**Proposed Plan for the United Nuclear Corporation
Disposal Site at the Oak Ridge Y-12 Plant,
Oak Ridge, Tennessee**

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1. INTRODUCTION

R The U.S. Department of Energy (DOE) in compliance with Section 117(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, is releasing the proposed plan for remedial action at the United Nuclear Corporation (UNC) Disposal Site located at the DOE Oak Ridge Operations (ORO) Y-12 Plant, Oak Ridge, Tennessee. The purpose of this document is to present and solicit for comment to the public and all interested parties the “preferred plan” to remediate the UNC Disposal Site. However, comments on all alternatives are invited.

At the direction of the U.S. Environmental Protection Agency (EPA) and the Tennessee Department of Conservation (TDOC), DOE recently compiled the results of previous reports on the nature and extent of contamination, completed a baseline risk assessment, and evaluated four potential remedial alternatives for the UNC Disposal Site, the results of which are highlighted in the proposed plan. For a more in-depth discussion of contaminant characterization and the development of remedial alternatives, consult the *Feasibility Study for the UNC Disposal Site* and *Pathways Analysis for UNC Disposal Pit, Y-12 Plant*. [Note: The latter report serves as a surrogate remedial investigation (RI) report.]

The proposed plan provides a description of the alternative preferred by DOE along with the rationale for remedy selection. The preferred alternative for the UNC Disposal Site is construction of a modified Resource Conservation and Recovery Act (RCRA) landfill closure cover or cap. A modified RCRA cap protects human health and the environment, complies with applicable or relevant and appropriate requirements (ARARs), is easily implemented, and is cost effective. Other alternatives evaluated by DOE included no-action, treatment and capping, and off-site disposal.

2. SITE BACKGROUND

2.1 DESCRIPTION

The UNC Disposal Site is located near the crest of Chestnut Ridge, in the southern portion of the Y-12 Plant, in Oak Ridge, Tennessee (Fig. 1). For two years the UNC Disposal Site received waste from the decommissioning of a UNC uranium recovery facility in Wood River Junction, Rhode Island. Between June 1982 and November 1984, the UNC Disposal Site received 11,000 55-gal drums of sludge fixed in cement, 18,000 drums of contaminated soil, and 288 wooden boxes of contaminated building and process demolition materials. The UNC Disposal Site consists of a 1.3-acre excavation cut into the side of Chestnut Ridge. The UNC pit depth ranges from 25 to 30 ft on the northern side, to less than 5 ft on the southern side. The drums are stacked horizontally, 10 high, in a pyramid shape following the contour of the excavation. The wooden boxes are on the south side of the stacked drums, and the entire waste site is covered in polyvinyl chloride (PVC) sheeting. Many of the drums and boxes have deteriorated, allowing their contents to be exposed to the environment.

Items of concern at the UNC Disposal Site included physical hazards presented by the exposed drums, potential environmental impacts, and potential human health risks.

The deteriorated condition of the drums and the potential migration of constituents from the drums prompted characterization of the waste, soil, and groundwater of the UNC Disposal Site. Extraction procedure (EP) toxicity testing in 1985 on the drummed sludge and soil indicated the waste to be nonhazardous as defined by the Resource Conservation and Recovery Act (RCRA). Nitrate and strontium-90 levels in the EP toxicity extract were above the Safe Drinking Water Act (SDWA) maximum contaminant level criteria. A total nitrate and strontium-90 inventory of ~53 t and 25 mCi, respectively, was estimated for the site. Soil and groundwater analysis indicate no elevated levels of contaminants, verifying that migration of contaminants has not occurred. Based on the estimated source inventory concentration, and on toxicological, physical, chemical, and environmental fate characteristics, nitrate and strontium-90 were deemed most likely to contribute to potential human health risk.

2.2 REGULATORY HISTORY

R In June 1989 and prior to placement of the Oak Ridge Reservation (ORR) on the National Priorities List (NPL), DOE submitted the closure plan (Baily et al. 1989) for the UNC Disposal Site to EPA's Waste Management Branch for review and comment. DOE responded to EPA's comments, and in December 1989 EPA concurred that its comments had been adequately addressed (EPA 1989a). However, before this plan could be implemented, the Y-12 Plant was placed on NPL, which subsequently required the UNC

Disposal Site to meet CERCLA guidelines. EPA identified several specific tasks required to support closure of the UNC Disposal Site. In general, the tasks required preparing a feasibility study (FS) that met the CERCLA guidelines and provided documentation of community and regulatory review and the decision process. EPA further concluded that a separate RI report was not necessary and that the report *Pathways Analysis for UNC Disposal Pit, Y-12 Plant* could serve as the RI with minor supplements (i.e., Risk Assessment and recent groundwater quality data) (Scarborough 1990).

3. SCOPE AND ROLE OF RESPONSE ACTION

In general, the objectives for source control actions include (1) preventing or mitigating the release of contaminants to surrounding environmental media and (2) eliminating or minimizing the threat to public health and environment from the source material (drummed soil/sludges and miscellaneous scrap).

The first objective, preventing or mitigating the release of contaminants to the surrounding environment, involves assessment of migration pathways for the contaminants of concern. The primary exposure or transport pathway is the downward movement of the leached contaminants from the drummed soil/sludges into the groundwater and surface water.

The potential transport pathways to groundwater are primarily the infiltration of precipitation through the exposed sludge/soil to the unsaturated zone of the soil, with subsequent leaching and transport of contaminants to the groundwater. Surface runoff is a potential contaminant migration mechanism at the UNC Disposal Site, which would also affect the local soil and groundwater. No soil or groundwater contamination, however, has been identified at the site.

The second objective, eliminating or minimizing the threat posed to public health or the environment from the UNC Disposal Site, involves addressing exposure pathways, receptor populations, and levels of exposure. Human exposure risks are minimal because the site is isolated from the public (secured area), and personnel at the Y-12 Plant are not normally in contact with the site.

Future human and wildlife exposure at the UNC Disposal Site is expected to be minimal due to continued institutional control. Potential human exposure would essentially be limited to construction workers for the duration of remedial and corrective actions.

In summary, the potential for direct exposure to contamination from sources at the UNC Disposal Site is minimal. Target levels [Maximum Contaminant Levels (MCLs) in groundwater] for source control have been developed considering migration of contaminants from the drummed sludges/soil to soil and subsequently to the groundwater and surface water as the primary exposure route of concern. Hypothetical exposure to contaminated groundwater is the basis for establishing acceptable levels of contaminants in groundwater. However, groundwater at the UNC Disposal Site is not now or is not anticipated, to be a source of drinking water.

Source control actions were developed in accordance with the requirements of NCP. Based on source control actions, the following types of alternatives were developed to the extent practicable:

1. an alternative that would minimize the need for long-term management;

2. an alternative that would use treatment as a principal element to reduce contaminant levels in the source;
3. an alternative that involves containment of materials with little or no treatment, but provides protection of human health and the environment by preventing exposure and/or by reducing the mobility; and
4. a no-action alternative.

4. SUMMARY OF SITE RISKS

4.1 CONTAMINATED MEDIA AND CONTAMINANTS OF CONCERN

Soil and groundwater analysis has not identified any migration of contamination from the UNC wastes. The only contaminated media at the UNC Disposal Site are the drummed soils/sludge and miscellaneous scrap (source media). The objectives of the remedial action are to address potential migration from the UNC wastes and the physical risk associated with the site to workers.

The contaminants of concern in the source material are nitrate and strontium-90. No migration to the soil or groundwater of these constituents has occurred. Waste characterizations have indicated both these constituents are in high concentration and have the greatest potential to leach from the drummed wastes. Based on their source inventory concentration and on their toxicological, physical, chemical, and environmental fate characteristics, these constituents were deemed most likely to contribute to potential human risk.

4.2 EXPOSURE PATHWAYS AND POPULATIONS

The UNC Disposal Site is situated within the limited area of the Oak Ridge Y-12 Plant. Direct access by the general public is unlikely now, or at any time within the foreseeable future due to the location of the site on ORR. Employees of the DOE facilities are the most likely exposed population, and only a small percentage of these employees are expected to access the UNC Disposal Site. The only potential receptors are the maintenance workers who monitor the site.

Modeling was used to conservatively predict the effect nitrates and strontium-90 could have on various environmental media if the site was left in its present condition (Weston 1986). Modeling identified a potential impact to both groundwater and surface water through groundwater releases. Groundwater is the only exposure pathway for contaminants in the UNC waste.

4.3 RISK ASSESSMENT

Quantification of risk is limited to the adverse health effects of the two contaminants of concern, nitrate and strontium-90, determined in the UNC Waste (Energy Systems 1990). To provide perspective on the potential for nitrate and strontium-90 to affect human health adversely, hazard quotients and cancer risks were determined for present conditions and each remedial alternative. The evaluation of human health risks associated with each remedial alternative is used in the selection process for choosing the preferred alternative.

The residual risk associated with the UNC Disposal Site if left as is (no action) provides a baseline to judge the remedial alternatives.

The pathways analysis indicates no current human exposure to contaminants at the UNC Disposal Site. Nevertheless, as a conservative means of evaluating the effectiveness of the remedial alternatives, human exposure was assumed to occur through ingestion of contaminated groundwater. To determine the magnitude of potential residual risks for the existing and future conditions and the remedial alternatives at the UNC Disposal Site modeling results were evaluated (Weston 1986, 1987, 1990). Groundwater modeling efforts focused on predicting nitrate and strontium-90 concentrations migrating from the site.

4.3.1 Nitrate

R Nitrate is not identified as a hazardous constituent by EPA. However, the federal drinking water standard for nitrate is 10 mg/L (as nitrogen). Acute nitrate poisoning is very rare because a one-time ingestion of 0.5 gm is required. However, chronic exposure to nitrates results in methemoglobinemia in infants <3 or 4 months old due to conversion of nitrates to nitrites in the gastrointestinal tract. Nitrate has a Group D cancer classification, meaning there is no evidence of carcinogenicity in humans or animals. There has been no evidence of mutagenicity related to nitrate exposures.

4.3.2 Strontium-90

EPA classifies strontium-90 as a Group A carcinogen because ionizing radiation is known to be carcinogenic in humans and animals. Strontium is acquired by humans primarily through ingesting strontium-90 contaminated food. It is retained by the body largely in bone and may inhibit bone calcification. Absorption of strontium-90 by the body is relatively high, and it has a long biological retention time. Effects of acute strontium toxicity include excessive salivation, vomiting, colic, and diarrhea. Animal studies have also shown acute effects to strontium exposure, including respiratory failure in rats.

4.4 RISK CHARACTERIZATION

For the assessment of human health risks, two approaches are used, depending on whether the toxic endpoint has a threshold (noncarcinogenic) or no threshold (carcinogenic) effect. Noncarcinogenic hazards are quantified as the ratio of the exposure dose to a verified Reference Dose (RfD). This ratio is termed a hazard quotient (HQ), and an HQ <1.0 is an indication that exposure levels are below those that have been associated with any adverse effects. Thus, an HQ <1.0 is generally used as the basis for designating an acceptable level of exposure to noncarcinogens.

Cancer risks are based on extrapolated hypothetical lifetime excess cancer incidences. Risks are estimated as the incremental probability of an individual developing cancer over

a lifetime as a result of exposure to the carcinogen (i.e., incremental or excess individual lifetime cancer risk). The carcinogenic risk estimate represents a conservative estimate with a >95% confidence level on the probability of a carcinogenic response. Thus, there is only a 5% probability that the actual risk is higher than the estimate and may very likely be less than the estimate. Cancer risk levels within the range of 1×10^{-4} to 1×10^{-6} are within the range of concern (EPA 1989b). Cancer risk levels less than 1×10^{-6} are considered acceptable. Cancer risk levels greater than 1×10^{-4} are an indication that exposure levels are probably unacceptable.

To evaluate the noncarcinogenic effects of nitrate, a measure of the potential health risk is obtained by comparing exposure levels to the RfD. Potential nitrate exposure levels, calculated for ingestion of groundwater, are identified as milligrams per kilogram of body weight per day (mg/kg/d). For the current conditions representing an exposed uncapped excavation (no-action alternative), modeling predicted 10 years for the nitrates to reach the groundwater system (Weston 1986). After ~13 years, a maximum nitrate concentration of 193 mg/L was predicted. The HQ for the groundwater nitrate concentration of 193 mg/L is 3.4. This HQ is greater than unity (1.0), indicating that the no-action alternative may result in nitrate concentrations that may cause adverse noncarcinogenic health effects. As previously stated, human exposure is not occurring and was only assumed as a means of evaluating the effectiveness of the treatment alternatives.

Potential strontium-90 exposure levels are identified as picocuries. For the no-action alternative, modeling predicted 10 years for strontium-90 to reach the groundwater system. The maximum concentration predicted by the model for the defined conditions was 50 pCi/L. Risk was then calculated to determine the probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen. The risk for the present conditions (no-action alternative) is $8.3 \text{ E-}5$, which is within EPA's range of concern ($1.0 \text{ E-}4$ to $1.0 \text{ E-}6$).

5. SUMMARY OF ALTERNATIVES

The universe of remedial response actions, technologies, and process options were screened based on applicability to the UNC Disposal Site. Those that passed this initial screening were then evaluated for effectiveness, ease of implementation, and cost. The most effective remedial actions, technologies, and process options were then combined to form four remedial action alternatives. These were

1. Alternative 1, no action;
2. Alternative 2, containment via selective multilayered capping;
3. Alternative 3, treatment using a combination of (1) solid waste processing; (2) physical, chemical, and biological treatment of the aqueous waste; and (3) modified RCRA cap; and
4. Alternative 4, off-site shipment and disposal.

5.1 ALTERNATIVE 1: NO ACTION

This alternative involves security for the entire site. All drummed soils/sludges and miscellaneous scrap will be left in place. Appropriate warning signs will be placed along the perimeter for additional security. Signs are assumed to be 4 ft², made of steel with reflective coating, and placed at the midpoint of each side of the pit. Land-use restrictions around the site may be implemented as part of the alternative. Once signs are delivered to the site, completion of the alternative can be accomplished rapidly. Treatment rates and disposal distances are not applicable to this alternative. This alternative has negligible spatial requirements and no imposed limitations. The cost and time required to implement the alternative are presented below:

D
N

Estimated capital costs:	\$ 240
Estimated annual O&M costs:	\$ 44,000
Estimated present-worth costs:	\$ 483,000
Estimated implementation time:	3 months

5.2 ALTERNATIVE 2: MODIFIED RCRA CAP

Alternative 2 involves capping the drummed soils/sludges and miscellaneous scrap (boxes) with a multilayer/multimedia modified RCRA cap for long-term minimization of infiltration.

Little site preparation is required to implement the cap. Some movement of barrels and boxes may be necessary to facilitate grading. Additional site preparation with this design includes only minor grading and negligible clearing and grubbing because the land surface at the UNC Disposal Site has only sparse vegetation.

A modified RCRA cap is composed, at a minimum, of a 24-in-thick clay layer over the drummed soil/sludges and miscellaneous scrap boxes, overlain by a minimum 30-mil synthetic liner, overlain by a polyethylene drainage geonet, overlain by a polypropylene filter fabric, overlain by a minimum 24-in-thick topsoil layer. Some variations of this design may be necessary to accommodate site-specific requirements of the UNC Disposal Site.

The time required for the placement of a cap is relatively shorter than alternatives that use treatment as the principal element. Treatment rates, disposal distances, and imposed limitations are negligible or not applicable to the alternative. Spatial requirements for this alternative include temporary facilities for field offices and equipment storage and maintenance. The cost and time required to implement this alternative are presented below:

D

N

Estimated capital costs:	\$ 780,500
Estimated annual O&M costs:	\$ 69,800
Estimated present-worth costs:	\$ 1,467,500
Estimated implementation time:	8 months

5.3 ALTERNATIVE 3: TREATMENT AND MODIFIED RCRA CAP

This alternative treats only the 11,000 drums containing sludges mixed with cement. The 18,000 drums of soil are not treated because they account for only 1% of the nitrate at the site. Miscellaneous demolition materials are not treated due to compositional variations and negligible nitrate content. The alternative involves four main processing steps: (1) solid waste processing of the drummed sludge, (2) leaching of the nitrate from the sludge, (3) treatment of the nitrate-bearing leachate, and (4) containment of the leached sludge, drummed soil, and miscellaneous boxed scrap.

Solid waste processing involves identifying the drummed sludges from the soils, removing the waste from the barrel, reducing the particle size of the solid waste by primary and secondary crushing, shredding empty barrels, and leaching nitrates from the crushed solid waste.

An excavator with a drum grappling arm would perform the required drum handling from the pile and around the site. Deheading the drum and identifying of the contents would be performed manually. Drums containing soil would be emptied and their contents covered with PVC sheeting and isolated until completion of the treatment process.

A concrete pulverizer (primary crushing jaws attached to an excavator) would remove the drum surrounding the concrete and reduce the concrete fragments to a diameter <9 in. The crushed concrete would then be transported to a secondary crusher, where it would be crushed to the optimum particle size for nitrate leaching.

A soil washing system would be used to leach nitrate from the crushed material. The system uses aggressive washing and leaching techniques developed in the mineralogical industry. Water, energy, and detention time requirements for the soil washing system would be minimal because nitrate is highly soluble. Treatability studies to determine the final design specifications would be necessary.

Wastewater generated from solid waste leaching would require treatment by neutralization/pH adjustment, anaerobic fixed film treatment, and sedimentation. This treatment scheme represents historic and tested wastewater treatment technology and can be provided by mobile or package systems offered by contract wastewater treatment service firms. Treatability studies would be required to define the design specifications of the wastewater treatment system.

The wastewater treatment would be performed by a contract service firm that routinely treats soil washing wastewater. The aqueous treatment system includes pH adjustment, proprietary fixed film bioreactor, and sedimentation. Treated effluents would have to meet National Pollutant Discharge Elimination System (NPDES) discharge criteria and would be directed to a nearby surface stream or the Y-12 Plant storm sewer. Sludges from the treatment process would be placed back in the excavation.

The leached crushed sludge, soil emptied from drums, and miscellaneous scrap would be placed back in the existing excavation and covered with a multilayer cap as outlined in Alternative 2. The miscellaneous scrap would be removed from the wooden boxes to prevent void spaces during filling. All barrels would be shredded. Soil would be removed from the drums and placed in the excavation, and the drums would be shredded.

D Treatability studies to determine solid waste processing and wastewater characteristics would be required. Spatial requirements include temporary facilities for field office, equipment storage, and maintenance.

The time required for treatment of the solid waste is relatively long compared with nontreatment alternatives. The main time constraint is obtaining appropriate permits and regulatory approval. Engineering details of the process may be worked out relatively quickly.
D The cost and time required to implement this alternative are presented below:

N	Estimated capital costs:	\$ 2,353,100
	Estimated annual O&M costs:	\$ 69,800

Estimated present-worth costs:	\$ 3,033,000
Estimated implementation time:	25 months

5.4 ALTERNATIVE 4: OFF-SITE DISPOSAL

Shipment and disposal of UNC Disposal Site wastes off Y-12 Plant grounds is considered to provide an alternative involving minimal long-term oversight or maintenance. Potential difficulties exist, however, in obtaining Y-12 Plant and/or DOE approval for shipment of the wastes off-site.

Disposal of UNC wastes off-site involves handling and preparing the waste for shipping, transportation, and disposal at an appropriate facility. Waste preparation is assumed to consist of handling, overpacking drummed soil and sludges, and containing miscellaneous wastes. Transportation would be via truck. Potential low-level radioactive contamination limits disposal facilities that will accept the wastes. The wastes will be transported to U.S. Pollution Control's land disposal facility in Beatty, Nevada. Once waste is removed, the site will be backfilled with clean soil and returned to a natural state.

Spatial requirements consist of temporary equipment storage and staging facilities at the UNC Disposal Site, as well as long-term land disposal facility spatial requirements resulting from disposal of the wastes. The cost and time required to implement this alternative are presented below:

D

N

Estimated capital costs:	\$13,954,000
Estimated annual O&M costs:	\$ 39,000
Estimated present-worth costs:	\$14,073,000
Estimated implementation time:	12 months

R 6. EVALUATION OF ALTERNATIVES AND THE PREFERRED ALTERNATIVE

The purpose of the comparative analysis is to weigh the advantages and disadvantages of the alternatives relative to each other and to the nine criteria used in the detailed assessment. This procedure differs from the individual examinations because interrelationships between the alternatives are considered. The comparative analysis allows for identification of items that were used by the decision-making party to determine the preferred alternative. Short- and long-term effectiveness; toxicity, mobility, and volume reductions through treatment; ease of implementation; and costs receive the greatest consideration, whereas overall protection and compliance with ARARs are generally examined as threshold determinations in that they must be met by the alternative for it to be eligible for selection. State and community acceptance is evaluated to the extent possible at this stage of the RI/FS process and should be considered only as a preliminary assessment at this time. A comparison of the CERCLA criteria and the four alternatives is presented in Table 1.

R

6.1 OVERALL PROTECTION OF HUMAN HEALTH AND ENVIRONMENT

Alternative 1, no action, has the lowest degree of overall protection of human health and environment of the alternatives because of its low long-term effectiveness and its potential future noncompliance with ARARs. Alternative 2, capping, offers the highest degree of protection of human health and the environment of the alternatives because it requires minimal disruption of the site to affect short-term effectiveness, has high degree of long-term effectiveness, and fully complies with ARARs. Alternative 3, treatment and capping, and Alternative 4, off-site disposal, offer moderate degrees of overall protection of human health and the environment because of their low degrees of short term effectiveness due to significant handling and processing of the waste and potential exposure to the environment.

6.2 COMPLIANCE WITH ARARS

Since there is no evidence of contaminated groundwater or soil, there are no chemical-specific ARARs for cleanup at the UNC Disposal Site. However, based on simulations representing an uncapped, exposed excavation, the potential exists for contamination of groundwater to levels exceeding SDWA MCLs. With the exception of the no-action alternative, the other three alternatives selected would minimize the potential leaching of contaminants into groundwater, thus ensuring compliance with the MCLs.

Alternative 1, no action, would preclude compliance with chemical-specific ARARs. Although no chemical-specific ARARs are applicable at this time, given the potential (modeled) for groundwater contamination, this alternative would not comply with SDWA

Table 1. Alternative assessment summary and comparison

Assessment criteria	Alternative 1: no action	Alternative 2: modified RCRA cap	Alternative 3: treatment and modified RCRA cap	Alternative 4: off-site disposal
<i>Overall protection of human health and environment</i>	Low	High, if cap is properly maintained	Moderate, if cap is properly maintained	Moderate
<i>Compliance with ARARs</i>				
1. Chemical-specific	MCLs may be exceeded in the future	Reduces future potential nitrate and strontium-90 concentrations to below MCLs	Reduces future potential nitrate and strontium-90 concentrations to below MCLs	Not applicable, source of potential contamination eliminated
2. Location-specific	Not applicable	Are easily met during implementation	Are easily met during implementation	Area easily met during implementation
3. Action-specific	Not applicable	Alternative 2 represents an appropriate response	Alternative 3 represents an appropriate response	Alternative 4 represents an appropriate response
<i>Short-term effectiveness</i>				
1. Worker protection	Low exposure risk to workers	Low exposure risk to workers	Moderate to high exposure risk to workers	Moderate exposure risk to workers
2. Community protection	Low exposure risk to the community	Low exposure risk to the community	Moderate exposure risk to the community	Low exposure risk to the community
3. Environmental protection	Low exposure risk to the environment	Low exposure risk to the environment	Moderate exposure risk to the environment	Moderate exposure risk to the environment
4. Estimated time until remedial action objectives are achieved	Including sign delivery, ~12 weeks	Total time is 8 months maximum	Total time is 25 months maximum	Total time is 12 months maximum
<i>Long-term effectiveness and permanence</i>				
1. Magnitude of residual risks	Residual risks may increase in future	Low residual risk, exposure pathways are reduced	Low residual risk, source of future contamination reduced, exposure pathways reduced	Residual risk at site eliminated, potential future liability off-site

Table 1. (continued)

Assessment criteria	Alternative 1: no action	Alternative 2: modified RCRA cap	Alternative 3: treatment and modified RCRA cap	Alternative 4: off-site disposal
2. Adequacy of controls	Adequate, given the objectives of a no-action response	Adequate if cap is maintained	Adequate if cap is maintained	Not applicable, no material remains at the site
3. Reliability of controls	Reliable, given the objectives of a no-action response	Reliable if cap is maintained	Reliable if cap is maintained	Not applicable, no material remains at the site
<i>Reduction of toxicity, mobility, and volume</i>				
1. Toxicity	None	None	Nitrate	All constituents of concern
2. Mobility	None	All constituents of concern	All constituents of concern	All constituents of concern
3. Volume	None	None	Nitrate	All constituents of concern
<i>Implementability</i>				
1. Technical	Very high	Feasible, moderate design and engineering requirements	Feasible, moderately high design and engineering requirements	Feasible, low design and engineering requirements
2. Administrative	Very high	Feasible	Feasible	Feasible
3. Availability of materials	Readily available	Materials and equipment readily available	Materials and equipment readily available	Materials and equipment readily available, off-site disposal sites limited
<i>Costs</i>				
1. Capital	\$240	\$780,500	\$2,353,100	\$13,954,000
2. Annual O&M	Year 1: \$68,000 Years 2–30: \$44,000	Year 1: \$93,600 Years 2–30: \$69,800	Year 1: \$93,600 Years 2–30: \$69,800	Year 1: \$63,000 Years 2–4: \$39,000
3. Present worth	30 year: \$483,000	30 year: \$1,467,500	30 year: \$3,033,000	4 Year: \$14,073,000

Table 1. (continued)

Assessment criteria	Alternative 1: no action	Alternative 2: modified RCRA cap	Alternative 3: treatment and modified RCRA cap	Alternative 4: off-site disposal
<i>Compliance with ARARs</i>				
1. Chemical-specific	MCLs may be exceeded in the future	Reduces future potential nitrate and strontium-90 concentrations to below MCLs	Reduces future potential nitrate and strontium-90 concentrations to below MCLs	Not applicable, source of potential contamination eliminated
2. Location-specific	Not applicable	Are easily met during implementation	Are easily met during implementation	Area easily met during implementation
3. Action-specific	Not applicable	Alternative 2 represents an appropriate response	Alternative 3 represents an appropriate response	Alternative 4 represents an appropriate response
<i>State acceptance</i>	To be addressed	To be addressed	To be addressed	To be addressed
<i>Community acceptance</i>	To be addressed	To be addressed	To be addressed	To be addressed

MCLs. Action-specific and location-specific ARARs are not applicable to the no-action alternative.

Alternative 2, capping, would be in compliance with all action-specific ARARs at the time of implementation. Surface water runoff controls would avoid any impact on adjacent streams, and fugitive dust emission control would reduce any impact on the adjacent environment. Therefore, compliance with location-specific ARARs will also be met by this alternative. Alternative 2 would comply with chemical-specific ARARs given the potential for future groundwater.

Alternative 3, treatment and capping, will be in compliance with all location- and action-specific ARARs during implementation. Alternative 3 would comply with chemical-specific ARARs given the potential for future groundwater contamination as predicted by modeling.

Alternative 4, off-site disposal, will comply with location- and action-specific ARARs. Chemical-specific ARARs are met by removal of the source of potential contamination.

6.3 SHORT-TERM EFFECTIVENESS

The complexity of the alternative typically results in decreased short-term effectiveness because of increased handling and processing associated with it. Alternative 1, no action, provides the greatest degree of protection to workers, the public, and the environment because the drummed soil/sludges and miscellaneous scrap are left undisturbed. Alternative 1 requires the shortest time to implement. The short-term effectiveness decreases in the alternatives in the following order: 2, 4, and 3. Alternative 2, capping, will require little handling or movement of the drums or boxes. Once the initial layer of fill material is deposited, the source material will be isolated from the workers. Dust will be generated by the earth-moving aspects of the alternative.

Alternative 4, off-site disposal, has a high degree of short-term effectiveness because it requires handling of the drums and miscellaneous scrap. Once a drum is overpacked, it is isolated from the worker. The drums are in poor condition and many may fail when handled, resulting in exposure to workers and the environment to the contents. Alternative 4 requires ~12 months to complete.

Alternative 3, treatment and capping, has the highest degree of short-term risks and requires the longest time to complete (25 months). Extensive handling and movement of the drums is required. The drums have to be unstacked, the contents removed and separated, and drummed sludge mechanically crushed and leached. These steps will result in fugitive dusts, producing potential physical risks to workers. The dusts may have high concentrations of nitrate and radioactive contaminants.

6.4 LONG-TERM EFFECTIVENESS AND PERMANENCE

Human health risks after remediation give an indication of the long-term effectiveness of an alternative. Human health risks from exposure of contaminated groundwater, surface water, and soils are reduced from the existing risk by varying degrees, depending on the degree of treatment provided by the alternatives. Risk values for the remedial target concentrations achieved by the remedial alternatives are presented in the detailed analysis tables.

Alternative 1, no action, has a low long-term effectiveness because the post-implementation residual risks are equal to the long term risks at the site. However, the remoteness of the site and the secured nature of the site should minimize the risk of direct contact with drummed soils/sludges and miscellaneous scrap. The continuation of the monitoring program at existing wells should suffice to evaluate potential contaminant migration.

Capping, as provided in Alternative 2, has a high overall long-term effectiveness and permanence for source control. The mobility of the contaminants due to infiltration is reduced if the cap is properly maintained. Cap failure may potentially result in groundwater contamination that could approach the no-action values. The continuation of the monitoring program at existing wells should suffice to evaluate potential contaminant migration.

Alternative 3, treatment and capping, offers a high degree of long-term effectiveness and performance. In Alternative 3 the toxicity and volume of the main constituent of concern (nitrate) is reduced by 70%, and the migration of constituents in the residual material is restricted by the installation of a cap (if the cap is maintained). The continuation of the monitoring program at existing wells should suffice to evaluate potential contaminant migration.

Alternative 4, off-site disposal, offers the highest degree of long-term effectiveness and performance. The drummed soil/sludge and miscellaneous scrap are transported off-site to a treatment and disposal facility. No source material remains at the site for potential future risks.

6.5 REDUCTION OF TOXICITY, MOBILITY, AND VOLUME THROUGH TREATMENT

Alternative 1, no action, does not reduce the toxicity, mobility, or volume of contaminants. The human health risks of nitrate and strontium-90 associated with the potential migrations of nitrate and strontium to groundwater under no action were presented in Sect. 4.4. The no-action alternative predicts 193 mg/L of nitrate in the groundwater, resulting in a hazardous quotient for nitrate of 3.4. Hazard quotients > 1 indicate that the nitrate concentration to groundwater may cause adverse noncarcinogenic health effects.

Exposure to 50 pCi/L of strontium-90 is predicted under the no-action alternative. Strontium-90 presents a carcinogenic health risk. The carcinogenic risk for no-action alternative is $8.3\text{E-}5$, which is within EPA's range of concern ($1.0\text{E-}4$ to $1.0\text{E-}6$).

Alternative 2, the capping alternative, reduces the mobility of constituents of concern through reduced infiltration. Some migration remains possible if the cap is not properly maintained. Capping reduces the concentration of nitrate and strontium-90 potentially migrating to the groundwater to 8 mg/L and 2 pCi/L, respectively. The hazard quotient for this nitrate concentration is 0.14 (<1), indicating that capping reduces the nitrate concentration to a level that will not cause adverse health effects. The risk associated with 2 pCi/L is $3.3\text{E-}6$, which is still in EPA's range of concern but lower than the risk associated with no-action alternative.

Alternative 3, treatment of the drummed sludge and capping, reduces the toxicity and volume of the nitrate in the source material. Capping reduces the mobility of the remaining inorganic constituents in the drummed sludge, drummed soil, and miscellaneous scrap. The treatment alternative reduces the potential nitrate groundwater concentration to 2 mg/L. This figure corresponds to a hazard quotient of 0.04. This value indicates that exposure to the corresponding nitrate concentration will not cause adverse health effects. Risks associated with strontium-90 will be reduced to the same level as Alternative 2, capping.

Alternative 4, off-site disposal, eliminates the toxicity, volume, and potential mobility of the constituents of concern in the source material but transfers the material somewhere else.

6.6 EASE OF IMPLEMENTATION

The design, engineering, and administrative requirements associated with Alternative 1, no action, are essentially negligible. Materials required for the components of this alternative are readily available. The remaining alternatives are all technically and administratively feasible. The engineering and design requirements increase with the complexity of the alternatives in the following order: Alternative 2, capping; Alternative 4, off-site disposal; and Alternative 3, treatment and capping.

Materials and services for the various alternatives are readily available. The cap design of Alternative 2 is easily implemented. Similar cap designs have been installed at the Y-12 Plant. Materials and services are available locally.

Alternative 3 has the highest degree of difficulty to implement because of engineering, design, and administrative requirements. Alternative 3 combines tested and available technologies to achieve the treatment, but their combination has high engineering demands.

Alternative 4 has high administrative requirements because of the large volume of material to be transported off-site.

Before implementing the remedial alternatives under CERCLA, a NEPA review must be performed (Levin 1989). Alternative 1, no action, has no NEPA requirements. Alternative 2, capping, has received a categorical exclusion and requires no further NEPA review. Alternatives 3 and 4 must be submitted for NEPA approval. It is anticipated this process will take 6 months.

6.7 COSTS

The comparative analysis of costs incorporates only differences in capital, operation and maintenance, and present worth values. Costs for each alternative have been provided in detail in Tables 1 through 4. The costs increase with the complexity of the alternative and the volume of contaminant to be treated. The no-action alternative has the lowest costs, with a 30-year present worth of \$483,000. Alternative 2, modified RCRA cap, has a 30-year present worth of \$1,467,500. Alternative 3, treatment and capping, has a 30-year present worth of \$3,033,000. Alternative 4, off-site disposal, has a 4-year present worth of \$14,073,000.

6.8 STATE ACCEPTANCE

Upon review, the Tennessee Department of Conservation concurs with the screening of these alternatives. Alternative 2, the modified RCRA cap, is recommended for implementation for the UNC Disposal Site.

6.9 COMMUNITY ACCEPTANCE

Community acceptance of these alternatives is not now known. Community viewpoints will be addressed during public review and comment.

6.10 PREFERRED ALTERNATIVE

A summary and comparison of the alternatives is presented in Table 5. Comparison of the CERCLA evaluation criteria indicates that Alternative 2, modified RCRA cap, is the preferred alternative. The modified RCRA cap provides the best balance of trade-offs among the alternatives with respect to the criteria used to evaluate the remedies. The preferred alternative protects human health and the environment, complies with ARARs, is cost-effective, and uses permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. The preferred alternative will not satisfy the preference for treatment as a principal element.

7. COMMUNITY PARTICIPATION

Community participation is encouraged in the decision-making process outlined in this proposed plan. Specific information related to this plan, including background on the remedial action site, investigative study results, and RI/FS, is available for review at the following information repository:

Administrative Record Location:

Information Resource Center
Environmental Restoration Program
Oak Ridge Reservation
Lee Wan & Associates
120 South Jefferson Circle
Suite 100
Oak Ridge, TN 37830
(615) 483-9870

Public comments to this proposed plan are welcomed and should be addressed to the following lead agency contact:

Robert C. Sleeman, Director
Environmental Restoration Division
Department of Energy, Oak Ridge Operations Office
Post Office Box 2001
Oak Ridge, TN 37831-8541
(615) 576-0715

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Regulatory support agency personnel are

Mr. Craig Brown
United States Environmental
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Region IV, 345 Courtland Street, NE
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Mr. Earl C. Leming
DOE Project Coordinator
Tennessee Department
of Conservation
2700 Middlebrook Pike, Suite 220
Knoxville, TN 37921

R The public comment period is from March 17 through April 30, 1991. On April 18, 1991, a public meeting will be held at 7 p.m. in Oak Ridge, Tennessee, in the American Museum of Science and Energy auditorium. The public is invited to ask questions and make comments regarding this proposed plan.

These public comments, along with written comments received during the 45-day comment period, will be incorporated into the administrative record.

R The community participation schedule will be as follows:

1991

February	Preparation of fact sheet
February	Background/informational article in Environmental Update publication (distributed quarterly to community on environmental restoration programs on the ORR)
February/March	Distribute fact sheets to the public and hold information briefings
March 15	Notice of public comment period (Advertisements and news releases will be placed with the local media notifying the public of the 45-day comment period, locations where copies of the plan can be viewed, names of agency contact periods who can answer questions and receive comments, and a summary of the plan contents)
April 8	Notice of public meeting scheduled for April 18 (advertisement and news release)
April 15	Reminder notice of public meeting (advertisement and news release)
April 18	Public Meeting American Museum of Science and Energy Oak Ridge, Tennessee 7 p.m., Auditorium
April 30	Close of public comment period

8. REFERENCES

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