-247-120 (Appendix B)	Requires the use of best available radionuclide control technology (BARCT)	Substantive requirements applicable if airborne radionuclide emissions are anticipated during remedial action.	100-NR-1 100-NR-2
Habitat Buffer Zone for Bald Eagle Rules	RCW 77.12.655			
Bald Eagle Protection Rules	WAC 232-12-292	Prescribes action to protect bald eagle habitat, such as nesting or roost sites, through the development of a site management plan.	Applicable if the areas of remedial activities include bald eagle habitat. No habitat buffer zones at the 100-N Area.	100-NR-1 100-NR-2
The Indian Graves and Records Act of the State of Washington	RCW 27.44	Prohibits the willful removal, mutilation, defacement, or destruction of any cairn, grave, or glyphic or painted record of any Native Indian or prehistoric people. Requires agency to consult with traditional religious leaders regarding activities that might affect religious sites.	There are Native American burial grounds and cultural areas within the 100 Area Operable Units; therefore, this is applicable.	100-NR-1 100-NR-2
Department of Game State Environmental Policy Act	WAC 232-012	Requires management plans if endangered, threatened, or sensitive wildlife or habitat is affected. Washington State Department of Fish and Wildlife will be consulted to minimize ecological impacts.	Upon the determination of impacts to threatened, endangered, or sensitive species or habitat by the remedial actions, this may be applicable.	100-NR-1 100-NR-2
U.S. Department of Ecology	43.12A RCW	Vests the Washington Department of Ecology with the authority to undertake the state air regulation and management program.		
Air Pollution Regulations	WAC 173-400	Establishes requirements to control and/or prevent the emission of air contaminants.	Applicable if emission sources are created during remedial action.	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Standards for Maximum Emissions	WAC 173-400-040	Requires best available control technology to use to control fugitive emissions of dust from materials handling, construction, demolition, or any other activities that are sources of fugitive emissions. Restricts emitted particulates from being deposited beyond the Hanford Site. Requires control of odors emitted from the source. Prohibits masking or concealing prohibited emissions. Requires measures to prevent fugitive dust from becoming airborne.	Applicable to dust emissions from cutting of concrete and metal and vehicular traffic during remediation	100-NR-1
Emission Limits for Radionuclides	WAC 173-480	Controls air emissions of radionuclides from specific sources.	Applicable to remedial activities that result in air emissions	100-NR-1 100-NR-2
New and Modified Emission Units	WAC 173-480-060	Requires the best available radionuclide control technology be used in planning constructing, installing, or establishing a new emissions unit.	Applicable to remedial actions that result in air emissions	100-NR-1 100-NR-2
Washington Clean Air Act	RCW 70.94	Establishes a statewide framework for the planning, regulation control, and management of air pollution sources.		
Controls for New Sources of Toxic Air Pollutants	WAC 173-460	Establishes systematic control of new sources emitting toxic air pollutants	Applicable if new sources emitting toxic air pollutants are established	100-NR-1 100-NR-2
Decontaminating Ambient Impact Compliance	WAC 173-460-080	Requires the owner or operator of a new source to complete an acceptable source impact level analysis using dispersion modeling to estimate maximum incremental ambient impact of each Class A or B toxic air pollutant. Establishes numerical limits for small quantity emission rates.	Applicable to remedial alternatives with the potential to release toxic air pollutants	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Hazardous Waste Management Act of 1976, as amended in 1980 and 1983	70.105 RCW	Establishes a statewide framework for the planning, regulation, control, and management of hazardous waste.		
Dangerous Waste Regulations	WAC 173-303	Establishes the design, operation, and monitoring requirements for management of dangerous waste. Includes requirements for generators of dangerous waste. Dangerous waste includes the full universe of wastes regulated by WAC 173-303, including extremely hazardous waste.	Applicable if dangerous or extremely hazardous waste is generated and/or managed during remedial action.	100-NR-1 100-NR-2
Waste Designation	WAC 173-303-070, 071, 080, 082, 090, 100, 110	Exceeds federal RCRA program by requiring designation of waste including additional parameters (i.e., toxicity and persistence), additional listed wastes, and PCBs.	Applicable if remediation wastes, based on process knowledge/analysis exceed the parameters.	100-NR-1 100-NR-2
Land Disposal Restrictions	WAC 173-303-140	State LDR requirements exceed the federal requirements for nonradiological extremely hazardous, organic/carbonaceous, and solid acid wastes.	Applicable if remediation wastes meet additional categories.	100-NR-1 100-NR-2
Corrective Action Management Unit (CAMU)	WAC 173-303-646(4)	Authorizes designation of a corrective action management unit, which does not constitute land disposal of dangerous waste	May be used if dangerous waste not meeting LDR standards is placed on the land	100-NR-1
Solid Waste Management Act	70.95 RCW	Establishes a statewide program for solid waste handling, recovery, and/or recycling		
Minimum Functional Standards for Solid Waste Handling	WAC 173-304	Establishes requirements to be met statewide to handle all solid waste	Applicable if management of solid waste occurs during remediation. Solid waste controlled by this Act includes garbage, industrial waste, construction waste, ashes, and swill.	100-NR-1
Onsite Containerized Storage, Collection, and Transportation Standards	WAC 173-304-200	Sets requirements for containers and vehicles to be used on site	Applicable if containers are used during remediation.	100-NR-1
Water Pollution Control Act	90.48 RCW	Prohibits discharge of polluting matter in waters		

Description	Citation	Requirements	Remarks	Operable Unit Affected
Water Quality Standards for Groundwater	WAC 173-200	Establishes groundwater standards for groundwaters of the State of Washington	Provides groundwater standards based on MCLs.	NR-1 NR-2
Water Quality Standards for Surface Waters	WAC 173-201A	Establishes water quality standards for surface waters of the State of Washington	Defines the Columbia River as a Class A river	NR-1 NR-2
State Waste Discharge Permit Program	WAC 173-216	Requires the use of all known available and reasonable methods of prevention, control, and treatment. Discharges must meet limits, which ensure that groundwater, and surface water standards are not exceeded.	Applicable for any discharges of liquids to the ground	100-NR-1
Underground Injection Control Program	WAC 173-218	Sets requirements for injection of effluents through wells that may endanger the groundwaters of the state	Applicable to any discharges of liquids through a well.	100-NR-2
Water Well Construction Act	18.104 RCW			
Standards for Construction and Maintenance of Wells	WAC 173-160	Establishes minimum standards for design, construction, capping, and sealing of all wells; sets additional requirements, including disinfection of equipment, abandonment of wells, and quality of drilling water.	Applicable if water supply wells, monitoring wells, or other wells are used during remediation.	100-NR-2
Shoreline Management Act	90.48 RCW			
Shoreline Development Permits	WAC 173-14	Requirements associated with administration and enforcement of shoreline management permits.	Substantive compliance with this ARAR and the Shoreline Management Act is required for river construction activities.	NR-1 NR-2
Hydraulic Projects Permits	WAC 220-110	Establishes regulations for construction activities that will use, divert, obstruct, or change the natural flow of the bed of the Columbia River.	Established for the protection of fish life	NR-1 NR-2
Benton Clean Air Authority	Regulation 1, Article 5	Establishes a regional program for open burning	These county regulations are authorized by the state Clean Air Act.	100-NR-1
Benton Clean Air Authority	Regulation 1, Article 8	Establishes regulations relative to asbestos	Must be considered if asbestos is found during remediation	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
A Guide on Remedial Actions at Superfund Sites with PCB Contamination	EPA Directive 9355-.4-01FS	Provides a general framework to determine cleanup levels, identify treatment options, and assess necessary management controls for residuals of PCBs.	Must be considered if PCBs are found during remediation	100-NR-1 100-NR-2
U.S. Department of Energy Orders		Select DOE Orders are contractual requirements of the ERC.		
Materials Transportation and Traffic Management	DOE Order 1540.1A	Establishes DOE requirements for transporting materials	For onsite shipments, these requirements specify compliance with 49 CFR but allow for other means of transportation and packaging if they offer an equivalent degree of safety.	100-NR-1 100-NR-2
Radiation Dose Limit (All Pathways)	DOE-5400.5, Chapter II, Section 1a	The exposure of the public to radiation sources because of all routine DOE activities shall not cause, in a year, an effective dose equivalent greater than 100 mrem from all exposure pathways, except under specified circumstances.	If remedial activities are considered "routine DOE activities", this order would be relevant and appropriate.	100-NR-1 100-NR-2
NRC Draft Radiological Criteria for Decommissioning	10 CFR 20 (proposed revision)	This rule provides a clear and consistent regulatory basis to determine the extent to which lands and structures must be remediated before a site can be considered decommissioned.	This will be applicable upon promulgation.	100-NR-1
Radioactive Waste Management	DOE Order 5820.2A	Defines waste designation for TRU, high- and low-level waste and establishes criteria for the management and disposal of LLW.		100-NR-1
Radioactive Waste Management	DOE 5820.2A Chapters III and IV	Establishes policies and guidelines by which DOE manages radioactive waste, waste byproducts, and radioactive contaminated surplus facilities. Disposal shall be on the site, which it was generated, if practical, or at another DOE facility. DOE waste containing byproduct material shall be stored, stabilized in place, and/or disposed of consistent with the requirements of the residual radioactive material guidelines contained in 40 CFR 192.	Must be met when managing radioactive waste created by remediation activities.	100-NR-1

Description	Citation	Requirements	Remarks	Operable Unit Affected
Safety Requirements for the Packaging of Fissile and Other Radioactive Materials	DOE 5480.3, Sections 7 and 8	Establishes requirements for packaging and transportation of radioactive materials for DOE facilities	Requirements must be met if radioactive material is packaged and transported to disposal facility.	100-NR-1
Draft EPA Radiation Site Cleanup Regulations	40 CFR 196 (draft notice of proposed rulemaking)	This draft notice of proposed rulemaking will set standards for the remediation of soils, groundwater, surface water, and structures at federal facilities.	These standards are intended to set limits for radiation doses to the public.	100-NR-1 100-NR-2
Draft Department of Energy Radiation Protection of the Public and the Environment	10 CFR 834	Additional requirements above 5400.5 that are more prescriptive	Substantive requirements largely the same as 5400.5	100-NR-1
Wild and Scenic Rivers Act	16 U.S.C. 1271	Prohibits federal agencies from recommending authorization of any water resource project that would have a direct and adverse effect on the values for which a river was designated as a wild and scenic river or included as a study area.	The Hanford Reach of the Columbia River is under study for inclusion as a wild and scenic river.	100-NR-1 100-NR-2
Residual Radioactive Material as Surface Contamination	U.S. NRC Regulatory Guide 1.86	Sets contamination guidelines release equipment and building components for unrestricted use, and if buildings are demolished, shall not be exceeded for contamination in the ground.	Dependent upon land use decisions, this guide may be considered.	D&D Facilities
Fish and Wildlife Coordination Act	16 U.S.C. 661 et seq.	This Act ensures that wildlife conservation is given equal consideration with other values during the planning of activities that affect water resources. The Act authorizes the Secretary of the Interior to provide assistance to federal, state, and public or private agencies in the "development, protection, rearing, and stocking of all species of wildlife, resources thereof, and their habitat..." The Act also requires a consultation with the U.S. Fish and Wildlife Service (USFWS) when a federal agency plans to impound, deepen, or otherwise modify a body of water.	While the recommendations by the USFWS are not legally binding, DOE is required to give them full consideration.	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Executive Orders Protection of Wetlands	EO 11990	This Executive Order requires that each federal agency "....take action to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities for (1) acquiring, managing, and disposing of federal lands and facilities; and (2) providing federally undertaken, financed, or assisted construction and improvements; and (3) conducting federal activities and programs affecting land use, including but not limited to, water and related land resources planning, regulating, and licensing activities."	Must be considered if action is taken that may impact wetland area.	100-NR-1 100-NR-2
Floodplain Management	EO 11988	This Order requires federal agencies to take floodplain management into account when formulating or evaluating water or land use plans. The Order specifies that "...each agency shall...restore and reserve the natural and beneficial values served by Flood Plains in carrying out its responsibilities for (1) acquiring, managing, and disposing of federal land and facilities; (2) providing federally undertaken, financial, or assisted construction and improvements; and (3) conducting federal activities and programs affecting land use, and licensing conducting activities.	Must be considered if actions are taken within a floodplain	100-NR-1 100-NR-2
Protection and Enhancement of the Cultural Environment	EO 11593	Provides direction to federal agencies to preserve, restore, and maintain cultural resources.	Pertains to sites, structures, and objects of historical, archeological, or architectural significance	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Exotic Organisms	EO 11987	This Order requires federal agencies to restrict, to the extent possible, the introduction of exotic species into the lands or waters that they own, lease, or hold for purposes of administration. It also restricts the use of federal funds and programs for importation and introduction of exotic species.	Must be considered during revegetation	100-NR-1
Department of Ecology Liquid Effluent Consent Order	DE 91NM-177	Requires discharges of liquid effluent to the soil to column to be eliminated, treated, or otherwise minimized.	Must be considered if discharges of liquid effluent to the soil column are part of the remedial alternative	100-NR-1
Tri-Party Agreement		Establishes requirements, guidelines, and schedules for the environmental restoration program at the Hanford Site	Must be adhered to and complied with by all parties with regard to remedial actions at all operable units.	100-NR-1 100-NR-2

Chapter 4.0 Cost Estimates

4.0 COST ESTIMATES 4.1

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Abbreviations and Acronyms

bcy	Bank cubic yards
CMS	Corrective Measures Study
Distribs	Distributables
G&A	General and Administrative
ID	Identification
MCACES	A model used to provide cost estimates for some of the remedial alternatives
MCRIS	Modified CRCIA ranger/industrial scenario
O&M	Operations and maintenance
PM/CM	Project management/construction management
RACER	A model used to provide cost estimates for some of the remedial alternatives
Sub01	Mobilization & prep work costs
Sub02	Monitoring, sampling, & analysis costs
Sub08	Solid collection & containment costs
Sub20	Site restoration costs
Sub21	Demobilization costs
Sub70	Project/construction management & support cost

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4.0 COST ESTIMATES

4.1 COST ESTIMATES FOR THE 100-NR-1 SOURCE WASTE SITES

The cost estimates for the 100-NR-1 source wastes sites were developed using the Micro Computer Aided Cost Estimating System (MCACES) software package or the Remedial Action Cost Engineering and Requirements (RACER) software package. The MCACES package was selected for estimating costs for the Remove/Dispose Remedial Alternative (using the crib and French drain, trench, and piping models) and the Containment Remedial Alternative (using the RCRA cap model). The cost models associated with these alternatives are presented in the *100 Areas Source Operable Unit Focused Feasibility Study Cost Models* (DOE-RL1995b). The MCACES and RACER packages were used for there move/ex situ bioremediation/dispose cost estimates. The RACER package was used for estimating costs for the remaining source remedial alternatives: in situ bioremediation, in situ solidification, and capping. Cost estimates provided by these two packages are suitable for comparative analysis of remedial alternatives but are not intended for establishing definitive cost estimates. The total costs as shown do not include design costs (3 percent) or costs for collecting design data in the field (3 percent).

Attachment 1 is the MCACES summary report for the UPR-100-N-1 site, and it typifies the reports generated for the remainder of the sites. In this model, costs are summarized into seven categories as follows:

Code	Cost category	Total Cost
01	Mobilization & Prep Work	14,320
02	Monitoring, Sampling, & Analysis	1,200
08	Solids Collection& Containment	34,390
18	Disposal (Other than Commercial)	11,970
20	Site Restoration	8,560
21	Demobilization	5,000
70	Project/Construction Mgmt & Supt	29,180

These costs are presented in Tables 4.1 and 4.2 for the Remove/Dispose Alternatives for both the Rural-Residential and Modified CRCIA Ranger/Industrial Exposure Scenarios.

These models rely upon a set of user-supplied input parameters. Six of these parameters (depth of excavation, top excavation length, bottom excavation length, contaminated soil volume, non-contaminated soil volume, and bottom area) are presented in Table 4.3 for the sites. The other five input parameters (hauling distance for borrow, hauling distance for contaminated soil, hauling distance for demo waste, transition zone soil percentages, and groundwater protection samples) are fixed for all the 100-NR-1 sites and areas presented on the third page of the example.

The cost estimating process for the Remove/Ex Situ Bioremediation/Dispose Remedial Alternative consisted of two steps. The initial step was to estimate the cost of removing the contaminated soil from the waste site and transporting it to the location selected for ex situ bioremediation. These costs were estimated using the MCACES program and are similar to the costs developed for similar tasks under the Remove/Dispose Alternative. The RACER program was then used to estimate the cost of the actual bioremediation. The minimum size remediation cell used in the estimate was 100 loose cubic yards (LCY) of material. Since the majority of sites were less than this volume, soils from these small sites were combined into one cell and the cost prorated on a LCY basis. These costs are presented in Tables 4.1 and 4.5.

The cost estimates for the Containment Remedial Alternative (capping) were determined in the same fashion as the Remove/Dispose Remedial Alternative and used the MCACES program. The cost estimates are presented in Tables 4.6 and 4.7. The cost estimates for in situ bioremediation and in situ solidification were determined using the RACER program and are presented in Tables 4.8 and 4.9, respectively.

Thecostestimateforsite100-N-45, a septic system in the HGP area, was assumed the same as site124-N-2. Site 100-N-46, an underground storage tank (UST) at HGP, was estimated following the existing practice for USTs at Hanford. A summary sheet for this estimate is on page G1-22. No estimates were made for three sites in the HGP area (100-N-50, 100-N-51a, and 100-N-51b) because of the limited data available. Cost estimates will be established during design.

The cost estimates for the river shoreline site followed Hanford cost estimating practices. These estimates are summarized, beginning on page G1-23. Institutional control costs need to be added to these numbers to reach the total costs presented in Section 8.0. No estimate was provided for site 100-N-65 (a petroleum intercepter trench) because remediation of this site depends, in part, upon the information developed during the remediation design of UPR-100-N-17, the source of this leak.

Table 4.1. 100-NR-1/2 CMS Residential Scenario Recalculate MCACES with 15 Percent PM/CM

Site ID	Sub01 $	Sub02 $	Sub08 $	Sub18 $	Sub20 $	Sub21 $	Subtotal w/o PM/CM	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Cntgcy 34%	Total Cost $
UPR-100-N-1	14,320	21,200	34,390	11,970	8,560	5,000	95,440	14,316	15,432	6,685	44,837	176,709
UPR-100-N-2	13,920	19,980	35,970	7,180	6,260	5,000	88,310	13,247	14,279	6,186	41,487	163,508
UPR-100-N-3	15,060	29,600	53,670	17,960	15,510	5,000	136,800	20,520	22,119	9,582	64,267	253,288
UPR-100-N-4	12,740	16,420	17,620	320	540	5,000	52,640	7,896	8,511	3,687	24,730	97,464
UPR-100-N-5	16,170	32,220	64,890	43,050	20,100	5,000	181,430	27,215	29,335	12,708	85,234	335,922
UPR-100-N-6	13,040	16,700	19,550	740	1,170	5,000	56,200	8,430	9,087	3,936	26,402	104,056
UPR-100-N-7	15,870	36,380	93,320	30,140	22,030	5,000	202,740	30,411	32,781	14,201	95,245	375,378
UPR-100-N-8	12,620	16,150	17,450	40	270	5,000	51,530	7,730	8,332	3,609	24,208	95,409
UPR-100-N-9	12,980	16,700	19,040	1,610	860	5,000	56,190	8,429	9,085	3,936	26,397	104,037
UPR-100-N-10	12,620	16,150	17,450	40	270	5,000	51,530	7,730	8,332	3,609	24,208	95,409
UPR-100-N-11	12,650	16,150	17,100	600	270	5,000	51,770	7,766	8,371	3,626	24,321	95,853
UPR-100-N-12	16,540	42,480	115,470	41,130	27,750	5,000	248,370	37,256	40,159	17,397	116,682	459,863
UPR-100-N-13	10,410	16,150	16,180	110	150	5,000	48,000	7,200	7,761	3,362	22,550	88,873
UPR-100-N-14	12,620	16,150	17,450	40	270	5,000	51,530	7,730	8,332	3,609	24,208	95,409
UPR-100-N-15												
UPR-100-N-17	18,100	284,460	767,570	31,920	194,150	5,000	1,301,200	195,180	210,391	91,142	611,290	2,409,203
UPR-100-N-18	13,070	16,970	20,060	180	1,430	5,000	56,710	8,507	9,169	3,972	26,642	105,000
UPR-100-N-19	13,140	16,970	20,180	420	1,510	5,000	57,220	8,583	9,252	4,008	26,881	105,944
UPR-100-N-20	13,000	16,700	19,120	210	1,090	5,000	55,120	8,268	8,912	3,861	25,895	102,056
UPR-100-N-21	12,730	16,420	17,620	180	530	5,000	52,480	7,872	8,485	3,676	24,655	97,168
UPR-100-N-22	13,080	16,970	20,070	210	1,430	5,000	56,760	8,514	9,178	3,976	26,665	105,092
UPR-100-N-23	13,020	16,970	19,680	110	1,170	5,000	55,950	8,393	9,047	3,919	26,285	103,593
UPR-100-N-24	13,150	16,970	20,540	810	1,590	5,000	58,060	8,709	9,388	4,067	27,276	107,499
UPR-100-N-25	12,770	16,420	17,660	420	540	5,000	52,810	7,922	8,539	3,699	24,810	97,779
UPR-100-N-26	12,850	16,420	18,140	810	740	5,000	53,960	8,094	8,725	3,780	25,350	99,908
UPR-100-N-29	12,980	16,700	19,120	40	1,090	5,000	54,930	8,240	8,882	3,848	25,806	101,704
UPR-100-N-30	13,350	17,520	23,020	2,000	2,470	5,000	63,360	9,504	10,245	4,438	29,766	117,313
UPR-100-N-32	13,080	16,970	20,070	210	1,430	5,000	56,760	8,514	9,178	3,976	26,665	105,092
UPR-100-N-36	12,680	16,420	17,620	40	530	5,000	52,290	7,844	8,455	3,663	24,565	96,816
UPR-100-N-37	12,420	16,150	17,030	40	120	5,000	50,760	7,614	8,207	3,555	23,847	93,983
UPR-100-N-38	12,620	16,150	17,410	110	270	5,000	51,560	7,734	8,337	3,611	24,222	95,465
UPR-100-N-39	12,880	16,420	18,480	110	740	5,000	53,630	8,045	8,671	3,756	25,195	99,297
UPR-100-N-40	13,710	18,890	31,310	4,690	4,170	5,000	77,770	11,666	12,575	5,447	36,536	143,993
UPR-100-N-41	12,570	16,150	17,060	210	190	5,000	51,180	7,677	8,275	3,585	24,044	94,761
UPR-100-N-42	19,720	326,530	891,310	67,170	225,530	5,000	1,535,260	230,289	248,236	107,536	721,249	2,842,571
UPR-100-N-43	13,150	16,970	20,220	630	1,590	5,000	57,560	8,634	9,307	4,032	27,041	106,574
100-N-1	15,960	44,750	55,390	35,810	16,420	5,000	173,330	26,000	28,026	12,141	81,429	320,925
100-N-3	14,740	23,520	42,640	19,710	11,100	5,000	116,710	17,507	18,871	8,175	54,829	216,091
100-N-4	17,540	30,760	63,520	72,450	19,630	5,000	208,900	31,335	33,777	14,632	98,139	386,783
100-N-5	20,360	44,590	49,070	54,670	14,980	5,000	188,670	28,301	30,506	13,215	88,635	349,327
100-N-6	12,420	16,150	17,030	110	120	5,000	50,830	7,625	8,219	3,560	23,879	94,113
100-N-12	12,300	16,150	17,030	40	110	5,000	50,630	7,595	8,186	3,546	23,785	93,743
100-N-13	12,820	16,420	18,050	110	660	5,000	53,060	7,959	8,579	3,717	24,927	98,242
100-N-14	12,820	16,420	18,050	110	660	5,000	53,060	7,959	8,579	3,717	24,927	98,242
100-N-16	12,510	16,150	17,030	140	180	5,000	51,010	7,652	8,248	3,573	23,964	94,446
100-N-17	12,490	16,150	17,030	40	180	5,000	50,890	7,634	8,228	3,565	23,908	94,224
100-N-18	12,410	16,150	17,030	40	120	5,000	50,750	7,613	8,206	3,555	23,842	93,965
100-N-19	12,500	16,150	17,030	180	180	5,000	51,040	7,656	8,253	3,575	23,978	94,502
100-N-22	13,510	17,790	23,700	4,870	2,790	5,000	67,660	10,149	10,940	4,739	31,786	125,274
100-N-23	12,310	16,150	17,030	110	110	5,000	50,710	7,607	8,199	3,552	23,823	93,891
100-N-24	13,280	17,790	23,180	140	2,690	5,000	62,080	9,312	10,038	4,348	29,165	114,943
100-N-25	13,170	16,970	21,010	810	1,670	5,000	58,630	8,795	9,480	4,107	27,544	108,555
100-N-26	12,940	16,700	19,040	110	1,080	5,000	54,870	8,231	8,872	3,843	25,777	101,593
100-N-27												
100-N-29	13,470	18,340	29,570	670	3,640	5,000	70,690	10,604	11,430	4,951	33,209	130,884
100-N-30	13,470	18,340	29,570	670	3,640	5,000	70,690	10,604	11,430	4,951	33,209	130,884
100-N-31	13,470	18,340	29,570	670	3,640	5,000	70,690	10,604	11,430	4,951	33,209	130,884
100-N-32	13,470	18,340	29,570	670	3,640	5,000	70,690	10,604	11,430	4,951	33,209	130,884
100-N-33	13,250	16,970	19,710	1,510	1,230	5,000	57,670	8,651	9,325	4,039	27,093	106,777
100-N-34	12,340	16,150	17,030	40	110	5,000	50,670	7,601	8,193	3,549	23,804	93,817
100-N-35	12,820	16,420	18,050	110	660	5,000	53,060	7,959	8,579	3,717	24,927	98,242
100-N-36	12,550	16,150	17,030	250	180	5,000	51,160	7,674	8,272	3,583	24,034	94,724
100-N-37	15,130	36,250	29,610	14,910	5,510	5,000	106,410	15,962	17,205	7,453	49,990	197,021
100-N-38	13,470	18,340	29,570	670	3,640	5,000	70,690	10,604	11,430	4,951	33,209	130,884
100-N-39	12,830	16,150	17,500	810	360	5,000	52,650	7,898	8,513	3,688	24,734	97,483
100-N-47	15,130	36,250	29,610	14,910	5,510	5,000	106,410	15,962	17,205	7,453	49,990	197,021
120-N-3	13,350	17,790	23,620	740	2,770	5,000	63,270	9,491	10,230	4,432	29,724	117,146
124-N-2	13,510	33,990	20,750	4,870	2,790	5,000	80,910	12,137	13,082	5,667	38,011	149,807
124-N-3	13,510	33,990	20,750	4,870	2,790	5,000	80,910	12,137	13,082	5,667	38,011	149,807
124-N-4	21,330	75,940	125,480	143,360	43,070	5,000	414,180	62,127	66,969	29,011	194,577	766,864
128-N-1	14,740	18,580	21,500	11,550	4,530	5,000	75,900	11,385	12,272	5,316	35,657	140,531

Site ID	Sub01 $	Sub02 $	Sub08 $	Sub18 $	Sub20 $	Sub21 $	Subtotal w/o PM/CM	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Cntgcy 34%	Total Cost $
130-N-1												
600-32	37,130	242,580	289,620	417,410	113,510	5,000	1,105,250	165,788	178,708	77,416	519,235	2,046,397
600-35	17,750	28,350	17,740	13,410	4,850	5,000	87,100	13,065	14,083	6,101	40,919	161,268
Pipelines	$855,845	$2,162,119	$3,138,771		$2,375,727	$5,000	$18,601,082	$2,790,162	$3,007,609	$1,302,899	$8,738,596	$34,440,348
Totals:							$28,010,722					$51,862,521

Table 4.2. 100-NR-1 CMS Modified CRCIA Ranger/Industrial Scenario Recalculate MCACES with 15 Percent PM/CM

Site ID	Sub01	Sub02	Sub08	Sub18	Sub20	Sub21	Subtotal w/o PM/CM	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Cntgcy 34%	Total Cost
UPR-100-N-1	14,020	19,710	28,920	7,980	5,500	5,000	81,130	12,170	13,118	5,683	38,114	150,214
UPR-100-N-2							-	-	-	-	-	-
UPR-100-N-3							-	-	-	-	-	-
UPR-100-N-4	12,740	16,420	17,620	320	540	5,000	52,640	7,896	8,511	3,687	24,730	97,464
UPR-100-N-5	14,960	23,120	42,680	21,530	10,970	5,000	118,260	17,739	19,121	8,283	55,557	218,961
UPR-100-N-6	13,040	16,700	19,550	740	1,170	5,000	56,200	8,430	9,087	3,936	26,402	104,056
UPR-100-N-7							-	-	-	-	-	-
UPR-100-N-8	12,610	16,150	17,450	40	270	5,000	51,520	7,728	8,330	3,609	24,204	95,391
UPR-100-N-9	12,980	16,700	19,040	1,610	860	5,000	56,190	8,429	9,085	3,936	26,397	104,037
UPR-100-N-10	12,610	16,150	17,450	40	270	5,000	51,520	7,728	8,330	3,609	24,204	95,391
UPR-100-N-11	12,640	16,150	17,100	600	270	5,000	51,760	7,764	8,369	3,625	24,316	95,835
UPR-100-N-12							-	-	-	-	-	-
UPR-100-N-13	10,410	16,150	16,180	110	150	5,000	48,000	7,200	7,761	3,362	22,550	88,873
UPR-100-N-14	12,620	16,150	17,450	40	270	5,000	51,530	7,730	8,332	3,609	24,208	95,409
UPR-100-N-15							-	-	-	-	-	-
UPR-100-N-17	18,100	284,460	767,570	31,920	194,150	5,000	1,301,200	195,180	210,391	91,142	611,290	2,409,203
UPR-100-N-18	12,980	16,700	19,080	140	1,090	5,000	54,990	8,249	8,891	3,852	25,834	101,815
UPR-100-N-19	13,030	16,700	19,470	350	1,170	5,000	55,720	8,358	9,009	3,903	26,177	103,167
UPR-100-N-20	12,990	16,700	19,080	210	1,090	5,000	55,070	8,261	8,904	3,857	25,871	101,963
UPR-100-N-21	12,720	16,420	17,620	180	530	5,000	52,470	7,871	8,484	3,675	24,650	97,149
UPR-100-N-22	12,990	16,700	19,080	180	1,090	5,000	55,040	8,256	8,899	3,855	25,857	101,908
UPR-100-N-23	12,930	16,700	19,040	70	1,080	5,000	54,820	8,223	8,864	3,840	25,754	101,501
UPR-100-N-24	13,110	16,970	20,190	770	1,510	5,000	57,550	8,633	9,305	4,031	27,036	106,555
UPR-100-N-25	12,770	16,420	17,660	420	540	5,000	52,810	7,922	8,539	3,699	24,810	97,779
UPR-100-N-26	12,850	16,420	18,140	810	740	5,000	53,960	8,094	8,725	3,780	25,350	99,908
UPR-100-N-29	12,920	16,700	18,690	40	1,000	5,000	54,350	8,153	8,788	3,807	25,533	100,630
UPR-100-N-30	13,270	17,250	21,590	1,680	2,120	5,000	60,910	9,137	9,849	4,266	28,615	112,776
UPR-100-N-32	12,990	16,700	19,080	180	1,090	5,000	55,040	8,256	8,899	3,855	25,857	101,908
UPR-100-N-36	12,680	16,420	17,620	40	530	5,000	52,290	7,844	8,455	3,663	24,565	96,816
UPR-100-N-37	12,420	16,150	17,030	40	120	5,000	50,760	7,614	8,207	3,555	23,847	93,983
UPR-100-N-38	12,620	16,150	17,410	110	270	5,000	51,560	7,734	8,337	3,611	24,222	95,465
UPR-100-N-39	12,880	16,420	18,480	110	740	5,000	53,630	8,045	8,671	3,756	25,195	99,297
UPR-100-N-40	13,510	18,070	23,940	3,120	3,140	5,000	66,780	10,017	10,798	4,678	31,373	123,645
UPR-100-N-41	12,570	16,150	17,060	210	190	5,000	51,180	7,677	8,275	3,585	24,044	94,761
UPR-100-N-42	19,720	326,530	891,310	67,170	225,530	5,000	1,535,260	230,289	248,236	107,536	721,249	2,842,571
UPR-100-N-43	13,080	16,970	19,710	530	1,430	5,000	56,720	8,508	9,171	3,973	26,646	105,018
100-N-1	15,660	42,710	51,540	29,820	14,430	5,000	159,160	23,874	25,735	11,148	74,772	294,689
100-N-3	14,100	19,440	28,450	11,830	5,170	5,000	83,990	12,599	13,580	5,883	39,458	155,509
100-N-4	17,450	30,760	63,520	72,450	19,630	5,000	208,810	31,322	33,762	14,626	98,097	386,617
100-N-5	20,360	44,590	49,070	54,670	14,980	5,000	188,670	28,301	30,506	13,215	88,635	349,327
100-N-6	12,420	16,150	17,030	110	120	5,000	50,830	7,625	8,219	3,560	23,879	94,113
100-N-12	12,300	16,150	17,030	40	110	5,000	50,630	7,595	8,186	3,546	23,785	93,743
100-N-13	12,820	16,420	18,050	110	660	5,000	53,060	7,959	8,579	3,717	24,927	98,242
100-N-14	12,820	16,420	18,050	110	660	5,000	53,060	7,959	8,579	3,717	24,927	98,242
100-N-16	12,510	16,150	17,030	140	180	5,000	51,010	7,652	8,248	3,573	23,964	94,446
100-N-17	12,490	16,150	17,030	40	180	5,000	50,890	7,634	8,228	3,565	23,908	94,224
100-N-18	12,410	16,150	17,030	40	120	5,000	50,750	7,613	8,206	3,555	23,842	93,965
100-N-19	12,500	16,150	17,030	180	180	5,000	51,040	7,656	8,253	3,575	23,978	94,502
100-N-22	13,510	17,790	23,700	4,870	2,790	5,000	67,660	10,149	10,940	4,739	31,786	125,274
100-N-23	12,310	16,150	17,030	110	110	5,000	50,710	7,607	8,199	3,552	23,823	93,891
100-N-24	12,940	16,700	19,040	70	1,080	5,000	54,830	8,225	8,865	3,841	25,759	101,519
100-N-25	13,100	16,970	20,190	670	1,510	5,000	57,440	8,616	9,287	4,023	26,985	106,352
100-N-26	12,940	16,700	19,040	110	1,080	5,000	54,870	8,231	8,872	3,843	25,777	101,593
100-N-27	12,950	16,700	18,690	180	1,010	5,000	54,530	8,180	8,817	3,820	25,618	100,964
100-N-29												
100-N-30												
100-N-31												
100-N-32												
100-N-33	13,250	16,970	19,710	1,510	1,230	5,000	57,670	8,651	9,325	4,039	27,093	106,777
100-N-34	12,340	16,150	17,030	40	110	5,000	50,670	7,601	8,193	3,549	23,804	93,817
100-N-35	12,820	16,420	18,050	110	660	5,000	53,060	7,959	8,579	3,717	24,927	98,242
100-N-36	12,550	16,150	17,030	250	180	5,000	51,160	7,674	8,272	3,583	24,034	94,724
100-N-37	15,130	36,250	29,610	14,910	5,510	5,000	106,410	15,962	17,205	7,453	49,990	197,021
100-N-39	12,830	16,150	17,500	810	360	5,000	52,650	7,898	8,513	3,688	24,734	97,483
100-N-47	15,130	36,250	29,610	14,910	5,510	5,000	106,410	15,962	17,205	7,453	49,990	197,021
120-N-3	13,070	16,700	19,540	420	1,170	5,000	55,900	8,385	9,038	3,915	26,261	103,500
124-N-2	13,510	33,990	20,750	4,870	2,790	5,000	80,910	12,137	13,082	5,667	38,011	149,807
124-N-3	13,510	33,990	20,750	4,870	2,790	5,000	80,910	12,137	13,082	5,667	38,011	149,807
124-N-4	21,330	75,940	125,480	143,360	43,070	5,000	414,180	62,127	66,969	29,011	194,577	766,864
128-N-1	14,740	18,580	21,500	11,550	4,530	5,000	75,900	11,385	12,272	5,316	35,657	140,531

Site ID	Sub01	Sub02	Sub08	Sub18	Sub20	Sub21	Subtotal w/o PM/CM	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Cntgcy 34%	Total Cost
130-N-1							-	-	-	-	-	-
600-32	37,130	242,580	289,620	417,410	113,510	5,000	1,105,250	165,788	178,708	77,416	519,235	2,046,397
600-35	17,750	28,350	17,740	13,410	4,850	5,000	87,100	13,065	14,083	6,101	40,919	161,268
Pipelines	855,845	2,162,199	3,138,771		2,375,727	5,000	18,601,162	2,790,174	3,007,622	1,302,904	8,738,633	34,440,496
Totals:							$26,872,142					$49,754,413

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Table 4.3. 100-NR-1 CMS MCACES Input Parameters

Site Name	Depth of Excavation Res (ft)	Depth of Excavation Rec (ft)	Top Excavation Length (ft)	Top Excavation Width (ft)	Contaminated Soil Res (bcf)	Non-Contaminated Soil Res (bcf)	Contaminated Soil Rec (bcf)	Non-Contaminated Soil Rec (bcf)	Bottom Area Rec (sq. ft.)	Bottom Area Res (sq. ft.)
UPR-100-N-1	12.00	10.00	72.60	72.60	8,021	30,761	5,348	23,017	1,340	1,340
UPR-100-N-2	15.00		62.90	62.90	4,813	28,787				320
UPR-100-N-3	15.00		94.10	94.10	12,032	70,751				2,411
UPR-100-N-4	6.00	6.00	23.80	23.80	201	1,490	201	1,490	34	34
UPR-100-N-5	15.00	10.00	98.80	98.80	28,877	64,287	14,439	34,612	2,894	2,894
UPR-100-N-6	9.25	9.25	36.55	36.55	481	5,657	481	5,657	77	77
UPR-100-N-7	15.00		108.60	108.60	20,214	96,880				4,045
UPR-100-N-8	6.00	6.00	19.50	19.50	13	1,026	13	1,026	2	2
UPR-100-N-9	6.25	6.25	31.75	31.75	1,059	2,500	1,059	2,500	169	169
UPR-100-N-10	6.00	6.00	19.50	19.50	13	1,026	13	1,026	2	2
UPR-100-N-11	2.00	2.00	20.00	20.00	392	200	392	200	196	196
UPR-100-N-12	15.00		120.00	120.00	27,852	120,375				5,625
UPR-100-N-13	3.00	3.00	13.20	13.20	53	221	53	221	18	18
UPR-100-N-14	6.00	6.00	19.80	19.80	19	1,058	19	1,058	3	3
UPR-100-N-17	64.00	64.00	210.90	210.90	21,390	1,282,248	21,390	1,282,248	357	357
UPR-100-N-18	11.25	11.25	37.85	37.85	107	7,336	107	7,336	17	17
UPR-100-N-19	11.25	11.25	40.25	40.25	267	8,375	267	8,375	42	42
UPR-100-N-20	10.25	10.25	35.35	35.35	134	5,842	134	5,842	21	21
UPR-100-N-21	6.25	6.25	22.85	22.85	107	1,457	107	1,457	17	17
UPR-100-N-22	11.25	11.25	38.35	38.35	134	7,548	134	7,548	21	21
UPR-100-N-23	11.25	11.25	36.65	36.65	53	6,838	53	6,838	8	8
UPR-100-N-24	10.25	10.25	40.05	40.05	535	7,585	535	7,585	86	86
UPR-100-N-25	6.25	6.25	25.25	25.25	267	1,738	267	1,738	42	42
UPR-100-N-26	6.25	6.25	28.05	28.05	535	2,066	535	2,066	86	86
UPR-100-N-29	11.00	10.00	34.50	34.50	13	5,880	11	4,461	2	2
UPR-100-N-30	11.00	10.00	47.90	47.90	1,337	11,843	1,114	9,580	222	222
UPR-100-N-32	11.25	10.00	38.35	38.35	134	7,548	107	5,486	21	21
UPR-100-N-36	7.00	7.00	22.40	22.40	13	1,588	13	1,588	2	2
UPR-100-N-37	3.00	3.00	10.30	10.30	5	143	5	143	2	2
UPR-100-N-39	9.00	9.00	30.60	30.60	53	3,856	53	3,856	13	13
UPR-100-N-40	12.00	10.00	58.80	58.80	3,128	19,881	2,086	13,959	520	520
UPR-100-N-41	4.00	4.00	17.10	17.10	134	553	134	553	26	26
UPR-100-N-42	65.00	65.00	222.40	222.40	45,046	1,449,549	45,046	1,449,549	751	751
UPR-100-N-43	11.00	11.00	41.20	41.20	401	8,637	401	8,637	67	67
100-N-1	15.00	10.00	145.00	85.00	24,000	80,750	20,000	45,000	4,000	4,000
100-N-3	17.50	17.50	85.00	85.00	15,840	53,938	15,840	53,938	1,056	1,056
100-N-4	6.00	6.00	118.00	99.00	48,600	10,638	48,600	10,638	8,100	8,100
100-N-5	2.00	2.00	141.00	141.00	36,664	1,652	36,664	1,652	18,225	18,225
100-N-6	1.00	1.00	10.30	10.30	53	26	53	26	53	53
100-N-12	1.00	1.00	5.60	5.60	7	12	7	12	7	7
100-N-13	8.00	8.00	28.20	28.20	54	2,943	54	2,943	18	18
100-N-14	8.00	8.00	28.20	28.20	54	2,943	54	2,943	18	18
100-N-16	3.00	3.00	14.50	14.50	90	317	90	317	30	30
100-N-17	3.00	3.00	13.20	13.20	18	257	18	257	18	18
100-N-18	2.00	2.00	10.20	10.20	18	100	18	100	18	18
100-N-19	1.00	1.00	13.40	13.40	108	35	108	35	108	108
100-N-22	10.00	10.00	49.00	49.00	3,249	10,061	3,249	10,061	361	361
100-N-23	1.00	1.00	5.70	5.70	53	12	53	12	7	7
100-N-24	15.00	10.00	48.00	48.00	90	15,570	45	4,945	9	9
100-N-25	11.00	10.00	42.40	42.40	535	9,178	446	7,262	88	88
100-N-26	10.00	10.00	33.00	33.00	53	4,945	53	4,945	9	9
100-N-29	15.00		54.40	54.40	446	20,729				88
100-N-30	15.00		54.40	54.40	446	20,729				88
100-N-31	15.00		54.40	54.40	446	20,729				88
100-N-32	15.00		54.40	54.40	446	20,729				88
100-N-33	4.00	4.00	43.60	43.60	999	4,768	999	4,768	999	999
100-N-34	1.00	1.00	6.40	6.30	11	14	11	14	11	11
100-N-35	8.00	8.00	28.20	28.20	53	2,943	53	2,943	18	18
100-N-36	1.00	1.00	15.00	15.00	144	40	144	40	144	144
100-N-37	1.00	1.00	103.00	103.00	10,000	304	10,000	304	10,000	10,000
100-N-38	15.00		54.40	54.40	446	20,729				88
100-N-39	1.00	1.00	26.10	26.10	535	73	535	73	534	534
100-N-47	1.00	1.00	103.00	103.00	10,000	304	10,000	304	10,000	10,000
120-N-3	14.00	10.00	49.30	49.30	481	15,535	267	6,456	53	53
124-N-2	10.00	10.00	49.00	49.00	3,249	10,061	3,249	10,061	361	361
124-N-3	10.00	10.00	49.00	49.00	3,249	10,061	3,249	10,061	361	361
124-N-4	8.33	8.33	120.99	188.99	96,164	76,606	96,164	76,606	15,744	15,744
128-N-1	1.00	1.00	91.00	91.00	7,744	268	7,744	268	7,744	7,744
600-32	2.00	2.00	380.00	380.00	280,000	4,520	280,000	4,520	139,876	139,876

Site Name	Depth of Excavation Res (ft)	Depth of Excavation Rec (ft)	Top Excavation Length (ft)	Top Excavation Width (ft)	Contaminated Soil Res (bcf)	Non-Contaminated Soil Res (bcf)	Contaminated Soil Rec (bcf)	Non-Contaminated Soil Rec (bcf)	Bottom Area Rec (sq. ft.)	Bottom Area Res (sq. ft.)
600-35	1.00	1.00	98.00	98.00	9,000	289	9,000	289	9,025	9,025

Table 4.4. Ex Situ Bioremediation Costs from RACER Model

Waste Site	Volume (LCY)	Unit Cost (/LCY)	Cost ()
UPR-100-N-18	5	359.39	1,797
UPR-100-N-19	11	359.39	3,953
UPR-100-N-20	6	359.39	2,156
UPR-100-N-21	5	359.39	1,797
UPR-100-N-22	6	359.39	2,156
UPR-100-N-23	2	359.39	719
UPR-100-N-24	23	359.39	8,266
UPR-100-N-36	1	359.39	359
UPR-100-N-43	17	359.39	6,110
100-N-3	562	N/A	64,335
100-N-12	1	359.39	359
100-N-35	2	359.39	719
100-N-36	6	359.39	2,156
124-N-2	138	N/A	38,649

Table 4.5. 100-NR-1 CMS Summary of Ex Situ Bioremediation Costs

Site ID	Sub01	Sub02	Sub08	Sub18	Sub20	Sub21	Subtotal w/o PM/CM	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Cntgcy 34%	Total Cost
UPR-100-N-18	13,070	16,970	20,060		1,430	5,000	56,530	8,480	9,140	3,960	26,557	104,667
XSITU-BIO							1,797	270	291	126	844	3,328
Total	13,070	16,970	20,060	-	1,430	5,000	58,327	8,749	9,431	4,086	27,402	107,995
UPR-100-N-19	13,140	16,970	20,180		1,510	5,000	56,800	8,520	9,184	3,979	26,684	105,167
XSITU-BIO							3,953	593	639	277	1,857	7,319
Total	13,140	16,970	20,180	-	1,510	5,000	60,753	9,113	9,823	4,256	28,541	112,486
UPR-100-N-20	13,000	16,700	19,120		1,090	5,000	54,910	8,237	8,878	3,846	25,796	101,667
XSITU-BIO							2,156	323	349	151	1,013	3,992
Total	13,000	16,700	19,120	-	1,090	5,000	57,066	8,560	9,227	3,997	26,809	105,660
UPR-100-N-21	12,730	16,420	17,620		530	5,000	52,300	7,845	8,456	3,663	24,570	96,835
XSITU-BIO							1,797	270	291	126	844	3,328
Total	12,730	16,420	17,620	-	530	5,000	54,097	8,115	8,747	3,789	25,414	100,163
UPR-100-N-22	13,080	16,970	20,070		1,430	5,000	56,550	8,483	9,144	3,961	26,567	104,704
XSITU-BIO							2,156	323	349	151	1,013	3,992
Total	13,080	16,970	20,070	-	1,430	5,000	58,706	8,806	9,493	4,112	27,580	108,696
UPR-100-N-23	13,020	16,970	19,680		1,170	5,000	55,840	8,376	9,029	3,911	26,233	103,389
XSITU-BIO							719	108	116	50	338	1,330
Total	13,020	16,970	19,680	-	1,170	5,000	56,559	8,484	9,145	3,961	26,571	104,720
UPR-100-N-24	13,150	16,970	20,540		1,590	5,000	57,250	8,588	9,257	4,010	26,895	106,000
XSITU-BIO							8,266	1,240	1,337	579	3,883	15,305
Total	13,150	16,970	20,540	-	1,590	5,000	65,516	9,827	10,594	4,589	30,779	121,305
UPR-100-N-36	12,680	16,420	17,620		530	5,000	52,250	7,838	8,448	3,660	24,547	96,742
XSITU-BIO							359	54	58	25	169	664
Total	12,680	16,420	17,620	-	530	5,000	52,609	7,891	8,506	3,685	24,715	97,407
UPR-100-N-43	13,150	16,970	20,220		1,590	5,000	56,930	8,540	9,205	3,988	26,745	105,407
XSITU-BIO							6,110	916	988	428	2,870	11,312
Total	13,150	16,970	20,220	-	1,590	5,000	63,040	9,456	10,193	4,416	29,615	116,720
100-N-3	15,030	27,260	52,230		14,320	5,000	113,840	17,076	18,407	7,974	53,481	210,777
XSITU-BIO							64,335	9,650	10,402	4,506	30,224	119,117
Total	15,030	27,260	52,230	-	14,320	5,000	178,175	26,726	28,809	12,480	83,705	329,894
100-N-12	12,300	16,150	17,030		110	5,000	50,590	7,589	8,180	3,544	23,767	93,669
XSITU-BIO							359	54	58	25	169	665
Total	12,300	16,150	17,030	-	110	5,000	50,949	7,643	8,238	3,569	23,935	94,333
100-N-35	12,820	16,420	18,050		660	5,000	52,950	7,943	8,561	3,709	24,875	98,038
XSITU-BIO							719	108	116	50	338	1,330
Total	12,820	16,420	18,050	-	660	5,000	53,669	8,050	8,677	3,759	25,213	99,369
100-N-36	12,550	16,150	17,030		180	5,000	50,910	7,637	8,232	3,566	23,917	94,261
XSITU-BIO							2,156	323	349	151	1,013	3,992
Total	12,550	16,150	17,030	-	180	5,000	53,066	7,960	8,581	3,717	24,930	98,253
124-N-2	13,510	33,990	20,750		2,790	5,000	76,040	11,406	12,295	5,326	35,723	140,790
XSITU-BIO							38,649	5,797	6,249	2,707	18,157	71,559
Total	13,510	33,990	20,750	-	2,790	5,000	114,689	17,203	18,544	8,033	53,880	212,349

Table 4.6. 100-NR-1 CMS Modified CRCIA Ranger/Industrial Scenario Summary of Capping Costs

Site ID	Area %of Total	Sub01	Sub02	Sub08	Sub20	Sub21	Subtotal w/o PM/CM	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Cntgcy 34%	Total Cost
Unit#1Cap#1		242,000	6,918	211,765	193,308	18,236	672,227					
UPR-100-N-10	14.79%	35,792	1,023	31,320	28,590	2,697	99,422	14,913	16,076	6,964	46,708	184,083
UPR-100-N-39	85.21%	206,208	5,895	180,445	164,718	15,539	572,805	85,921	92,617	40,122	269,098	1,060,561
		242,000	6,918	211,765	193,308	18,236	672,227	100,834	108,692	47,086	315,805	1,244,644
Unit#1Cap#2		242,108	6,918	217,465	193,500	18,250	678,241					
UPR-100-N-29	0.92%	2,227	64	2,001	1,780	168	6,240	936	1,009	437	2,931	11,553
UPR-100-N-30	90.46%	219,011	6,258	196,719	175,040	16,509	613,537	92,031	99,203	42,975	288,233	1,135,978
UPR-100-N-32	8.62%	20,870	596	18,745	16,680	1,573	58,464	8,770	9,453	4,095	27,466	108,248
		242,108	6,918	217,465	193,500	18,250	678,241	101,736	109,665	47,507	318,631	1,255,779
Unit#4Cap#1		280,638	130,066	2,688,254	198,830	21,697	3,319,485					
UPR-100-N-4	0.18%	505	234	4,839	358	39	5,975	896	966	419	2,807	11,063
UPR-100-N-5	15.39%	43,190	20,017	413,722	30,600	3,339	510,869	76,630	82,602	35,783	240,001	945,886
UPR-100-N-6	0.41%	1,151	533	11,022	815	89	13,610	2,041	2,201	953	6,394	25,199
UPR-100-N-8	0.01%	28	13	269	20	2	332	50	54	23	156	615
UPR-100-N-25	0.23%	645	299	6,183	457	50	7,635	1,145	1,234	535	3,587	14,136
100-N-26	0.05%	140	65	1,344	99	11	1,660	249	268	116	780	3,073
124-N-4	83.73%	234,978	108,904	2,250,875	166,480	18,167	2,779,405	416,911	449,402	194,681	1,305,736	5,146,134
		280,638	130,066	2,688,254	198,830	21,697	3,319,485	497,923	536,728	232,511	1,559,460	6,146,106
Unit#4Cap#2		242,502	8,302	231,375	193,288	18,307	693,774					
UPR-100-N-9	98.26%	238,282	8,158	227,349	189,925	17,988	681,702	102,255	110,224	47,749	320,257	1,262,188
UPR-100-N-14	1.74%	4,220	144	4,026	3,363	319	12,072	1,811	1,952	846	5,671	22,351
		242,502	8,302	231,375	193,288	18,307	693,774	104,066	112,176	48,595	325,928	1,284,539
Unit#4Cap#3		242,195	6,918	211,877	193,306	18,279	672,575					
UPR-100-N-13	16.94%	41,028	1,172	35,892	32,746	3,096	113,934	17,090	18,422	7,980	53,525	210,952
UPR-100-N-26	83.06%	201,167	5,746	175,985	160,560	15,183	558,641	83,796	90,327	39,130	262,444	1,034,337
		242,195	6,918	211,877	193,306	18,279	672,575	100,886	108,749	47,110	315,969	1,245,289

Table 4.7. 100-NR-1 CMS Modified CRCIA Ranger/Industrial Scenario Summary of Capping Costs

Site Name	Remove/Dispose	Capping	In Situ Solidification
CAP1-1			
UPR-100-N-10	95,391	653,884	157,016
UPR-100-N-39	99,297	3,767,236	415,600
Subtotal	194,688	4,421,120	572,616
CAP1-2			
UPR-100-N-29	100,630	41,563	158,467
UPR-100-N-30	112,776	4,086,761	349,849
UPR-100-N-32	101,908	389,430	173,568
Subtotal	315,314	4,517,754	681,884
CAP4-1			
UPR-100-N-4	97,464	83,646	192,295
UPR-100-N-5	218,961	7,151,720	651,238
UPR-100-N-6	104,056	190,527	217,955
UPR-100-N-8	95,391	4,647	157,016
UPR-100-N-25	97,779	106,881	202,532
100-N-26	101,593	23,235	163,047
124-N-4	766,864	38,909,260	1,388,214
Subtotal	1,482,108	46,469,916	2,972,297
CAP4-2			
UPR-100-N-9	104,307	4,672,424	345,617
UPR-100-N-14	95,409	82,740	158,496
Subtotal	199,716	4,755,164	504,113
CAP4-3			
UPR-100-N-13	88,873	749,331	181,321
UPR-100-N-26	99,908	3,674,112	252,221
Subtotal	188,781	4,423,443	433,542
Miscellaneous In Situ Solidification			
UPR-100-N-1	150,214		386,077
UPR-100-N-11	95,835		345,010
100-N-13	98,242		340,414
100-N-14	98,242		340,414
Subtotal	442,533		1,411,915
Total for Capping and Remove/Dispose	2,380,607	64,587,397	
Total for In Situ Solidification and Remove/Dispose	2,823,140		6,576,367

[a] Costs based on the modified CRCIA ranger/industrial exposure scenario
NA-Not Applicable

1 **Table 4.8. 100-NR-1 CMS In Situ Bioremediation**

Site ID	Total Site Volume (bcy)	Time Frame Years	Task Subtotals	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Contingency 34%		Total Cost
UPR-100-N-17									
Site Restoration	1,170		1,170	176	189	82	550		3,336
Construction	77,100		77,100	11,565	12,466	5,400	36,221	Capital	219,852
RACERO & M Cost	23,644	15.00	354,660	53,199	57,345	24,842	166,616	O&M	680,321
Total			$432,930	$64,940	$70,000	$30,324	$203,386		$903,510
UPR-100-N-42									
Site Restoration	2,190		2,190	329	354	153	1,029		6,245
Construction	78,365		78,365	11,755	12,671	5,489	36,815	Capital	223,460
RACERO & M Cost	23,644	15.00	354,660	53,199	57,345	24,842	166,616	O&M	680,321
Total			$435,215	$65,282	$70,370	$30,484	$204,460		$910,026

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Table 4.9. 100-NR-1/2 CMS In Situ Solidification

Site ID	Total Site Volume (bcy)	Fixed Unit Cost /bcy	Variable Unit Cost /bcy	PM/CM 1500%	Direct Distribs 1406%	G&A 534%	Contingency 34%		Total Cost $
UPR-100-N-1(rec)	4963	16835	24320	RACER Model Run					
RACER Fixed Cost	83,550			12,533	13,509	5,852	39,251	Capital	154,695
RACER Variable Cost	120,699			18,105	19,516	8,454	56,703	O&M	223,477
Soil Cover Cost	4,269			640	690	299	2,006	Cover	7,905
	204,249		-	31,278	33,715	14,606	97,960		386,077
UPR-100-N-5(rec)	8926	16835	24320	UPR-100-N-1(rec) Unit cost					
RACER Fixed Cost	83,550			12,533	13,509	5,852	39,251	Capital	154,695
RACER Variable Cost	217,078			32,562	35,099	15,205	101,981	O&M	401,926
Soil Cover Cost	9,385			1,408	1,518	657	4,409	Cover	17,377
	310,014		-	46,502	50,126	21,715	145,641		573,998
UPR-100-N-30(rec)	822	1,01285	1,26746	RACER Model Run					
Fixed Cost	83,256			12,488	13,462	5,832	39,113	Capital	154,150
Variable Cost	104,185			15,628	16,846	7,298	48,945	O&M	192,901
Soil Cover Cost	1,511			227	244	106	710	Cover	2,798
	187,441		-	28,343	30,552	13,235	88,768		349,849
UPR-100-N-6(rec)	264	1,01285	1,26746	UPR-100-N-30(rec) Unit cost					
Fixed Cost	83,256			12,488	13,462	5,832	39,113	Capital	154,150
Variable Cost	33,461			5,019	5,410	2,344	15,720	O&M	61,954
Soil Cover Cost	1,000			150	162	70	470	Cover	1,851
	116,717		-	17,657	19,034	8,245	55,302		217,955
UPR-100-N-32(rec)	78	1,01285	1,26746	UPR-100-N-30(rec) Unit cost					
Fixed Cost	83,256			12,488	13,462	5,832	39,113	Capital	154,150
Variable Cost	9,886			1,483	1,598	692	4,644	O&M	18,304
Soil Cover Cost	601			90	97	42	282	Cover	1,113
	93,142		-	14,061	15,157	6,566	44,040		173,568
100-N-26(rec)	33	1,01285	1,26746	UPR-100-N-30(rec) Unit cost					
Fixed Cost	83,256			12,488	13,462	5,832	39,113	Capital	154,150
Variable Cost	4,183			627	676	293	1,965	O&M	7,744
Soil Cover Cost	622			93	101	44	292	Cover	1,152
	87,439		-	13,209	14,239	6,168	41,370		163,047
UPR-100-N-9(rec)	391	2,12834	2,61148	RACER Model Run					
RACER Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
RACER Variable Cost	102,109			15,316	16,510	7,152	47,970	O&M	189,057
Soil Cover Cost	1,339			201	217	94	629	Cover	2,480
	185,327		-	28,000	30,182	13,075	87,694		345,617
UPR-100-N-4(rec)	76	2,12834	2,61148	UPR-100-N-9(rec) Unit cost					
Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
Variable Cost	19,847			2,977	3,209	1,390	9,324	O&M	36,748
Soil Cover Cost	792			119	128	55	372	Cover	1,467
	103,065		-	15,579	16,793	7,275	48,791		192,295

Site ID	Total Site Volume (bcy)	Fixed Unit Cost /bcy	Variable Unit Cost /bcy	PM/CM 1500%	Direct Distribs 1406%	G&A 534%	Contingency 34%		Total Cost $
UPR-100-N-8(rec)	04	2,12834	2,61148	UPR-100-N-9(rec) Unit cost					
Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
Variable Cost	1,045			157	169	73	491	O&M	1,934
Soil Cover Cost	541			81	87	38	254	Cover	1,002
	84,263		-	12,721	13,712	5,940	39,840		157,016
UPR-100-N-10(rec)	04	2,12834	2,61148	UPR-100-N-9(rec)Unit cost					
Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
Variable Cost	1,045			157	169	73	491	O&M	1,934
Soil Cover Cost	541			81	87	38	254	Cover	1,002
	84,263		-	12,721	13,712	5,940	39,840		157,016
UPR-100-N-14(rec)	07	2,12834	2,61148	UPR-100-N-9(rec) Unit cost					
Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
Variable Cost	1,828			274	296	128	859	O&M	3,385
Soil Cover Cost	557			84	90	39	262	Cover	1,031
	85,046		-	12,840	13,841	5,996	40,215		158,496
UPR-100-N-25(rec)	97	2,12834	2,61148	UPR-100-N-9(rec) Unit cost					
Capital Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
Fixed Cost	25,331			3,800	4,096	1,774	11,900	O&M	46,902
Variable Cost	837			126	135	59	393	Cover	1,550
Soil Cover Cost	108,549		-	16,408	17,687	7,662	51,389		202,532
UPR-100-N-26(rec)	199	2,12834	2,61148	UPR-100-N-9(rec) Unit cost					
Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
Variable Cost	51,969			7,795	8,403	3,640	24,414	O&M	96,221
Soil Cover Cost	1,037			156	168	73	487	Cover	1,920
	135,187		-	20,434	22,026	9,542	63,996		252,221
UPR-100-N-29(rec)	07	2,12834	2,61148	UPR-100-N-9(rec) Unit cost					
RACER Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
RACER Variable Cost	1,828			274	296	128	859	O&M	3,385
Soil Cover Cost	541			81	87	38	254	Cover	1,002
	85,587		-	12,838	13,839	5,995	40,208		158,467
UPR-100-N-11(rec)	145	5,73869	7,01372	RACER Model Run					
RACER Fixed Cost	83,211			12,482	13,454	5,828	39,092	Capital	154,067
RACER Variable Cost	101,699			15,255	16,444	7,123	47,777	O&M	188,298
Soil Cover Cost	1,428			214	231	100	671	Cover	2,645
	186,338		-	27,951	30,129	13,052	87,540		345,010
UPR-100-N-13(rec)	2	5,73869	7,01372	UPR-100-N-11(rec) Unit cost					
Fixed Cost	83,211			12,482	13,454	5,828	39,092	Capital	154,067
Variable Cost	14,027			2,104	2,268	983	6,590	O&M	25,972
Soil Cover Cost	692			104	112	48	325	Cover	1,282
	97,931		-	14,690	15,834	6,859	46,007		181,321
UPR-100-N-39(rec)	198	5,73869	7,01372	UPR-100-N-11(rec) Unit cost					
Fixed Cost	83,211			12,482	13,454	5,828	39,092	Capital	154,067
Variable Cost	138,872			20,831	22,454	9,727	65,241	O&M	257,124
Soil Cover Cost	2,381			357	385	167	1,119	Cover	4,409
	224,464		-	33,670	36,294	15,722	105,451		415,600

Site ID	Total Site Volume (bcy)	Fixed Unit Cost /bcy	Variable Unit Cost /bcy	PM/CM 1500%	Direct Distribs 1406%	G&A 534%	Contingency 34%		Total Cost $
124-N-4(rec)	48573	4380	10416	RACER Model Run					
RACER Fixed Cost	212,729			31,909	34,396	14,900	99,938	Capital	393,873
RACER Variable Cost	505,941			75,891	81,806	35,438	237,686	O&M	936,762
Soil Cover Cost	31,098			4,665	5,028	2,178	14,610	Cover	57,579
	749,768		-	112,465	121,230	52,517	352,233		1,388,214
100-N-14(rec)	53	15,29528	19,26396	RACER Model Run					
RACER Fixed Cost	81,065			12,160	13,107	5,678	38,083	Capital	150,094
RACER Variable Cost	102,099			15,315	16,508	7,151	47,965	O&M	189,039
Soil Cover Cost	692			104	112	48	325	Cover	1,282
	183,164		-	27,578	29,728	12,878	86,374		340,414
100-N-13(rec)	53	15,29528	19,26396	100-N-14(rec) Unit cost					
Fixed Cost	81,065			12,160	13,107	5,678	38,083	Capital	150,094
Variable Cost	102,099			15,315	16,508	7,151	47,965	O&M	189,039
Soil Cover Cost	692			104	112	48	325	Cover	1,282
	183,164		-	27,578	29,728	12,878	86,374		340,414

Table 4.10. 100-N-46 Underground Fuel Storage Tank at HGP

Item Description	Equipment	Materials	Labor	S/C	Subtotal Direct	Field Distribs 26.0%	Home Off. 3.0%	S/C Fee 4.0%	B&O Tax 0.47%	Total Bid
Pre-Construction Activities	-	124	14,233	-	14,358	ERC Activities Include DD&G&A)				14,358
Prepare Site/ Mobilize	848	216	3,029	-	4,092	1,064	155	212	26	5,549
Removal Action	2,004	486	2,292	12,247	17,030	4,428	644	884	108	23,093
Restore Site	749	-	347	84	1,181	307	45	61	7	1,602
Tank Disposal	437	-	1,201	-	1,638	426	62	85	10	2,221
Removal Activity Closeout	-	-	1,920	-	1,920	ERC Activities (Include DD&G&A)				1,920
Subtotals:	$4,038	$826	$23,023	$12,332	$40,218	6,225	905	1,243	152	$48,743

ERC Direct Distribs @18.09% (excludes ERC labor) 5,873

ERC G&A @4.04 (excludes ERC labor) 1,549

TOTAL: 56,165

Contingency @ 34% 19,096
TOTAL: 75,261

Pre-Construction and Close out are preformed with ERC Labor
Removal and site restoration work performed with Subcontractor (Building Trades) Labor.
Sample Analysis costs: Average ERC Cost for FY97 (Quanterra) (Inter office Memo Jan 15, 1997)

Table 4.11. Riversshore Site Residential Scenario Remove/Dispose Summary

Item Description	Equipment	Materials	Labor	S/C	Subtotal Direct	Field Distribs 26.00%	Home Office 3.00%	S/C Fee 4.00%	B&O Tax 0.47%	**Total Bid**
Grout Wells	-	49	450	-	499	130	19	26	3	676
Excavate Site	107,489	92,794	285,981	577,095	1,063,359	276,473	40,195	55,201	6,746	1,441,974
Restore Site	197,503	266,706	113,099	42,830	620,137	161,236	23,441	32,193	3,934	840,941
Support Facilities	-	-	-	133,920	133,920	34,819	5,062	6,952	850	181,603
Mobilization/Demobilization	29,914	4,502	136,783	-	171,199	44,512	6,471	8,887	1,086	232,155
Subtotals:	334,905	364,052	536,312	753,844	1,989,114	517,170	75,189	103,259	12,618	2,697,349

Bond		25,962
Total Subcontractor Cost	SUBTOTAL:	2,723,311
PM/CM @15%		408,497
	SUBTOTAL:	3,131,808
Haul to ERDF and Disposal		3,447,990
	SUBTOTAL:	6,579,798
	Directdistribs@18.09%	1,190,285
	G&A@4.04%	313,911
	TOTAL:	8,083,995
	Contingency@34%	2,748,558
	TOTAL:	**10,832,553**

Assumptions:
All excavation will take place above the water table.
Backfill material consists of clean natural fill material from the 100 BC Area.
Riprap material above the water line is placed with a backhoe.
Rip-rapmaterialwasassumedtoinclude4feetof+2ftmaterialrestingon2feetof12"minusmaterial.
Existing wells will be grouted closed.
Two new monitoring wells will be established through the clean cover material.
Contractor markups are taken from the 300 FFFPE.
PM/CM was included as 15% of the project direct costs to be comparable to the other estimates in the CMS.

Table 4.12. Riversshore Site Modified CRCIA Ranger/Industrial Scenario Remove/Dispose Net Present Value

Calculation of Net Present Value annually escalated at 3.2 % per year and discounted at 10 % (7 % plus 3.2 %) per year for 300 years. The 3.2% is published by DOE and is an average for 300 years, and the 7% Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

The cash flow is made up of the following:

100 NR-1 & 100-NR-2 CMS rivershore site recreational scenario: remove/dispose alternative work must be repeated every 20 years.

	Rate	Compounding Value	Total Net Present Worth
Discount Rate % (EPA) for 300 Yrs	7%	1102	
Inflation Rate % (DOE) for 300 Yrs	32%	1032	13,325,126

Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
1	$9,738,935	$9,738,935	$9,738,935	1000	$9,738,935	100	$9,738,93500
2				1032		110	
3				1065		121	
4				1099		134	
5				1134		147	
6				1171		163	
7				1208		179	
8				1247		197	
9				1287		217	
10				1328		240	
11				1370		264	
12				1414		291	
13				1459		321	
14				1506		353	
15				1554		390	
16				1604		429	
17				1655		473	
18				1708		521	
19				1763		574	
20				1819		633	
21	$9,738,935	$9,738,935	$9,738,935	1878	$18,285,440	698	$2,621,03924
22				1938		769	
23				2000		847	
24				2064		934	
25				2130		1029	
26				2198		1134	
27				2268		1249	
28				2341		1377	
29				2416		1517	
30				2493		1672	
31				2573		1843	
32				2655		2031	
33				2740		2238	
34				2828		2466	
35				2918		2718	
36				3012		2995	
37				3108		3300	

	Rate	Compounding Value	Total Net Present Worth
Discount Rate % (EPA) for 300 Yrs	7%	1102	
Inflation Rate % (DOE) for 300 Yrs	32%	1032	13,325,126

Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
38				3207		3637	
39				3310		4008	
40				3416		4417	
41	$9,738,935	$9,738,935	$9,738,935	3525	$34,332,020	4867	$705,40020
42				3638		5363	
43				3754		5911	
44				3875		6513	
45				3999		7178	
46				4127		7910	
47				4259		8717	
48				4395		9606	
49				4536		10586	
50				4681		11665	
51				4830		12855	
52				4985		14166	
53				5145		15611	
54				5309		17204	
55				5479		18959	
56				5654		20892	
57				5835		23023	
58				6022		25372	
59				6215		27960	
60				6414		30812	
61	$9,738,935	$9,738,935	$9,738,935	6619	$64,460,446	33954	$189,84433
62				6831		37418	
63				7049		41234	
64				7275		45440	
65				7508		50075	
66				7748		55183	
67				7996		60811	
68				8252		67014	
69				8516		73850	
70				8788		81382	
71				9069		89683	
72				9360		98831	
73				9659		1,08912	
74				9968		1,20021	
75				10287		1,32263	
76				10616		1,45754	
77				10956		1,60621	
78				11307		1,77004	
79				11669		1,95058	
80				12042		2,14954	
81	$9,738,935	$9,738,935	$9,738,935	12427	$121,028,388	2,36880	$51,09280
82				12825		2,61041	
83				13235		2,87667	
84				13659		3,17010	
85				14096		3,49345	
86				14547		3,84978	
87				15013		4,24245	

	Rate	Compounding Value	Total Net Present Worth
Discount Rate % (EPA) for 300 Yrs	7%	1102	
Inflation Rate % (DOE) for 300 Yrs	32%	1032	13,325,126

Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
88				15493		4,67518	
89				15989		5,15205	
90				16500		5,67756	
91				17028		6,25667	
92				17573		6,89485	
93				18136		7,59813	
94				18716		8,37314	
95				19315		9,22720	
96				19933		10,16837	
97				20571		11,20555	
98				21229		12,34851	
99				21908		13,60806	
100				22609		14,99608	
101	$9,738,935	$9,738,935	$9,738,935	23333	$227,238,125	16,52568	$13,75060
102				24080		18,21130	
103				24850		20,06886	
104				25645		22,11588	
105				26466		24,37170	
106				27313		26,85761	
107				28187		29,59709	
108				29089		32,61599	
109				30020		35,94282	
110				30980		39,60899	
111				31972		43,64911	
112				32995		48,10132	
113				34051		53,00765	
114				35140		58,41443	
115				36265		64,37271	
116				37425		70,93872	
117				38623		78,17447	
118				39859		86,14827	
119				41134		94,93539	
120				42451		104,61880	
121	$9,738,935	$9,738,935	$9,738,935	43809	$426,653,333	115,28992	$3,70070
122				45211		127,04949	
123				46658		140,00854	
124				48151		154,28941	
125				49692		170,02693	
126				51282		187,36968	
127				52923		206,48139	
128				54616		227,54249	
129				56364		250,75182	
130				58168		276,32851	
131				60029		304,51402	
132				61950		335,57445	
133				63932		369,80304	
134				65978		407,52295	
135				68089		449,09029	
136				70268		494,89750	
137				72517		545,37704	

	Rate	Compounding Value	Total Net
Discount Rate % (EPA) for 300 Yrs	7%	1102	Present Worth
Inflation Rate % (DOE) for 300 Yrs	32%	1032	13,325,126

Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
138				74837		601,00550	
139				77232		662,30806	
140				79704		729,86349	
141	$9,738,935	$9,738,935	$9,738,935	82254	$801,067,455	804,30956	$99597
142				84886		886,34914	
143				87603		976,75675	
144				90406		1,076,38594	
145				93299		1,186,17730	
146				96284		1,307,16739	
147				99366		1,440,49846	
148				102545		1,587,42931	
149				105827		1,749,34710	
150				109213		1,927,78050	
151				112708		2,124,41411	
152				116315		2,341,10435	
153				120037		2,579,89699	
154				123878		2,843,04649	
155				127842		3,133,03723	
156				131933		3,452,60703	
157				136155		3,804,77294	
158				140512		4,192,85978	
159				145008		4,620,53148	
160				149648		5,091,82569	
161	$9,738,935	$9,738,935	$9,738,935	154437	$1,504,052,632	5,611,19191	$26805
162				159379		6,183,53349	
163				164479		6,814,25390	
164				169743		7,509,30780	
165				175174		8,275,25720	
166				180780		9,119,33343	
167				186565		10,049,50544	
168				192535		11,074,55499	
169				198696		12,204,15960	
170				205054		13,448,98388	
171				211616		14,820,78024	
172				218388		16,332,49982	
173				225376		17,998,41481	
174				232588		19,834,25312	
175				240031		21,857,34693	
176				247712		24,086,79632	
177				255639		26,543,64955	
178				263819		29,251,10180	
179				272261		32,234,71418	
180				280974		35,522,65503	
181	$9,738,935	$9,738,935	$9,738,935	289965	$2,823,949,849	39,145,96584	$7214
182				299244		43,138,85436	
183				308820		47,539,01751	
184				318702		52,387,99729	
185				328900		57,731,57301	
186				339425		63,620,19346	
187				350287		70,109,45320	

	Rate	Compounding Value	Total Net
Discount Rate % (EPA) for 300 Yrs	7%	1102	Present Worth
Inflation Rate % (DOE) for 300 Yrs	32%	1032	13,325,126

Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
188				361496		77,260,61742	
189				373064		85,141,20040	
190				385002		93,825,60284	
191				397322		103,395,81433	
192				410036		113,942,18739	
193				423157		125,564,29050	
194				436698		138,371,84814	
195				450673		152,485,77664	
196				465094		168,039,32586	
197				479977		185,179,33710	
198				495337		204,067,62949	
199				511187		224,882,52769	
200				527545		247,820,54552	
201	$9,738,935	$9,738,935	$9,738,935	544427	$5,302,136,760	273,098,24116	$1941
202				561848		300,954,26176	
203				579828		331,651,59646	
204				598382		365,480,05930	
205				617530		402,759,02534	
206				637291		443,840,44593	
207				657685		489,112,17141	
208				678730		539,001,61290	
209				700450		593,979,77741	
210				722864		654,565,71471	
211				745996		721,331,41761	
212				769868		794,907,22221	
213				794504		875,987,75887	
214				819928		965,338,51028	
215				846165		1,063,803,03833	
216				873243		1,172,310,94824	
217				901186		1,291,886,66496	
218				930024		1,423,659,10478	
219				959785		1,568,872,33347	
220				990498		1,728,897,31148	
221	$9,738,935	$9,738,935	$9,738,935	1022194	$9,955,082,680	1,905,244,83725	$523
222				1054904		2,099,579,81065	
223				1088661		2,313,736,95134	
224				1123498		2,549,738,12038	
225				1159450		2,809,811,40865	
226				1196553		3,096,412,17234	
227				1234843		3,412,246,21392	
228				1274358		3,760,295,32773	
229				1315137		4,143,845,45116	
230				1357221		4,566,517,68718	
231				1400652		5,032,302,49128	
232				1445473		5,545,597,34539	
233				1491728		6,111,248,27461	
234				1539464		6,734,595,59863	
235				1588727		7,421,524,34968	
236				1639566		8,178,519,83335	
237				1692032		9,012,728,85635	

	Rate	Compounding Value	Total Net
Discount Rate % (EPA) for 300 Yrs	7%	1102	Present Worth
Inflation Rate % (DOE) for 300 Yrs	32%	1032	13,325,126

Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
238				1746177		9,932,027,19970	
239				1802055		10,945,093,97407	
240				1859720		12,061,493,55943	
241	$9,738,935	$9,738,935	$9,738,935	1919231	$18,691,270,263	$13,291,765,90249	$141
242				1980647		14,647,526,02454	
243				2044028		16,141,573,67905	
244				2109436		17,788,014,19431	
245				2176938		19,602,391,64213	
246				2246600		21,601,835,58963	
247				2318492		23,805,222,81977	
248				2392683		26,233,355,54739	
249				2469249		28,909,157,81322	
250				2548265		31,857,891,91017	
251				2629810		35,107,396,88500	
252				2713964		38,688,351,36727	
253				2800810		42,634,563,20674	
254				2890436		46,983,288,65382	
255				2982930		51,775,584,09651	
256				3078384		57,056,693,67436	
257				3176892		62,876,476,42914	
258				3278553		69,289,877,02491	
259				3383467		76,357,444,48146	
260				3491738		84,145,903,81856	
261	$9,738,935	$9,738,935	$9,738,935	3603473	$35,093,991,210	92,728,786,00806	$038
262				3718784		102,187,122,18088	
263				3837785		112,610,208,64333	
264				3960595		124,096,449,92495	
265				4087334		136,754,287,81729	
266				4218128		150,703,225,17466	
267				4353108		166,074,954,14247	
268				4492408		183,014,599,46501	
269				4636165		201,682,088,61044	
270				4784522		222,253,661,64870	
271				4937627		244,923,535,13687	
272				5095631		269,905,735,72083	
273				5258691		297,436,120,76435	
274				5426969		327,774,605,08232	
275				5600632		361,207,614,80071	
276				5779852		398,050,791,51039	
277				5964808		438,651,972,24445	
278				6155682		483,394,473,41338	
279				6352663		532,700,709,70154	
280				6555949		587,036,182,09110	
281	$9,738,935	$9,738,935	$9,738,935	6765739	$65,891,092,563	646,913,872,66439	$010
282				6982243		712,899,087,67616	
283				7205674		785,614,794,61913	
284				7436256		865,747,503,67028	
285				7674216		954,053,749,04465	
286				7919791		1,051,367,231,44720	
287				8173224		1,158,606,689,05482	

	Rate	Compounding Value	Total Net Present Worth
Discount Rate % (EPA) for 300 Yrs	7%	1102	
Inflation Rate % (DOE) for 300 Yrs	32%	1032	13,325,126

Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
288				8434768		1,276,784,571,33841	
289				8704680		1,407,016,597,61493	
290				8983230		1,550,532,290,57165	
291				9270693		1,708,686,584,20996	
292				9567356		1,882,972,615,79938	
293				9873511		2,075,035,822,61091	
294				10189463		2,286,689,476,51723	
295				10515526		2,519,931,803,12198	
296				10852023		2,776,964,847,04043	
297				11199288		3,060,215,261,43855	
298				11557665		3,372,357,218,10528	
299				11927510		3,716,337,654,35202	
300				12309190		4,095,404,095,09593	
Total	$146,084,025	$146,084,025	$146,084,025		$140,964,380,098		$13,325,126

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Table 4.13. Riversshore Site Modified CRCIA Ranger/Industrial Scenario Remove/Dispose Summary

Item Description	Equipment $	Materials $	Labor $	S/C $	Subtotal Direct	Field Distribs 26.00%	Home Office 3.00%	S/C Fee 4.00%	B&O Tax 0.47%	**Total Bid $**
Grout Wells	$-	$66	$450	$-	$516	$134	$19	$27	$3	$699
Excavate Site	$93,772	$80,955	$249,486	$533,273	$957,486	$248,946	$36,193	$49,705	$6,074	$1,298,404
Restore Site	$175,411	$266,706	$98,275	$42,830	$583,222	$151,638	$22,046	$30,276	$3,700	$790,881
Support Facilities	$-	$-	$-	$133,920	$133,920	$34,819	$5,062	$6,952	$850	$181,603
Mobilization/ Demobilization	$29,914	$4,502	$136,783	$-	$171,199	$44,512	$6,471	$8,887	$1,086	$232,155
Subtotals:	$299,097	$352,230	$484,993	$710,022	$1,846,342	$480,049	$69,792	$95,847	$11,713	$2,503,743

Bond		$24,626
Total Subcontractor Cost	Subtotal:	$2,528,369
PM/CM @ 15%		$379,255
	Subtotal:	$2,907,624
Haul to ERDF& Disposal		$3,007,900
	Subtotal:	$5,915,524
	Direct distribs @ 18.09%	$1,070,118
	G&A @ 4.04%	$282,220
	TOTAL:	$7,267,862
	Contingency @ 34%	$2,471,073
	TOTAL:	**$9,738,935**

Assumptions:
All excavation will take place above the water table.
Backfill material consists of clean natural fill material from the 100 BC Area.
Riprap material above the waterline is placed with a backhoe.
Rip-rap material was assumed to include 4 feet of +2ft material resting on 2 feet of 12 " minus material.
Existing wells will be grouted closed.
Two new monitoring wells will be established through the clean cover material.
Contractor markups are taken from the 300 FF FPE.
PM/CM was included as 15% of the project direct costs to be comparable to the other estimates in the CMS.

Table 4.14. Rivershore Site Residential Scenario Remove/Dispose Net Present Value

Calculation of Net Present Value annually escalated at 3.2 % per year and discounted at 10 % (7 % plus 3.2 %) per year for 300 years. The 3.2 % is published by DOE and is an average for 300 years, and the 7 % Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

The cash flow is made up of the following:

100-NR-1 & 100-NR-2 CMS river shore site, residential scenario: remove/dispose alternative work must be repeated every 20 years

	Rate	Compounding Value	Total Net Present Worth
Discount Rate % (EPA) for 300 Yrs.	7%	1.102	
Inflation Rate % (DOE) for 300 Yrs.	3.2%	1.032	14,821,449

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
1	10,832,553	10,832,553	10,832,553	1.000	10,832,553	1.00	10,832,553.00
2			-	1.032	-	1.10	
3			-	1.065	-	1.21	
4			-	1.099	-	1.34	
5			-	1.134	-	1.47	
6			-	1.171	-	1.63	
7			-	1.208	-	1.79	
8			-	1.247	-	1.97	
9			-	1.287	-	2.17	
10			-	1.328	-	2.40	
11			-	1.370	-	2.64	
12			-	1.414	-	2.91	
13			-	1.459	-	3.21	
14			-	1.506	-	3.53	
15			-	1.554	-	3.90	
16			-	1.604	-	4.29	
17			-	1.655	-	4.73	
18			-	1.708	-	5.21	
19			-	1.763	-	5.74	
20			-	1.819	-	6.33	
21	10,832,553	10,832,553	10,832,553	1.878	20,338,774	6.98	2,915,364.61
22			-	1.938	-	7.69	
23			-	2.000	-	8.47	
24			-	2.064	-	9.34	
25			-	2.130	-	10.29	
26			-	2.198	-	11.34	
27			-	2.268	-	12.49	
28			-	2.341	-	13.77	
29			-	2.416	-	15.17	
30			-	2.493	-	16.72	
31			-	2.573	-	18.43	
32			-	2.655	-	20.31	
33			-	2.740	-	22.38	
34			-	2.828	-	24.66	
35			-	2.918	-	27.18	

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
36			-	3.012	-	29.95	
37			-	3.108	-	33.00	
38			-	3.207	-	36.37	
39			-	3.310	-	40.08	
40			-	3.416	-	44.17	
41	10,832,553	10,832,553	10,832,553	3.525	38,187,279	48.67	784,611.98
42			-	3.638	-	53.63	
43			-	3.754	-	59.11	
44			-	3.875	-	65.13	
45			-	3.999	-	71.78	
46			-	4.127	-	79.10	
47			-	4.259	-	87.17	
48			-	4.395	-	96.06	
49			-	4.536	-	105.86	
50			-	4.681	-	116.65	
51			-	4.830	-	128.55	
52			-	4.985	-	141.66	
53			-	5.145	-	156.11	
54			-	5.309	-	172.04	
55			-	5.479	-	189.59	
56			-	5.654	-	208.92	
57			-	5.835	-	230.23	
58			-	6.022	-	253.72	
59			-	6.215	-	279.60	
60			-	6.414	-	308.12	
61	10,832,553	10,832,553	10,832,553	6.619	71,698,928	339.54	211,162.59
62			-	6.831	-	374.18	
63			-	7.049	-	412.34	
64			-	7.275	-	454.40	
65			-	7.508	-	500.75	
66			-	7.748	-	551.83	
67			-	7.996	-	608.11	
68			-	8.252	-	670.14	
69			-	8.516	-	738.50	
70			-	8.788	-	813.82	
71			-	9.069	-	896.83	
72			-	9.360	-	988.31	
73			-	9.659	-	1,089.12	
74			-	9.968	-	1,200.21	
75			-	10.287	-	1,322.63	
76			-	10.616	-	1,457.54	
77			-	10.956	-	1,606.21	
78			-	11.307	-	1,770.04	
79			-	11.669	-	1,950.58	
80			-	12.042	-	2,149.54	
81	10,832,553	10,832,553	10,832,553	12.427	134,619,076	2,368.80	56,830.18
82			-	12.825	-	2,610.41	
83			-	13.235	-	2,876.67	
84			-	13.659	-	3,170.10	
85			-	14.096	-	3,493.45	
86			-	14.547	-	3,849.78	

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
87			-	15.013	-	4,242.45	
88			-	15.493	-	4,675.18	
89			-	15.989	-	5,152.05	
90			-	16.500	-	5,677.56	
91			-	17.028	-	6,256.67	
92			-	17.573	-	6,894.85	
93			-	18.136	-	7,598.13	
94			-	18.716	-	8,373.14	
95			-	19.315	-	9,227.20	
96			-	19.933	-	10,168.37	
97			-	20.571	-	11,205.55	
98			-	21.229	-	12,348.51	
99			-	21.908	-	13,608.06	
100			-	22.609	-	14,996.08	
101	10,832,553	10,832,553	10,832,553	23.333	252,755,463	16,525.68	15,294.70
102			-	24.080	-	18,211.30	
103			-	24.850	-	20,068.86	
104			-	25.645	-	22,115.88	
105			-	26.466	-	24,371.70	
106			-	27.313	-	26,857.61	
107			-	28.187	-	29,597.09	
108			-	29.089	-	32,615.99	
109			-	30.020	-	35,942.82	
110			-	30.980	-	39,608.99	
111			-	31.972	-	43,649.11	
112			-	32.995	-	48,101.32	
113			-	34.051	-	53,007.65	
114			-	35.140	-	58,414.43	
115			-	36.265	-	64,372.71	
116			-	37.425	-	70,938.72	
117			-	38.623	-	78,174.47	
118			-	39.859	-	86,148.27	
119			-	41.134	-	94,935.39	
120			-	42.451	-	104,618.80	
121	10,832,553	10,832,553	10,832,553	43.809	474,563,680	115,289.92	4,116.26
122			-	45.211	-	127,049.49	-
123			-	46.658	-	140,008.54	
124			-	48.151	-	154,289.41	
125			-	49.692	-	170,026.93	
126			-	51.282	-	187,369.68	
127			-	52.923	-	206,481.39	
128			-	54.616	-	227,542.49	
129			-	56.364	-	250,751.82	
130			-	58.168	-	276,328.51	
131			-	60.029	-	304,514.02	
132			-	61.950	-	335,574.45	
133			-	63.932	-	369,803.04	
134			-	65.978	-	407,522.95	
135			-	68.089	-	449,090.29	
136			-	70.268	-	494,897.50	
137			-	72.517	-	545,377.04	

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
138			-	74.837	-	601,005.50	
139			-	77.232	-	662,308.06	
140			-	79.704	-	729,863.49	
141	10,832,553	10,832,553	10,832,553	82.254	891,022,033	804,309.56	1,107.81
142			-	84.886	-	886,349.14	
143			-	87.603	-	976,756.75	
144			-	90.406	-	1,076,385.94	
145			-	93.299	-	1,186,177.30	
146			-	96.284	-	1,307,167.39	
147			-	99.366	-	1,440,498.46	
148			-	102.545	-	1,587,429.31	
149			-	105.827	-	1,749,347.10	
150			-	109.213	-	1,927,780.50	
151			-	112.708	-	2,124,414.11	
152			-	116.315	-	2,341,104.35	
153			-	120.037	-	2,579,896.99	
154			-	123.878	-	2,843,046.49	
155			-	127.842	-	3,133,037.23	
156			-	131.933	-	3,452,607.03	
157			-	136.155	-	3,804,772.94	
158			-	140.512	-	4,192,859.78	
159			-	145.008	-	4,620,531.48	
160			-	149.648	-	5,091,825.69	
161	10,832,553	10,832,553	10,832,553	154.437	1,672,947,796	5,611,191.91	298.14
162			-	159.379	-	6,183,533.49	
163			-	164.479	-	6,814,253.90	
164			-	169.743	-	7,509,307.80	
165			-	175.174	-	8,275,257.20	
166			-	180.780	-	9,119,333.43	
167			-	186.565	-	10,049,505.44	
168			-	192.535	-	11,074,554.99	
169			-	198.696	-	12,204,159.60	
170			-	205.054	-	13,448,983.88	
171			-	211.616	-	14,820,780.24	
172			-	218.388	-	16,332,499.82	
173			-	225.376	-	17,998,414.81	
174			-	232.588	-	19,834,253.12	
175			-	240.031	-	21,857,346.93	
176			-	247.712	-	24,086,796.32	
177			-	255.639	-	26,543,649.55	
178			-	263.819	-	29,251,101.80	
179			-	272.261	-	32,234,714.18	
180			-	280.974	-	35,522,655.03	
181	10,832,553	10,832,553	10,832,553	289.965	3,141,060,743	39,145,965.84	80.24
182			-	299.244	-	43,138,854.36	
183			-	308.820	-	47,539,017.51	
184			-	318.702	-	52,387,997.29	
185			-	328.900	-	57,731,573.01	
186			-	339.425	-	63,620,193.46	
187			-	350.287	-	70,109,453.20	
188			-	361.496	-	77,260,617.42	

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
189			-	373.064	-	85,141,200.40	
190			-	385.002	-	93,825,602.84	
191			-	397.322	-	103,395,814.33	
192			-	410.036	-	113,942,187.39	
193			-	423.157	-	125,564,290.50	
194			-	436.698	-	138,371,848.14	
195			-	450.673	-	152,485,776.64	
196			-	465.094	-	168,039,325.86	
197			-	479.977	-	185,179,337.10	
198			-	495.337	-	204,067,629.49	
199			-	511.187	-	224,882,527.69	
200			-	527.545	-	247,820,545.52	
201	10,832,553	10,832,553	10,832,553	544.427	5,897,531,657	273,098,241.16	21.59
202			-	561.848	-	300,954,261.76	
203			-	579.828	-	331,651,596.46	
204			-	598.382	-	365,480,059.30	
205			-	617.530	-	402,759,025.34	
206			-	637.291	-	443,840,445.93	
207			-	657.685	-	489,112,171.41	
208			-	678.730	-	539,001,612.90	
209			-	700.450	-	593,979,777.41	
210			-	722.864	-	654,565,714.71	
211			-	745.996	-	721,331,417.61	
212			-	769.868	-	794,907,222.21	
213			-	794.504	-	875,987,758.87	
214			-	819.928	-	965,338,510.28	
215			-	846.165	-	1,063,803,038.33	
216			-	873.243	-	1,172,310,948.24	
217			-	901.186	-	1,291,886,664.96	
218			-	930.024	-	1,423,659,104.78	
219			-	959.785	-	1,568,872,333.47	
220			-	990.498	-	1,728,897,311.48	
221	10,832,553	10,832,553	10,832,553	1022.194	11,072,972,635	1,905,244,837.25	5.81
222			-	1054.904	-	2,099,579,810.65	
223			-	1088.661	-	2,313,736,951.34	
224			-	1123.498	-	2,549,738,120.38	
225			-	1159.450	-	2,809,811,408.65	
226			-	1196.553	-	3,096,412,172.34	
227			-	1234.843	-	3,412,246,213.92	
228			-	1274.358	-	3,760,295,327.73	
229			-	1315.137	-	4,143,845,451.16	
230			-	1357.221	-	4,566,517,687.18	
231			-	1400.652	-	5,032,302,491.28	
232			-	1445.473	-	5,545,597,345.39	
233			-	1491.728	-	6,111,248,274.61	
234			-	1539.464	-	6,734,595,598.63	
235			-	1588.727	-	7,421,524,349.68	
236			-	1639.566	-	8,178,519,833.35	
237			-	1692.032	-	9,012,728,856.35	
238			-	1746.177	-	9,932,027,199.70	
239			-	1802.055	-	10,945,093,974.07	

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
240			-	1859.720	-	12,061,493,559.43	
241	10,832,553	10,832,553	10,832,553	1919.231	20,790,176,315	13,291,765,902.49	1.56
242			-	1980.647	-	14,647,526,024.54	
243			-	2044.028	-	16,141,573,679.05	
244			-	2109.436	-	17,788,014,194.31	
245			-	2176.938	-	19,602,391,642.13	
246			-	2246.600	-	21,601,835,589.63	
247			-	2318.492	-	23,805,222,819.77	
248			-	2392.683	-	26,233,355,547.39	
249			-	2469.249	-	28,909,157,813.22	
250			-	2548.265	-	31,857,891,910.17	
251			-	2629.810	-	35,107,396,885.00	
252			-	2713.964	-	38,688,351,367.27	
253			-	2800.810	-	42,634,563,206.74	
254			-	2890.436	-	46,983,288,653.82	
255			-	2982.930	-	51,775,584,096.51	
256			-	3078.384	-	57,056,693,674.36	
257			-	3176.892	-	62,876,476,429.14	
258			-	3278.553	-	69,289,877,024.91	
259			-	3383.467	-	76,357,444,481.46	
260			-	3491.738	-	84,145,903,818.56	
261	10,832,553	10,832,553	10,832,553	3603.473	39,034,814,357	92,728,786,008.06	0.42
262			-	3718.784	-	102,187,122,180.88	
263			-	3837.785	-	112,610,208,643.33	
264			-	3960.595	-	124,096,449,924.95	
265			-	4087.334	-	136,754,287,817.29	
266			-	4218.128	-	150,703,225,174.66	
267			-	4353.108	-	166,074,954,142.47	
268			-	4492.408	-	183,014,599,465.01	
269			-	4636.165	-	201,682,088,610.44	
270			-	4784.522	-	222,253,661,648.70	
271			-	4937.627	-	244,923,535,136.87	
272			-	5095.631	-	269,905,735,720.83	
273			-	5258.691	-	297,436,120,764.35	
274			-	5426.969	-	327,774,605,082.32	
275			-	5600.632	-	361,207,614,800.71	
276			-	5779.852	-	398,050,791,510.39	
277			-	5964.808	-	438,651,972,244.45	
278			-	6155.682	-	483,394,473,413.38	
279			-	6352.663	-	532,700,709,701.54	
280			-	6555.949	-	587,036,182,091.10	
281	10,832,553	10,832,553	10,832,553	6765.739	73,290,226,540	646,913,872,664.39	0.11
282			-	6982.243	-	712,899,087,676.16	
283			-	7205.674	-	785,614,794,619.13	
284			-	7436.256	-	865,747,503,670.28	
285			-	7674.216	-	954,053,749,044.65	
286			-	7919.791	-	1,051,367,231,447.20	
287			-	8173.224	-	1,158,606,689,054.82	
288			-	8434.768	-	1,276,784,571,338.41	
289			-	8704.680	-	1,407,016,597,614.93	
290			-	8983.230	-	1,550,532,290,571.65	

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
291			-	9270.693	-	1,708,686,584,209.96	
292			-	9567.356	-	1,882,972,615,799.38	
293			-	9873.511	-	2,075,035,822,610.91	
294			-	10189.463	-	2,286,689,476,517.23	
295			-	10515.526	-	2,519,931,803,121.98	
296			-	10852.023	-	2,776,964,847,040.43	
297			-	11199.288	-	3,060,215,261,438.55	
298			-	11557.665	-	3,372,357,218,105.28	
299			-	11927.510	-	3,716,337,654,352.02	
300			-	12309.190	-	4,095,404,095,095.93	
Total	$162,488,295	$162,488,295	$162,488,295		$156,793,747,830		$14,821,449

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Table 4.15. Rivershore Site Modified CRCIA Ranger/Industrial Cover Scenario Summary

Item Description	Equipment	Materials	Labor	S/C	Subtotal Direct	Field Distribs 2600%	Home Office 300%	S/C Fee 400%	B&O Tax 047%	Total Bid
Grout Wells		590	899		1,489	387	56	77	9	2,019
Cover Construction	302,281	1,406,262	198,824	351,442	2,258,808	587,290	85,383	117,259	14,329	3,063,070
Support Facilities				45,036	45,036	11,709	1,702	2,338	286	61,071
Mobilization/ Demobilization	24,198	4,323	133,742		162,263	42,188	6,134	8,423	1,029	220,038
Subtotals:	326,479	1,411,174	333,466	396,478	2,467,596	641,575	93,275	128,098	15,654	3,346,198

Bond		30,439
	SUBTOTAL:	3,376,637
PM/CM @ 15%		506,496
	SUBTOTAL:	3,883,132

Assumptions:

Cover material consists of clean natural fill material from the 100 BC Area.

Riprap materials below the water line are placed from a barge in the river.

Riprap material above the waterline is placed with a backhoe.

Rip-rap material was assumed to include 4 feet of +2ft material resting on 2 feet of 12 " minus material.

Existing wells will be grouted closed.

Two new monitoring wells will be established through the clean cover material.

Contractor markups are taken from the 300 FF FPE.

PM/CM was included as 15% of the project direct costs to be comparable to the other estimates in the CMS.

Direct distribs @ 18.09%	$702,459
G&A @ 4.04%	$ 185,258
TOTAL:	$4,770,849
Contingency @ 34%	$1,622,089
TOTAL:	**$6,392,937**

4.1.1 Attachment 1, MCACES Summary Report for the UPR-100-N-1 Site

100-N Area CMS MCACES Estimating Models Notes, Qualifications, & Assumptions, May 8, 1997

The Corrective Measures Study (CMS) used three of the generic MCACESERC baseline estimating models, including the Trench model, the Crib/French Drain model, and the Modified RCRA 'C' Barrier model..

The CMS includes 76 sites in the 100-N area. Sixteen of the 76 sites were covered by Five Modified RCRA 'C' Barriers (Caps). Differences between the CMS model estimates and the generic model estimates are as follows:

- Contingency of 34% was included in the CMS estimates.
- The HAMTC rates in the CMS estimates were updated to reflect the IOM entitled, *FY96 ERC All-in wage rates for BHI, THI, HAMTC, Building Trades by resource Code, and Field Support Heavy Equipment Pool Rates*, dated October 18, 1996 (CCN#038622).
- RA Production rates in the CMS estimates for soil excavation are about 93% of the rates in the RA baseline models, which were updated after the CMS runs were completed.
- The ERC adders in the CMS estimate are 14.06% (DD) and 5.34% (G&A) as opposed to the 1997 adders, which are 18.09% (DD) and 4.04% (G&A). The DD and G&A rates were updated after the CMS runs.
- PM/CM cost in the CMS estimates was calculated by applying 15% to the project direct cost.
- Transportation and disposal costs are included in the CMS estimates based on ERDF experience.

4.1.1.1 Extract from the RD/RA Baseline Cost Estimates Notes, Qualifications, &Assumptions 1997

EXHIBIT 6 - MODEL ASSUMPTIONS

1.0 GENERAL

1.1 BACKGROUND

In June 1993, RL tasked the U.S. Army Corps of Engineers,Walla Walla District with the preparation of pre-conceptual baseline estimates for RD/RA for a number of solid waste management units (SWMUs) at the Hanford Site. The purpose of the effort waste assist the Richland ER Project in baseline planning for FY94 through FY2000. TheFY95-97 baseline efforts by BHI represents a continued refinement of the Remedial Action Estimating system initiated at the beginning of FY94. The estimates are considered preconceptual. Significant Remedial Action work began in 1996 and lessons learned will reflect in the models in mid 1997.

1.2 METHODOLOGY

Ten (10) RA estimating models were created by the USACE using MCACES Gold for the FY94 Baseline. The models were based on the type of site and there mediation approach. They reflect how work is performed at the Hanford Site interms of division of workscope performed by onsite and offsite contractors, laborrates, and contractor markups. Six (6) models were revised and used for the BL95 and eight (8) for BL97. The additional two models used in the BL97 were the site closure model and the Modified RCRA C Barrier model. (See2.11formodellist).

The MCACES models are used to create baseline cost estimates for each waste site or group of waste sites requiring remediation. Subproject estimates are then created using EXCEL Spreadsheets to rollup the MCACES site remedial action model estimates by operable unit and Subproject.

1.3 OPERABLEUNITANDWASTESITESUMMARY

A total of 1233 waste sites were estimated in the BL 97 using MCACES generic RA and Barrier models as per the *Richland Environmental Restoration Project Baseline, Volume 2: Fiscal Year 1997 Baseline Cost Summary.*

2.0 COSTESTIMATEDEVELOPMENT

2.1 COSTESTIMATEBREAKDOWNSTRUCTURE

MCACES Gold allows up to six levels of titling hierarchy to organize cost estimate details. The cost estimate breakdown structure was developed from the U.S. Army Corps of Engineers HTRWWBS and modified for remediation work at Hanford. The following is an example of the breakdown structure used:

Level 0:	1.4.10.1.1.5.1.2.4	100-BC-1 Trench 116-B-1
Level 1:	08	Solids Collection & Containment
Level 2:	08.01	Excavation
Level 3:	08.01.03	Contaminated Soil
Level 4:	08.01.03.01	Excavate/Load Contaminated Soil
Level 5:		Cost Details
Level 6:		not used and availabl*e*

2.2 CONTRACTORMARKUPS

Contractor markups were included for work performed by subcontractors to BHI. The models calculate Program Management and Construction Management by multiplying FTE's per functional group times the project duration. The ERC adders are then applied to total direct costs in the model.

2.3 SALESTAX

An 8.0% Washington State sales tax is applied to all materials.

2.4 CONTINGENCY

The models include a contingency calculation. A more refined calculation maybe used in the baseline.

The FY 97 baseline contingency analysis was performed by project area. The analysis resulted in contingency rates of 15.7% for the 100 area, 30% for the 200 area, and 15.6% for the 300 area. These rates were applied to the BL 97 estimates outside of the MCACES models.

2.5 PRICELEVEL

The pricing level used in the MCACES models is:

Labor-ERC Labor Rate *BHFY96-HanfordAll-inWageRate1995*.

Equipment-*BHI-93EE, Eq. Rates EP-1110-1-8, Aug.1993*

2.7 ESCALATION

Escalation is applied outside of the MCACES models.

2.8 LABORRATES

A Labor Rate database was created for all classifications to be used on the Hanford ERC Project. The rates reflect the ERC average wage rates issued on December 20, 1996 (CCN#040990). The database includes the labor resource categories and organizational codes, and reflects payroll additives and an average of 4% overtime. BHI's direct distributable and general indirect costs are applied at the bottom line in the models. The baseline database recomputes these costs using current approved rates.

2.9 EQUIPMENT

Equipment pricing data is based on an extract from the latest USACE equipment price book (EP1110-8, Aug 93) which is the basis for the MCACES Version 5.30 equipment rate database. The rates are equivalent to an owner ship rate, and include depreciation, maintenance, fuel, and repairs. These rates were judged adequate for present day costs.

2.10 CREWS

The MCACES crew database, although available, was not used in these MCACES models.

2.11 LIST OF MODELS

The following estimating models were developed based on type of waste site, size, and remediation approach:

1. Burial Ground (Small, Medium to Large)
2. Crib/French drain(Small, Medium, & Large)
3. Trench (Small, Medium, & Large)
4. Septic Tank
5. Below grade structure (Small & Medium)
6. Reactor Area Piping (Large)
7. Retention Basin (Large)
8. Site Closure (Created in 1996)
9. Modified RCRA 'C' Barrier (Createdin1996from1995crewupestimates)

A model size categories area follows.

Small-<or=4,356SF Medium-4,357SFto87, 120SF Large->87,120SF

Separate models for each size were developed in 1996 to accommodate different productivity rates, crew sizes, and equipment types.

2.12 SUMMARY OF MODEL INPUT PARAMETERS

Major cost drivers or "parameters" form the basis for each model. The major quantity inputs necessary to support the parameter calculations areas follows:

A. EXCAVATIONMODELS:
   1. Length, width, and depth of waste site in linear feet (lf)
   2. Noncontaminated, contaminated, and demolition waste volume in bank cubic feet (bcf)
   3. Percent of Transition Soil

B. Modified RCRA 'C' Barrier Model:
   1. Barrier surface area in square feet.

3.0 NOTES AND ASSUMPTIONS

3.1 EXCAVATION MODELS

1. Remediation technology is excavation and disposal.
2. The model calculations include excavation, sampling, monitoring of the excavation, backfill, and site restoration.
3. All contaminated material was assumed to below level waste (LLW).
4. LLW samples were taken every 200L CY excavated for field monitoring and every 1,078 SF of bottom area for closure samples.
5. All LLW samples will be analyzed on site; an additional 5% for QA/QC samples will be analyzed offsite.
6. Material will be loaded into 20 cubic yard (cy) containers. Containers will be filled to approximately 15 LCY due to load restrictions on the total combined weight of the tractor, trailer, and filled container on the highways (40tons).
7. The transport and disposal rate per cubic yard was calculated by the ERDF Subproject based on actual ERDF costs. These costs are not applied in the MCACES models.
8. Appropriate contractor markups were added in the MCACES models.
9. Estimates include QA/Safety and Health Physics (HP) oversight by the ERC team.
10. Key estimate planning quantities and notes are included under each title level with in each estimate.

3.2 RCRA 'C' BARRIER MODELS

1. Remediation technology is to cover the contaminated area with a soil barrier approved under RCRA guidelines.
2. Appropriate contractor markups were added in the MCACES models.
3. Estimates include QA/Safety and Health Physics (HP) oversight by the ERC team.
4. Key estimate planning quantities and notes are included under a title level with in each estimate.

4.0 MCACES MODEL DETAILS

The MCACES models for excavation take 11 input quantities and calculate 25 additional quantities, which are used to price all resources required to setup, sample, excavate, and restore each waste site. These estimates are grouped on the baseline spreadsheets into operable units for each Subproject where contingency is applied. The MCACES models estimate to the base cost, plus subcontractor adders and BHI markups and computed in the ACCESS Baseline Database.

The basic input parameters include the following:

1. Noncontaminated Soil Volume in bcf
2. Contaminated Soil in bcf
3. Demolition Waste in bcf

4. Top Excavation Length in lf
5. Top Excavation Width in lf
6. Bottom Area in sf
7. Number of Groundwater Protection Samples (Small sites <10,000 sf-3 ea.; Medium sites 10,000 to 100,000 sf-21 ea.; and Large sites>100,000-60ea.)
8. Transition Zone Soil percentage
9. Hauling distance for Borrow in miles
10. Hauling distance for demolition waste in miles (not used)
11. Hauling distance for contaminated soil in miles (not used)

The models also include the following fixed values, which are used to calculate and/or convert additional quantities, and resource requirements (labor and equipment types and hours).

RA Models

1. Soils well factor-15%
2. Demolition wastes well factor - 60%
3. Noncontaminated soil excavation rate
   Small-56LCY/Hr (with exception of Burial Ground, which is 77 LCY/Hr)
   Medium-112LCY/Hr (with exception of Burial Ground, which is 154 LCY/Hr for Medium To Large)
   Large-224 LCY/Hr
4. Transition soil excavation rate
   Small-28LCY/Hr (withexceptionofBurialGroundwhichis30LCY/Hr)
   Medium-56LCY/Hr (withexceptionofBurialGroundwhichis60LCY/HrforMediumToLarge)
   Large-112LCY/Hr
5. Contaminated soil excavation rate
   Small-37LCY/Hr (withexceptionofBurialGroundwhichis20LCY/Hr)
   Medium-70LCY/Hr (withexceptionofBurialGroundwhichis40LCY/HrforMediumToLarge)
   Large-140LCY/Hr
6. Demolitionwasteexcavationrate-12LCY/Hr(withexceptionof16LCY/HrfortheRetentionBasinmodel)
7. Sampleanalysiscostforon-sitemobilelab-400.00/Sample
8. Sampleanalysiscostforoff-sitelaboratory-2,000/Sample

RCRA'C'BarrierModel

1. Load/HaulSoils&OtherMaterials-120LCY/Hr
2. Place Asphalt
   (Base course)-65SY/Hr
   (Permeable Layer)-57.5LCY/Hr
3. Spread/CompactSoils-120LCY/Hr
4. Spread/CompactSand/Gravel-105LCY/Hr
5. PlacePerimeterBermBackfill-60LCY/Hr

With these inputs, MCACES determines how much of each resource is needed for each operation estimated in the model. These resource quantities are then priced according to the rate tables provided with MCACES. The subcontractor markups on the labor and material, and the Owner markups were applied within MCACES models. The MCACES models estimate all costs with the exception of escalation and contingency.

4.1.2 Attachment 3, Model Assumptions for RACER-Ex Situ Bioremediation

Land Farming (Ex Situ)

Ex situ bioremediation – 1 and farming, is a process for treating contaminated soil that requires excavation and movement to a treatment cell. The contaminated soil is spread in a thin layer over an area to enhance volatilization, aeration, -biodegradation, and photolysis. This model estimates costs to construct and operate a lined treatment cell and enhance the biodegradation process. The model provides options to stimulate growth of indigenous bacteria (biostimulation) or to cultivate and add bacteria to the site (bioaugmentation).

State and local regulations often impact the location, design, and operation of a land farming treatment cell. The model assumes that the cell is located on the same property as the contaminated soil and is enclosed by a berm and covered. The model also assumes that the soil will be tilled at least once a week.

The following topics are available for the Land Farming (Ex Situ) model:

TECHNICAL HELP
- General Information
- Required Parameters
- Secondary Parameters
- Other Related Costs
- References

SYSTEM HELP
- Button Bar
- Model Processing

Required Parameters

Required parameters are the minimum amount of information required to generate a cost estimate. There are no defaults as the values are site-specific. A reasonable cost estimate can be generated from the required parameters. The required parameters include:

- Total Volume of Soil Treated
- Volume of Soil Per Batch
- Number of Temporary Holding Areas
    - Temporary Holding Area Size
- Treatment Duration per Batch
- Safety Level

Total Volume of Soil Treated

This is the total ex situ volume (in loose cubic yards) of the contaminated soil to be treated. Bank or in situ soil swells approximate) 110% to 130% when excavated. Assuming a swell factor of 1.3 (130%), a one-acre area would be needed to land farm 2500 loose cubic yards (1900.bank cubic yards) of soil 18 inches deep.

For this reason, it may be more desirable to treat larger volumes of soil in a series of successive batches rather than construct a treatment bed large-enough to treat all of the soil at one time. The valid range is 100 to 99,999 loose cubic yards.

Volume of Soil per Batch

This is the ex situ volume (in loose cubic yards) of the contaminated soil that will be treated at one time. The volume of soil per batch determines the size of the treatment cell, setup parameters, amount of tilling, quantity of nutrients, and cell parameters applicable to the site. Therefore, the largest volume of soil to be treated at one time should be entered at this parameter. In most cases, the optimum volume of soil per batch is between 1,000 and 2,000 loose cubic yards. Larger volumes would require excessively large treatment beds. The model determines the number of batches by dividing the total volume of soil treated by the volume of soil per batch, and the model will not allow any combination of input, which causes the number of batches to exceed 90. The valid range is 100 to 10,000 loose cubic yards. The volume of soil per batch cannot be less than the total volume of contaminated soil.

The primary cost driver in an ex situ land farming application is the construction of the treatment bed. Therefore, treating soil in a series of successive batches rather than treating all of the soil at one time will reduce the overall cost of treatment. In determining the total volume the optimum volume of soil per batch, the user may wish to run several different scenarios and observe the costs for each scenario.

Number of Temporary Holding Areas

The scheduling and coordination of ex situ soil remediation projects often require the contaminated soil to be temporarily stockpiled adjacent to the treatment bed. Contaminated stockpiles should be placed in lined holding areas and covered with plastic. The number of temporary holding areas should correspond to the maximum number of stockpiles, which will be present at any one time. The temporary holding area in this model is lined with a 40-mil PVC liner and is surrounded by a 1.5-foot high berm to prevent surface water intrusion. For each holding area, the model includes one pump and one holding tank for collection and containment of accumulated rainwater or leachate. The valid range is 0 to 99 areas.

Temporary Holding Area Size - If the number of temporary holding areas is 1 or more, this parameter is used to specify the size of each holding area. The model assumes that all holding areas are the same size. Assuming a stockpile height of 8 feet and a soil angle of repose of 34 degrees will yield a conservative estimate for the holding area size required for a given volume of contaminated soil. The valid range is 100 to 999,999 square feet.

Treatment Duration per Batch

The treatment duration is the total time that each batch will be in the bioremediation cell. Treatment time can be estimated from information obtained in the bench and pilot studies. The duration is dependent upon the application rates of nutrients, moisture, pH, and microorganisms, as well as the specific contamination and concentration of the contaminant. Climate and soil type also significantly impact the treatment duration. Biodegradation occurs at much slower rates in colder climates. Also, soils having high clay contents require considerably longer treatment duration than sandy soils. The user should consider the climate and the soil type when determining the treatment duration. The amount of nutrients, moisture, pH, and cultured bacteria are important but can be controlled. Total treatment duration is determined by multiplying the treatment duration per batch by the number of batches. The duration for a single treatment is usually between 8 and 20 weeks; however, longer durations are not uncommon. The valid range is 1 to 104 weeks.

Safety Level

The safety level will be affected by the contaminant(s) at the site. Safety level refers to those levels as required by OSHA, 29 CFR Part 1910. The four levels are designated as A, B, C, and D where "A" is the most protective and "D" is the least protective. A safety level of E is also included to simulate normal construction "no hazard" conditions as prescribed by the EPA. A complete description of-safety 1evels and associated requirements is 1ocated- in the On-Line Help for Safety Levels.

Secondary Parameters

A reasonable cost estimate can be created using only the required parameters. However, if more detailed information is known, the secondary parameters can be used to create a more precise and site-specific estimate. Secondary parameters, unlike the required parameters, have defaults that are determined by the model. The defaults are dictated by the engineering design and model assumptions. The secondary parameter sets are:

- Treatment Cell
- Maintenance

Treatment Cell

The treatment cell parameters are listed and described below.

- Cell Area
- Depth of Contaminated Soil
- Sire of French Drain
- Containment Cover
- Sump Pump Capacity
- Sump Pump Quantity

Cell Area – The model defaults to a square treatment cell. The default surface area of the remediation cell will be calculated in square yards based on two factors: the volume of soil to be treated and the depth of soil placed in the remediation cell. The valid range is 1 to 193,600 square yards. It is important to note that this model uses ex situ or loose soil volume measurements. Quantity estimates based on bank (in situ) volumes must be converted to loose volume by multiplying by the appropriate swell factor.

Depth of Contaminated Soil in the Cell – The depth of contaminated soil in the biodegradation cell depends on the capability of the aerating plow, for this model 1 to 18 inches. The depth of the soil will affect the size of the containment cell, the equipment used, and possibly the duration. The default depth is 12 inches. The valid range is 1 to 18 inches. Note: A six-inch minimum soil depth is recommended. An 18 inch depth, if soil conditions allow, will minimize the required treatment cell area, which will reduce costs.

It-is important- to- note that the cell area and depth of contaminated soil are interrelated. If one of these parameters is changed, the model will automatically re-calculate the other based on the volume of soil per batch.

Size of French Drain – The model includes a French drain for leachate collection. The leachate flows (via gravity) to a low end of the benned area and is pumped from there. Leachate is pumped back onto the soil for continued remediation. Options for 1eachate holding tanks are available at the assembly level. Costs for leachate treatment and disposal are not included in this model. The default French drain size is 18' x 18'. At sites with predominate dry seasons, leachate collection systems may not be required, as evapotranspiration and periodic covering of the land farm will control excess saturation.

Options:

- 12' x 12"
- 18'x18'
- 24' x 24"
- None

Containment Cover – A containment cover is recommended and is required in some states. A cover forms a barrier over the cell area to limit moisture infiltration into and out of the contaminated soil. The default is to include a cover, with 135-pound tear strength, fiberglass reinforced plastic sheet being the default cover.

Sump Pump Capacity – The default sump pump is a 75 gpm installed sump pump. The model assumes that electrical service is available at the site. Portable, gasoline powered water pumps are also available.

Note: Provisions must be made to remove excess rainwater in the cell. For cost estimating purposes, the water truck used to sprinkle the soil can be used as a pumper truck to remove water to a treatment facility or holding tank.

Options:

- 75 gpm installed
- 100 gpm installed
- 6,000 gph portable gasoline powered
- 8;000 gph portable gasoline powered o 10,000 gpm portable gasoline powered

Sump Pump Quantity – This is the quantity of pumps required. The model defaults to one 75-gpm pump. This parameter may be set to zero if no pumps are required. The valid range is 0 to 99 pumps.

Maintenance

The maintenance parameters are listed and described below.

- Tilling Frequency
- Number of Passes Per Day
- Microorganisms
- Watering Frequency
- Fertilizing. Frequency

Tilling Frequency – The tilling frequency affects the amount of aeration. The- model assumes that a D3 dozer with a tiller will be used to till the soil. The default tilling frequency1st 44 days, per month, which equates to one day per week (days per-week, days per month/4.33; rounded up-to the nearest whole number). The-model assumes that the dozer wi11 remain on-site for-the entire project duration if the tilling frequency is greater than 2 days per week and the time required for each day of tilling is greater than 4 hours. Otherwise, the model assumes that the doter will be removed from the site at the conclusion of each day of tilling. The dozer is assumed to be decontaminated prior to leaving the site. The valid range is 0 to 7 days per week.

Number of Passes Per Day – This is the number of times during each day of tilling that the tiller will pass through the soil. The default is 2 passes per day. If the tilling frequency (number of days per month of tilling) is decreased, then the number of passes should be increased. The number of passes per day directly impacts the number of hours required for each day of tilling. The number of hours required for each day of tilling depends on the cell area, number of passes per day, and the tillage productivity of the dozer. The model defaults to a minimum of 4 hours of dozer rental for each day of tilling. This 4-hour minimum is assumed to account for equipment mobilization. The valid range is 1 to 10 passes per day.

Microorganisms – Bacteria may be cultured and added to the contaminated soil. Since addition of bacteria is not common in bioremediation, as enhancement of existing bacteria, the default is not to add microorganisms. If microorganisms are added, application rates are 50 pounds per 1,000 cubic yards initially and 25 pounds per 1,000 cubic yards on a monthly basis thereafter.

Watering Frequency - The watering frequency specifies the number of times per month that water is applied to the contaminated area to retain consistent moisture content. Maintenance of soil moisture is vital during excessive dry periods, particularly at sites in low humidity areas. On the other hand, high humidity or excessive rainfall may reduce or eliminate the requirement for watering. The model assumes that the soil moisture content of new soil put into the remediation cell is less than 80%. If the soil becomes too wet, additional plowing to enhance evaporation may be required. Also, in climates where rainfall exceeds the evaporation rate, excessive watering will result in increased amounts of leachate requiring treatment and disposal. The default watering frequency is 4 times per month, which equates to once per week. The model assumes that a water truck will be used. However, a sprinkler system is available at the assembly level. The valid range is 0 to 99 times per month.

Fertilizing Frequency – Nutrients can be added with the water. The addition of nutrients for the microorganisms, primarily in the form of nitrogen and phosphorus, along with the oxygen from soil tilling, are critical to good growth. The nutrient mix will vary from site to site, with the optimum mix determined through pilot studies and geochemical evaluations of the site. However, a default has been determined based on actual field cases. The default is 0.5 pounds of 20:20:20 fertilizer per cubic yard of contaminant. The default fertilizing frequency is once per month. The valid range is 0 to 400 times per-month.

Date 11/04/96 Page 1
Time 11:57

PROJECT SUMMARY REPORT

10ON CMS
HANFORD
Pasco Washington WA
JA LAPIERRE / B BENNETT
11/04/96

Category		Amount
PA/SI		
Site Assessment		8
Studies		0
Remedial Design		0
RA Capital		22,166
Site Work		0
Sampling and Analysis		0
RA Professional Labor		0
Subcontractor Overhead & Profit		3,584
General Conditions		10,189
Studies/Professional Labor Overhead		0
Prime Contractor Home Office		0
Subtotal		$35,939
Prime Contractor		
Profit - (Fee) (0.00%)		0
RA Operations and Maintenance		0
0&M Service Contract		
Overhead, Tax & Profit		0
Subtotal		$35,939
Escalation		2,120
Total Contract Costs		$38,059
Contingencies	(0.00%)	0
Project Management	(0. 00%)	0
Total Project Costs		$38,059

********** END OF REPORT *********

This System Intended for Government Use Only

Date 11/04/96 Page 1
Time 11:48

PROJECT SUMMARY REPORT

10ON CMS, RUN 2
Pasco Washington WA
JAL & BRB
11/04/96

Category		Amount
PA/SI		
Site Assessment		0
Studies		0
Remedial Design		0
RA Capital		24,199
Site Work		0
Sampling and Analysis		0
RA Professional Labor		0
Subcontractor Overhead & Profit		3,870
General Conditions		10,580
Studies/Professional Labor Overhead		0
Prime Contractor Home Office		0
Subtotal		$38,649
Prime Contractor		
Profit - (Fee) (0.00%)		0
RA Operations and Maintenance		0
0&M Service Contract		
Overhead, Tax & Profit		0
Subtotal		$38,649
Escalation		2,280
Total Contract Costs		$40,929
Contingencies	(0.00%)	0
Project Management	(0. 00%)	0
Total Project Costs		$40,929

********** END OF REPORT *********

This System Intended For Government Use Only

Date 11/04/96 Page 1
Time 12:06

PROJECT SUMMARY REPORT

100N, CMS RUN 3
RUN 3
Pasco Washington WA
JAL & BRB
11/04/96

Category	Amount
PA/SI	0
Site Assessment	0
Studies	0
Remedial Design	0
RA Capital	42,741
Site Work	0
Sampling and Analysis	0
RA Professional Labor	0
Subcontractor Overhead & Profit	6,552
General Conditions	15,042
Studies/Professional Labor Overhead	0
Prime Contractor Home Office	0
Subtotal	$64,335
Prime Contractor	0
Profit - (Fee) (0.00%)	0
RA Operations and Maintenance	0
0&M Service Contract	
Overhead, Tax & Profit	0
Subtotal	$64,335
Escalation	3,796
Total Contract Costs	$
Contingencies (0.00%)	0
Project Management (0. 00%)	0
Total Project Costs	$68,131

********** END OF REPORT *********

This System Intended For Government Use Only

4.1.3 Attachment 4, Model Assumptions for RACER-In Situ Bioremediation

In Situ Biodegradation (Bioventing)

Bioventing can be particularly effective for removing volatile contaminants muse they are highly susceptible to physical removal. Bioventing has been developed and applied by the petroleum industry to remediate fuel-contaminated sites. This model assumes that the contaminants of concern are petroleum hydrocarbons.

One of the main advantages of aerobic biodegradation of petroleum hydrocarbon contaminants over other techniques is that the contaminants are completely destroyed, as the byproducts axe primarily carbon dioxide, water, and biomass. Biodegradation avoids generating hazardous byproducts and additional waste streams.

The following topics are available for the In Situ Biodegradation (Bioventing) model:

TECHNICAL HELP

- General Information
- Required Parameters
- Secondary Parameters
- Other Related Costs
- References
- Tables
- Algorithms

SYSTEM HELP

- Button Bar
- Model Processing

General Information

Situ biodegradation involves microbial transformation of organic contaminants to affect cleanup of soils, groundwater, and/or other contaminated media. Biodegradation of organics in soil/groundwater systems is a natural process by which indigenous microorganisms obtain energy and/or carbon through the metabolism of organic contaminants. Various designations are used to describe essentially the same remediation technology:

- In Situ Biodegradation
- In Situ Bioremediation
- In Situ Bioreclamation
- Enhanced Bioreclamation
- Bioremediation or Biodegradation

All of these designations refer to processes where contaminants are degraded by in-place biological processes.

One means of performing in situ biodegradation is through soil venting. Soil venting, also called bioventing, is similar to soil vapor extraction (see the Soil Vapor Extraction model)' except that with bioventing, in situ biodegradation is stimulated intentionally. This process utilizes one or more vacuum extraction wells screened outside the contaminated zone to direct oxygen from the surface through the subsurface. Extracted air can be pulled directly through soil pores from the atmosphere or supplied by one or more injection wells. This procedure physically removes volatile organic compounds (VOCs) in the soil gas and establishes a contaminant gradient between the solid/liquid and gas phases, thereby allowing continuous removal as contaminants redistribute into the gas phase. Pulling air through the subsurface also provides oxygen that can be used as an electron acceptor in aerobic biodegradation of organics. This oxygen, in combination with moisture, nutrients, and possibly microorganisms supplied by either sprinkler systems or infiltration trenches/galleries, stimulates in situ biodegradation of organic Contaminants.

Bioventing can be used in saturated soil columns the groundwater table is lowered to expose more of the contaminated layer. Air injected into the subsurface is drawn through the contaminated zone to stimulate biodegradation and physically strip volatile contaminants. Water and nutrients are provided via infiltration.

Growth factors, which affect the rate of microbial degradation, include:

- Soil Moisture
- Oxygen Requirements
- Soil pH
- Soil Nutrients
- Soil Temperature

Soil Moisture

Moisture control may take the form of supplemental water to the site (irrigation), removal of excess water (drainage, well points), or other methods (e.g., soil additives). Also, the addition of vegetation to a site will increase vapotranspiration of water and, therefore, assists in retarding the downward migration of water (e.g., leaching). When natural precipitation is insufficient to maintain soil moisture within an optimal range for microbial activity, irrigation may be necessary. Water can be applied by standard irrigation methods (e.g., sub-irrigation or sprinkler irrigation) in the case of shallow contamination not exceeding 10 feet. In the case of deep soil contamination, injection wells may be installed for injection of water with or without nutrients and microbial culture. The ease of controlling moisture depends on how easily water is controlled at the site and on the availability of a suitable water source (e.g., transport distance, drilling of new wells, availability, and cost of energy for pumping). Controls to manage the run-on and runoff at the site are necessary to prevent drainage end erosion problems. Costs for erosion control and runoff can be modeled using the Site Work and Utilities module of the RACER System.

Oxygen Requirements

Aerobic degradation is the most attractive of the processes for microbial transformation of petroleum hydrocarbon contaminants because it proceeds at a more rapid rate and does not produce the noxious byproducts associated with anaerobic decomposition. For petroleum hydrocarbons, approximately 3.5 pounds of oxygen are required per pound of hydrocarbon. For bioventing, however. the critical factor is making sure that the vacuum wells are keeping the subsurface aerated. Passive injection vents allow a path for air to be pulled through the subsurface.

Soil pH

Depending on the nature of the hazardous waste components contaminating the soil, it may be advantageous to optimize the soil pH for a particular segment of the microbial community because both microbial structure and activity are affected by the soil pH. Near neutral pH values are most conducive to microbial functioning in general. with a range of 7.0 to 8.5 Considered acceptable. For this model, it will be assumed that the pH does not need adjusting.

Soil Nutrients

As in the case of all living organisms, indigenous microbial populations must have specific inorganic nutrients (e.g., nitrogen. phosphorus, potassium. calcium, magnesium. etc.) and a carbon and energy source to survive. The nutrients necessary to stimulate in situ biodegradation in the subsurface should be studied and defined in a pilot study. Carbon, nitrogen, and Phosphorus amendments to the soil can be added at variable rates depending on microorganism requirements. Standard agricultural methods are used-to add nutrients to the soil. Sufficient nitrogen and phosphorus must be reapplied to ensure that these nutrients do not limit the microbial and metabolic activity.

Soil Temperature

Soil temperature is one of the most important factors controlling microbiological activity and the rate of decomposition of organic contaminants. It also influences the rate of volatilization of compounds from the soil. Optimal growth of microbial populations responsible for biodearadation of petroleum products occurs between 20 and 35° C. Because-of the insulating properties of plant cover, vegetation plays a significant role in soil temperature. Bare soil unprotected from the sun's direct rays becomes very warm during the hottest part of the day; it also loses its heat rapidly during colder seasons. A well-vegetated soil does not become as warm as a bare soil during the summer, and the vegetation acts as an insulator to reduce heat loss from the soil in the winter.

Required Parameters

Required parameters are the minimum amount of information necessary to generate a cost estimate. There are no defaults as the parameter values are specific. A reasonable cost estimate can be generated using only the required parameters. The required parameters include:

- Installation
  - Average Depth to Top of Screen (Vertical Installation)
  - Trench Depth (Horizontal Installation)
  - Screen Length (Vertical and Horizontal Installation)
- Soil Type
- Area of Contaminated Soil
- VEPs
- Blowers
- Startup Period
- O&M Period
- Safety Level

Installation

Installation refers to the type of installation, either vertical or horizontal vapor extraction point (VEP) installation.

Options:

- Vertical
- Horizontal

If vertical installation is selected, the user must provide the average depth to the top of screen, which is used to cost drilling and construction materials. The valid range is 6 to 999 feet. If horizontal installation is selected, the user must provide the trench depth, which is used to cost trenching and construction materials. The valid range is 3 to 30 feet.

The user must also provide the screen length. In the vertical bioventing system, the screen length is designed to span the vertical extent of soil contamination. The total depth of the vertical bioventing well is the sum of the depth to the top of the screen and screen length. However, the total depth of vertical VEP may not exceed 999 feet. In the horizontal installation, the screen length is designed to remediate effectively the entire site. The screen length is based on the radius of influence of the vapor extraction well and area of contaminated soil. The valid range for horizontal screen length is 1 to 999 feet.

Soil Type

The soil properties greatly affect the design of the in situ bioremediation system. The primary controlling soil parameter is soil permeability. Permeability should be sufficient to permit adequate flow of air through the contaminated matrix. The radius of influence of applied vacuum at the vapor extraction point extends over a greater distance in soils with higher permeability. The soil permeability directly relates to the soil particle size. This model classifies soil types into four groups based on particle size. Table 1 shows the range of soil permeability for different soil types.

Options

- Silty Clay, Clay
- Mixed Sandy, Silty, Clayey Soils
- Primarily Sand
- Sand and Gravel

Area of Contaminated Soil

The area of contaminated soil is the appropriate areal extent of the contamination to be remediated by bioremediation. The valid range is 1 to 1,000,000 square feet. This roughly correlates to a rectangular impact zone of 23 acres or 1,000 ft x 1,000 ft. Typically, a site with an impact area as great as this would be addressed in stages or divided into smaller areas and addressed as independent cells. If this is the case. it is advisable to execute multiple runs of the model to account for each cell.

VEPs

The number of VPs are calculated based on the default well spacing, a secondary parameter, using the equations shown in Algorithm 1. The number of VEPS cannot be directly changed on this screen. However, they may be changed at the VEP Design parameters by changing the default VEP spacing or by directly changing the number of VEPs.

Blowers

Represents the default quantity of blowers, which is determined from the secondary parameter, total flow rate (Q). The quantity of blowers cannot be directly changed on this screen. However, the quantity and type of blowers may be changed by editing the VEP Design parameters.

Startup Period

The total treatment duration is divided into startup and O&M. The coats associated with the startup period (e.g. equipment acquisition, installation and optimization) are considered capital costs, and the O&M costs are identified separately. This parameter may be used to identify the startup period (e.g., equipment procurement, installation, and optimization) or it may cover the entire treatment period. The unit of measure for the startup period is weeks'. The valid range for this model is 4 to 999 weeks.

O&M Period

The O&M period may be 0 to 999 months. (Reference Startup Period above) safety Level.

Safety Level

The safety level will be affected by the contaminant(s) at the site. Safety level refers to those levels as required by OSIDA in 29 CFR Part 1910. The four levels are designated as A. B, C, and D; where "A" is the most protective and "D" is the least protective. A safety level of E is also included to simulate normal construction "no hazard" conditions as prescribed by the EPA. A complete description of safety levels and associated requirements is located in the On-Line Help for Safety Levels.

Secondary Parameters

Reasonable cost estimate can be created using only the required parameters. However, if more detailed information is known, secondary parameters can be added to create a more precise and site-specific estimate. Secondary parameters, unlike the required parameters, have defaults that are determined by the model. The defaults are dictated by the engineering design and model assumptions. The secondary parameters are divided into the following four categories:

- VEP Design
- Drill Vertical*
- Trench Horizontal**
- Soil Additives

*These parameters are only available when the type of VEP installation is vertical

**These parameters are only available when the type of VEP installation is horizontal.

VEP Design

The parameters for the design of the bioventing extraction system include:

- VEP Spacing
- Number of VEPs
- Gas Flow Rate
- Total Flow Rate
- Quantity of Blowers
- Type of Blower

VEP Spacing - The design of vapor extraction systems depends primarily on the soil type. The model defaults quantities to the design parameters based on the required parameter. soil type. Since the radius of influence depends on the soil type, the VEPS spacing, number of VEPs, gas flow rate, and blower specifications also depend on the soil type, The model design parameters for different roil' types are based on data obtained from CAM RILL soil vapor extraction projects. Table 2 shows the default values for VEP spacing and gas flow rate.

In bioventing, the purpose of vapor extraction is not to cause volatilization of organic compounds, but merely to provide sufficient vacuum to cause the infiltration of ambient air (due to the development of a pressure gradient) into the subsurface soils to promote biorespiration. Therefore, it is not advisable to apply high vacuum at the vapor extraction well because it would cause volatilization of organic compounds, thus, requiring treatment of the extracted subsurface vapors.

Number of VEPs - The number of VEPS are calculated based on well spacing using the equations shown in Algorithm 1. The number of VEPS may be changed directly by the user, or they may be calculated based on the -VEP spacing.

Gas Flow Rate - The gas flow rate is used in the calculation for total flow rate (Q), which determines the default quantity of blowers. Q is calculated from the equation shown in Algorithm 2. The valid range is .01 to 99.99.

Total Flow Rate - The total flow rate, as calculated by the model, is displayed to provide the user with off-gas treatment quantities, which can be input into other models such as carbon adsorption - gas, etc. This field cannot be edited and is displayed for information purposes only.

Quantity of Blowers - The user may change the default quantity of blower6 directly, or have the modal calculate the quantity of blowers. Table 3 shows the model defaults for type of blower and quantity of blowers. The valid range is 1 to 99 blowers.

Note: Because the quantity of blowers is determined from the total flow rate, if the user changes the default VEP spacing (which determines the number of VEPs, also used in the calculation of total flow rate) or changes the gas flow rate (also used in the calculation of total flow rate) and wants to use the default quantity of blowers, the user must re-calculate by clicking the Calculate push button.

Type of Blowers - The user is given the option of the four blowers provided below. Table 3 shows the model defaults for type of blower and quantity of blowers.

Options

- 98 SCAM. I HP
- 127 SUM. 1.5 9P
- 160 SCPM. 2 HP
- 280 SC t. S HP

Drill Vertical

The parameters for drilling vertical VEPs are listed and described below.

- Diameter
- Construction Material
- Drilling Method
- Soil Sample Collection
- Drum Drill Cuttings

Diameter - The modal defaults to 2" diameter vertical VEPS. However, an option of 4" diameter vertical VEPs is al.50 available in the model. The VEP diameter affects the diameter of borehole and cost of construction material and drill cutting containment (drumming).

Options

- 2 inch
- 4 inch

Construction Material - Vertical VEPs are typically constructed of either PVC or stainless steel screen and casing. Primary selection considerations are cost and material compatibility with the contaminant.

Options

- PVC - Schedule 40
- PVC - Schedule 80
- Stainless Steel

The model defaults to Schedule 40 PVC for the construction of all vertical VEPS less than 85 feet deep. However, when the depth of the vertical VEPs is greater than 85 feet, the model defaults to Schedule 80 PVC material.

Drilling Method – The vertical VEPs can be installed using a variety of vertical drilling techniques, depending on site hydrogeology and desired depth of the borehole. The three vertical drilling techniques included in this model are:

- Hollow Stem Auger
- Water/Mud Rotary
- Air Rotary

The model defaults to hollow 6tem auger for 2-inch and 4-inch diameter vertical VEP installation when the well depth is less than 150 feet below ground surface (bgs). The water/mud rotary method is the model default for drilling when the VEP depth is greater than 150 feet bgs. Air rotary drilling is also available a6 an option. It is assumed that drilling is in an unconsolidated formation. If the subsurface is consolidated, then the user should use water/mud rotary or air rotary rather than hollow stem augers even for depths less than 150 feet bgs. Table 4 gives the diameter of borehole for the different drilling methods.

All connection piping is assumed to be aboveground installation. The Piping model should be run if below ground piping is desired. The amount of connection piping defaulted is the radius of influence times the number of VEPS. The amount of manifold pipe will be defaulted at half the length of the connection piping, and is the same material as the connection pipe. A pressure gauge and other piping appurtenances will be defaulted as well. The connection and manifold pipe size defaults for vertical VEPs are shown in Table 5.

Soil Sample Collection - Sample collection during borehole advancement allows characterization of the geology beneath the site and definition of the magnitude and extent of contaminants in the vadose zone. According to the IRP Statement of Work 1991. Soil samples shall be collected every five feet or at each change in lithology, whichever is less for lithologic description. Drill cuttings can be collected as the borehole is advanced for general geologic information. Discrete samples are collected in unconsolidated sediment using a variety of methods including split spoon, Shelby tubes, and the California brass ring.

The model defaults to collection of soil samples with a split spoon sampler with standard penetration tests at five-foot intervals during borehole advancement. Samples are screened with an organic vapor analyzer (OVA) for volatile organics and described for the lithologic log by the geologist supervising drilling.

If laboratory analysis is desired, the user must decide how many soil samples and what type of analysis will be required. The user must then add these soil analyses to the Sampling and Analysis model.

Drum Drill cuttings - The drill cuttings are generally placed in 55-gallon drums and stored until disposal options have been evaluated. The model default is to include drill cuttings containment.

The professional labor hours spent in the field supervising the installation of the vertical VEPs are passed to the RA Professional Labor model. The model makes the following assumptions for staff hydrogeoiogist hours related to vertical VEP installation:

- If sample collection is included, VEPs are drilled at a rate of 20 feet per hour, plus 2 hours per well for well completion. Total labor hours are for drilling supervision by a staff hydrogeologist.
- If sample collection is not included, VEPs are drilled at a rate of 40 feet per hour, plus 2 hours per well for well completion. Total labor hours are for drilling supervision by a staff hydrogeologist.

Decontamination procedures for the VEPs screen, riser, and caps as well as decontamination of drilling tools (e.g., hollow stem augers) will be conducted prior to and between each borehole/well installation. Procedures consist of steam cleaning with a high-pressure steam-generating pressure washer and detergent, in accordance with AFCEE requirements.

Decontamination procedures for split spoon samplers, bailers, and hand augers were also based on AFCEE requirements and consist of:

- Clean with tap water and detergent using a brush.
- Rinse thoroughly with tap water.
- Rinse with deionized water.
- Rinse twice with pesticide-grade isopropanol.
- Rinse with organic-free deionized water.
- Allow to air dry.

Monitoring wells art usually installed on the periphery of the soil contaminant plume. Monitoring wells are not included in this model, but may be estimated by using the Monitoring model.

Trench Horizontal

Horizontal installation involves excavating a narrow trench and installing a screened or perforated pipe at a common elevation. The model defaults to a horizontal installation method depending on the depth of installation. The model defaults to the use of chain trencher when the depth of installation is less than or equal to 4 feet. The crawler mounted, hydraulic excavator is defaulted when the depth of installation is greater than 4 feet but less than or equal to 20 feet. The Horizontal Dewatering Systems, Inc- (IWSI) proprietary method (Patent *4927292) will be defaulted for depths of installation between 21 and 30 feet. The model does not consider the need for cave-in protection when installing bioventing systems in trenches exceeding.l0 feet. Additional controls such as a trench box, well points, sheeting, or side sloping maybe required due to soil conditions. If this is the case, refer to the Site Work and Utilities models.

The HDSI proprietary method uses specialized equipment to drill a 14-inch wide hole to set a vertical PVC blank pipe. After drilling, the machine dig6 in either a forward or backward direction to create a horizontal VEP. As it digs, a high-density polyethylene (HDPE) perforated pipe is laid horizontally. The pipe is simultaneously covered with a filter pack and connected to the vertical PVC pipe.

Note that the trenching methods do not permit collection of discrete soil samples for laboratory analysis. Therefore, the soil sample collection option is not provided for horizontal VEPs installation.

All connection piping is assumed to be aboveground installation. The Piping model should be run if below ground piping is desired. The amount of connection piping defaulted is the radius of influence times the number of VEPs. The amount of manifold pipe will be defaulted at half the length of the connection piping and is the same material as the connection pipe. A pressure gauge and other piping appurtenances will be defaulted as well.

The model defaults to 2-inch and 4-inch diameter schedule 40 PVC connection and manifold pipe, respectively when a 2-inch diameter screen pipe is specified. The model defaults to 4-inch and +-inch diameter schedule 40 PVC connection and manifold pipe, respectively when a 4-inch diameter screen pipe is specified, and C-inch and 8-inch diameter schedule 40 PVC connection and manifold pipe. Respectively when a C-inch diameter screen pipe is specified.

The parameters for horizontal installation are listed and described below.

- VEP Diameter
- Contaminant of Trench Cutting

VEP Diameter - The model defaults to 2• diameter horizontal VEPs for depths of installation less than or equal to 10 feet. However, an option of 4" diameter horizontal VEPs is also available in the model.

When the installation depth is greater than 20 feet, the model defaults to installation of horizontal VEPs by the HDSI proprietary method; therefore, the construction materials cannot be edited. Per this construction method, a choice of 4-inch or C-inch diameter perforated HDFE horizontal pipe is available for installation. The model defaults to 4-inch diameter horizontal VEPS for depths of installation greater than 10 feet.

Containment of Trench Cutting - The trench cuttings can be placed in 55- gallon d---J= and stored until disposal options have been evaluated. If containment is included, this option will be coated. Otherwise, it is assumed that the waste soil is backfilled into the trench to be treated, along with the in situ contaminated soil. The model default is not to include containment of trench cuttings.

Another alternative that is not included in this model would be stockpiling tie waste soil at a location near the bioventing area.

The amount of waste soil to be drummed using the HDSI proprietary method is less than that drummed using conventional excavating equipment. This is due to the minimal disturbance of subsurface soil when using the WSI method.

The professional labor hours spent in the field supervising the installation of the horizontal VEPS are included with the VEP installation costs. The model makes the following assumptions for staff hydrogeologist hours related to horizontal VEP installation:

- 45 minutes for vertical blank PVC pipe installation of a staff hydrogeologist per VEP
- 1 minute per 2 feet of horizontal screen section, installation of a staff hydrogeologist per VEP
- 1.5 hours for loading, moving, and setting up on site.

Decontamination, procedures for the VEP screen, riser, and caps, as well as decontamination of trenching tools, will be conducted prior to and between each VEP installation. Procedures consist of steam cleaning with a high-pressure steam-generating pressure washer and detergent, in accordance with AFCEE requirements.

Monitoring wells are usually Installed= the periphery of the soil contaminant plume. Monitoring wells are not included in this model, but may be estimated by using the Monitoring model.

Soil Additives

The soil additives parameters are Listed and described below.

- Watering
- Nutrients
- Microorganisms

Watering – Moisture and nutrients will generally be delivered to the soil by one of the three methods: spray irrigation (sprinkler system), infiltration gallery, or injection wells. This model assumes that if the watering Qztion is selected, a sprinkler will be wed. The model default is to include watering. The Infiltration Gallery or Injection Wells models may be used to estimate costs for the other options.

Nutrients – The most basic bioremediation processes involve the addition of oxygen and appropriate nutrients, typically nitrogen and phosphorus. The optimum nutrient mix must be determined by laboratory growth studies and geochemical evaluations of the site: however, a default has been determined for a rough estimate of nutrients and quantities. If nutrients are selected, the default is a nitrogen/ phosphorus/potassium (20:20:20) pulverized fertilizer, at an application of Boo lbs/acre. The model default is to include nutrients.

Microorganisms – When naturally occurring microorganisms are few in number or are absent, or when rapid cleanup is desired, acclimated organic matter may be added to the soil to be treated. The acclimated organic matter supplies organisms capable of initiating the degradation process. For this model, it will be assumed that microorganisms will not be added to the subsurface. The applications for the microorganisms, if chosen, will be0.5 lb bioculture per gallon of water. The monthly application is estimated to be 25 lbs of bacteria per 1.000 cubic yards of waste. This corresponds to 200 gallons of water and bioculture per month per 1.000 cubic yards of contaminated soil.

4.1.4 Attachment 5, Model Assumptions for RACER-In Situ Solidification

In Situ Solidification

Solidification/Stabilization (S/S) is a treatment technology in which chemical gents are mixed with waste to make use of complex chemical and physical actions to improve physical properties and reduce contaminant solubility, toxicity, and/or mobility. S/S is a viable treatment for contaminated materials when the constituents cannot be treated, recovered, or destroyed by other methods because of technical or economical limitations.

The In Situ model does not include excavation, transportation, or disposal of solidified material. Solidification of in-drum waste is not addressed with this model- This model assumes that the site is fully accessible by heavy equipment (e.g., 100-ton crane, large earth moving equipment. etc.). It is also assumed that the site has been properly characterized prior to use of the In Situ Solidification model.

The following topics are available for the In Situ Solidification model:

TECHNICAL HELP

- General Information
- Required Parameters
- Secondary Parameters
- Other Related Costs
- References
- Tables

SYSTEM HELP

- Button Bar
- Model Processing

To solidification, a reagent is added to transform a liquid, sludge, sediment, roil into a Solid form. Solidification may immobilize the contaminants .within the crystalline structure of the solidified material thus reducing the contaminant leaching potential: although this varies depending upon waste, soil, and reagent characteristics. In stabilization, a reagent is added to transform the material so that the hazardous constituents are in the least mobile or toxic form. Solidification is a physical treatment, whereas, stabilization is a chemical treatment. Compatibilities of common reagents with various waste components are shown in Table 1.

A bench-scale laboratory program is usually performed to determine the type and amount of the S/S reagent required to satisfy the regulatory treatment objectives.

S/S is generally most effective for inorganic compounds and radionuclides. Solidification/stabilization is generally effective on certain contaminants, or contaminant groups: volatile and non-volatile metals (with some exceptions, anionic complexes of metals such as chromium, selenium, arsenic, cyanides, strong acids, oxidizing agents, and reducing agents); other inorganics, polychlorinated biphenyls (PCBs), and radionuclides. Treatment of some semivolatile compounds has been documented using S/S, although treatment of volatile organic compounds (VOCs) is currently the focus of research and debate.

This technology can be performed using a variety of equipment. Several methods include Open Pit/Trench/Area Mixing, in Situ/In Drum Mixing, and Ex Situ treatment in a mixing unit. The Open Pit/Trench/Area mixing method requires a reagent to be dumped on top of the waste and mixed with conventional earth saving and earth handling equipment. The in Situ/In Drum method requires a specialized or patented piece of equipment (usually a hollow stem auger or multiple auger rig) that injects and mixes reagent into the waste in place and can be used at depths up to 120 feet below grade. The ex situ method requires excavation, conveyance, or pumping of a contaminated medium into a mixing unit where a reagent is added. Treatment would be processed through a pugmill (mixing apparatus). The process modeled herein is the In Situ process using crane-mounted mixing augers. The Ex situ process may be estimated using the Solidification/Stabilization model.

In most instances, the solidified material can be left in place and capped. However, local and state regulations should be reviewed to evaluate provisions for in-place disposal of solidified material. In Situ S/S eliminates the higher costs and additional hazards associated with excavation, handling and transport of hazardous materials associated with On-Site treatment and/or off-site disposal. In cases where the solidified material cannot be left in place, disposal options should be evaluated prior to technology selection. If land filling is the disposal option of choice, then the effectiveness of the S/S technology to meet the requirements of the Land Disposal Restrictions (LDRs) under the Resource Conservation and Recovery Act (RCRA) should be evaluated prior to proceeding. If the waste contains PCBs, then the waste disposal is regulated by the Toxic Substance Control Act (TSCF). EPA guidelines recommend a minimum unconfined compressive strength 'TTCS) of 50 pounds per square inch (psi) for treated waste that is disposed in landfill with no free liquids phase. For in Situ applications, strength should be adequate to serve the anticipated future uses of the site.

The total cost for this remediation technology will vary depending upon the chemical and physical characteristics of the waste, the site characteristics, and the treatment requirements.

Required parameters are the minimum amount of information required to generate cost estimate. There are no defaults as the values are site-specific. A reasonable cost estimate can be generated from the required parameters. The required parameters include:

- Type of Waste
- Total Volume of Waste*
- Depth of Bore*
- Boring Surface Area*
- Soil Type
- Safety Level

* Note: The user must enter two of these three required parameters. The remaining value is then calculated by the two entered values. The entered values must not allow the calculated value to exceed its valid range.

Type of Waste

The selections for type of waste are solid or sludge. It is assumed that the sludge is pumpable. The type of waste will affect the S/S mix design. It is assumed in the model that the waste is suitable for the S/S process. Waste with high concentrations of organics and other miscellaneous materials (i.e., oil and grease, loess, peat, highly plastic clays) may inhibit the effectiveness of this technology.

Options

- Solid
- Sludge

Total Volume of Waste

The volume of the waste is specified in cubic yards. The volume will be converted to weight since ratios using weight comparisons are most commonly used. The valid range is 1 to 9,999,999 cubic yards. Sludges can be converted from gallons to cubic yards by multiplying the number of gallons by 0.005.

Depth of Bore

This parameter reflects the depth of the contaminated waste to be treated. The depth of waste to be solidified drives the size of the equipment used for treatment. The valid range is 1 to 120 feet.

Boring Surface Area

This is the surface area affected by the boring for the solidification/stabilization process. The boring surface area drives the number of borings required. The valid range is 1 to 9,999,999 square feet.

1 Type

The soil type will affect the size of the boring equipment.

Options

- Silty Clay, Clay
- Mixed Sandy, Silty, Clayey Soils

- Primarily Sand
- Sand & Gravel

Safety Level

The safety level will be affected by the contaminant(s) at the site. Safety level refers to those levels as required by OSHA in 29 CFR Part 1910. The four levels are designated as A, B, C, and D; where

'"A" is the most protective and "D" is the least protective. A safety level of E is also included to simulate normal construction "no hazard" conditions as prescribed by the EPA. A complete description of safety levels and associated requirements is located in the On-Line Help for Safety Levels.

Secondary Parameters

The secondary parameters are listed and described below.

A reasonable cost estimate can be created using only the required parameters. However, if more detailed information is known, the secondary parameters can used to create a more precise and site-specific estimate. Secondary parameters, unlike the required parameters, have defaults that are determined by the model. The defaults are dictated by the engineering design and model assumptions. The secondary parameter sets are:

- Secondary
- Additives

Secondary

The secondary parameters are listed and described below.

- Initial Moisture Content
- Density of Waste
- Auger Diameter

Initial Moisture Content – The initial moisture content varies depending upon the waste medium. The moisture content will aid in determining the mix design for the waste and additives. The default moisture contents are shown in Table 2. The valid range for solid waste is 0 to 30%. For sludge waste, the valid range is 31 to 70%.

Density of Waste – The density of waste is specific to the waste medium and will be presented in pounds per cubic foot (pcf). This will provide information necessary to calculate the mix design and volume expansion encountered after the solidified waste has cured. The unit weight can be adjusted to the field conditions of the waste. The default waste densities are shown in Table 3. The-valid range for solid waste is 60 to 200 pcf. For sludge waste, the valid range is 40 to 200 pcf.

Auger Diameter – The auger diameter refers to the diameter of the boring bit. The auger diameter will default based on soil type and depth of boring. The auger diameter will determine the number of borings required.

Additives

The additives parameters are listed and described below.

- Chemical Additive Ratios
- Calculate Volume of Treated Waste

Chemical Additive Ratios – There are many chemical additives that can be used effectively in the S/S process. However, additive ratios axe highly waste specific and should be determined by beach and pilot testing. The chemical additive ratio defaults provided in this model are rudimentary and are provided only to obtain estimated chemical additive costs. A more precise estimate can be provided upon completion of beach and pilot testing.

This parameter group may include such chemicals as: water, proprietary chemical binders, Portland cement, fly ash, cement kiln dust, hydrated lime, asphalt, bitumen, polyolefins, epoxy, urea formaldehyde, activated carbon, modified Clay, pumice, blast furnace slag, polycrylares, and polyacrylamides. Mix ratios will be defaulted based on the required parameter input and standard S/S mix designs.

The default additives will include water, proprietary chemical binder, fly ash, kiln dust, and Portland cement. The mix proportions will be weight based and contingent upon the initial moisture. Content and unit weight of the waste. Table 4 provides a list of the default weight of additive to waste ratios Table 5 provides a summary of specific gravity and weight for both chemical additives and waste streams. These defaults are estimated based on information obtained from the EPA SITE program, and conversations with consultants and vendors.

Calculate Volume of Treated Waste - This is a locked field that will display the amount of waste after treatment and curing has been completed. This is displayed for informational purposes only. In general the volume of the treated waste will increase based on the amount of chemical additive that has been added for treatment. This increase in volume will raise the ground surface of the site over the aerial' limits of the untreated waste if the treated material is left in place. The-site would require grading end capping based on its future use. If the treated material were to be disposed of in a landfill, the total volume of the treated waste would indicate the amount that is to be disposed of either in a Subtitle "C" (hazardous) or Subtitle "D" (non-hazardous) landfill depending upon the outcome of the Toxicity Characteristic Leaching Procedure (TCLP) analytical results. Groundwater monitoring adjacent to the solidified material may be required and should be estimated using the Monitoring model. Well installation can be estimated using the Groundwater Monitoring Wells model.

4.2 COST ESTIMATES FOR GROUNDWATER ALTERNATIVES

4.2.1 Costs – Alternative 2

NET PRESENT WORTH FOR 100-NR-2 CMS ALTERNATIVE 2

Calculation of Net Present Worth of a cash flow annually escalated at 3.2% and annually discounted at 10.2% (7%plus 3.2%) per year for 300 years. The 3.2% annual escalation is published by DOE (ERC rates 12/20/96) and is assumed constant for 300 years. The 7% Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

START-UP CAPITAL COSTS (IN 1997 DOLLARS) IS $63,358

NET PRESENT WORTH OF OPERATIONS & MAINTENANCE AND FUTURE CAPITAL COSTS FOR 100-NR-2 CMS ALTERNATIVE # 2 IS $699,468

The cash flow is made up of the following:

1. Install Signs Along the River @ 5,076 every 20 Years. Start at year one.
2. Sample Sr-90 to River @ 5,687/yr. for 300 Yrs. Capital Well Replacement Costs of $48,557 every 20 Yrs.
3. Monitor Tritium to River $11,270/yr for 15Yrs.
4. Sample Sr-90 in Aquifer @ 13,893/yr for 300 Yrs. Capital Well Replacement Costs of $291,408 every 20 Yrs.
5. Sample Other Contaminants @ $8,314/yr. for 100 Yrs. Capital Well Replacement Costs of $58,282 every 25 Yrs.

The total inosculated capital costs is $5,068,784

The total inosculated operating cost is $6,874,535

The average annual in osculated operating cost is $6,874,535/300 YRS. = 22,915

The actual average yearly operating costs will vary since projects requiring O&M run for 15,100, & 300 years.

4.2.2 Costs – Alternative 3

NET PRESENT WORTH FOR 100-NR-2 CMS ALTERNATIVE 3

Calculation of Net Present Worth of a cash flow annually escalated at 3.2% and annually discounted at 10.2 % (7 % plus 3.2 %) per year for 300 years. The 3.2 % annual escalation is published by DOE (ERC rates 12/20/96) and is assumed constant for 300 years. The 7 % Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

Start-up capital costs (in 1997 dollars) is $8,240,697

Net present worth of operations & maintenance and future capital costs for 100-NR-2 cms alternative #3 is $1,021,528

The cash flow is made up of the following:

1. Install Clino Wall at the River 1 st yr. @ 8,182,415. This is all Capital cost with no Yearly O&M.
2. SampleSr-90 to River at Clino Wall @ 19,389/Yr. for 300 Yrs. Capital Well Replacement Costs of $321,218 Every 20 Yrs.
3. Monitor Tritium to River $11,270/yr for 15 Yrs.
4. Sample Sr-90 in Aquifer @ $13,893/Yr. for 300 Yrs. Capital Well Replacement Costs of $291,408 Every 20 Yrs.
5. Sample Other Contaminants @ 8,314/yr for 100Yrs. Capital Replacement Well Costs of $58,282 Every 25 Yrs.

The total unescalated capital costs is $16,992,315

The total unescalated operating cost is $10,985,030

The average annual unescalated operating cost is $10,985,030 /300 yrs. = 36,617

The actual average yearly operating costs will vary since projects requiring O&M run for 15,100, & 300 years.

4.2.3 Costs – Alternative 4

NET PRESENT WORTH FOR 100-NR-2 CMS ALTERNATIVE 4

Calculation of Net Present Worth of a cash flow annually escalated at 3.2 % and annually discounted at 10.2 % (7 % plus 3.2 %) per year for 270 years. The 3.2 % annual escalation is published by DOE (ERC rates 12/20/96) and is assumed constant for 270 years. The 7 % Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

Start-up capital costs (in 1997 dollars) is $1,754,609

Net present worth of operations & maintenance and future capital

Costs for 100-nr-2 cms alternative # 4 is $12,491,105

The cash flow is made up of the following:

1. Pump & Treat to 200 gpm, O&M @ $674,185/yr for 270 years. Plant & well construct & replacement @ 1, 20, & 50 yrs.
2. Monitor Tritium to River $11,270/yr. for 15 Yrs.
3. Sample Sr-90 in Aquifer @ $30,923/Yr. for 270 Yrs. Capital Well Replacement Costs of $524,535 Every 20 Yrs.
4. Sample Other Contaminants @ $8,314/yr for 100 Yrs. Capital Well Replacement Costs of $58,282 Every 25 Yrs.
5. Monitor Water Levels @ 7,046/yr for 270 Yrs. Capital Well Replacement Costs of $194,228 Every 50 Yrs.

The total unescalated capital costs is $38,160,277

The total unescalated operating cost is $193,282,168

The average annual unescalated operating cost is $193,282,168 /270yrs. = 715,860

The actual average yearly operating costs will vary since projects requiring O&M run for 15,100, & 270 years.

4.2.4 Costs – Alternative 5

NET PRESENT WORTH FOR 100-NR-2 CMS ALTERNATIVE 5

Calculation of Net Present Worth of a cash flow annually escalated at 3.2 % and annually discounted at 10.2 % (7 % plus 3.2 %) per year for 270years. The 3.2 % annual escalation is published by DOE (ERC rates 12/20/96) and is assumed constant for 270 years. The 7 % Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

Start-up capital costs (in 1997 dollars) is $4,580,204

Net present worth of operations & maintenance and future capital

Costs for 100-nr-2 cms alternative #5 is $34,585,404

The cash flow is made up of the following:

1. Pump & Treat to 200 gpm, O&M @ $674,185/yr for 270 years. Plant & well construct & replacement @ $1,20 & 50 yrs.
2. Maintain Tritium Hydraulic Control $l2,175/yr. for 15 Yrs. Capital well costs $115,796 at day one.
3. Sample Sr-90 in Aquifer @ $30,923/yr for 270 Yrs. Capital Well Replacement Costs of $524,535 Every 20 Yrs.
4. Sample Other Contaminants @ $8,314/yr for 100 Yrs. Capital Well Replacement Costs of $58,282 Every 25 Yrs.
5. Monitor Water Levels @ $7,046/yr for 270 Yrs. C Capital Well Replacement Costs of $194,228 Every 50 Yrs.
6. Others Pump & Treat to 200 gpm, O&M @ $1,356,033/yr for 90 years. Plant & well construct & replacement @ 1, 20 & 50 yrs. intervals

The total unescalated capital costs is $50,409,080

The total unescalated operating cost is $315,188,703

The average annual unescalated operating cost is $315,188,703 /270yrs. = $1,167,366

The actual average yearly operating costs will vary since projects requiring O&M run for $15,90,100, & 270 years.

4.2.5 Costs – Alternative 6

NET PRESENT WORTH FOR 100-NR-2 CMS ALTERNATIVE 6

Calculation of Net Present Worth of a cash flow annually escalated at 3.2 % and annually discounted at 10.2 % (7 % plus 3.2 %) per year for 300 years. The 3.2 % annual escalation is published by DOE (ERC rates 12/20/96) and is assumed constant for 300 years. The 7 % Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

Start-up capital costs (in 1997 dollars) is $20,389,389

Net present worth of operations & maintenance and future capital

Costs for 100-nr-2 cms alternative #6 is $36,269,137

The cash flow is made up of the following:

1. Pump & Treat to 135 gpm, O&M @ $589,180/yr for 270 years. Plant & well construct & replacement @ 1, 20, & 50 years.
2. Maintain Tritium Hydraulic Control 11,270/yr for 15 years.
3. Sample Sr-90 in Aquifer @ 21,580/yr for 270 years. Capital Well Replacement Costs of 349,630 Every 20 years.
4. Sample Other Contaminants @ 8,314/yr for 100 years. Capital Well Replacement Costs of 58,282 Every 25 years.
5. Monitor Water Levels @ 7,046/yr for 270 years. Capital Well Replacement Costs of 194,228 Every 50 years.
6. Others Pump & Treat to 200 gpm, O&M @ 1,356,033/yr for 90 years. Plant & well construct & replacement @ 1, 20, & 50 yrs. intervals
7. Install Freeze Wall at the River. O&M 212,463/yr for 300 years. Capital Installation Costs 1st .year 16,463,096.

The total unescalated capital costs is $56,753,369

The total unescalated operating cost is $353,590,138

The average annual unescalated operating cost is $353,590,138/ 300yrs. = $1,178,634.

The actual average yearly operating costs will vary since projects requiring O&M run for 15, 90, 100, 270 & 300years.

4.2.6 Costs – Alternative 7

NET PRESENT WORTH FOR 100-NR-2 CMS ALTERNATIVE 7

Calculation of Net Present Worth of a cash flow annually escalated at 3.2 % and annually discounted at 10.2 % (7 % plus 3.2 %) per year for 100 years. The 3.2 % annual escalation is published by DOE (ERC rates 12/20/96) and is assumed constant for 100 years. The 7 % Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

Start-up capital costs (in 1997 dollars) is $22,416,808

Net present worth of operations & maintenance and future capital costs for 100-nr-2 cms alternative # 7 is $114,113,817

The cash flow is made up of the following:

1. Pump & Treat to 250 gpm, O&M @ 4,966,263/yr for 20years. Original Capital Cost $2,048,414
2. Maintain Tritium Hydraulic Control 2175/yr for 15 years. New Well Capital Costs $115,796
3. Sample Sr-90 in Aquifer @ 13,519/yr for 20years.
4. Sample Other Contaminants @ 8,314/yr for 100 years. Capital Well Replacement Costs of 58,282 every 25 years.
5. Monitor Water Levels @ 10,404/yr for 100 years. Capital Well Replacement Costs of $294,740 @ 50 years.
6. Others Pump & Treat to 200 gpm, O&M @ 1,356,033/yr for 90 years. Plant & well construct & replacement @ 1, 20, & 50 yrs. intervals
7. Install Soil Flushing. O&M 2,953,284/yr for 20 yr. Capital Installation Costs 1st. year $8,708,080.
8. Install Sheet Piling Wall Original Capital Cost $8,776,437. Remove in 20 years @1,077,752

The total unescalated capital costs is $32,309,602

The total unescalated operating cost is $283,686,469

The average annual unescalated operating cost is $283,686,469138/ 100yrs. = 2,836,864.

The actual average yearly operating costs will vary since projects requiring O&M run for 152,090,100 years.

4.3 GROUNDWATER ALTERNATIVES DESCRIPTIONS 100-NR-1/100-NR-2 CMS

4.3.1 Alternative 1: No Action

PHYSICAL FEATURES

None

NOTES

- National Contingency Plan requires evaluation of the No Action alternative
- Columbia River in vicinity of N-Springs currently exceeds MCLs for tritium, strontium, and nitrate.
- Nitrate load to the Columbia River from the N-Area is very small in comparison to the load from irrigation return flows

ASSOCIATED ACTIVITIES

- No cleanup activities at all
- No institutional controls after DOE releases the property in 2018

CONSEQUENCES

- Tritium conc. in to river exceeds MCL for next 10-15 years
- Tritium conc. in aquifer exceeds MCL for next 25 years
- Strontium conc. into river exceeds MCL for next 270 years
- Strontium conc. in aquifer exceeds MCL for next 300 years
- Other contaminants in aquifer will exceed MCLs for few to 90 years
- Manganese conc. into river may exceed MCL sat future date for few years
- Contaminant conc. into river could change without being detected

4.3.2 Alternative 2: Institutional Controls

NR-1/NR-2CMS GROUNDWATER ALTERNATIVES – DESCRIPTIONS

August 5, 1996

PHYSICAL FEATURES

- Monitoring wells
- Tritium- 4 wells, sample 1/yr, test for tritium, for 15 years
- Strontium- 9 wells, sample rate varies, test for Sr-90, for 300 years
- Others- 3 wells, sample 1/yr, test for 5 analytes, for 20 to 100 years
- Signs along river

NOTES

- Columbia River in vicinity of N-Springs currently exceeds MCLs for tritium, strontium, and nitrate.

ASSOCIATED ACTIVITIES

- Access controls on river shoreline along N-Springs
- Controls on GW use for 300 years
- Limits on irrigation in the general area
- Monitoring for 300 years
- Regulatory acceptance of institutional controls

CONSEQUENCES

- No use of unconfined aquifer allowed for 300 years
- Must maintain monitoring, institutional controls, etc. for 300 years
- Risk to ecological receptors along river may occur due to strontium
- Changing groundwater conditions would be detected by monitoring
- Tritium and strontium would continue to flow into the Columbia River

Also:

- Tritium conc. into river exceeds MCL for next 10-15 years
- Tritium conc. in aquifer exceeds MCL for next 25 years
- Strontium conc. into river exceeds MCL for next 270 years
- Strontium conc. in aquifer exceeds MCL for next 300 years
- Other contaminants in aquifer will exceed MCLs for few to 90 years
- Manganese conc. in to river may exceed MCL sat future date for few years

4.3.3 Alternative 3: Permeable Wall and Institutional Controls

NR-1/NR-2 CMS GROUNDWATER ALTERNATIVES – DESCRIPTIONS
(IC for tritium to river and all COCs in aquifer)
August 5, 1996

PHYSICAL FEATURES

- Permeable barrier, 2000 ft. long (for strontium) (top of barrier wall at least 10 ft below ground surface)
- Monitoring wells
  Tritium- 4 wells, sample 1/yr, test for tritium, for 15 years
  Strontium- 2 wells plus 40 sample tubes impermeable wall, sample rate varies, test for Sr-90, for 300 yrs.
  Strontium- 5 wells, once every 2 yrs, test for Sr-90, for 300years
  Others- 3 wells, sample 1/yr, test for 5 analytes, for 20 to 100 years
- Signs along river

NOTES

- Columbia River in vicinity of N-Springs currently exceeds MCLs for tritium, strontium, and nitrate.
- Nitrate load to the Columbia River from the N-Area is very small in comparison to the load from irrigation return flows
- Permeable wall operates passively; little O&M required

ASSOCIATED ACTIVITIES

- Land use controls for area containing permeable wall
- Monitoring for permeable barrier integrity for 300 years
- Institutional controls on GW use for 300 years
- Institutional controls along river for 15 years, for tritium
- (assume other COCs pose no risk to river)
- Monitoring north and south of permeable wall for groundwater quality going in to river
- Regulatory acceptance of institutional controls

CONSEQUENCES

- No use of unconfined aquifer allowed for 300 years
- Must maintain monitoring and institutional controls for 300 years
- Permeable wall reduces risk to ecological receptors along river that is due to strontium

Also:

- Tritium conc. into river exceeds MCL for next 10-15 years
- Tritium conc. in aquifer exceeds MCL for next 25 years
- Strontium conc. into river will be less than MCL
- Strontium conc. in aquifer exceeds MCL for next 300 years
- Other contaminants in aquifer will exceed MCLs for few to 90 years
- Manganese conc. into river may exceed MCL sat future date for few years

4.3.4 Alternative 4: Hydraulic Controls And Pump and Treat for Strontium, Institutional Controls for Tritium to River and Other COCs in Aquifer

NR-1/NR-2 CMS GROUNDWATER ALTERNATIVES – DESCRIPTIONS
August 5, 1996

PHYSICALFEATURES

- Sr-90Hyd.Control and P&T: 9 extraction wells, 5 of 9 new
  3 injection wells, 1 of 3 new
  1 Treat Plant expand existing plant)
  Pumping rate- 15 gpm for 9 extraction wells
- Monitoring wells along river
  Tritium- 4 wells, sample 1/yr, test for tritium, for 15 years
  Strontium- 9 wells, sample rate varies, test for Sr-90, for 270 years
  Others- 3 wells, sample 1/yr, test for 5 analytes, for 20 to 100 years
  Water levels- 11 wells + 1 river stage, sample 4 wells/year, for 270 years
- Treatment facility at north end of 1301-N trench

NOTES

- Hydraulic controls for Sr-90 will partly control tritium to river

ASSOCIATED ACTIVITIES

- Institutional controls on GW for 270 years
- Institutional controls of land use where wells and treatment plant are located
- Monitor groundwater for 270 years
- O&M of treatment plant for 270 years
- O&M of wells and pipelines for 270 years
- Regulatory acceptance of institutional controls rather than significant expense of remediation
- Treatment plant residuals disposed at ERDF

CONSEQUENCES

- No use of unconfined aquifer allowed for 270 years
- Must maintain monitoring and institutional controls for 270 years
- Contaminants north and south of Sr-90 plume would continue going into the river.
- Tritium conc. into river exceeds MCL for next 10-15 years
- Tritium conc. in aquifer exceeds MCL for next 25 years
- Strontium conc. into river will be less than MCL
- Strontium conc. in aquifer exceeds MCL for next 270 years
- Other contaminants in aquifer will exceed MCLs for few to 90 years
- Manganese conc. into river may exceed MCL sat future date for few years

4.3.5 Alternative 5: Hydraulic Controls for Tritium and Strontium to River Pump and Treat Strontium and Other COCs in Aquifer

NR-1/NR-2 CMS GROUNDWATER ALTERNATIVES – DESCRIPTIONS
August 5, 1996

PHYSICAL FEATURES

• Sr-90 Hyd. Control and P&T:	9 extraction wells, 5 of 9 new 3 injection wells, 1 of 3 new 1 Treat. Plant (expand existing plant and modify for nitrate treat.) Pumping rate-six well sat 15 gpm - three well sat 20 gpm
• Tritium-Hyd. Control	2 extraction wells, both new 0 injection wells (use new Sr-90 well) 0 Treat. Plant
• "Others"-P&T	8 extraction wells, 4 of 8 new 3 injection wells, all new 1 Treat. Plant-new

- Monitoring wells along river
  Strontium- 9 wells, sample rate varies, test for Sr-90, for 300 years
  Others- 3 wells, sample 1/yr, test for 5 analytes, for 20 to 100 years
  Water levels- 11 wells + 1 river stage, sample 4 wells/year, for 270 years
- Treatment facility at north end of 1301-N trench (Sr and NO3)
- Treatment facility NE of 1324-N for "Others"

NOTES

- Hydraulic controls for Sr-90 will partly control tritium to river
- Pump and treat for "Others" will retard their migration to the river

ASSOCIATED ACTIVITIES

- Institutional controls on GW for 270 years
- Institutional controls of land use where wells and treatment plant are located
- Monitor groundwater for 270 years
- O&M of wells, pipelines, & treatment plant for strontium for 270 years
- O&M of wells, pipelines, & treatment plant for "Others" for up to 90 years

CONSEQUENCES

- No use of unconfined aquifer for 270 years
- Must maintain wells, piping systems, and treatment plant for strontium for 270 years
- Wells, piping systems, and treatment plant for "Others" will be shutdown as contaminant concentrations fall below MCLs
- Contaminant migration south of Sr-90 plume would be retarded by the pump and treat actions, so river will be protected
- Tritium conc. in aquifer exceeds MCL for next 25 years
- Strontium conc. in to river will be less than MCL
- Strontium conc. in aquifer exceeds MCL for next 270 years
- Other contaminants in aquifer will exceed MCLs for few years

4.3.6 Alternative 6: Impermeable Barrier for Strontium, Institutional Controls for Tritium, Pump and Treat All Groundwater COCs

NR-1/NR-2 CMS GROUNDWATER ALTERNATIVES – DESCRIPTIONS
August 5, 1996

PHYSICALFEATURES

- Sr-90-P&T — 6 extraction wells, 4 of 6 new
  3-injection wells, 1 of 3 new
  1 Treat. Plant (expand existing plant and modify to treat nitrate)
- "Others"-P&T — 8 extraction wells, 4 of 8 new
  3-injection wells, all new
  1 Treat. Plant-new
- Monitoring wells along river
  Tritium- 4 wells, sample 1/yr, test for tritium, for 15 years
  Strontium- 9 wells, sample rate varies, test for Sr-90, for 270 years
  Others- 3 wells, sample 1/yr, test for 5 analytes, for 20 to 100 years
  Water levels- 11 wells + 1 river stage, sample 4 wells/year, for 270 years
- Treatment facility at north end of 1301-N trench (Sr and NO3)
- Treatment facility NE of 1324-N for "Others"

NOTES

- Impermeable barrier for Sr-90 will partly control tritium to river
- Columbia River tritium concentrations near Richland water intake are higher than at the N-Springs area. Health risks under current conditions are acceptable to the City of Richland and the Regulators.

ASSOCIATED ACTIVITIES

- Institutional controls on GW for 270 years
- Institutional controls of land use where impermeable barrier, wells and treatment plants are located
- Monitor groundwater for 270 years
- O&M of wells, pipelines, & treatment plant for strontium for 270 years
- O&M of wells, pipelines, & treatment plant for "Others" for up to 90 years

CONSEQUENCES

- No use of unconfined aquifer for 270 years
- Must maintain wells, piping systems, and treatment plant for strontium for 270 years
- Wells, piping systems, and treatment plant for "Others" will be shutdown as contaminant concentrations fall below MCLs
- Contaminants north and south of Sr-90 plume would continue going into the river.
- Tritium conc. into river exceeds MCL for next 10-15 years
- Tritium conc. in aquifer exceeds MCL for next 25 years
- Strontium conc. into river will be less than MCL
- Strontium conc. in aquifer exceeds MCL for next 270 years
- Other contaminants in aquifer will exceed MCLs for few to 90 years

4.3.7 Alternative 7: Impermeable Barrier for Strontium to River, Impermeable Barrier and Hydraulic Controls for Tritium to River, Soil Flushing for Strontium in the Aquifer, Pump and Treat for Other COCs in Aquifer

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100-NR-1/NR-2 CMS Groundwater Alternatives – Descriptions
(May 11, 1997)

<u>PHYSICAL FEATURES</u>

- Tritium-Hyd .Control — 2 extraction wells, both new
  0 Treat. Plant
- Soil Flushing — 9 extraction wells, 8 new
  1 Treat. Plant (expand existing plant and modified to treat nitrate)
  3 injection wells, 1 new
- Others-P&T — 8 extraction wells, 4 of 8 new
  3 injections wells, all new
  1 Treat. Plant-new
- Monitoring wells along river
  Strontium- 9 wells, sample rate varies, test for Sr-90, for 20 years
  Others- 3 wells, sample 1/yr, test for 5 analytes, for 20 to 100 years
  Water levels- 11 wells + 1 river stage, sample 4 wells/year, for 270 years
- Treatment facility at north end of 1301-N trench
- Treatment facility NE of 1324-N for "Others"
- Operate a sheet pile barrier for 20 years and remove

<u>NOTES</u>

- Impermeable barrier and hydraulic controls will control strontium and tritium to river
- Pump and treat for "Others" will retard their migration to the river

<u>ASSOCIATED ACTIVITIES</u>

- Institutional controls on groundwater for 100 years
- Institutional controls of land use where well sand treatment plant are located
- Monitor groundwater for 100 years
- O&M of wells, pipelines, & treatment plant for strontium for 20 years
- O&M of wells, pipelines, & treatment plant for "Others" for up to 90 years

<u>CONSEQUENCES</u>

- No use of unconfined aquifer for 100 years
- Must maintain wells, piping systems, and treatment plant for strontium for 20 years
- Wells, piping system, and treatment plant for "Others" will be shutdown as contaminant concentrations fall below MCLs
- Tritium conc. in aquifer exceeds MCL for next 25 years
- Strontium conc. into river will be less than MCL
  - Strontium conc. in aquifer exceeds MCL for next 20 years
  - Other contaminants in aquifer will exceed MCLs for few years

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Chapter 5.0 Comparative Analysis of Alternatives

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5.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

5.1 COMPLIANCE WITH ARARS

The ARARs are standards, requirements, criteria, or limitations promulgated under Federal or state environmental laws that must be met or waived for actions conducted under CERCLA. Only the substantive provisions of requirements that are ARARs must be met (or waived) for actions conducted entirely onsite (CERCLA, Section 121 [d][2]). Such onsite actions are exempted from obtaining Federal, state, and local permits (CERCLA, Section 121 [e][1]). Also, to be considered requirements are nonpromulgated standards, including DOE orders, proposed regulations, and regulatory guidance that may be referenced to the extent necessary for the response action to be adequately protective.

Because no action is being taken, Alternative 1 would not meet ARARs for cleanup. All other alternatives would meet ARARs requiring protection of human health and the environment. Key ARARs for the other alternatives include waste management standards, air emission control standards, radiation control standards, and standards for protection of cultural and ecological resources. Proposed environmental cleanup standards for remediation of the 100-N Area soil (proposed soil cleanup standards of 15 mrem/yr above background and MTCA Method B) are addressed in the 100-NR-1 and 100-NR-2 CMS; therefore, they are not discussed in this document. Other standards to be met by the response action include various DOE, Federal, and state worker safety standards.

5.1.1 Columbia River Protection Standards

40 CFR 122 addresses technology-based limitations and standards, control of toxic pollutants, and monitoring for discharges to United States waters, including storm water. Public Law 100-605, *Study of the Hanford Reach of the Columbia River*, requires new activities near the Columbia River to minimize direct and adverse effects on the values being studied for the Columbia River.

No wastewater discharges to the Columbia River are planned under any of the alternatives. Erosion and storm water controls would be used as necessary for alternatives involving demolition.

5.1.2 Cultural and Ecological Resource Protection Standards

The *National Historic Preservation Act of 1966* (implemented via 36 CFR 800) requires Federal agencies to evaluate and mitigate adverse effects of Federal activities on any site eligible for inclusion on the National Register of Historic Places. The PA for the maintenance, deactivation, alteration, and demolition of the built environment allows RL to prepare a treatment plan that provides for the mitigation of historic structures at 100-N Area. The PA requires that all mitigation activities identified in the treatment plan must be completed prior to any demolition, alteration or removal of artifacts from the 100-N facilities.

The cultural resource protection requirements apply because of the presence of potentially significant archaeological sites or artifacts in the 100-N Area, and the potential historical significance of facilities in the area. The cultural significance of the 100-N Area facilities has been evaluated and mitigation has been established under the PA. It is unlikely that archaeological sites would be impacted by demolition activities.

The *Native American Graves Protection and Repatriation Act* (40 CFR 10) requires agencies to consult and notify culturally affiliated Tribes when Native American human remains are inadvertently discovered during project activities. The 100-N restoration activities could inadvertently uncover previously disturbed or intact graves associated with archaeological sites.

The President's Executive Order 1300.7 requires agencies to consider impacts of actions on sacred sites. An area at 100-N called *Mooli Mooli* may be a sacred site that will require consultations with affected Tribes.

The *National Archaeological and Historical Preservation Act of 1974* requires action to recover and preserve artifacts in areas where activity may cause irreparable harm, loss, or destruction of significant artifacts. The *Endangered Species Act of 1973* (implemented via 50 CFR 402) and WAC 232-012-297) prohibit activities that threaten the continued existence of listed species or destroy critical habitat. The *Migratory Bird Treaty Act* makes it illegal to remove, capture, or kill any migratory bird, or any part of nests or the eggs of any such birds.

Threatened and endangered species are known to be present in the 100 Area, but no adverse impacts on protected species or critical habitat resulting from implementation of any of the alternatives is anticipated. Facility-specific ecological reviews would be conducted to identify potentially adverse impacts prior to the performance of any demolition work.

5.1.3 Waste Management Standards

The RCRA regulates management and disposal of hazardous (dangerous) waste. Authority for much of RCRA has been delegated to the State of Washington. Implementing state regulations contained in WAC 173-303 requires identification and appropriate management of dangerous wastes and dangerous components of mixed wastes, and identifies standards for treatment and disposal of these wastes. These requirements are applicable to any existing wastes or any wastes that are generated during D&D of the ancillary facilities that are designated, in accordance with WAC 173-303, as a dangerous or mixed waste. Similarly, WAC 173-304 requires identification and appropriate management of solid wastes. It is applicable to any solid waste generated during D&D of the ancillary facilities. Except for Alternative 1, each of the alternatives would generate waste that would be subject to WAC-173-303, -304, and -460.

Performance objectives for land disposal of low-level radioactive waste are provided in 10 CFR 61, Subpart C. Although not applicable to DOE facilities, these standards are relevant and appropriate to any disposal facility for low-level and mixed waste generated during D&D of the ancillary facilities.

All alternatives, except for Alternative 1, would generate solid, dangerous, low-level, and/or mixed waste. For each of these alternatives, actions proposed to manage such waste would satisfy the waste management ARARs and all wastes would be evaluated and managed in compliance with the appropriate requirements. Prior to disposal, dangerous, low-level, or mixed wastes would be managed in a manner that prevents releases or inadvertent exposure to workers, and is protective of the environment. The ERDF is engineered to meet RCRA minimum technological requirements for landfills, including standards for a double liner, a leachate collection system, leak detection, and final cover. The ERDF also meets the appropriate performance standards under 10 CFR 61 for disposal of low-level waste (LLW) and mixed waste. Treatment requirements including land disposal restriction requirements, if any, necessary to dispose of wastes in the ERDF would be identified to meet the ERDF waste acceptance criteria. Treatment may include stabilization, dewatering, encapsulation, or other readily available treatment methods. Packaging and transportation requirements for waste generated during D&D of the ancillary facilities would be identified and implemented prior to movement of any wastes. Any offsite facility receiving dangerous wastes would meet all RCRA administrative and substantive requirements. Any offsite shipment of waste would comply with appropriate U.S. Department of Transportation requirements (49 CFR 171-173).

At this time, no listed dangerous wastes are expected to be generated as a result of implementing any of the alternatives. Wastes designated as characteristic may be generated and would be subject to the dangerous waste management standards in WAC 173-303.

5.1.4 Air Emission Standards

The *Clean Air Act* regulates both toxic and radioactive airborne emissions. Under implementing regulations found in 40 CFR 61, Subpart H, and WAC 246-247, radionuclide airborne emissions from all combined operations at the Hanford Site may not exceed 10 mrem/year effective dose equivalents to the hypothetical offsite maximally exposed individual. WAC 246-247 requires verification of compliance, typically through periodic confirmatory air sampling. WAC 173-400 establishes requirements for the control and/or prevention of the emission of air contaminants, including dust.

The radionuclide emission standards would apply to any fugitive, diffuse, and point-source air emissions of radionuclides generated during activities associated with any of the D&D alternatives. If there is a potential for a non-zero radioactive emission, best available radionuclide control technology would be required. If the action would increase emission of toxic air pollutants to the atmosphere above the small quantity emission rates, implementation of best available control technology for toxics would be required. Alternatives 3 and 4 propose using decontamination of surfaces to control radiological contaminants and standard construction techniques to provide dust control during demolition.

Standard construction techniques are used at the ERDF to control fugitive emissions during placement of wastes. The in situ burial operations would also use standard construction techniques to control fugitive emissions during placement of wastes. These methods should adequately control fugitive radionuclide emissions and toxic air pollutants. Therefore, standard construction techniques would be considered the best available radionuclide control technology and the best available control technology for toxics for any of the proposed activities as demonstrated during the 100-N Area treatability study (DOE-RL 1996a).

5.1.5 Radiation Protection Standards

Occupational Radiation Protection (10 CFR 835) establishes radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation resulting from the conduct of DOE activities. It also requires that measures be taken to maintain radiation exposure as low as reasonably achievable (ALARA). This regulation is applicable to activities considered under each of the four alternatives.

A combination of personal protective equipment, personnel training, physical design features (e.g., confinement, remote handling, shielded containers), and administrative controls (e.g., limiting time in radiation zones) would be used to ensure that the requirements for worker and visitor protection are met by all alternatives. Alternatives 3 and 4 would also meet the requirements to maintain exposure ALARA by decontaminating surfaces prior to demolition and by providing personal protective equipment, training, and administrative controls. For all alternatives, individual monitoring would be performed as necessary to verify compliance with the requirements.

5.1.6 Polychlorinated Biphenyls

The *Toxic Substance Control Act of 1976* (TSCA) and WAC 173-303 regulates the management and disposal of PCBs and PCB waste. The implementing regulations in 40 CFR 761 contain requirements for the management of spills and remediation of materials suspected to contain PCB waste. The ERDF is authorized to accept certain PCB waste for disposal. All waste suspected to contain PCBs would be evaluated to determine whether the waste meets the ERDF waste acceptance criteria. Any PCB waste that does not meet the ERDF waste acceptance criteria would be sent to an onsite PCB storage area meeting the substantive requirements for TSCA storage, and would be transported for disposal at a TSCA-approved disposal facility.

5.1.7 Asbestos

Removal and disposal of asbestos and ACM are regulated under the *Clean Air Act* (40 CFR 61, Subpart M) and Occupational Safety and Health Administration (OSHA) (29 CFR 1910.1101 and WAC 296-62). These regulations provide for special precautions to prevent environmental releases or exposure to workers of airborne emissions of asbestos fibers during removal actions. 40 CFR 61.52 identifies packaging requirements. Alternative 1 would not remove asbestos. If ACM was encountered during routine S&M, as would be conducted under Alternative 2, it would be removed and disposed in accordance with applicable regulations. Alternatives 3 and 4, since they involve decontamination, would be expected to include actions that would encounter and disturb ACM. These alternatives shall comply with the requirements for management and disposal of asbestos or ACM.

5.1.8 Environment, Safety, Quality, and Health Requirements

Worker protection standards are described in OSHA regulations, national consensus standards, and DOE orders (e.g., 29 CFR 1910, 29 CFR 1926, National Fire Protection Association [NFPA] 1990, WAC 296-62, and DOE Order 5400.5 [DOE 1993b]). Exposure limits, personnel protection requirements, and decontamination methods for hazardous chemicals are established by 29 CFR 1910. Additionally, 29 CFR 1910 requires identification and mitigation of physical hazards to workers posed by a facility, including but not limited to, confined spaces, falling hazards, fire, and electrical shock. The 29 CFR 1926 reference provides requirements for worker safety during construction activities.

The DOE orders establish requirements relating to safety, health, and environmental protection. The substantive requirements of these orders would be met for any S&M or D&D activities. Known and suspected inventories in each building will be screened during the design phase against the criteria in DOE Standard 1027 (DOE 1992a) to determine the appropriate DOE environmental safety and health order requirements. Site- and activity-specific requirements and controls would be identified in final design and work plan documents, including contingency plans and emergency response plans. In addition, the following DOE order requirements have been determined to contain requirements that are to be considered for one or more of the alternatives:

- The requirements in DOE Order 5400.5, *Radiation Protection of the Public and the Environment* (DOE 1993b), and limiting exposure of the public to radioactive releases, are relevant and appropriate to all alternatives.
- The requirement in DOE O 451.1, *National Environmental Policy Act Compliance Program* (DOE 1995), to address *National Environmental Policy Act of 1969* values are relevant and appropriate to all alternatives.
- The requirement in DOE Order 5480.3, *Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances and Hazardous Waste* (DOE 1985), to comply with U.S. Department of Transportation or equivalent packaging standards is relevant and appropriate to each alternative that generates waste for disposal. The requirements of the order for special handling of plutonium-bearing wastes could be relevant and appropriate for Alternatives 3 and 4 if facilities contain plutonium-bearing wastes (which are not likely).
- The requirements in DOE Order 5820.2A, *Radioactive Waste Management* (DOE 1988), for management of LLW are relevant and appropriate to all alternatives except Alternative 1. The requirements for the management of TRU waste would be relevant and appropriate to the demolition alterative if activities to implement the alternative generated one or more packages of waste that contain greater than 100 nCi/g of TRU constituents at the time of assay (although it is not expected that TRU waste will be generated).
- The requirements in DOE Order 5480.20A, *Personnel Selection, Qualification, and Training* (DOE 1994), are relevant and appropriate for all alternatives except Alternative 1 for facilities that are classified as nuclear by the preliminary hazard classification analysis.
- The requirements in DOE Order 5480.23, *Nuclear Safety Analysis Reports* (DOE 1992b), to identify hazards, analyze hazards and accidents, and identify controls and mitigation measures to safely manage the hazards are relevant and appropriate to all alternatives for facilities that are classified as nuclear by the preliminary hazard classification analysis.
- The requirements in DOE Order 5480.28, *Natural Phenomena Hazards Mitigation* (DOE 1993a), to analyze potential hazards from natural phenomena and identify appropriate mitigation measures are

relevant and appropriate to all alternatives for facilities that are classified as nuclear by the preliminary hazard classification analysis.

5.1.9 Draft Radiological Criteria for Decommissioning

Two agencies (U.S. Nuclear Regulatory Commission [NRC] and EPA) have proposed standards to establish acceptable levels of residual radioactivity for environmental remediation. These are nonpromulgated standards and are to be considered.

The draft NRC *Radiological Criteria for Decommissioning* (10 CFR 20, proposed revision) provides a regulatory basis to determine the extent to which lands and structures must be remediated before a site can be considered decommissioned.

The draft EPA *Radiation Site Cleanup Regulation* (40 CFR 196, Draft) will set the standards for remediation of soils, groundwater, surface water, and structures at Federal facilities. These proposed standards would not apply to Alternatives 1 and 2, because these alternatives do not decommission or demolish any facilities. Alternatives 3 and 4 would comply with these proposed standards.

5.2 OTHER CONSIDERATIONS

In accordance with DOE Order 451.1 (DOE 1995) and NEPA policy, DOE CERCLA documents are required to incorporate NEPA values such as analysis of cumulative, offsite, ecological, and socioeconomic impacts to the extent practicable.

Cumulative impacts may occur in both the short term and long term because of interrelationships among other activities occurring in the 100 Area. Other activities in the 100 Area include the following:

- Remediation of waste sites and groundwater in the reactor areas
- Safe storage activities for the 105-C Reactor (to be followed by safe storage activities for the other reactors)
- Storage and removal of spent fuel contained in basins at the 100-K Area
- Removal of ancillary facilities in the other reactor areas.

Each of these activities contributes to the goals of 100 Area remediation including protection of the Columbia River. However, due to the increasing scarcity of resources to accomplish the work, each of these activities also competes with the others for priority allocation of funding.

Near-term decontamination and demolition of the facilities addressed in this EE/CA would require significantly greater commitment of budget resources (including disposal costs, workers, equipment and supplies) during the time necessary to accomplish the removal action than would be required to continue S&M. Therefore, in the near term, Alternatives 3 and 4 would impose a greater cumulative burden in terms of additional competition for remediation dollars and work force resources than either Alternatives 1 or 2.

In the long term, the overall cumulative effect of the 100 Area activities is to enhance the protection of workers, the public, and the environment, which is consistent with the values expressed by the regulators, stakeholders, affected tribes, and the public. Long-term S&M will not provide a permanent remedy consistent with these cumulative benefits. In the long term, completion of either Alternatives 3 or 4 would be consistent with and supportive of the overall cumulative benefits that will be derived from the remedial activities in the 100 Area.

Offsite impacts include affects on the public or the environment due to release of contaminants resulting from an activity. Alternatives 1 and 2 are not expected to result in negative offsite impacts in the near term. Continued confinement of hazardous substances in the facilities would become more difficult with time, increasing the potential for offsite impacts. Alternatives 3 and 4 would potentially result in airborne emissions of hazardous substances, but significant or long-term impacts are not expected.

None of the alternatives are expected to affect existing natural resource conditions. Although bald eagles frequent the Columbia River during the winter, there are no identified roosts near the 100-N Area. Surveys indicate that all proposed activities are unlikely to disturb sensitive plant or animal species. Prior to initiation of any specific field activity, an ecological review of the facility and surrounding area would be conducted to ensure there would be no impacts to natural resources (e.g., migratory birds).

There would be no unmitigated impacts to cultural resources with implementation of any of the alternatives.

Socioeconomic impacts from any of the alternatives would be minimal. The work force required for current S&M activities is small. Personnel required to accomplish either Alternative 3 or Alternative 4 would be selected from the existing S&M and remediation work force at the Hanford Site or would be made available to subcontractors.

In evaluating Alternatives 3 and 4, consideration should be given to potential future land-use planning needs and values expressed by the regulators, stakeholders, public, and the Tribes, with regard to the preferred future use of the 100-N Area.

Table 5.1. Summary of Estimated Costs for Alternatives[a]

Description	Summary Cost Estimates[a]
Alternative 2 - Long Term Surveillance and Maintenance	
Remedial Unit 1	$15,140
Remedial Unit 2	$57,040
Remedial Unit 3	$40,000
Remedial Unit 4	$31,920
Remedial Unit 5	$324,030
Other Facilities	$141,000
Total (annual costs)	$609,130
Alternative 3 - D&D with Disposal at ERDF and Other Landfills	
Remedial Unit 1	$5,541,000
Remedial Unit 2	$2,574,000
Remedial Unit 3	$2,172,000
Remedial Unit 4	$5,553,000
Remedial Unit 5	$12,308,000
Other Facilities	$27,813,000
Total	$55,961,000
Alternative 4 - D&D, ERDF Disposal and In Situ Burial	
Remedial Unit 1	$5,332,000
Remedial Unit 2	$2,115,000
Remedial Unit 3	$1,814,000
Remedial Unit 4	$5,359,000
Remedial Unit 5	$6,210,000
Other Facilities	$20,759,000
Total	$41,589,000

[a]These estimates do not account for escalation or contingency.

Chapter 6.0 Recommended Alternative

6.0 RECOMMENDED ALTERNATIVE 6.1

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6.0 RECOMMENDED ALTERNATIVE

Based on implementability, short-term effectiveness, and cost, the recommended alternative to address the contaminated ancillary facilities (listed in Table 2.1 of this EE/CA) is to implement Alternative 2, which involves performing S&M until such time that D&D work could be planned and executed. At that time, Alternative Four would be implemented, which involves performing D&D work in accordance to the process and priority order established by the attached proposed integration plan (i.e., interfering facilities in RU 1 first, then interfering facilities in RU 4, etc., as listed in Table 2.1). Alternative Four provides a protective, permanent solution and is more effective than Alternative Two; however, in the interim, S&M provides adequate protection until final remedial actions can be scheduled in coordination with the overall 100 Area remedial priorities established in the Tri-Party Agreement based on values expressed by regulators, stakeholders, affected tribes, and the public.

It should be noted that Alternative 1 is not considered to be effective. Alternative Three provides protection of human health and the environment equal to Alternative 4 but it is not cost effective.

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Chapter 7.0 100-N Area Integration Plan for D&D & Remedial Action

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7.0 100-N AREA INTEGRATION PLAN FOR D&D & REMEDIAL ACTION

7.1 INTRODUCTION

This appendix (hereafter referred to as the Integration Plan) was developed to ensure that decontamination and demolition (D&D) and remediation activities associated with the 100-N Area would be coordinated and conducted in an efficient manner. The intent of the Integration Plan is to minimize the cost and optimize the efficiency of environmental remediation of contaminated waste sites and the removal of the facilities in the 100-N Area. Integration of 100-N Area D&D and remediation activities has been recognized by the U.S. Department of Energy, Richland Operations Office (RL) and the Washington State Department of Ecology (Ecology) as a critical step in ensuring effective and efficient environmental remediation of the 100-N Area.

The plan includes (1) assumptions used to develop the Integration Plan, (2) the criteria used to group waste sites into remedial units (RUs) and to establish remediation priority of the waste site groups, (3) the general work sequence established for the remediation of the 100-N Area, and (4) the proposed integrated schedule of the D&D of the 100-N facilities and the remediation of the RUs.

The prioritization and sequencing of the waste sites within a RU, and the detailed planning and design for the D&D of facilities and remediation activities are considered beyond the scope of this Integration Plan and will be provided in the remedial design report/remedial action work plan document.

7.2 ASSUMPTIONS

This section identifies the assumptions used to develop the Integration Plan. They are based on direction and scoping assumptions provided by RL and are based on current project planning strategies for the Environmental Restoration Program. These assumptions are:

- A ten-year duration was used for completion of D&D and remediation activities.
- The proposed schedule presented in the Integration Plan is a duration-only schedule (i.e., does not include specific start or end dates) and allows for flexibility for determining the start of the remedial activities.
- The recommended alternatives, as described in Section 6.0 of the Engineering Evaluation/Cost Analysis (EE/CA) will be implemented to address the 100-N Area ancillary facilities.
- For 100-N Area facilities, the D&D cost estimates, schedule and durations, and waste volume estimates were derived from the U.S. Army Corps of Engineers' Micro Computer-Aided Cost Estimating System (MCACES).
- For waste sites, the cost estimates, schedule and duration, and waste volume estimates were taken from the 100-NR-1 and 100-NR-2 Corrective Measures Study (CMS).
- The Integration Plan only addresses the liquid and solid waste disposal sites in the 100-N Area identified for the remedial action and D&D of the 100-N ancillary facilities.
- The 105-N Reactor Facility and the 109-N Heat Exchanger Facility (hereafter referred to as the Reactor Complex) are not addressed in this Integration Plan. These facilities are part of the Interim Safe Storage (ISS) Project and will be addressed with the long-term disposition of the 100-N Reactor.
- Remediation activities of waste sites in the buffer zone (defined as the facilities needed to support the reactor until the ISS program is implemented and all waste sites within 15.25 m [50 ft] of the 105-N and 109-N facilities) will not be conducted until a decision is made on the future disposition of the 100-N Reactor. The remediation activities will be according to the recommended alternative identified in the 100-NR-1 and 100-NR-2 Record of Decision (ROD). The facilities in the buffer

zone will be limited to surveillance and maintenance until a decision is made on the future disposition of the 100-N Reactor. Then, the facilities will be removed according to the recommended alternative identified in this document. These facilities and waste sites are included in the integrated schedule. This will allow early action on these sites and facilities should the opportunity occur but in no case later than the ISS.

- The Hanford Generating Plant Complex is addressed in the Integration Plan.
- Identification of the waste sites in the Integration Plan was based on the most current information available in the Corrective Measures Study for the 100-NR-1 and 100-NR-2 Operable Units, Draft A, DOE/RL-95-111 (DOE-RL 1996) and 100-NR-1 Treatment, Storage, and Disposal (TSD) Units Corrective Measures Study/Closure Plan, Draft A, DOE/RL-96-39 (DOE-RL 1997). The remediation cost estimates, schedule and durations, and waste volumes for the waste sites were also derived from the current information available in these documents.
- After the 100-NR-1 and 100-NR-2 Operable Units ROD is issued, the remedial design/remedial action process will be used to establish the detailed schedule for the integrated activities and the remedial design report/remedial action work plan will document the negotiated schedule dates.

7.3 REMEDIATION PRIORITIZATION AND SEQUENCING CRITERIA

This section provides the criteria used to establish the remediation prioritization for the waste sites and a sequence in which the work activities could be performed without causing interferences between activities.

7.3.1 Remediation Prioritization

The 100-N Area waste sites have been grouped into six RUs, the treatment, storage, and disposal (TSD) unit, and the Columbia River shoreline. Subdividing the 100-N Area waste sites by geographic location and type of contamination was found to be an effective management tool to plan and implement the remediation activities. In other words, when individual waste sites were in close proximity to one another, a common-sense approach was applied in considering their inclusion in a particular grouping. The contaminants of concern at the 100-N Area waste sites include radionuclides, petroleum hydrocarbons, and inorganic chemicals such as acids, nitrate, chromium, and lead. Grouping the waste sites increased flexibility for scheduling, funding, and contracting. The RUs do not have an established boundary, but are defined as:

Table 7.1. Comprehensive List of the Waste Sites Grouped by RUs

RU 1	Radioactive sites located between the 105-N Reactor and the Columbia River.
RU 2	Petroleum and fuel oil spills and leaks in the vicinity of the 184-N Powerhouse, which is directly east of the 105-N Reactor.
RU 3	A mixture of sites, mostly spills and releases of acids and caustics with potential radioactivity, south of the 105-N Reactor and near the water treatment facilities.
RU 4	A mixture of sites, mostly radioactive or diesel, and fuel oil spills and leaks in the vicinity of the 1310-N Chemical Storage Tank and the oil storage tank farm, north of the 105-N Reactor and near the Columbia River.
RU 5	Sites associated with the Hanford Generating Plant.
RU 6	Miscellaneous solid waste sites not included as part of another RU.
TSD Unit	Group of the four sites designated as TSD units under the Resource Conservation and Recovery Act of 1976 (RCRA).
River Shoreline	The river shoreline area adjacent to the N-Springs Area up to approximately the 123 m (402 ft) elevation. (The river shoreline is not addressed in the Integration Plan. No schedule has been proposed pending selection of the final groundwater remedial action alternative.)

Table A.1 provides a comprehensive list of the waste sites grouped by RUs, and Figures A.1 to A.6 illustrate the RU groupings. The TSD units are shown in Figure A.7. The remediation prioritization of the six RUs and the TSD unit was based on the following considerations:

- Potential short-term impact to the public and/or the environment
- Inventory of contaminants
- Potential of contaminant migration to the groundwater
- Proximity to the Columbia River
- Input by RL and regulators.

After evaluating the impacts of these factors, it was determined that, in the short term, there are no significant negative impacts to the public or the environment. This is based on the current administrative and institutional controls that are in place for the purpose of protecting the public and environment. Therefore, the first consideration did not weigh heavily in the prioritization process.

The type and quantity of contaminants were considered when prioritizing remedial units. It was determined that, in general, those sites contaminated with high inventories of radionuclides would receive a higher priority than sites that contain other hazardous substances, such as petroleum-product contamination or acids/caustics. However, because these factors are not considered independently of one another, there may be some sites without radioactive contamination that received a higher priority than some sites with radioactive contamination. Because petroleum is immiscible, petroleum contamination was also considered to be an important factor in determining priorities, particularly in terms of impact on groundwater. Another consideration was the recognition that the TSD units and certain ancillary facilities may be considered contributors to the "skyshine" that exists at the 100-N Area. Skyshine is a phenomena created by 100-N Area facilities and waste sites containing significant inventories of gamma emitting radionuclides (primarily cobalt-60). Skyshine is produced by the interaction of gamma rays with the atmosphere and the subsequent downward scatter of the gamma rays. Skyshine results in an increase in the ambient radiation over background conditions in the 100-N Area. The following TSD units and ancillary facilities have been considered contributors:

- 1304-N Emergency Dump Tank
- 1310-N Liquid and Waste Treatment Facility
- 1314-N Liquid Disposal Building
- 107-N Basin Recirculation Cooling Facility
- 105-N Fuel Basin
- 1301-N Liquid Waste Disposal Facility
- 1325-N Liquid Waste Disposal Facility

The recognition that these units and ancillary facilities could potentially contribute to skyshine supports the prioritization/sequencing criteria established in Section A3.0. The 1301-N and 1325-N facilities are within the TSD unit and the remaining facilities except for the 105-N, which is part of the ISS Program are within RU 1 and RU 4. These three units are the highest priority.

In conjunction with other considerations, waste sites in close proximity to the Columbia River were given a relatively higher priority because of the major importance to the community and public concern about this resource. RL and the regulators have confirmed during a planning meeting that these are valid factors for prioritizing remediation of waste sites.

Based on the considerations described above, the following is the priority ranking for the RUs and the TSD unit:

Table 7.2. Priority Ranking for the RUs and the TSD Unit

Priority	Unit	Reason
1	TSD	Largest radionuclide inventory/regulator input
2	RU 1	Radionuclide inventory/proximity to the Columbia River
3	RU 4	Radionuclide and petroleum inventories/proximity to the Columbia River
4	RU 2	Petroleum inventory/proximity to the Columbia River
5*	RUs 3, 6, and 5	Radionuclide and acid/caustic inventory plus solid waste

Note: Based on the applicable considerations, RUs 3, 6, and 5, scheduled in that order, were determined to be the lower priority units. However, the schedule is flexible to allow for reprioritization of these RUs. Remediation work associated with these units will be scheduled in a way that accomplishes efficient funding and contracting over the designated duration of the project.

7.3.2 Sequencing of Work

In establishing the sequence of work to integrate facility D&D and waste site remediation, several factors were considered: (1) proximity of facilities to waste sites, (2) 100-N Area active facilities and infrastructure requirements, and (3) impact of the ISS Program on the 100-N Reactor and the buffer zone.

7.3.2.1 Proximity of Facilities to Waste Sites

Several facilities in the 100-N Area are in close proximity to or will interfere with waste site remediation. If the selected remedy for the 100-NR-1 and 100-NR-2 operable units is the remove and dispose alternative, the facilities that are located adjacent to, or overlap, the waste site excavation footprint would need to be demolished prior to remediation. The facilities requiring D&D before remediation of a waste site (see Table A.2) were determined by assuming that excavation of a waste site would be 4.6 m (15 ft) below surrounding grade and would have a safety zone of approximately 7.6 m (25 ft) around the excavation footprint to provide protection from slope failure.

7.3.2.2 Critical Infrastructure Systems

Several facilities in the 100-N Area will remain active to support 100-Area D&D and remediation activities. These facilities will be operated until it is determined that they are no longer needed, at which time they will be decommissioned and demolished. Contaminated ancillary facilities will be decommissioned and demolished according to the decision documented in the Action Memorandum, a CERCLA decision document; a CERCLA decision document is not required for noncontaminated facilities. The noncontaminated facilities will be decommissioned and demolished under the existing NEPA categorical exclusion for decommissioning of small buildings according to 10 CFR 1021, B1.23. CERCLA applies to management of hazardous substances; therefore, no *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) documentation, such as an EE/CA, is required for addressing facilities that contain only nonhazardous substances.

Critical infrastructure systems (e.g., potable and sanitary water lines, electrical power utilities, and fire suppression pipelines), which must be maintained to protect and service active facilities, are expected to be near or within the excavation footprint of waste sites to be remediated. To avoid possible interferences with the remediation work, wherever possible, these utilities will be isolated, rerouted, and/or partially removed prior to remediation of the waste sites. However, it is recognized that some factors associated with the isolation of the infrastructure systems could potentially impact the waste site remediation sequence. These factors are identified below so the potential impacts to remediation of waste sites may be considered in the remedial design.

Electrical

Removal of electrical systems is typically the last isolation activity performed because power would be needed to support the D&D and remediation activities. However, if the underground conduit poses a threat to workers during excavation to isolate another utility (e.g., raw water), the electrical system would be deactivated first and alternative power supplies (e.g., generators, temporary overhead lines) would be used.

There are two areas of buried conduit banks that could impact the D&D and remediation activities. One area is located between the 1705-N and the 105-NB facilities, north of the 105-N Reactor facility, which feeds the office complex and machine shops in the 1705-N Building. There are no waste sites in the immediate vicinity. However, waste site 100-N-22 is located north of the area and the exact location of the conduit line would need to be determined to ensure that safety would not be jeopardized during excavation of the waste site. The other electrical conduit line begins on the north side of the 183-N, continues around the facility, then branches west toward the clearwell and south to the 1137-N and 163-NA facilities. Waste sites 100-N-27 and UPR-100-N-34 could be impacted by this conduit line.

Fire Protection

Fire protection pipelines, considered the most important underground utility at the site, would be a long-term requirement for the 100-N Area until all the facilities are removed. Once facilities have been decommissioned and demolished to the extent necessary to alleviate the need for fire suppression, the facilities would be isolated/removed from the buried fire line system. Therefore, the only buried fire pipes that could impact remediation are those supporting facilities during S&M. It is expected that D&D and remediation activities will interfere with buried fire lines, during which time acceptable temporary systems may be utilized (e.g., portable wheeled units using dry chemicals or carbon dioxide).

Potable Water and Sanitary Sewer

The 100-N area currently maintains a potable water supply system which serves several facilities. Additionally, several facilities are serviced by sanitary sewer systems. Isolation/removal of these systems would not impact the D&D and remediation activities because temporary sanitary systems (e.g., port-a-systems) would be installed, and bottled drinking water would be supplied.

Railroads

Prior to segregating the rail spur, railroad cars containing the contaminated shipping casks would need to be dispositioned and/or moved out of the area. The rail lines lying on the west side of the 100-N Reactor complex could impact the remediation of waste sites located in RUs 1 and 4. However, at this time there is no justification to keep the rail lines functional, therefore, they would be removed.

Roadways and Paved Areas

It is preferable to use existing paved and gravel roads because construction of new roads would potentially impact cultural and ecological resources. However, if roads interfere with D&D and remediation activities, the roads would be removed. Alternative transportation routes would be selected to minimize impacts to undisturbed areas.

Communications and Alarm Systems

Telephone and Hanford local area network (HLAN) fiber-optics lines are located throughout the 100-N Area and may be rerouted at relatively little expense and with short notice without impact to D&D and remediation activities. The public address system is not considered a critical system since the 105-N Reactor facility is currently being deactivated. An alarm tower on the 184-N facility would remain operable. The alarm system would be relocated prior to D&D of the facility.

7.3.2.3 ISS of the 100-N Reactor and the Buffer Zone

The 105-N Reactor Facility and the 109-N Heat Exchanger Facility are considered part of the ISS Program for the N Reactor. The ISS Program delays remediation of the N Reactor until sometime in the future. Associated with the 105-N and 109-N facilities are three other facilities, the 116-N Air Stack, the 117-N Exhaust Filter House, and the 119-N Stack Air Sampling Monitor Building, which support the ventilation system for the 105-N and 109-N facilities until the ISS Program is implemented. Additionally, 15 contaminated waste sites have been identified as sites that cannot be remediated until the facilities that interfere with these sites have been decommissioned and demolished. This sequence of D&D and remediation will preserve the integrity of the 105-N and 109-N Reactor buildings. Remediation of the 15 waste sites (in the buffer zone) that are identified in the 100-NR-1 and 100-NR-2 ROD will not be conducted until a decision is made on the future disposition of the 100-N Reactor. Additionally, the 116-N, 117-N, and the 119-N facilities (in the buffer zone) will be limited to surveillance and maintenance until a decision is made on the future disposition of the 100-N Reactor. The facilities will then be removed according to the recommended alternative identified in this document. The facilities and waste sites are included in the integrated schedule. This will allow early action on these sites and facilities should the opportunity occur but in no case later than the ISS.

The buffer zone consists of the waste sites identified below within 15.25 m (50 ft) of the 105-N and 109-N Reactor buildings and the following facilities:

Waste Sites		**Facilities**
100-N-29[1]	UPR-100-N-10	116-N Air Stack
100-N-30[1]	UPR-100-N-12	117-N Exhaust Filter House
100-N-31	UPR-100-N-3	119-N Stack Air Sampling Monitor Building
100-N-32	UPR-100-N-35	1300-N Emergency Dump Basin
100-N-38	UPR-100-N-39	1303-N Spacer Silos
116-N-4	UPR-100-N-9	
118-N-1	UPR-N-100-7	
UPR-100-N-14		

7.3.3 General Work Sequence

An evaluation of the sequencing factors (which were identified in Sections 3.2.1 through 3.2.3) indicates that initiation of remediation activities is dependent on the reconfiguration of interfering critical infrastructure systems and the D&D of interfering facilities. In addition, the sequence or timing of remediation of a small number of waste sites will be dictated by future decisions regarding the need for various 100-N active support facilities (e.g., water systems, electrical power) and final disposition of the 100-N Reactor. These considerations result in the following general work sequence applicable to each RU:

1. Reconfiguration of interfering critical infrastructure systems
2. D&D of interfering facilities
3. Remediation of waste sites
4. D&D of active facilities
5. Final remediation of waste sites associated with the active facilities and the 100-N Reactor.

7.4 SCHEDULE

Figure A.8 illustrates the integrated schedule for completing the remediation of the TSD unit, the six RUs (which include waste sites and interfering facilities), and D&D of the facilities independent of waste sites. This integrated schedule was developed based on the prioritization and sequencing discussed in Section A3.0 (e.g., remediation of the TSD unit was identified as the highest priority and therefore appears first on the schedule followed by RU 1, then RU 4). The remediation of the TSD units with the remaining RUs and interfering facilities was determined to encompass the first four years, and the independent facilities and underground piping system remediation was scheduled to begin during year four and continue through year ten.

The sequencing of the interfering facilities and waste sites within the RUs was based on the following logical order:

1. Deactivated interfering facilities
2. Associated waste sites
3. Active facilities
4. Associated waste sites
5. Independent facilities and underground piping systems

The primary driver was to develop a schedule with a relatively even distribution of funding requirements across the remaining six years. Generally, this sequence was followed, except when the independent facilities and underground piping systems were scheduled to accomplish the relatively even funding

[1] Waste sites 100-N-29 and 100-N-30 are in close proximity to 116-N-4 and may need to be remediated as part of 116-N-4.

distributions. Work durations and cost for the TSD units and the RU waste sites were taken from the 100-NR-1 and 100-NR-2 CMS and the 100-NR-1 TSD CMS/CP. Work duration and cost for all the facilities were taken from the MCACES data sheets.

Refined scheduling within these subgroups will be accomplished during detailed remedial design and documented in the remedial design report/remedial action work plan. The schedule assumes a critical path sequencing where first, initial infrastructure requirements, (e.g., isolating or rerouting underground utilities) will be completed at the affected waste site(s) followed by D&D of interfering facilities, and finally waste site remediation.

7.5 REFERENCES

10 CFR 1021, *National Environmental Policy Act Implementing Procedures*, Code of Federal Regulations, as amended.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. 9601, et seq.

DOE-RL, 1996, *Corrective Measures Study for the 100-NR-1 and 100-NR-2 Operable Units*, DOE/RL-95-111, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1997, *100-NR-1 Treatment, Storage, and Disposal (TSD) Units Corrective Measures Study/Closure Plan*, DOE/RL-96-39, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Resource Conservation and Recovery Act of 1976, 42 U.S.C. 6901, et seq.

Table 7.3. Interfering Facilities by Remedial Unit

Remedial Unit 1
1300-N Emergency Dump Basin
105-N to 107-N Pipe Trench
1304-N Emergency Dump Tank
1722-N Decontamination Hot Shop
107-N Recirculation Cooling Building
1303-N Spacer Silos
Remedial Unit 2
184-N Powerhouse
184-NA Powerhouse Annex
184-NB Air Handlers Main Building
184-NC Sample Shack
Remedial Unit 3
163-N Demineralization Water Treatment Plant
183-N Water Filter/Treatment Plant
Remedial Unit 4
13-N Storage Facilities
1310-N Radioactive Liquid and Waste Treatment Facility
1314-N Liquid Disposal Building
1322-N Waste Treatment Pilot Plant Facility
1322-NA Effluent Water Treatment Pilot Plant Annex
116-N Exhaust Air Stack
119-N Stack Air Sampling and Monitoring
Remedial Unit 5
185-N HGP
1716-NE Maintenance Garage
1908-NE HGP Outfall

Note: Remedial Unit 6 and the TSD sites do not contain facilities that would interfere with waste sites.

Figure 7.1 Remedial Unit Number 1

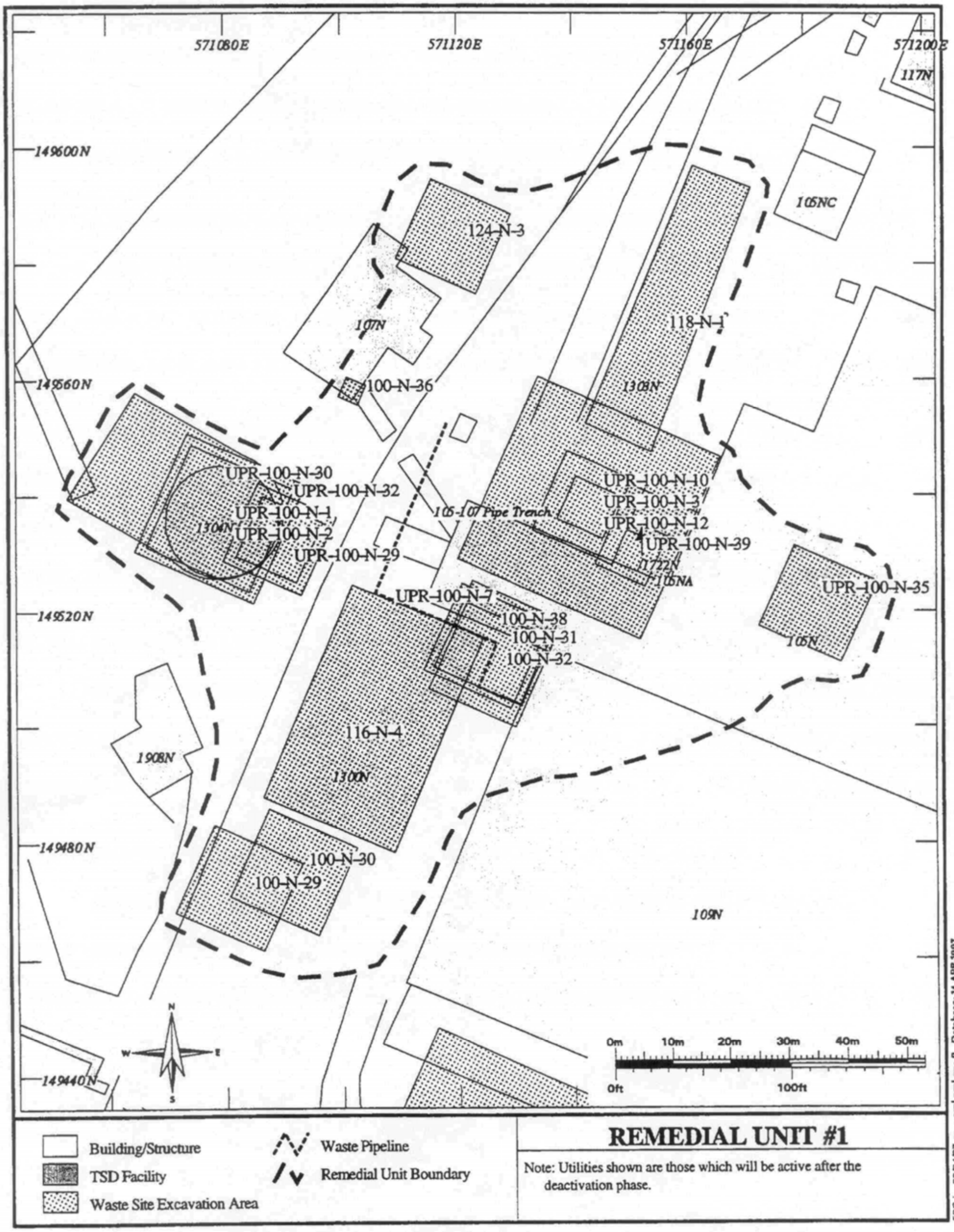


Figure 7.2 Remedial Unit Number 2

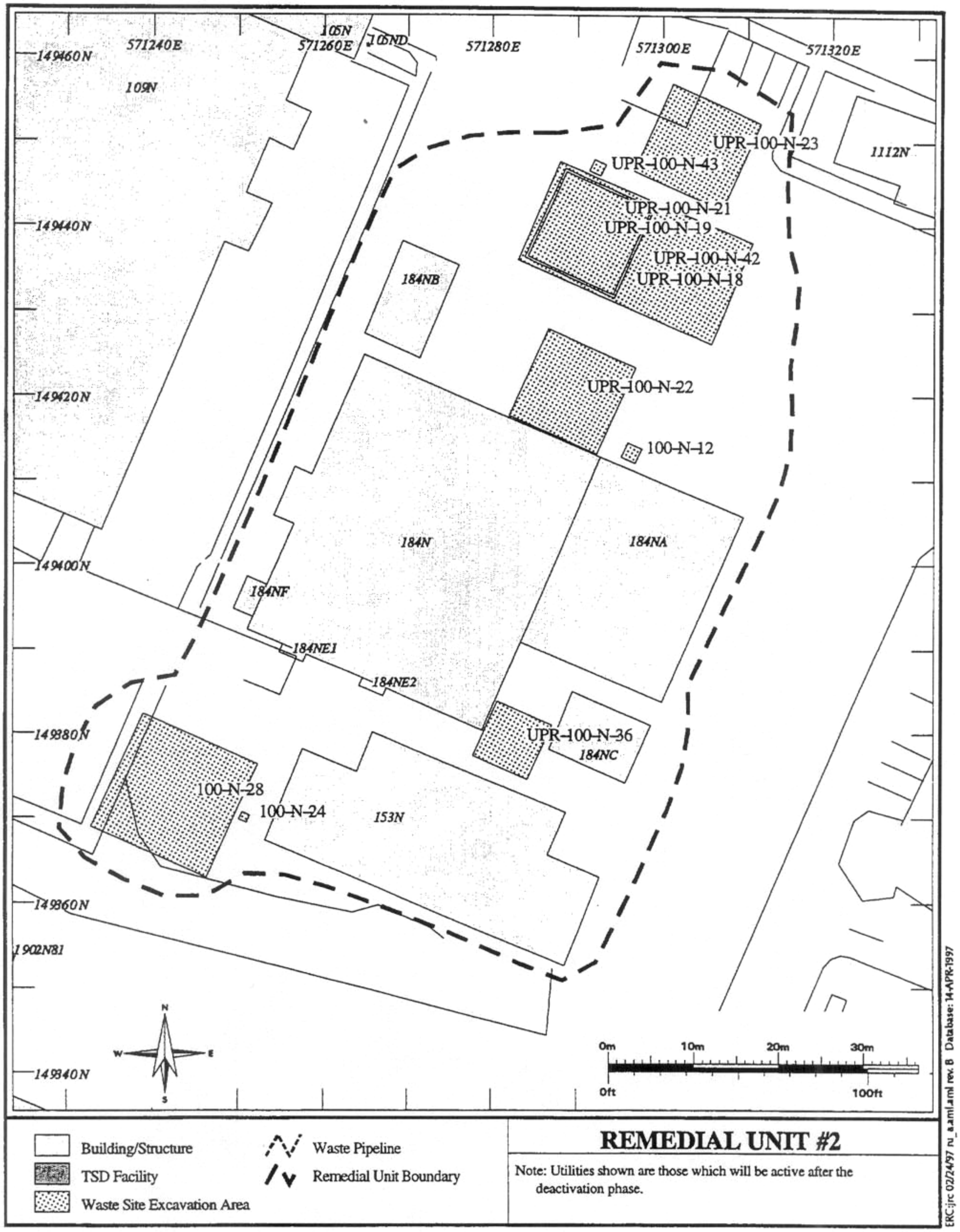


Figure 7.3 Remedial Unit Number 3

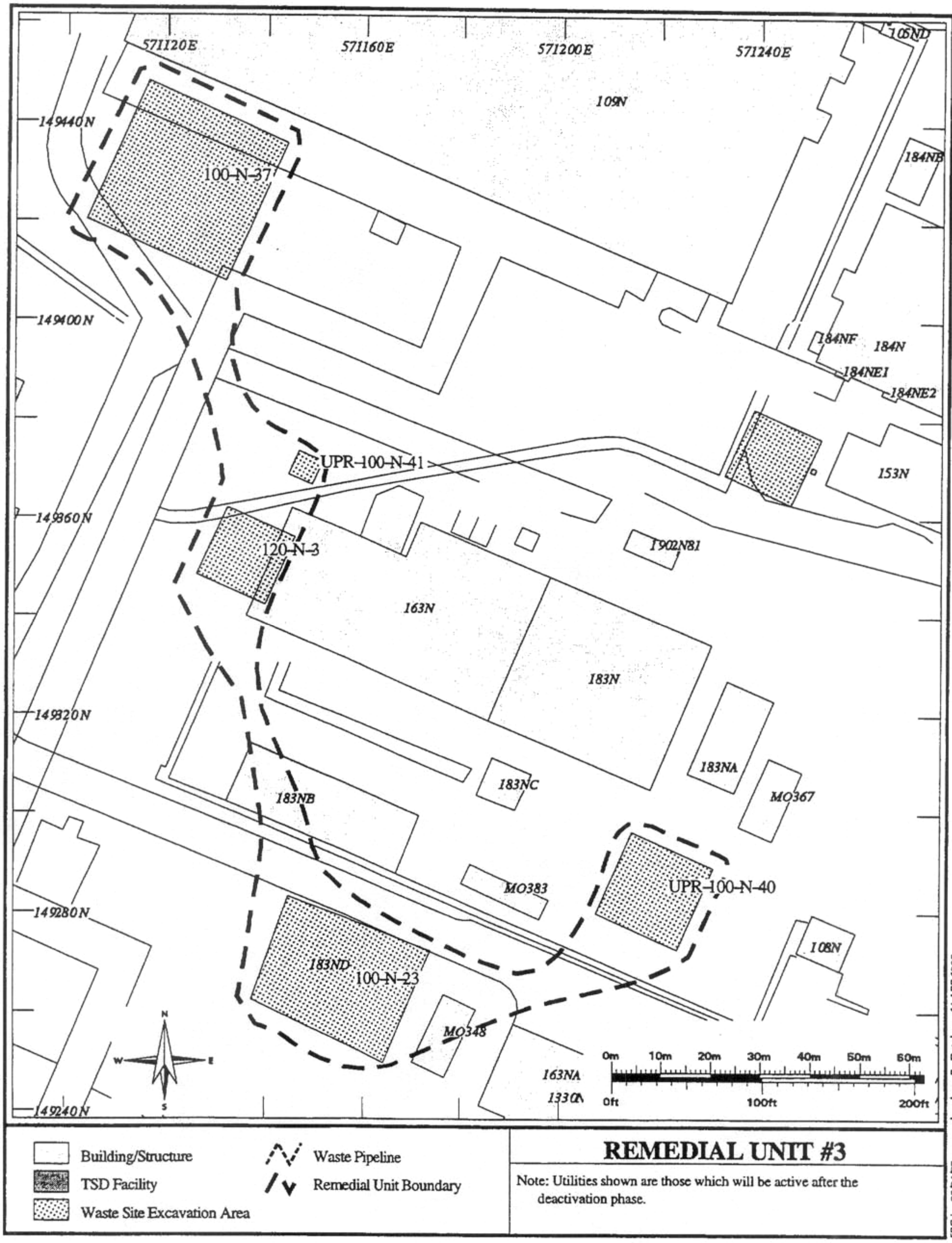
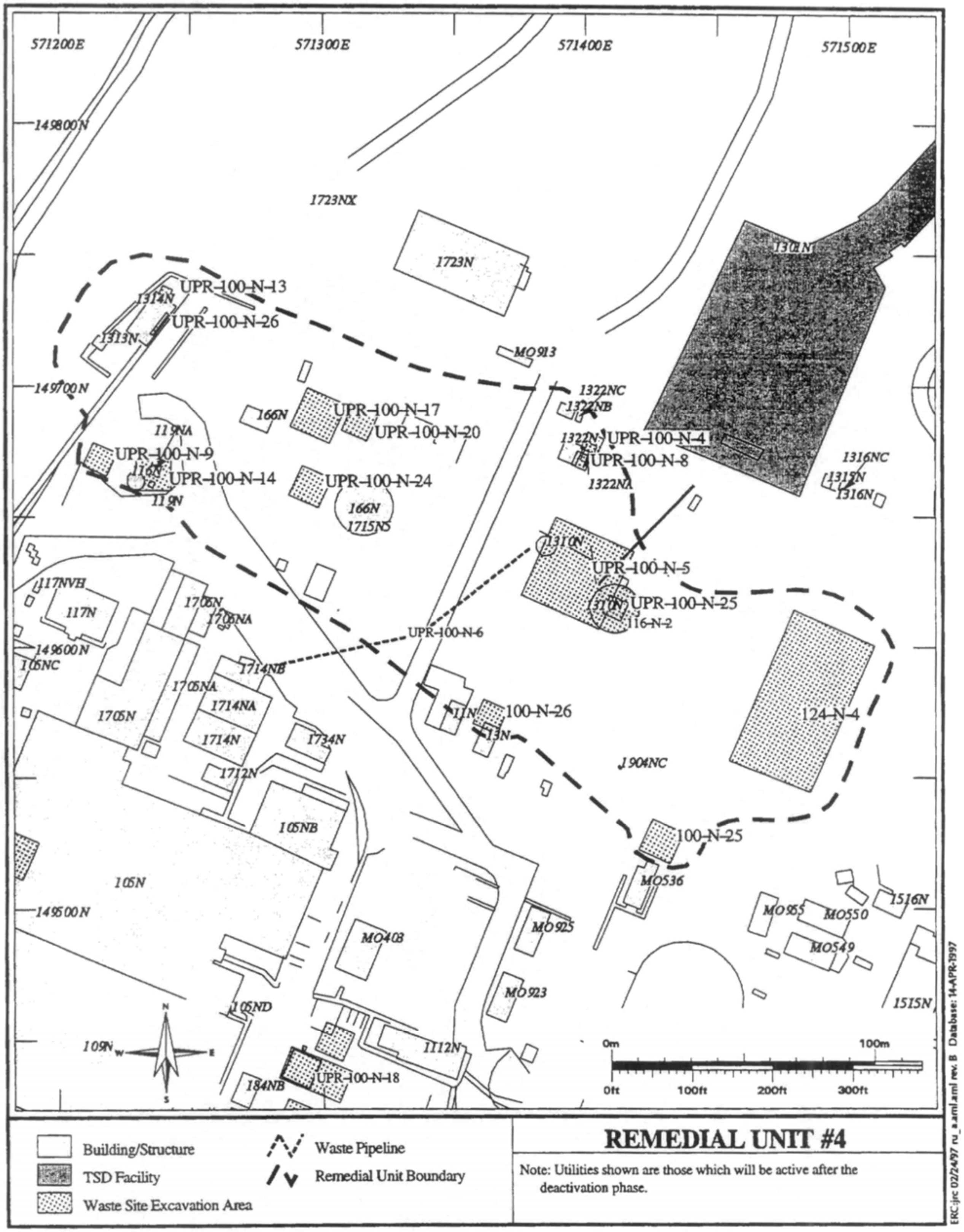


Figure 7.4 Remedial Unit Number 4



1 **Figure 7.5 Remedial Unit Number 5**

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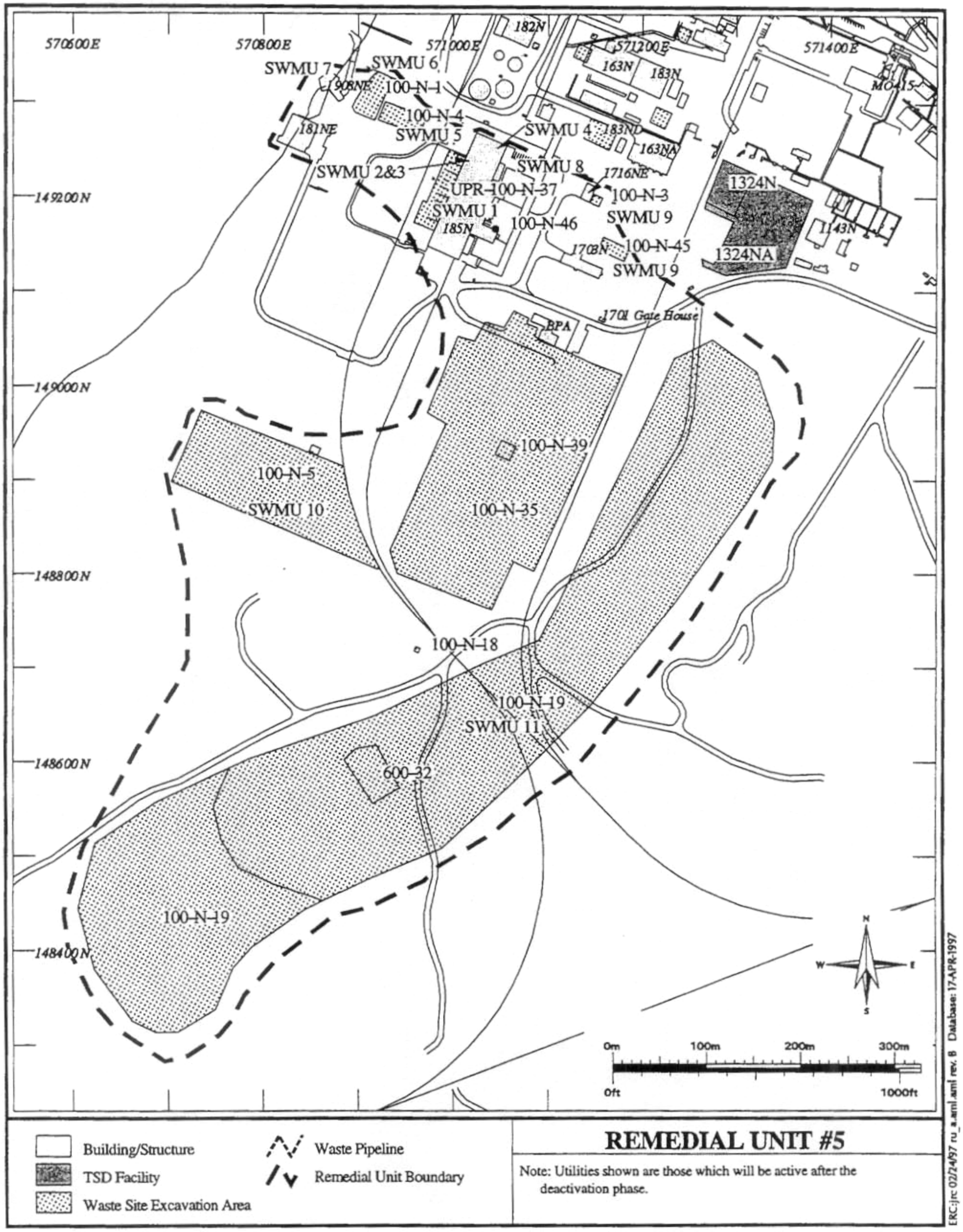


Figure 7.6 Remedial Unit Number 6

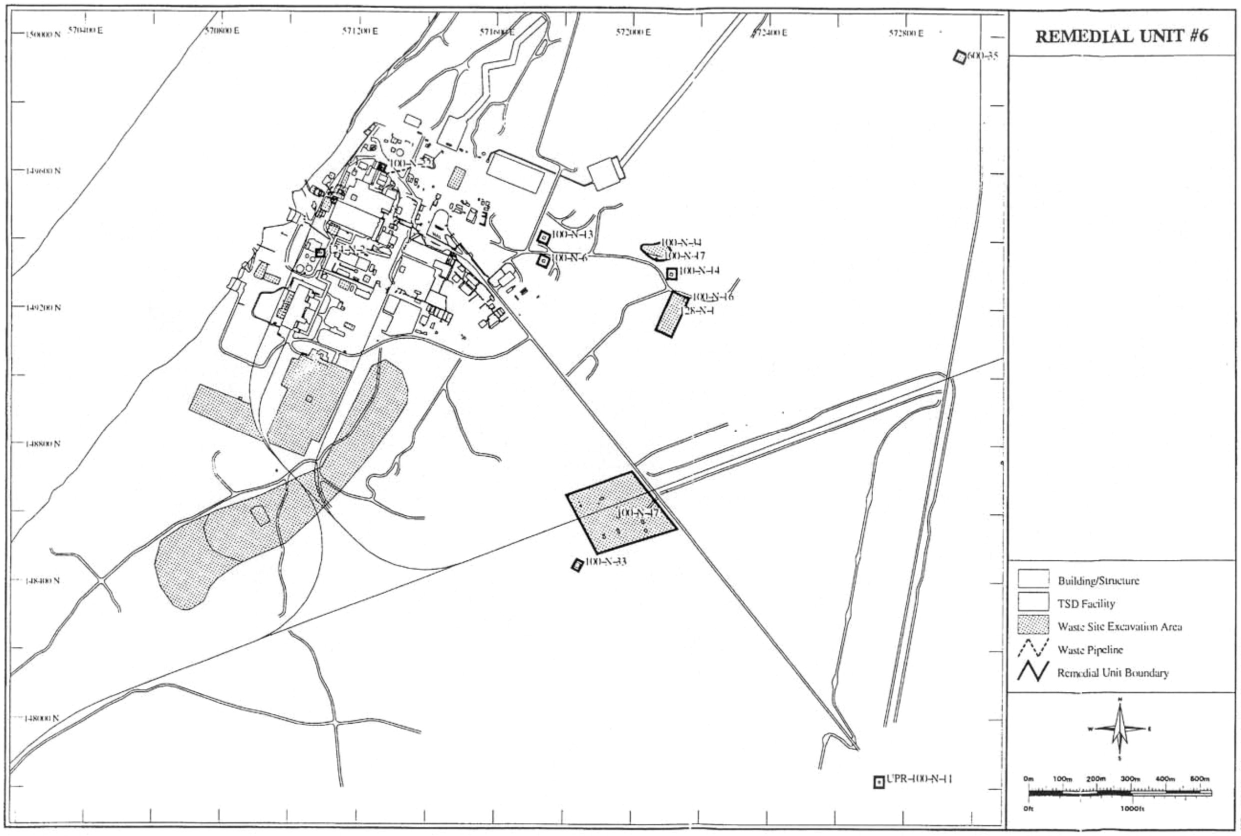


Figure 7.7 TSD Waste Sites at the 100-N Area

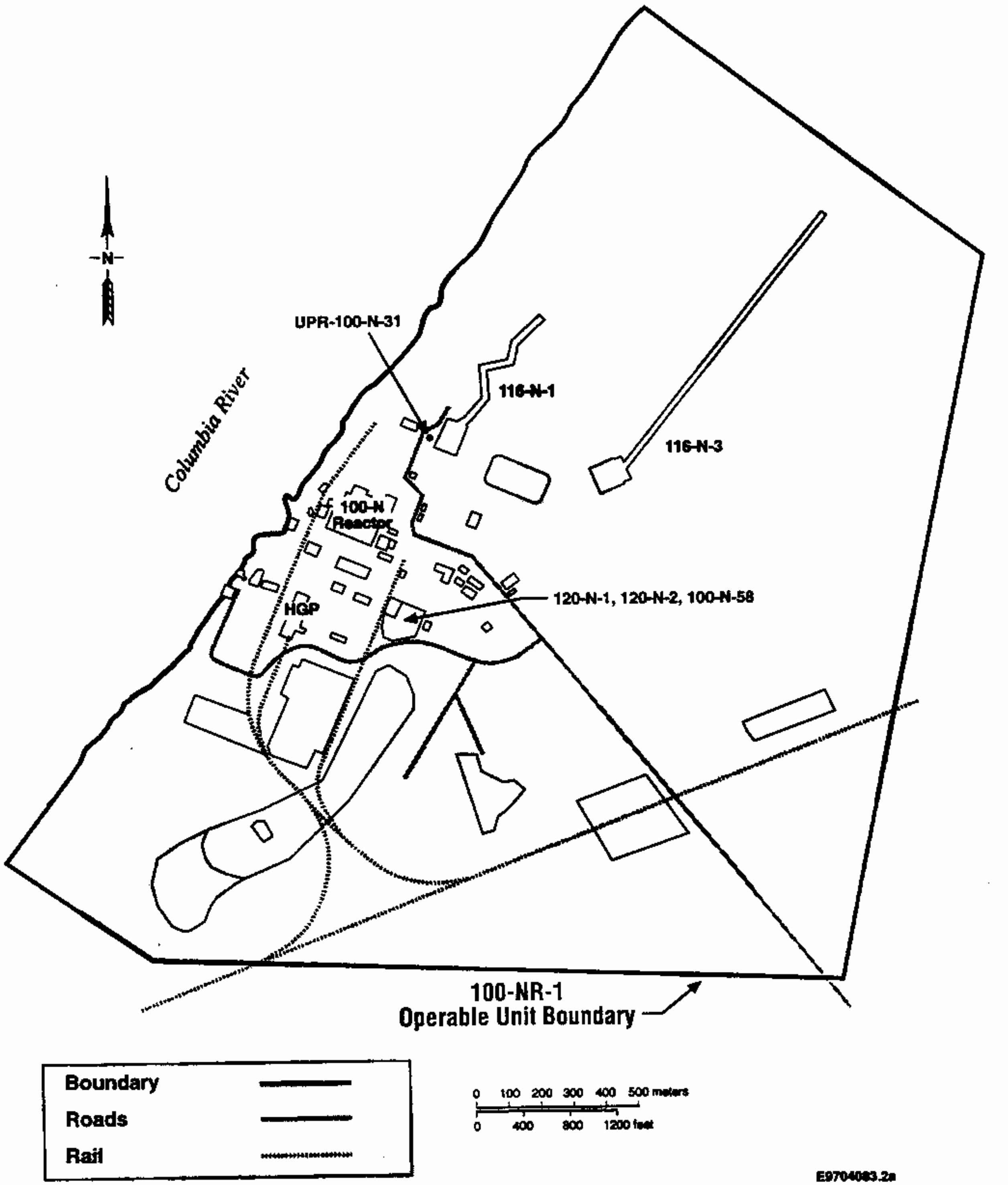
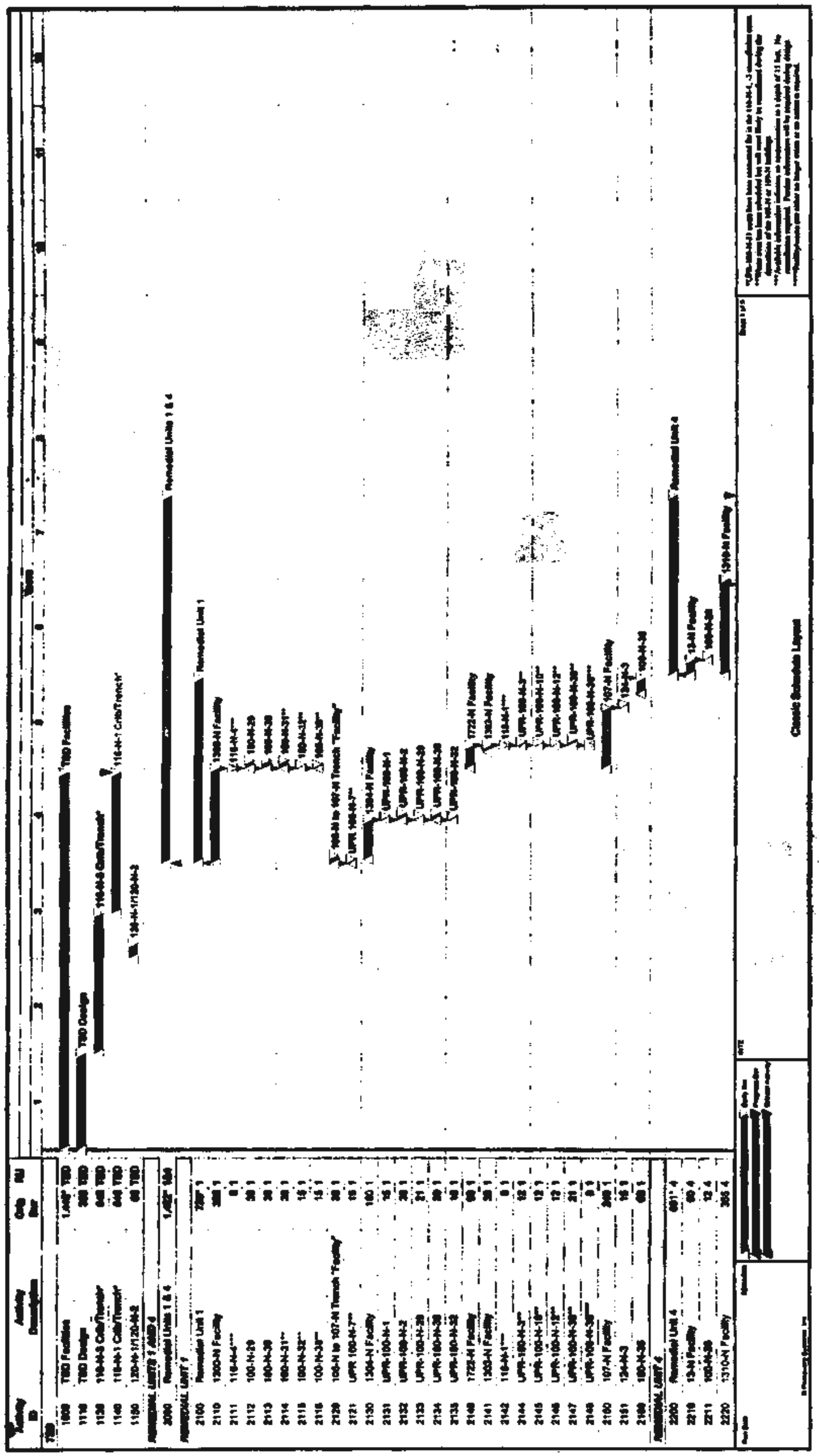
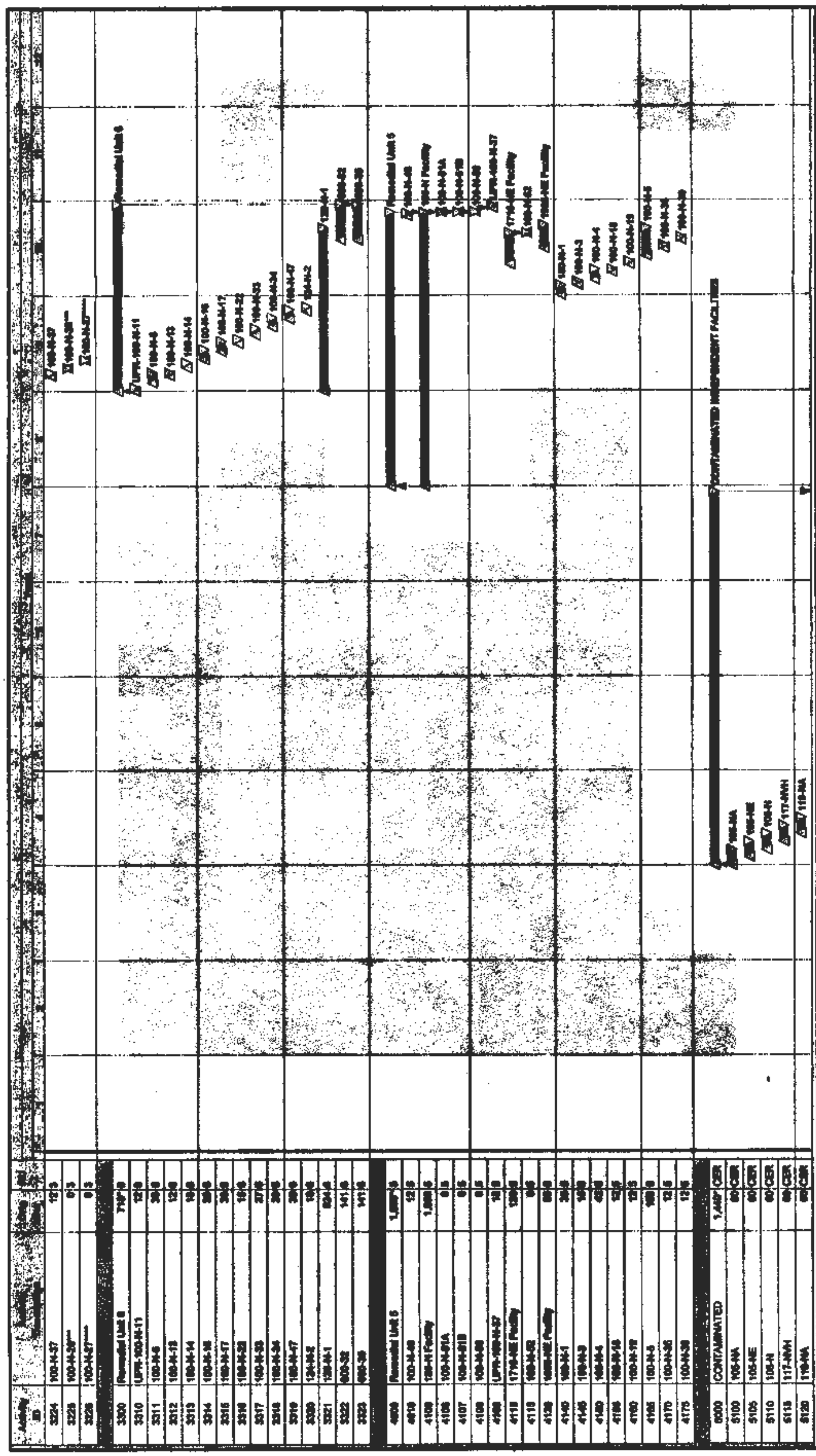


Figure 7.8 Integrated Schedule for the 100-N Area D&D Facilities and Remediation Activities

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3311 100-N-6 36 6
3312 100-N-13 12 6
3313 100-N-14 18 6
3314 100-N-16 36 6
3315 100-N-17 36 6
3316 100-N-22 18 6
3317 100-N-33 27 6
3318 100-N-34 36 6
3319 100-N-47 36 6
3320 124-N-2 18 6
3321 120-N-1 624 6
3322 600-32 141 6
3323 600-36 141 6
4000 Remedial Unit 5 1,069* 5
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4100 126-N Facility 1,069 5
4105 100-N-61A 0 5
4107 100-N-61B 0 5
4108 100-N-60 0 5
4109 UPR-100-N-37 18 5
4115 1716-NE Facility 126 5
4118 100-N-52 0 5
4125 1605-NE Facility 60 5
4140 100-N-1 36 5
4145 100-N-3 18 5
4150 100-N-4 42 5
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4160 100-N-19 12 5
4165 100-N-5 108 5
4170 100-N-35 12 5
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5105 105-NE 60 CER
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5115 117-NVH 60 CER
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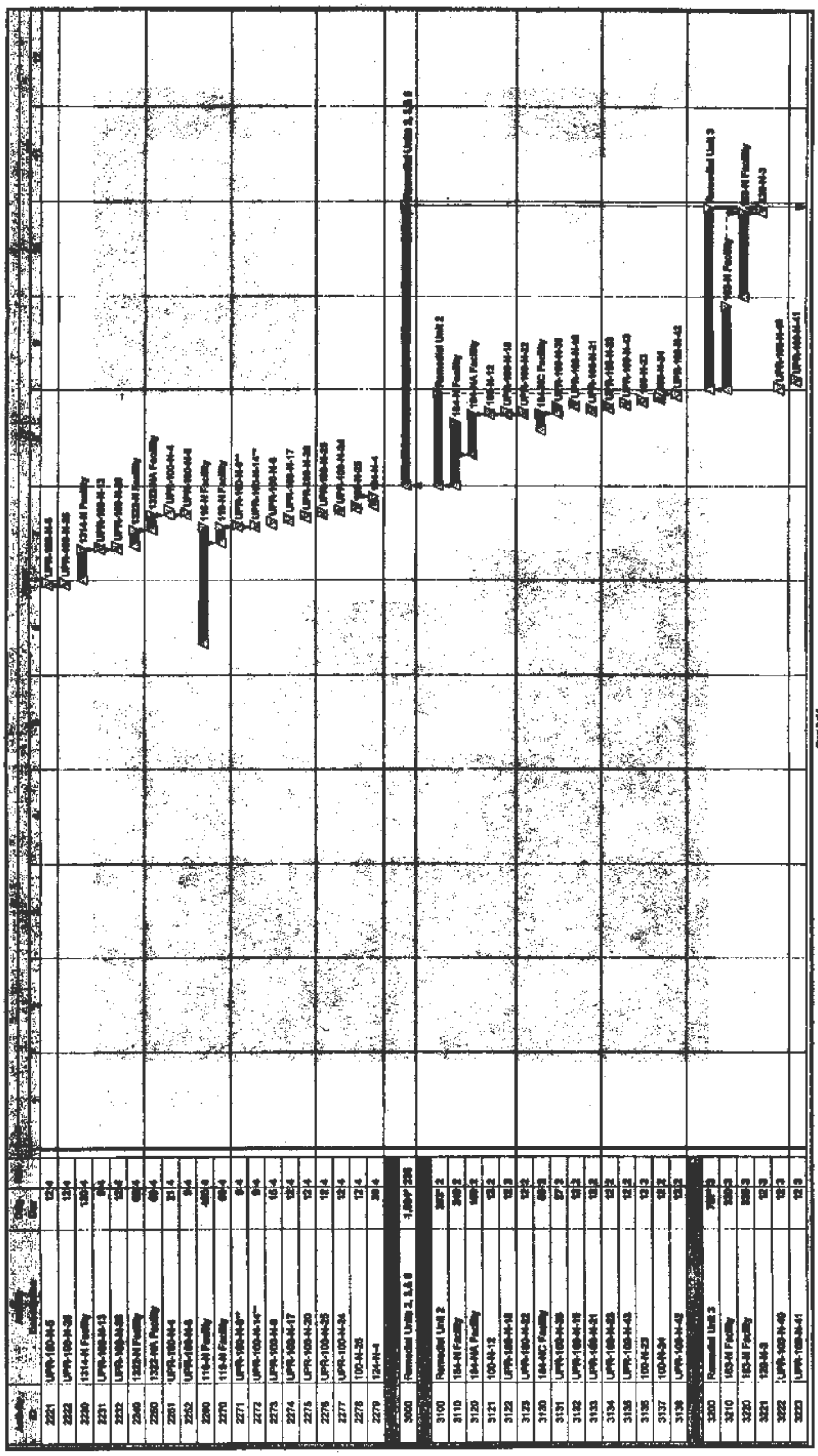
Remedial Unit 5
126-N Facility
1716-NE Facility
1605-NE Facility
CONTAMINATED INDEPENDENT FACILITIES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Remedial Units 2, 3, & 6
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Remedial Unit 2
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Remedial Unit 3
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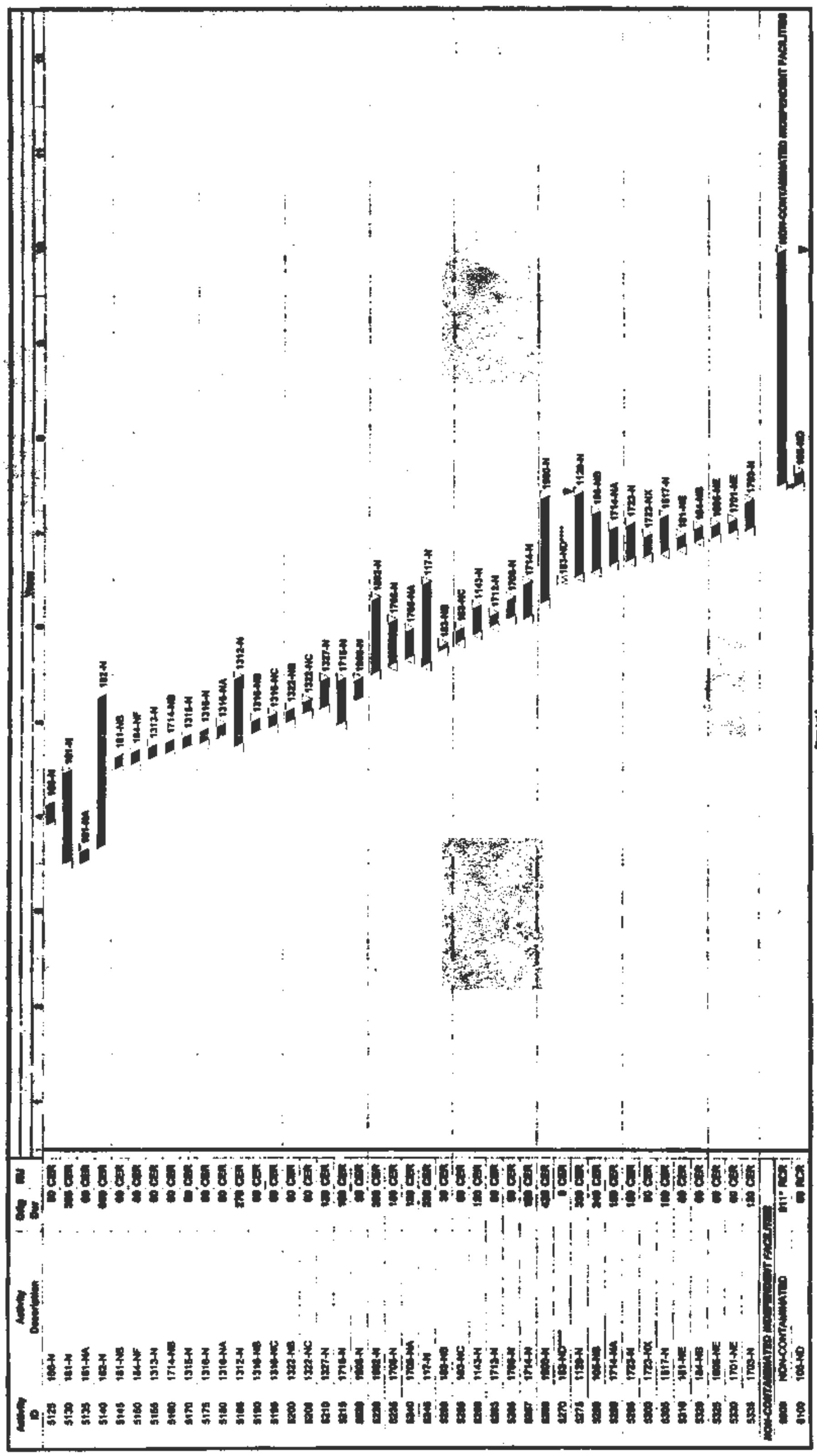

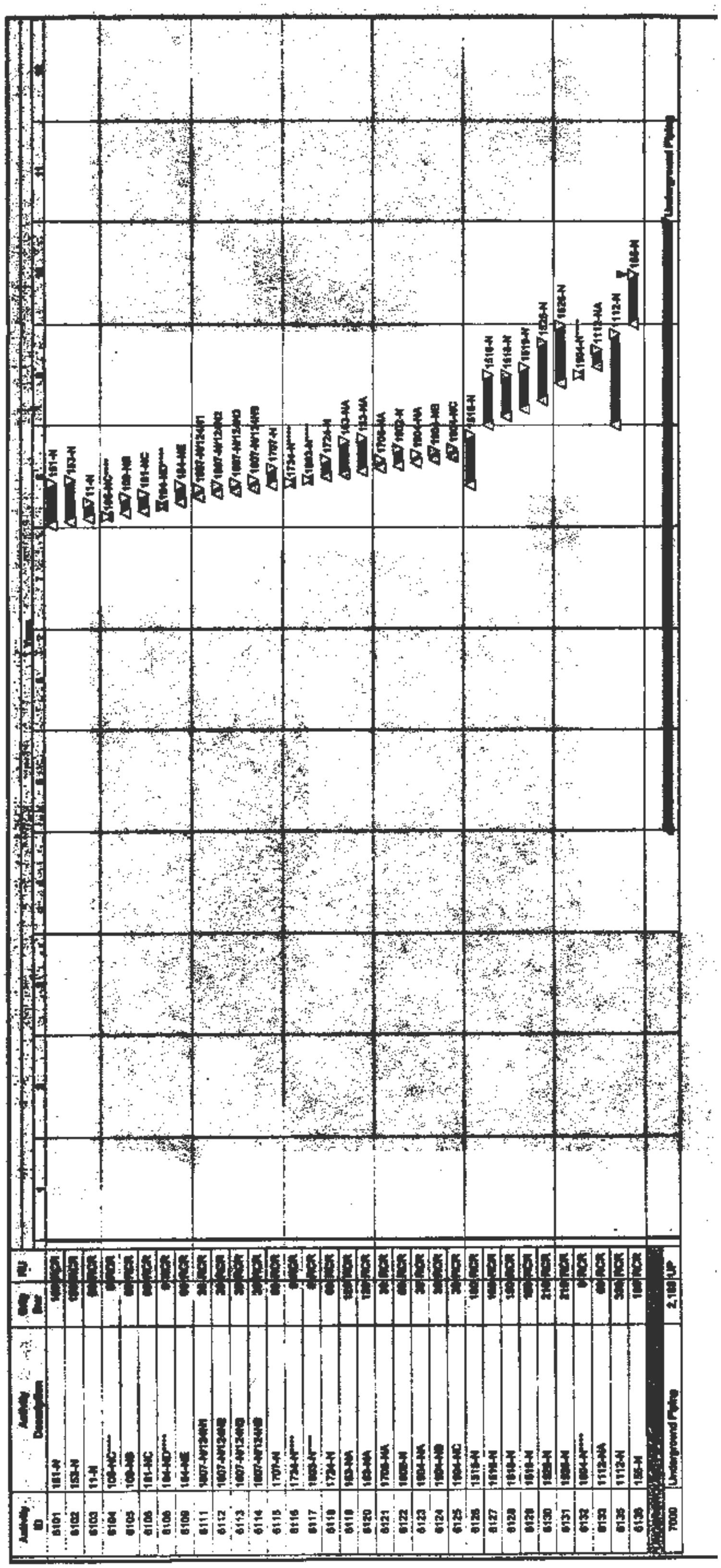

Table 7.4 100-N Area Remedial Action Waste Sites

Remedial Unit No. 1	Remedial Unit No. 2	Remedial Unit No. 3	Remedial Unit No. 4	Remedial Unit No. 5	Remedial Unit No. 6	River Shoreline	TSD Facilities
100-N-29[a] 100-N-30[a] 100-N-31[a] 100-N-32[a] 100-N-36 100-N-38[a] 116-N-4[a] 118-N-1[a] 124-N-3 UPR-100-N-1 UPR-100-N-2 UPR-100-N-3[a] UPR-100-N-7[a] UPR-100-N-10[a] UPR-100-N-12[a] UPR-100-N-29 UPR-100-N-30 UPR-100-N-32 UPR-100-N-35[a] UPR-100-N-39[a]	100-N-12 100-N-28 100-N-24 UPR-100-N-18 UPR-100-N-19 UPR-100-N-21 UPR-100-N-22 UPR-100-N-23 UPR-100-N-36 UPR-100-N-42 UPR-100-N-43	100-N-23 100-N-37 120-N-3 UPR-100-N-40 UPR-100-N-41	100-N-25 100-N-26 124-N-4 UPR-100-N-4 UPR-100-N-5 UPR-100-N-6 UPR-100-N-8 UPR-100-N-9[a] UPR-100-N-13 UPR-100-N-14[a] UPR-100-N-17[b] UPR-100-N-20 UPR-100-N-24 UPR-100-N-25 UPR-100-N-26	100-N-1 (SWMU 6) 100-N-3 (SWMU 9) 100-N-4 (SWMU 5) 100-N-5 (SWMU 10) 100-N-18 100-N-19 (SWMU 11) 100-N-35 100-N-39 100-N-45 (SWMU 9) 100-N-46 UPR-100-N-37 (SWMU 1) 1908-NE (SWMU 7)[c] 100-N-50 (SWMU 4)[c] 100-N-51a (SWMU 2)[c] 100-N-51b (SWMU 3)[c] 100-N-52 (SWMU 8)[c]	100-N-6 100-N-13 100-N-14 100-N-16 100-N-17 100-N-22 100-N-33 100-N-34 100-N-47 124-N-2 128-N-1 600-32 600-35 UPR-100-N-11	100-N-65 Shoreline Site	116-N-1 116-N-3 120-N-1 120-N-2 100-N-58 (South Pond) UPR-100-N-31

[a] Buffer zone sites; 13 buffer zone sites in RU 1 out of 15 total sites and 2 buffer zone sites in RU 4 out of a total of 15 sites.

[b] This site has been subdivided into two sites: UPR 100-N-17 is the leak and 100-N-65 is now the petroleum burn pit. 100-N-17 includes 100-N-65.

[c] Waste site contained within a facility.

Chapter 8.0 Hanford Generating Plant

8.0 HANFORD GENERATING PLANT 8.3
8.1 185-N HANFORD GENERATING PLANT TURBINE GENERATOR BUILDING 8.3
8.1.1 SWMUs 2, 3, and 4 Located within the 185-N HGP Facility 8.3
8.1.1.1 SWMU 2, HGP Building oil storage 8.3
8.1.1.2 SWMU 3, HGP Building floor drains, sumps, all piping to the settling pond and outfall 8.3
8.1.1.3 SWMU 4, Turbine oil filter unit 8.3
8.1.2 SWMU 7, 1908-NE HGP Outfall Structure 8.3
8.1.3 SWMU 8, 1716-NE Maintenance Garage (Storage Garage Building) 8.3

Table

Table 8.1. Suspected Contaminants in 100 N Area Ancillary Facilities 8.5

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8.0 HANFORD GENERATING PLANT

8.1 185-N HANFORD GENERATING PLANT TURBINE GENERATOR BUILDING

The 185-N Hanford Generating Plant (HGP) Turbine Generator Building (Remedial Unit 5) is a 19,065-m^2 (205,000-ft^2) facility owned by the Energy Northwest that housed two 430-megawatt, low-pressure steam turbine generators and associated equipment for generating electrical energy from steam supplied by the 100-N Reactor facility. The land under the HGP is owned by DOE and is part of the 100-N Area. The HGP operated continuously from April 1966 to December 1986. In 1996, Tri-Party Agreement Milestone M-16-01A was modified to require the submittal of necessary CERCLA documentation to support a cleanup decision of the HGP. This document fulfills that milestone. The responsibilities of the cleanup plans are negotiated between Energy Northwest and DOE.

Radiological contamination resulting from transferring 100-N Reactor steam was present in the building. The three SWMUs described below are located within of the 185-N HGP facility and are known to be contributors to the hazardous contamination identified in the facility. Additionally, asbestos-containing materials (ACMs) (e.g., insulation used in piping and floor tiles) are expected to have been used in the facility.

8.1.1 SWMUs 2, 3, and 4 Located within the 185-N HGP Facility

8.1.1.1 SWMU 2, HGP Building oil storage

Along the interior northwest was of the HGP building is a cinder block building approximately 2.4 by 7.6 m (8 ft by 25 ft). Drums and smaller containers of products (e.g., petroleum, oil, and lubricants) are stored on the floor and shelving. One drum is labeled for used oil. A blind concrete sump (no outlet) is located below the grated floor.

8.1.1.2 SWMU 3, HGP Building floor drains, sumps, all piping to the settling pond and outfall

Several floor drains in the basement level of the HGP building collect spills, leaks, and any floodwaters and direct them to two main sumps. The sump contents were then discharged to the settling pond (the settling pond is SWMU 6, which is addressed in the 100-NR-1 and 100-NR-2 CMS).

8.1.1.3 SWMU 4, Turbine oil filter unit

The turbine oil cleaning systems are in the basement of the HGP building along the northeast and southeast walls. Each unit consists of a steel tank, 0.7 m^2 by 1.2 m (8 ft^2 by 4 ft) tall as well as a below-grade sump approximately 0.5 m^2 by 1.8 m (6 ft^2 by 6 ft) deep. The tank has a series of filters used when moving the oil from the turbines and is surrounded by a concrete berm that is approximately 15 cm (6 in.) high.

8.1.2 SWMU 7, 1908-NE HGP Outfall Structure

The 1908-NE HGP Outfall Structure is a reinforced concrete, box-shaped structure that extends deep into the ground. This facility was used as a sump for several discharge lines and to drop the liquid discharge level for overflow to the river. An unknown amount of radioactive contamination exists within the structure because the discharge lines were associated with the reactor operations. The structure is no longer operational. The 1908-NE HGP Outfall Structure is also identified as SWMU 7.

8.1.3 SWMU 8, 1716-NE Maintenance Garage (Storage Garage Building)

The 1716-NE Maintenance Garage is an approximately 190-m^2 (2,100-ft^2), 5-m (17-ft) tall, structural-steel-frame building with metal siding and insulated wall panels. The garage is similar in design to a commercial gas station with a front office area, four vehicle bays with roll-up doors, and a back room in the northeast corner used to store paint and maintenance supplies, used oil, and solvents.

The back room contains unknown amounts of miscellaneous hazardous materials and is known as SWMU 8. The facility is no longer used.

Table 8.1. Suspected Contaminants in 100 N Area Ancillary Facilities

RU	Facility	Hazardous Substances
Ancillary Facilities that Interfere with Waste Site Remediation		
RU-1	105-N to 107-N Pipe Trench	Radioactive contamination
RU-1	107-N Basin Recirculation/Cooling Building	Radioactive contamination Miscellaneous chemicals Potential mercury (gauges, switches, drains) Lead (shielding/bricks) PCBs (in light ballasts and gear oils) Oil/petroleum products Potential asbestos
RU-1	1300-N Emergency Dump Basin	Radioactive contamination Potential asbestos (insulation)
RU-1	1304-N Emergency Dump Tank	Radioactive contamination
RU-1	1722-N Decontamination Building	Potential radioactive contamination Potential miscellaneous chemicals Potential solvents Potential asbestos
RU-1	1303-N Spacer Silos	Radioactive contamination Potential lead (paint shielding)
RU-2	184-N Power House	Oil/petroleum products Asbestos (insulation) Potential radioactive contamination Potential lead Potential solvents Mercury (gauges, switches, drains)
RU-2	184-NA Power House Annex	Oil/petroleum products Asbestos (insulation) Potential radioactive contamination
RU-2	184-NB Air Handler Main Building	Miscellaneous chemicals Potential radioactive contamination Potential asbestos
RU-3	163-N Demineralized Water Plant	Oil/petroleum products Radioactive contamination Miscellaneous chemicals Potential mercury Potential asbestos (insulation)
RU-4	116-N Ventilation Stack	Radioactive contamination Asbestos
RU-4	119-N Air Sample Facility	Radioactive contamination Potential miscellaneous chemicals Potential asbestos
RU-4	13-N Storage Facility	Potential radioactive contamination Potential lead (paint) Miscellaneous chemicals
RU-4	1310-N Radioactive Liquid and Waste Treatment Facility	Radioactive contamination Asbestos (insulation) Miscellaneous chemicals Lead (shielding/bricks)
RU-4	1314-N Liquid Disposal Building	Lead (shielding/bricks) Solvents Radioactive contamination Potential asbestos (insulation)

RU	Facility	Hazardous Substances
Ancillary Facilities that Interfere with Waste Site Remediation		
RU-4	1322-N Waste Treatment Pilot Facility	Lead (shielding/bricks) Potential solvents Radioactive contamination Potential asbestos (insulation)
RU-4	1322-NA Effluent Water Pilot Plant	Lead (shielding/bricks) Potential solvents Asbestos (insulation) Radioactive contamination
RU-5	185-HGP Turbine Generator Plant	Oil/petroleum products Potential PCB (gear oil) Potential radioactive contamination Asbestos (insulation) Mercury (gauges, switches) Lead
RU-5	1908-NE HGP Outfall	Potential radioactive contamination
RU-5	1716-NE Maintenance Garage	Miscellaneous chemical solvents Oil/petroleum products Lead (paint) Potential asbestos
100-N Facilities that do not Interfere with Waste Site Remediation		
	105-NA Emergency Diesel Enclosure	Oil/petroleum products Potential radioactive contamination Potential asbestos (insulation)
	105-NE Fission Products Trap	Radiological contamination Potential oil/petroleum products Potential mercury Asbestos Potential solvents Potential miscellaneous chemicals Potential lead (shielding)
	108-N Chemical Unloading Facility	Miscellaneous chemicals Potential oil/petroleum products Potential radioactive contamination Lead piping Potential asbestos (insulation)
	117-NVH Valve Control House	Radioactive contaminations Solvents Potential asbestos (insulation)
	119-NA Stack Air Sampling and Monitoring	Potential radioactive contamination Potential miscellaneous chemicals Potential asbestos (insulation)
	166-N Fuel Oil Storage Building	Asbestos (insulation) Oil petroleum products Potential PCB (light ballasts) Potential miscellaneous chemicals
	181-N River Pump house	Oil/petroleum products Potential asbestos (insulation)
	181-NA Pump house Guard Tower	Oil/petroleum products Potential asbestos (insulation)
	181-NB #3 Diesel Pump house	Oil/petroleum products Asbestos (insulation)

RU	Facility	Hazardous Substances
Ancillary Facilities that Interfere with Waste Site Remediation		
	182-N High Lift Pump house	Oil/petrolcurn products Asbestos (insulation) Mercury (switches, gauges) Potential radioactive contamination Potential solvents
	184-NF Chemical Injection	Miscellaneous chemicals
	1312-N Liquid Effluent Retention Facility	Potential radioactive contamination
	1313-N Change Control Building	Radioactive contamination Potential miscellaneous chemicals Potential asbestos (insulation) Potential oil products
	1315-N Diversion Valve House	Radioactive contamination Potential oil/petroleum products Potential asbestos
	1316-N Valve House	Radioactive contamination Potential oil/petroleum products Potential asbestos
	1316-NA Valve Vault	Radioactive contamination Potential oil/petroleum products Potential asbestos
	1316-NB Magnetic Flow meter Vault	Radioactive contamination Potential oil/petroleum products Potential asbestos
	1316-NC Turbine Meter Vault	Radioactive contamination
	1322-NB Crib Effluent Iodine Monitoring Building	Lead (shielding/pigs) Mercury (gauges, switches) Miscellaneous chemicals Radioactive contamination Potential asbestos
	1322-NC Crib Sample Pump Pit	Potential solvents Radioactive contamination Potential asbestos
	1327-N Diversion Valve House	Radioactive contaminants Potential oil/petroleum products Potential asbestos
	1715-N Oil Tanks	Oil/petroleum products Potential radioactive contamination
	1802-N Pipe Trestle (109-N to 185-N Building)	Asbestos Potential radioactive contamination
	1900-N Water Supply Tanks	Asbestos (insulation) Potential radioactive contamination
	1908-N Outfall Structure	Potential radioactive contamination
	181-NE HGP River Pump House	Oil/petroleum products Potential asbestos (insulation)
	1714-NB Warehouse	Potential oil/petroleum products Potential asbestos Potential radioactive contamination Potential solvents
	1712-N Insulator Shop	Miscellaneous chemicals Lead (paint) Solvents Potential asbestos
	1703-N Patrol Headquarters	Asbestos (insulation)
	1701-NE Gatehouse	Potential asbestos (insulation)

RU	Facility	Hazardous Substances
Ancillary Facilities that Interfere with Waste Site Remediation		
	1605-NE Observation Post	Potential asbestos (insulation)
	117-N Ventilation Filter Facility	Radioactive contamination