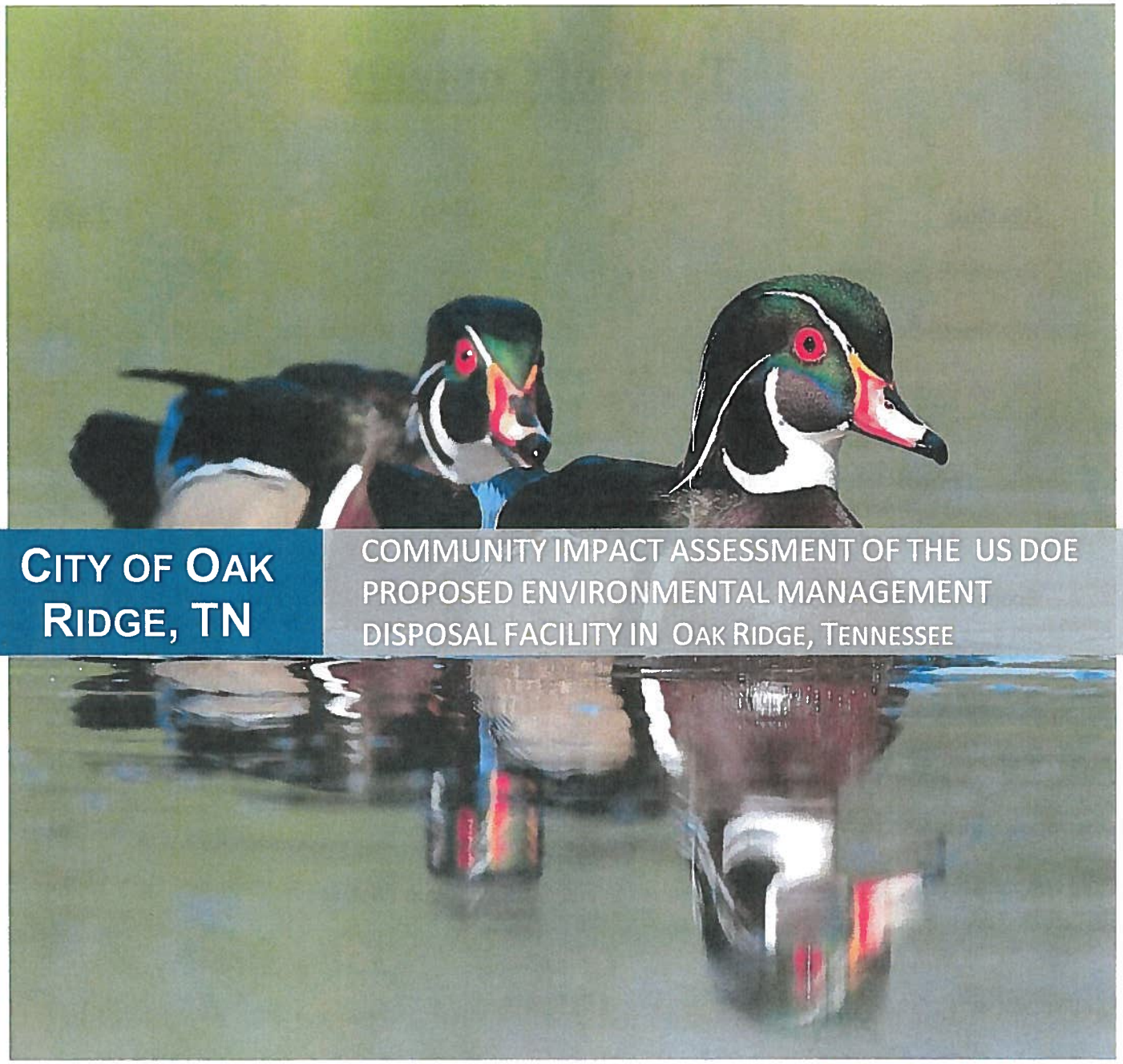
September 4, 2015



CITY OF OAK RIDGE, TN

COMMUNITY IMPACT ASSESSMENT OF THE US DOE PROPOSED ENVIRONMENTAL MANAGEMENT DISPOSAL FACILITY IN OAK RIDGE, TENNESSEE

THE FERGUSON GROUP LLC
1130 Connecticut Avenue, NW
Suite 300
Washington, D.C. 20036
202.331.8500
202.331.1598 fax

Table of Contents

Section	Page
Executive Summary	5
Introduction	15
Project Background	17
Scope of Services Item 1	20
EMDF Site Remedial Option	22
Off-Site Disposal Remedial Option	41
Analysis of Remedial Options	46
Scope of Services Item 2	59
Scope of Services Item 3	66
Recommendations	87
Bibliography	92
Appendix A	94
Appendix B - Approach for Analysis of Social and Economic Impacts	95

List of Figures

	Page
Figure 1 – Oak Ridge Reservation	17
Figure 2 – Location of the 13 sites considered for siting the EMDF	23
Figure 3 – Photograph of the EMDF site	25
Figure 4 – EMDF Site Plan	26
Figure 5 – Cross Section view of the EMDF Landfill	27
Figure 6 – Detailed view of EMDF Liner and Cover Layers	28
Figure 7 – Schematic Diagram of the French Drain System for the EMDF	30
Figure 8 – Geologic Map of the area near the EMDF site	32
Figure 9 – Locations of monitor well pairs and surface water flow monitoring stations	33
Figure 10 – Topographic and Hydrogeologic Map of the EMDF site	34
Figure 11 – Split Spoon samples from monitor well GW-976	35
Figure 12 – Rock Core section and Geophysical Logs	37
Figure 13 – Groundwater elevation at the proposed EMDF site	39
Figure 14 – Photograph of a Wier at Tributary NT-3 on the EMDF site.	40
Figure 15 – Costs Associated with On-site and Off-site Disposal Scenarios	41
Figure 16 – Off-Site Remedial Action Proposed Transportation Routes	42
Figure 17 – Process Diagram for Disposal of ORR Wastes at Off-Site Location by Trucks and Railcars	43
Figure 18 – Process Diagram for Disposal of ORR Wastes at Off-Site Location by Truck Only	44
Figure 19 – DOE Forecasted Waste Volumes at Oak Ridge Reservation	54
Figure 20 – Housing Stock by Construction Year as Percentage Stock Housing Stock	71
Figure 21 – Structures by Year Built as a Percentage of Total Housing Stock	71
Figure 22 – Median Housing Values Through Time	72
Figure 23 – Census Block Groups near the EMWMF with a Negative Change in Median Housing Values between 2000 and 2013 (Red) or an Increase of Less than 20%	73
Figure 24 – Percent Rental Housing Built Before 1980 by Census Block Groups near the EMWMF 2013	75
Figure 25 – Percentage of Persons Living at the Poverty Level, 2013 (US Census)	78
Figure 26 – Median Household Income, 2013 (US Census)	79
Figure 27 – Percent Population with Bachelor's Degree, 2012 (US Census)	80
Figure 28 - Percent Population without Health Insurance, 2012 (US Census)	81
Figure 29- Inflow/Outflow Job Counts for Oak Ridge, TN (US Census 2010)	85

List of Tables

	Page
Table 1 – Preliminary Screening of possible site locations for EMDF	22
Table 2 – Secondary Screening Criteria for selection of EMDF	24
Table 3 – Summary of Packer Test Results from Monitoring Wells at EMDF site	38
Table 4 – DOE Predicted Debris Types and Quantities for Volume Reduction	55
Table 5 – Summary of Size Reduction Cost/Benefit Study Results for the On-Site Disposal Alternative	56
Table 6 – Representative Repair Costs for 1940s Era Homes	76
Table 7 – Representative Demolition Costs for 1940s Housing (values based on estimated total number of 1940s homes in Oak Ridge)	77
Table 8 – Population Growth for Knoxville Metropolitan Area	82
Table 9 – DOE Direct Employment in TN – 2013	83
Table 10 – DOE Employment & Payroll by County, 2014	84
Table 11 – DOE Sales Tax Revenue in TN – 2013	84

Executive Summary

The City of Oak Ridge retained The Ferguson Group (TFG) Team to undertake a Community Impact Assessment of the U.S. Department of Energy's (DOE) proposed Environmental Management Disposal Facility (EMDF) on the Oak Ridge Federal Reservation (ORR). The primary basis for TFG's assessment was a technical review of the DOE report entitled "Remedial Investigation/Feasibility Study (RI/FS) for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Oak Ridge Reservation (ORR) Waste Disposal Oak Ridge, Tennessee - DOE/OR/Ol-2535&D3." The TFG Team's review of the RI/FS report also included a life cycle cost analysis and natural resource damage assessment (NRDA) associated with DOE's preferred remedial alternative.

DOE is undertaking this study because the Department has determined that there is insufficient capacity in the current operating low-level nuclear waste and hazardous waste landfill for the total volume of CERCLA waste expected to be generated during the life of the cleanup program at ORR. Therefore, additional waste disposal strategies are being evaluated, with DOE's preferred alternative being the construction of a second landfill at the ORR, the proposed EMDF.

The RI/FS report evaluates three remedial options:

1) No Action
2) Off-Site Disposal
3) Construct Environmental Disposal Facility (EMDF) next to the existing Environmental Management Waste Management Facility (EMWMF)

The No Action remedy would not provide for a coordinated effort to manage wastes generated by future CERCLA actions. Instead the remediation of future waste streams from ORR site cleanups would be addressed at the project-specific level. Because this remedy could result in a multitude of unique remedial options for specific site contamination, it is not possible to compare this option to the two remaining remedial options. Therefore, the TFG Team focused its effort on providing analysis of the two remaining proposed remedial options – Off-Site Disposal and On-Site construction of the EMDF.

The EMDF would be constructed to contain six waste cells with an estimated lifetime capacity of 2.5M yd3. DOE believes this waste capacity will be sufficient for completion of CERCLA remedial activities on the ORR. The construction of the EMDF is estimated to cost $817M and would encompass a 92-acre tract. It would be located just east of the EMWMF. DOE's plan is to start construction of the EMDF in mid-2017. From TFG's discussion with the DOE Environmental Manager for ORR in September, 2014, we understand that DOE is seeking to have the EMDF construction completed by 2021 and ready to accept waste by

2022. This timetable would provide a two-year window before the EMWMF is projected to be filled and closed in 2024.

The proposed EMDF has been designed to meet Resource Conservation and Recovery Act (RCRA), Toxic Substances Control Act (TSCA), and low-level nuclear waste regulatory design criteria and to be effective for protection of human health and the environment through waste isolation for up to 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years. However, the site would not be required to be licensed or permitted by either the State of Tennessee or the US DOE to operate as a low-level nuclear waste landfill as a result of the ORR designation as a Federal Superfund site. Permit and licensing requirements are waived under CERCLA Section 121 for on-site disposal activities.

The Off-Site remedial option would entail the transport of waste to approved disposal facilities. This process would be primarily undertaken by rail transport, but could also involve transport by truck. DOE's estimated cost for implementing the Off-site disposal alternative is $1.6B. DOE acknowledges that this alternative could isolate wastes more effectively long term than the EMDF alternative due to the arid climate and fewer receptors at off-site disposal facilities, but the Department believes that long-distance waste transportation in the short-term could result in more accidents, causing injuries or fatalities. It should also be noted, however, that a 2001 report produced by DOE to the Committees on Appropriations indicated that from 1996-2001 that shipments of spent nuclear fuel had been safely transported to the United States from 41 countries to the DOE facilities without a single death or injury.

The TFG Team's findings with respect to the EMDF remedial option are summarized in bulleted statements and organized by describing positive aspects of the EMDF site remedy and issues of concern.

<u>Positive Aspects of EMDF Site Remedy</u>

- The EMDF site is the most cost-effective remedy of the three considered by DOE. The EMDF cost is estimated at $.81B which is essentially half the cost of the Off-Site Disposal option.
- The EMDF parcel is appropriately zoned Controlled Industrial.
- The proposed site has some obvious advantages. The site's proposed location would allow use of a $20 million "haul road" that was built several years ago to transport wastes from K-25 and other demolition projects at ETTP. In addition, the Bear Creek Valley where EMWMF is located is not a pristine environment. Within Bear Creek Valley there are other contaminated sites. Therefore, the placement of the EMDF in an already contaminated area of the ORR would not be considered a

significant short-term incremental impact to either human health or the environment if the landfill construction is effective in containing wastes. In addition, the construction specifications for the EMDF landfill have been designed to protect human health and the environment through waste isolation for up to 1,000 years.

- The construction of the EMDF on the ORR is consistent with DOE's policy to treat, store, and in the case of LLW, dispose of waste at the site where it is generated, if practical, or at another DOE facility if on-site capabilities are not practical and cost-effective. Per DOE Manual 435.1-1(1)(2)(F)(4), the use of non-DOE facilities for storage, treatment, and disposal of Low-level nuclear waste may be approved by ensuring, at a minimum, that the facility complies with applicable federal, state, and local requirements and has the necessary permit(s), license(s), and approval(s) to accept the specific waste.
- The construction of the EMDF will damage surrounding natural resources; however, permitted landfills are not typically subject to natural resource damages claims as the result of permitted operations. In this case natural resource damages could only be claimed under CERCLA if there were releases of hazardous substances that exceeded permitted limits. Specifically CERCLA 107(f)(1) specifies that no liability shall be imposed where it can be demonstrated that "the damages to natural resources complained of were specifically identified as an irreversible and irretrievable commitment of natural resources in an environmental impact statement, or other comparable environmental analysis, and the decision to grant a permit or license authorizes such commitment of natural resources, and the facility or project was otherwise operating within the terms of its permit or license...."
- The TFG Team toured the EMWMF landfill site with DOE officials in September 2014. Our assessment of site operations was that the facility was well managed. In addition, a review of the leachate water analytical data from the underdrain system indicated that the landfill construction was effective in isolating waste from the groundwater and sub-soil media. The current wastewater treatment system has consistently met State water quality standards for recreational water use and for protection of aquatic biota.
- A 2013 study completed by the University of Tennessee's Center for Business and Economic Research documents the significant economic benefits DOE operations at the ORR have on creating jobs and income for residents and increasing state and local tax revenues. Overall spending by DOE and its contractors added approximately $3.6 billion to Tennessee's state gross domestic product (SGDP) in FY13. In addition, 40,646 full-time jobs were created in Tennessee by DOE in 2013, which includes both direct and indirect.

Issues of Concern

- The Superfund site decision process typically relies heavily upon laboratory analytical data collected from the testing of environmental media from a generally contaminated site and impacted off-site areas. Data are then evaluated relative to risk based criteria for both human health and ecologic receptors as well as Applicable Relevant and Appropriate Rules, Regulations, Standards and guidance (ARARs) to determine the degree of risk posed by site contaminants. DOE has prepared a prospective assessment of risk based on the type, quantity and concentration of waste contaminants that are presumed to be either transported off-site to a facility approved to accept these wastes, or for placement of these wastes in the proposed EMDF on the ORR.

  For Example, DOE did not undertake a risk assessment for the On-Site Disposal Alternative. This analysis represents a long-term risk analysis that can only be estimated when the types and amounts of contaminants are fully known.

- The proposed EMDF remedy was selected from 13 candidate sites at the ORR that had previously been identified during a 1996 DOE site screening study. DOE's rationale for not selecting certain sites was based on one or more of the following criteria: 1) the presence of karst features, 2) insufficient area for placement of the landfill, 3) surface water impacts, 4) unfavorable topography (excessive cut and fill), 5) known site contamination, and 6) sites being located in a the Bear Creek Valley Watershed - Zone 1 which has been designated for future unrestricted land use.

  The EMDF site location does not meet the Department criteria specified in the RI/FS for surface water impacts and sites with unfavorable topography.

- The RI/FS report documents the highly complex groundwater geometry of the site area. The majority of groundwater flow on the ORR occurs in highly complex fractures. The D3 limited groundwater and geotechnical/geophysical investigation at the EMDF documented the difficulty in determining aquifer hydraulic conductivity to measure the degree to which fractures can result in an unsuitable location to construct a low-level nuclear and hazardous waste landfill.

  DOE applied a ground water modeling to simulate future contaminant migration. The model treats the subsurface as an equivalent porous medium which limits its utility to predict the transport and fate of contaminants in highly complex fractured bedrock hydrogeologic setting.

- The conceptual design for the EMDF includes an underdrain system that, according to DOE "would act as a preferred migration pathway for contaminant movement ...if a failure of the liner system occurred." This structural requirement as part of the remedy has previously been documented to be a challenge when the EMWMF was being constructed. The fact that an underdrain system will also be required at the EMDF suggests that DOE should have given greater weight to other more suitable site locations that would not require the construction of an underdrain system (i.e., sites not located off a steep ridge area where the hydrologic regime is a high energy/force environment for the transmission of both surface water and groundwater).
- DOE presents in the RI/FS report limited information on hybrid remedial alternatives - combined on-site disposal and off-site disposal. These hybrid options, which range in 20% increments of off-site disposal from 20% to 100%, however, are not adequately described to fully understand the cost basis for each of the options. DOE should fully describe the assumptions/estimates used to calculate these cost ranges.
- DOE's cost estimate for the EMDF is based on a conceptual design that yields an approximate landfill waste disposal capacity (i.e., air space volume) of 2.5 M yd3, but does not include the cost for construction of the sixth cell as the current waste generation forecast (with a 25% volume contingency), would only fill five cells.
- Nuclear Regulatory Commission (NRC) technical documents indicate that disposal sites should be located in areas which have low population density and limited population growth potential. Disposal sites should be at least two kilometers from the property limits of the closest population centers. The nearest resident to the EMDF is approximately 0.84 miles north, and a larger residential subdivision is about 1.1 miles to the northwest. These subdivisions have a higher percentage of low-income and minority populations which DOE should take into consideration with respect to potential impact concerns.
- The EMDF site does not meet several other NRC regulatory requirements, nor TDEC's Licensing Requirements for Land Disposal of Radioactive Waste. NRC regulations require disposal facilities be selected so that projected population growth and future developments are not likely to affect the ability of the disposal facility to meet performance objectives. The disposal site must be generally well drained and free of areas of flooding and frequent ponding. Waste disposal shall not take place in a 100-year floodplain or wetland. Upstream drainage areas must be minimized to decrease the amount of runoff which could erode or inundate the disposal unit.

  NRC regulations also require that waste disposal facilities maintain appropriate separation of waste from the environment for a longer post-closure period than

DOE's own regulations. As a result of this and other differences, NRC licensees are required to maintain more robust post-closure funding mechanisms than the funding level assumed for the EMDF. Since DOE intends for TDEC to be responsible for post-closure issues at the EMDF, and given the known surface and groundwater issues at the EMWMF, the size of the post-closure fund for the EMDF should be carefully evaluated to ensure that the fund is sufficient for the future protection of the environment and local communities.

- A Remedial Action Objective (RAO) established by DOE provides for an acceptable level of risk of the Hazard Index (HI) to reach a risk tolerance of 3. The NCP provides for an unacceptable risk threshold of 1 or more. Therefore, a HI acceptable risk threshold of 3 would not be considered an acceptable level of risk. DOE's rationalization for increasing the HI risk to 3 is based on risk modeling uncertainty after 1,000 years.

  DOE's rationalization reflects the limitation of using the Superfund law and NCP regulation to determine the efficacy of siting a low-level nuclear and hazardous waste landfill. Superfund was developed only to address the adverse impact of hazardous substance release(s) into the environment and the consequent impact to either human health or ecologic receptors. The use of this law in this context draws into question whether the public will be adequately protected in the future from this facility siting.
- The risk assessment calculation for human health exposure from the Off-site Disposal remedial alternative in the RI/FS for radiation exposure results in a "total cancer risk (fatal and non-fatal) for maximum exposed individuals that ranged from 1.03E-03 to 8.64E-02 (non-fatal) to 7.75E-04 to 6.48E-02 (fatal). This is considered to be an unacceptable level of risk in the Superfund Program.

  Low-level nuclear waste is transported across the country safely on a daily basis and subject to U.S. Department of Transportation (DOT) and NRC health and safety requirements. The safety record for transport of theses wastes is good and well documented. It appears that the calculated risk assessment for off-site transport is overstated.

- A comprehensive NRDA of the EMDF cannot be completed until the site is constructed. Instead, the TFG Team undertook a bounding exercise to evaluate potential impacts to natural resources from the planned construction of the EMDF. The EMDF is expected to disturb approximately 92 acres of second-growth forest, result in the permanent re-location of an intermittent hillside tributary to Bear Creek, and destroy approximately 1.1 acres of forested wetland. Operation of the

site could also result in impacts to local groundwater and to Bear Creek if the site's liner fails, or if leachate collected and discharged from the site contains contaminants at concentrations above acceptable limits. If 92 acres of secondary forestland ecological services are permanently removed, the resulting loss would require approximately 1,000 acres of similar forested habitat to be preserved into perpetuity using past NRD settlements as a guide. Current land prices and management operations costs indicate the compensation required would range from $2 to $4 million. DOE has included these costs in their D3 RI/FS report.

- The landfill construction will require an Aquatic Resource Alteration Permit, which governs surface waters (streams and wetlands). Approximately 1.1 acres of forested wetlands would be lost in the construction of the landfill. This would require a minimum of 2.2 acres of wetlands restoration, and may require 3.3 acres depending upon the quality of the disrupted wetland. Mitigation bank credits range from $50,000 to $60,000 per acre. The amount of lineal feet of surface streams affected is unknown at this time. However, the affected area appears to have many seeps and streams. The Tennessee Stream Mitigation Program charges $200 per lineal foot for stream credit. DOE has incorporated these costs into their D3 RI/FS report.

- TFG's Life cycle cost analysis (LCA) of the proposed EMDF incorporated additional factors that were not evaluated in the DOE RI/FS. These factors included an analysis of short-and long-term economic opportunity costs associated with the Natural Resource Trustees decision to establish a permanent conservation easement comprising approximately 3,000 acres from land on the ORR with one portion of the easement located in the western part of the City of Oak Ridge. By selecting a section of the ORR contiguous to the City for the Watts Bar conservation easement, DOE has severely limited growth options on the western end of the City. This area of the City had already been identified for future growth, and, in fact, planning and infrastructure development to support this growth had already begun. Other areas on the ORR could have provided the same upland forest ecological benefits as the area selected for the easement without adversely impacting the long-term sustainability and quality of life in the City of Oak Ridge.
- TFG identified issues of concern with respect to the cost of operations analysis. The cost of operation of the EMWMF facility for surface water and groundwater management has been a more substantial than originally estimated, based in part on an incomplete initial characterization of the site. It is not clear that DOE has incorporated these actual operational cost issues into its assessment of EMDF costs.

DOE's off-site disposal cost estimates for commercial facilities (i.e., the EnergySolutions facility in Clive, Utah) were based on a simplistic analysis that compared the volume of waste bound for the proposed EMDF to the Department's current contractual rates for waste disposal at the facility. However, given the volume of material under consideration, it is likely that lower rates would be offered by disposal facilities for a guarantee of certain waste receipts. These discounts could substantially reduce off-site disposal costs.

- Socio-economic data for Oak Ridge clearly documents that the land areas immediately adjacent to the ORR are more economically distressed than areas located further from the reservation. Data from adjacent areas indicate that housing values have either declined or growth has been much slower than surrounding areas.

  The median home value in areas nearest to ORR is $102,400, median contract rent is $443, and the vacancy rate is 15.10%. The value of homes in this area of Oak Ridge is significantly lower than the median for the city of Oak Ridge which is $148,400 as of 2013. Median rents in Oak Ridge are $736 and the rental vacancy rate is 9.2%. From this data analysis, it is clear that the community nearest the EMWMF is lagging in all housing parameters relative to other areas in the City of Oak Ridge and surrounding areas, and it is reasonable to suggest a positive correlation between the introduction of a negative attribute (i.e., EMWMF) into an area which causes desirability to drop. The elevated percentage rental vacancy rates above 15% are also an indicator of a distressed housing market. This area also experiences the highest percentage rate of persons living in poverty at over 35%. The average poverty rate for the balance of the City is 17.7%.

  Oak Ridge has experienced marginal growth in population from 1990-2010. During this time period Oak Ridge's population increased by only 1,943 people, and the rate of population growth in Oak Ridge has trailed all the counties in the Knoxville Metropolitan Area. The closest county to population growth during this time period is Anderson County at 10.6% with Oak Ridge at 6.57%. Other counties such as Sevier, Loudon, and Blount Counties have experienced significant growth during this time interval. These counties have witnessed growth of 83.20%, 61.4% and 46.90%, respectively. The population growth lag that persists in Oak Ridge does not correlate with the City being a very large employment center unless ORR workers are consciously deciding not to reside in the City.

  Additional study is required to better quantify the degree of socio-economic impact to the City of Oak Ridge resulting from DOE's operations on the ORR, however, the

weight of evidence clearly reflects that on-site operations, including the EMWMF and the proposed EMDF have not resulted in an improved housing market and likely are major contributors to the degradation in this area of Oak Ridge. This is evidenced by the fact that the ORR is a major employment center where 26,929 people work in the City but live outside the City; only 5,292 live and work in the City; and 7007 live in the City but work elsewhere.

- Since the City of Oak Ridge was initially constructed as part of the Manhattan Project, it has certain unique characteristics. Principal among these is a large number of "legacy homes" constructed by the government as part of initial City development. Given their age and construction materials and techniques used in the 1940s, these homes typically now require substantial upgrades or demolition and replacement. The presence of these legacy homes within the City's housing stock has distorted and limited City development opportunities and increases the potential adverse socioeconomic impacts of facilities like the planned EMDF that may affect local housing values and future development

- Over time, the employment profile of the DOE facilities in Oak Ridge has shifted, and the facilities now employ substantially fewer people than in the past. In addition, fewer of these people live in Oak Ridge. These changes may have altered the local community's perception of the risks and benefits associated with operation of the EMWMF and the proposed EMDF – with associated impacts on local housing values and economic development. However, DOE has not evaluated these potential perception changes. These perceptual issues may be heightened by the relatively limited direct economic impact of the landfills on employment (as noted in the DOE RI/FS) and the lack of a mechanism (e.g., a tipping fee) to compensate the local community for the negative socioeconomic impacts typically associated with landfills.

- The City of Oak Ridge for more than a decade has raised concern with the funding DOE has provided to the City for revenues lost from the presence of the ORR in the city limits. As recently as October 20, 2014, City Council requested DOE revisit the Community Assistance Review as allowed within AECA 1955, PL 84-221, DOE Order 2100.12A to the City. DOE currently provides a funding subsidy to Oak Ridge based on an agricultural land use. The activities being undertaken at the ORR at Y-12, ORNL and ETTP should not be classified as an agricultural use. DOE should revisit this designation and revise the subsidy payments higher to reflect the use of the ORR for industrial uses.

- As noted in prior DOE Inspector General investigations of the existing EMWMF, a substantial quantity of waste disposed in the landfill was not sufficiently contaminated and could have been disposed at a State regulated solid waste landfill. This waste misdirection is one of the reasons that initial waste disposal volume estimates for the EMWMF have been exceeded and an additional landfill is necessary. Given the direct and indirect costs associated with landfill creation and the potential long-term risks associated with landfills, DOE should more aggressively police waste disposal at the on-site facilities, perhaps through use of a supplemental volume-based fee. In addition, DOE should evaluate additional remedial options such as enhanced characterization of waste that might allow most non-nuclear waste to be diverted from existing onsite landfills and disposed of through the state's Bulk Survey for Release Program.

- Based on the TFG Team's review of the RI/FS document and other relevant rules and regulations, we have developed a list of recommended actions for this project. These recommendations are fully described in a separate section of the report following the section on Scope of Services Item 3.

Introduction

The City of Oak Ridge retained the TFG Team to undertake a Community Impact Assessment of the U.S. Department of Energy's proposed EMDF on the ORR. The primary basis for TFG's assessment was a technical review of the DOE report entitled "Remedial Investigation/Feasibility Study for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal Oak Ridge, Tennessee - DOE/OR/01-2535&D3."

TFG was tasked with performing all of the services listed in the City of Oak Ridge's Request for Proposals (RFP) #FY2015-110. Specifically, the TFG Team was tasked with assessing the long-term, community impacts associated with the proposed EMDF. The assessment would include:

- A technical review of the DOE's 2012 Remedial Investigation/Feasibility Study (RI/FS) with identification of potential environmental impacts to the Oak Ridge community;
- A technical review of the DOE's 2015 D3 RI/FS;
- A life cycle cost analysis of the proposed facility that incorporates additional factors/alternatives not evaluated in the DOE RI/FS such as short-and long-term economic opportunity costs, and costs and benefits associated with alternatives not considered in the RI/FS; and
- An analysis of factors that would assist the Oak Ridge community in determining whether the community could accept the proposed EMDF including NEPA-type criteria such as potential human impacts, socioeconomic impacts, cultural and cumulative impacts, and off-site effects.

This report provides analysis and recommendations on DOE's preferred remedial alternative for disposal of both hazardous waste and low-level nuclear waste derived from environmental remediation activities occurring at the ORR. The report also provides an analysis of socio-economic impacts to the City of Oak Ridge from operations at the ORR.

The original project timeline for completion of this study was December 31, 2014 with a final report submitted by January 31, 2015. This timeline was extended to September, 2015 due to DOE completing on March 30, 2015 the PHASE I CHARACTERIZATION REPORT OF THE ENVIRONMENTAL MANAGEMENT DISPOSAL FACILITY SITE IN EAST BEAR CREEK VALLEY. The analysis of the March 30, 2015 report is included in TFG's report.

The TFG Team includes Karl Kalbacher, PG, TFG's Director of Environment, Economics, and Grant Services, as well two subcontract firms - ENVIRON International Corporation and EBA.

DOE's preferred remedy to construct a hazardous waste landfill for disposal of both hazardous waste and low-level nuclear waste could significantly impact the greater Oak Ridge region. This region includes the City of Oak Ridge and the following counties: Anderson, Knox, Morgan, and Roane. In 2012, elected officials from these political subdivisions formed the Oak Ridge Reservation Communities Alliance (ORRCA) to oversee and make recommendations to DOE's Office of Environmental Management (EM) on clean-up actions being undertaken at the ORR. ORRCA seeks to provide as much information as possible to the public on the RI/FS document with a particular focus on the EMDF proposal, and to engage in meaningful dialogue with the affected community on both the positive and negative aspects of the proposed facility.

Project Background

(The following information has been modified from the City of Oak Ridge REQUEST FOR PROPOSALS COMMUNITY IMPACT ASSESSMENT OF U.S. DEPARTMENT OF ENERGY'S PROPOSED ENVIRONMENTAL MANAGEMENT DISPOSAL FACILITY IN OAK RIDGE, TENNESSEE)

DOE's ORR covers approximately 34,000 acres and is located almost entirely within the corporate limits of the City of Oak Ridge. The site consists of three large industrial production facilities constructed as part of the World War II-era Manhattan Project: the Oak Ridge National Laboratory (formerly known as the X-10 Site), a research facility that includes nuclear reactors and ongoing energy, chemical, and biological programs; the former K-25 Site, now known as the East Tennessee Technology Park (ETTP), a former production facility that enriched uranium-235 by gaseous diffusion; and the Y-12 Plant, a production facility that formerly enriched uranium-235 by an electromagnetic process, and currently disassembles nuclear weapon components, processes nuclear materials, and performs other functions related to energy and national defense programs. Please see Figure 1 for the locations of these major facilities.

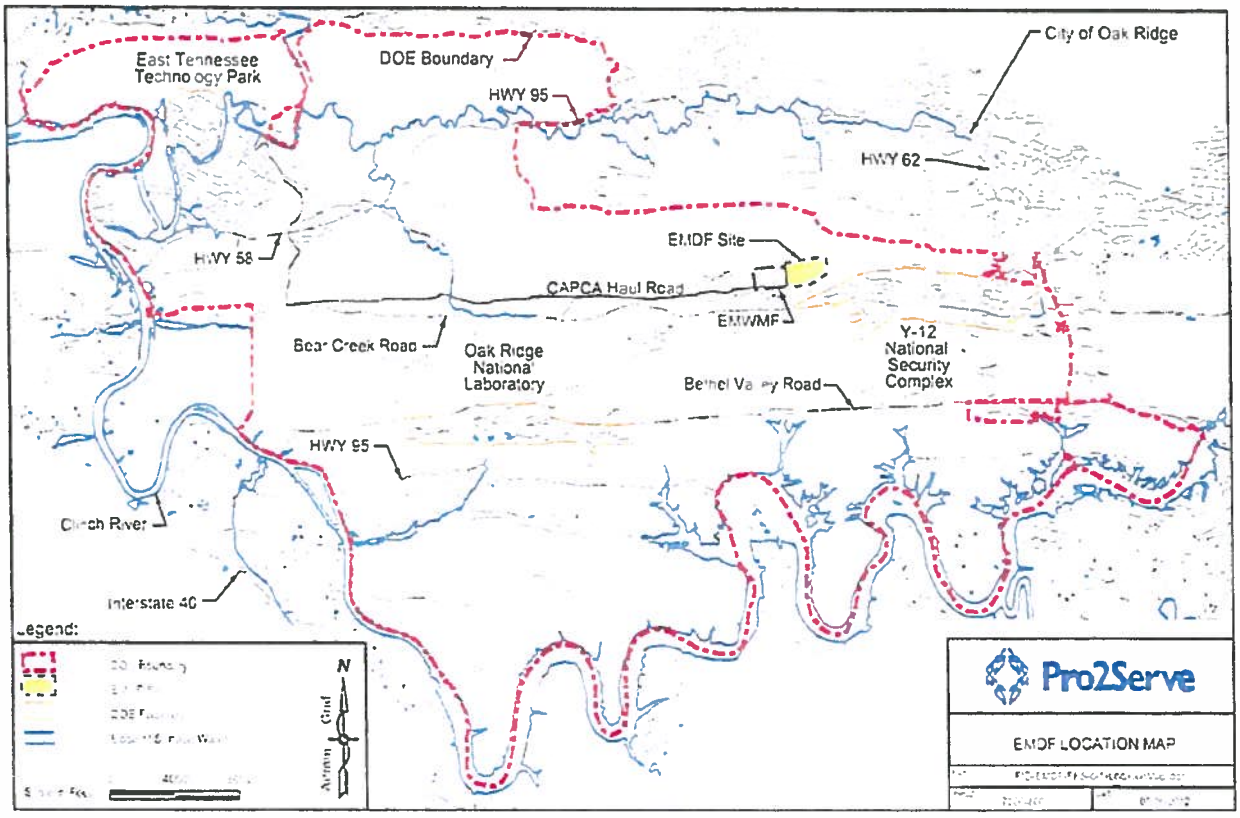


Figure 1. Oak Ridge Reservation

ORR site operations since the 1940's has generated a variety of radioactive, non-radioactive, and mixed (radioactive and non-radioactive) hazardous wastes, most of which were containerized and buried below ground or stored in buildings on the ORR.

An estimated 43,200 people obtain water from surface water intakes on the Tennessee River along a 118-mile stretch downstream from the site. The ORR was designated a National Priorities List Superfund site in 1989 pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). To date 52 operable units (OUs) have been identified at the ORR site and approximately 80 individual remedial and removal action decisions have been made. ORR contamination has migrated off-site into both groundwater and surface water bodies. In response, the Tennessee Department of Environment and Conservation (TDEC) issued a precautionary advisory for consumption of catfish in the Clinch River arm of Watts Bar Reservoir as a result of polychlorinated biphenyl (PCB) contamination.

TDEC, along with DOE and the U.S. Environmental Protection Agency (EPA) constitute the parties to the State of Tennessee's Federal Facilities Agreement (FFA). The FFA is a compliance agreement that sets forth the terms, framework, and enforceable schedule for the Federal government's environmental cleanup program at the ORR.

In 1999, the parties to the FFA signed a Record of Decision (ROD) to construct the Environmental Management Waste Management Facility (EMWMF) CERCLA Waste Cell on the ORR. As described in the ROD, the EMWMF would have 5 waste cells constructed. The EMWMF has been constructed and is currently operated by UCOR which is under contract to DOE. The EMWMF is designed to receive low-level (radioactive) waste, hazardous waste as defined under the Resource Conservation and Recovery Act (RCRA), waste as defined under the Toxic Substances Control Act (TSCA), and mixed waste consisting of combinations of these waste types. The EMWMF serves as the on-site landfill for cleanup waste from the ORR. The 1999 ROD was modified in 2000 to allow for the burial of classified waste.

In 2010, DOE issued an Explanation of Significant Differences (ESD) decision document for the 1999 EMWMF ROD. The ESD provided for the construction of a sixth waste cell. A sixth and final cell raised the EMWMF capacity to approximately 2.2 million cubic yards. This increased capacity has recently been determined by the FFA parties to be insufficient for the total volume of CERCLA waste expected to be generated during the life of the cleanup program at ORR. Therefore, additional waste disposal strategies are being evaluated, with DOE's preferred alternative being the construction of a second landfill, the proposed EMDF, which is included as an alternative in both the D1 September 2012 RI/FS and D3 March 2015 RI/FS.

Most federal construction projects require a comprehensive analysis pursuant to the National Environmental Policy Act (NEPA). A DOE policy established in 1994, however,

allows NEPA values to be incorporated into CERCLA-related projects in order to streamline analyses and expedite cleanup activities. Thus, the 1999 EMWMF ROD was based on CERCLA criteria as analyzed in DOE's 1999 RI/FS. The nine criteria include:

- Overall protection of human health and the environment;
- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs);
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume;
- Short-term effectiveness;
- Implementability;
- Cost;
- State acceptance; and
- Community acceptance.

The CERCLA criteria were also applied in DOE's RI/FS which recommended the construction of a second landfill facility, the proposed EMDF. The alternatives for waste disposition were evaluated with respect to the seven CERCLA criteria. The last two criteria, State acceptance and community acceptance will be evaluated during the issuance of the Proposed Plan of Remedial Action.

The three remedial alternatives were analyzed individually against each criterion and compared against one another to determine their respective strengths and weaknesses and to identify the key trade-offs that must be balanced for the ORR site. The results are described in the DOE's RI/FS.

From a community standpoint the CERCLA process does not require a detailed or robust socioeconomic analysis as prescribed by NEPA. The CERCLA process focuses primarily on toxicological impacts to both human health and to the immediate environment. NEPA requires consideration of potential human impacts of proposed federal actions, including socioeconomic impacts, cultural and cumulative impacts, and off-site effects. Since the proposed EMDF would be a permanent facility that will require perpetual surveillance and maintenance, the City of Oak Ridge and ORRCA have requested information and analysis on potential impacts of the proposed landfill on the affected host community in order to supplement DOE's, EPA's, and TDEC's analysis of the CERCLA-based community acceptance criterion.

Scope of Services Item 1

Technical review of the DOE's RI/FS with identification of potential environmental impacts to the Oak Ridge community

TFG's technical evaluation of the 2015 RI/FS document was undertaken relative to the requirements and limitations in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The NCP is the federal government's regulation for responding to oil spills and hazardous substance releases, specifically at Superfund sites.

A goal of the Superfund Program is to undertake response actions that achieve levels that are protective of human health, and which minimize the residual ecological risks at sites. Due to factors such as technical implementability and response costs at some sites, however, EPA recognizes that some response actions may not lead to complete recovery of the ecosystem and that additional restoration activities may have to be undertaken by the Federal and State Trustees to restore natural resources to their baseline condition within an acceptable time frame.

DOE's RI/FS for the disposal of ORR derived CERCLA wastes does not conform to the traditional Superfund process. The Superfund site decision process typically is focused on known contaminated sites and relies upon laboratory analytical data collected from the testing of environmental media from a defined site and impacted areas that are off-site (i.e., groundwater, surface water, sediment, surface water or air), and data from the testing of environmental receptors such as flora, fauna and invertebrates. This data and other site-specific investigations are evaluated relative to risk based criteria for both human health and ecologic receptors as well as in compliance with Applicable Relevant and Appropriate Rules, Regulations, Standards (ARARs) to determine the degree of risk posed by site contaminants.

In the case of this RI/FS, DOE has prepared a prospective assessment of risk based on the type, quantity and concentration of waste contaminants that are presumed to be either transported off-site to a facility approved to accept these wastes, or for placement of these wastes in the proposed EMDF on the ORR.

TFG has prepared a prospective analysis of the three proposed remedial options identified in the RI/FS report.

These three options are as follows:

1) No Action
2) Off-Site Disposal
3) Construct EMDF next to the existing EMWMF

The No Action remedy would not provide for a coordinated effort to manage wastes generated by future CERCLA actions. Instead, under this remedial option the remediation of future waste streams derived from ORR site cleanups would be addressed at the project-specific level. Because this remedy could result in a multitude of unique remedial options for specific site contamination, it is not possible to compare this option to the two remaining remedial options. Therefore, the TFG Team has focused its effort on providing analysis of the two remaining proposed remedial options – Off-Site Disposal and On-Site construction of the EMDF which are further described below.

The DOE cost estimate for construction of the EMDF is $.81 Billion. The cost estimate is based on a conceptual design that yields an approximate landfill waste disposal capacity (i.e., air space volume) of 2.5 M yd3, but does not include the cost for construction of the sixth cell as the current waste generation forecast (with a 25% volume contingency) would only fill five cells. This option is based on 100% of waste being disposed on-site. DOE notes in the RI/FS, however, that the disposal history for the EMWMF has been that between 1-4% of waste is disposed off-site as a consequence of not meeting Waste Acceptance Criteria (WAC). The DOE cost estimate for the Off-Site Disposal option is $1.6Billion. This option is based on 100% of waste being disposed off-site.

DOE acknowledges that the EMDF and Off-Site Disposal Options are cost estimates that will be refined based on information from the cleanup needs at sites on the ORR. These estimates can range from +50% to -30% per EPA guidance. The cost estimates for this RI/FS are based on the conceptual design and assumptions. Therefore, these costs are addressed qualitatively. For the On-Site and Off-site Disposal Alternatives, the following costs are addressed:

- Capital costs (direct and indirect)
- Operations costs, including long-term monitoring and maintenance costs
- Contingency (applied per EPA Guidance [EPA, 2000], see Appendix I) at 22% for the On-site Disposal Alternative total cost and 27% for the Off-site Disposal Alternative total cost.

The contaminants of concern at ORR are generally Base-Neutral Acids (BNA), metals, Polycyclic Aromatic Hydrocarbons (PAH), PCBs, pesticides, Volatile Organic Compounds (VOC) and radioactive materials. Of particular note is the large quantity of Mercury contaminated waste that will be generated from the demolition of mercury-process facilities at the Y-12 complex. DOE waste volume estimates for Mercury waste are approximately 381,000 yd3 of debris from the demolition of facilities at Y-12. Approximately, 150,000 yd3 of this is estimated to meet the definition of hazardous or mixed waste based on the mercury toxicity characteristic and would require treatment for land disposal.

EMDF Site Remedial Option

According to the RI/FS report, the proposed EMDF site was selected from 13 candidate sites at the ORR that had previously been identified utilizing data and information collected during a 1996 DOE site screening study (DOE 1996), the Environmental Management Waste Management Facility RI/FS (DOE 1998) and the 2008 ORR Planning document (DOE 2008a).

DOE's process for on-site landfill selection followed a two-step process. First, DOE undertook a preliminary screening process for selection of the EMDF site locations. This process consisted of the following steps: 1) identifying sites, 2) developing screening criteria to evaluate the sites, and 3) applying the criteria based on data and information gathered during the screening process. DOE screened the 13 candidate sites using an iterative process by applying criteria developed on the basis of facility design assumptions, available area, topography, regulatory drivers, and other siting considerations, including land use. Table 1 lists the 13 sites DOE evaluated and provides a brief description of the basis for consideration. The site locations are identified by number on Figure 2.

Candidate site	Preliminary Screening Criteria				Discussion
	Insufficient Area	Unfavorable Topography	Surface Water Impacts	Karst Features	
(1) East BCV-Option 1		X			Site eliminated due to unfavorable topography and excessive cut and fill.
(2) East BCV-Option 2			X		Carried forward to secondary screening, see Table C-6
(3) East BCV-Option 3			X		Site eliminated. Crosses headwaters of two tributaries (NT-2 and NT-3).
(4) East BCV-Option 4			X		Carried forward to secondary screening, see Table C-6.
(5) East BCV-Option 5			X		Modified version of Option 3 design (crosses NT-3 but avoids direct impacts to NT-2). Carried forward to secondary screening, see Table C-6
(6) East BCV-Option 6					A modified version of Option 4 design with an additional separate cell to the east. Carried forward to secondary screening, see Table C-6.
(7) East BCV-Option 7					Carried forward to secondary screening, see Table C-6.
(8) WBCV					Carried forward to secondary screening, see Table C-6.
(9) WWSY					Carried forward to secondary screening, see Table C-6.
(10) Chestnut Ridge		X		X	Carried forward to secondary screening, see Table C-6.
(11) West-Central Chestnut Ridge	X			X	Lack of suitable area for development due to proximity of SNS. Karst features are present.
(12) East Chestnut Ridge	X	X			Lack of suitable area for development due to site configuration and natural and anthropogenic features.
(13) Former Breeder Reactor Area				X	Carried forward to secondary screening, see Table C-6.

Table 1. Preliminary Screening of possible site locations for EMDF

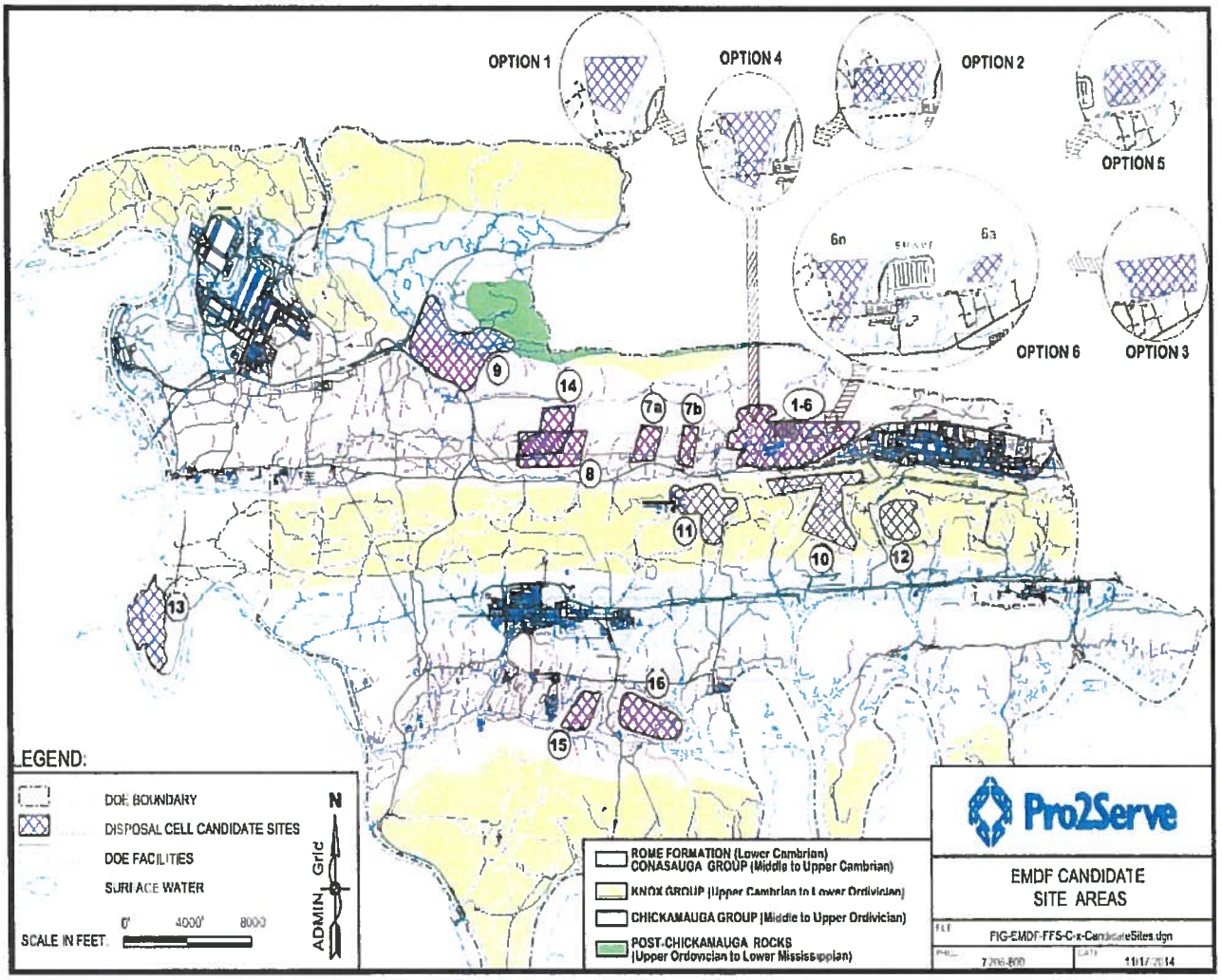


Figure 2. Locations of the 13 sites considered for siting the EMDF

DOE then undertook a secondary screening analysis of the 13 sites. This screening process focused on only the candidate sites which were carried forward from the preliminary screening analysis. A total of nine sites underwent further analysis. This process of secondary site screening is described in APPENDIX D - ON-SITE DISPOSAL ALTERNATIVE SITE DESCRIPTION of the D3 RI/FS document.

Candidate Site	Secondary Screening Criteria					Discussion
	Location and Access	Site Contamination	Buffer Zones	Land Use	Disposal Capacity	
(2) East BCV-Option 2		X	X			Site eliminated. Presence of buried waste and site contamination present significant challenges to facility construction.
(4) East BCV-Option 4			X		X	Site eliminated. Concern about adequate disposal capacity and shallow groundwater table south of the Haul Road.
(5) East BCV-Option 5						**Proposed candidate site.** Site is located in BCV Watershed Zone 3 designated for future controlled industrial use.
(6) East BCV-Option 6			X		X	Site eliminated. Concern about adequate disposal capacity. Two separate cells increase design, construction, and operations cost.
(7) East BCV-Option 7			X	X	X	Site eliminated. Adequate disposal capacity could potentially be achieved using two separate cells. Separate cells increase design, construction, and operations cost. Site is located in BCV Watershed Zone 2 designated for future recreational land use (short-term) and unrestricted land use (long-term).
(8) WBCV			X	X		Site eliminated. Site is located in BCV Watershed Zone 1 designated for future unrestricted land use.
(9) WWSY			X	X		Site eliminated. Site is located in an area designated for future unrestricted land use.
(10) Chestnut Ridge				X		Site eliminated. Located in the Walker Branch Watershed Research area, a long-term ecological research area.
(13) Former Breeder Reactor area	X		X	X		Site eliminated. Concern about proximity to the Clinch River. Site is located on karst bedrock and outside the DOE-ORR boundary.

Table 2. Secondary Screening Criteria for selection of EMDF

Sites subject to the secondary screening criteria were evaluated by DOE based on one or more of the following criteria: 1) the presence of karst features, 2) insufficient area for placement of the landfill, 3) surface water impacts, 4) unfavorable topography (excessive cut and fill), 5) known site contamination, and 6) sites being located in a the Bear Creek Valley Watershed Zone 1 which has been designated for future unrestricted land use. DOE's rationale for eliminating all sites except for East BCV – Option 5 is described in Table 2.

DOE ultimately chose East Bear Creek Valley-Option 5 for the location of the proposed EMDF. According to the DOE 2012 RI/FS report, "the proposed EMDF site is situated on the south flank of Pine Ridge. Pine Ridge has a very steep scarp (north-facing) slope, and a concave, very steep (- 30° or 1:2) to moderately steep (< 15° or 1:4) dip (south-facing) slope, and saw-tooth crest line. The dip slope is broken by a series of lower elevation knolls formed on harder rock units in the lower Maryville Limestone. Slopes on the south flank of

Pine Ridge are concave. Upper slopes feature sharp interfluves separated by deep, steep-sided ravines and zero-order and first order stream valleys organized in a trellis pattern with typical dip slopes. Valleys coalesce and open on lower slopes to form broad bowl-shaped valleys drained by first and second-order streams. Streams are moderately incised at the apparent boundary between the Rogersville Shale and the Maryville Limestone. There is no visible evidence of recent mass movement in the area. There are no indications of sink-holes or other surface features related to karst terrain." The photograph below is of the EMDF site (Figure 3). The road cuts were made to provide access for vehicles and equipment for the D3 Limited Investigation.

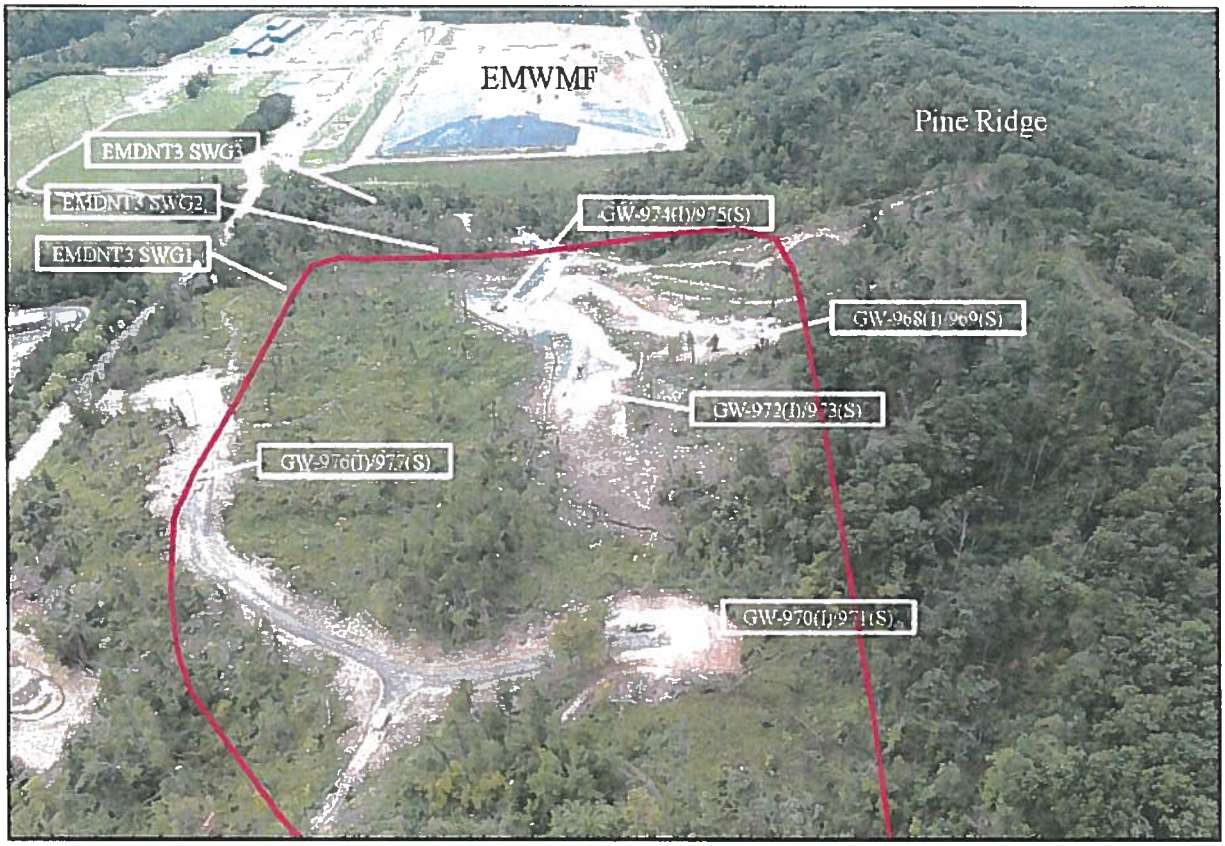


Figure 3. Photograph of the EMDF site. Source: DOE/OR/01-2535&D3

The conceptual layout for the EMDF site is presented in Figure 4. DOE is proposing that the EMDF be sited adjacent to the EMWMF landfill site. The EMDF would be constructed to contain 6 waste cells with an estimated lifetime capacity of 2.5M yd3. DOE believes this waste capacity will be sufficient for completion of CERCLA remedial activities on the ORR.

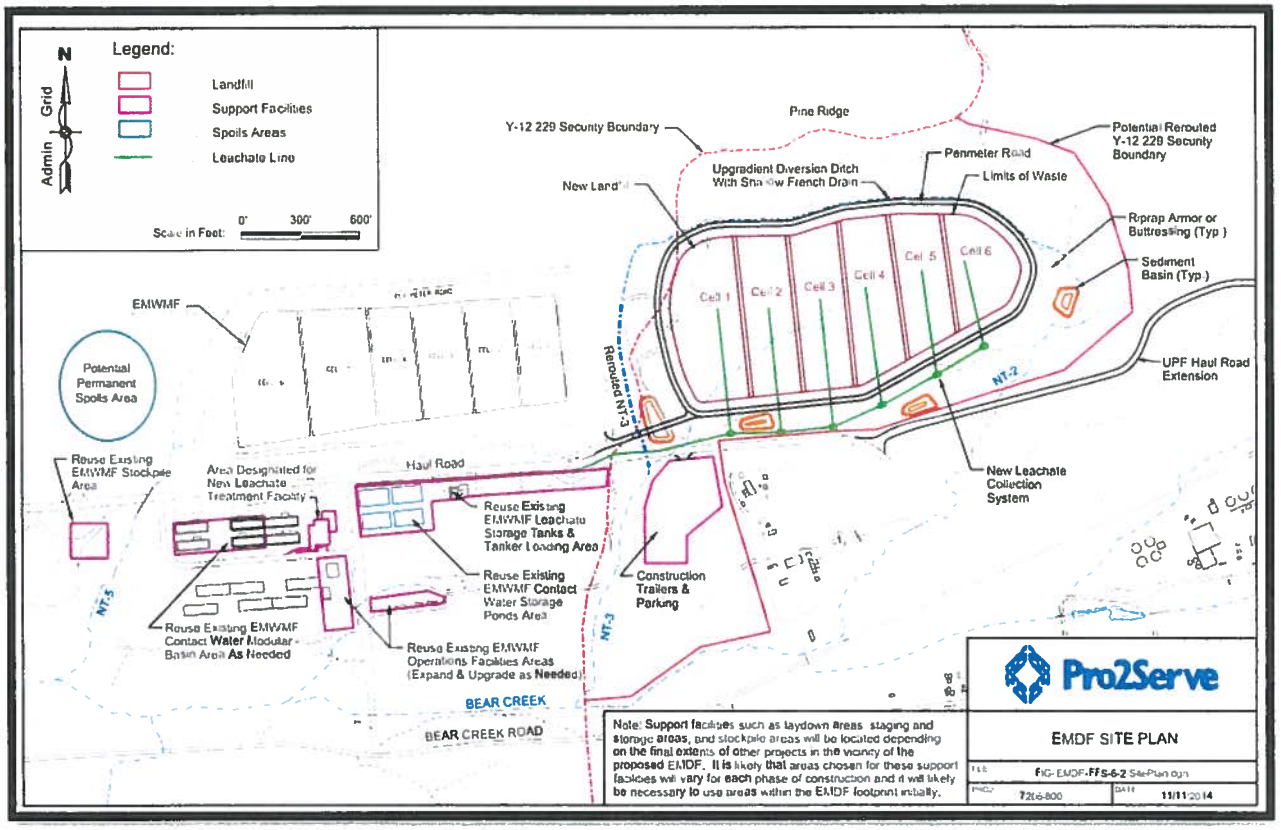


Figure 4. EMDF Site Plan

The schematic construction designs for the EMDF landfill are presented in Figures 5 and 6. The proposed landfill system has been designed to meet RCRA, TSCA, and low-level nuclear waste regulatory design criteria. The waste cell has been designed to be effective for protection of human health and the environment through waste isolation for up to 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years. Mercury contaminated waste is being proposed treated by macroencapsulation and subsequently placed in the EMDF.

The EMDF will not be required to be licensed or permitted by either the State of Tennessee or DOE to operate as a low-level nuclear waste landfill as a result of the ORR designation as a Federal Superfund site. Permit and licensing requirements are waived under CERCLA Section 121 for on-site disposal activities; however, Superfund sites are required to meet all ARARs.

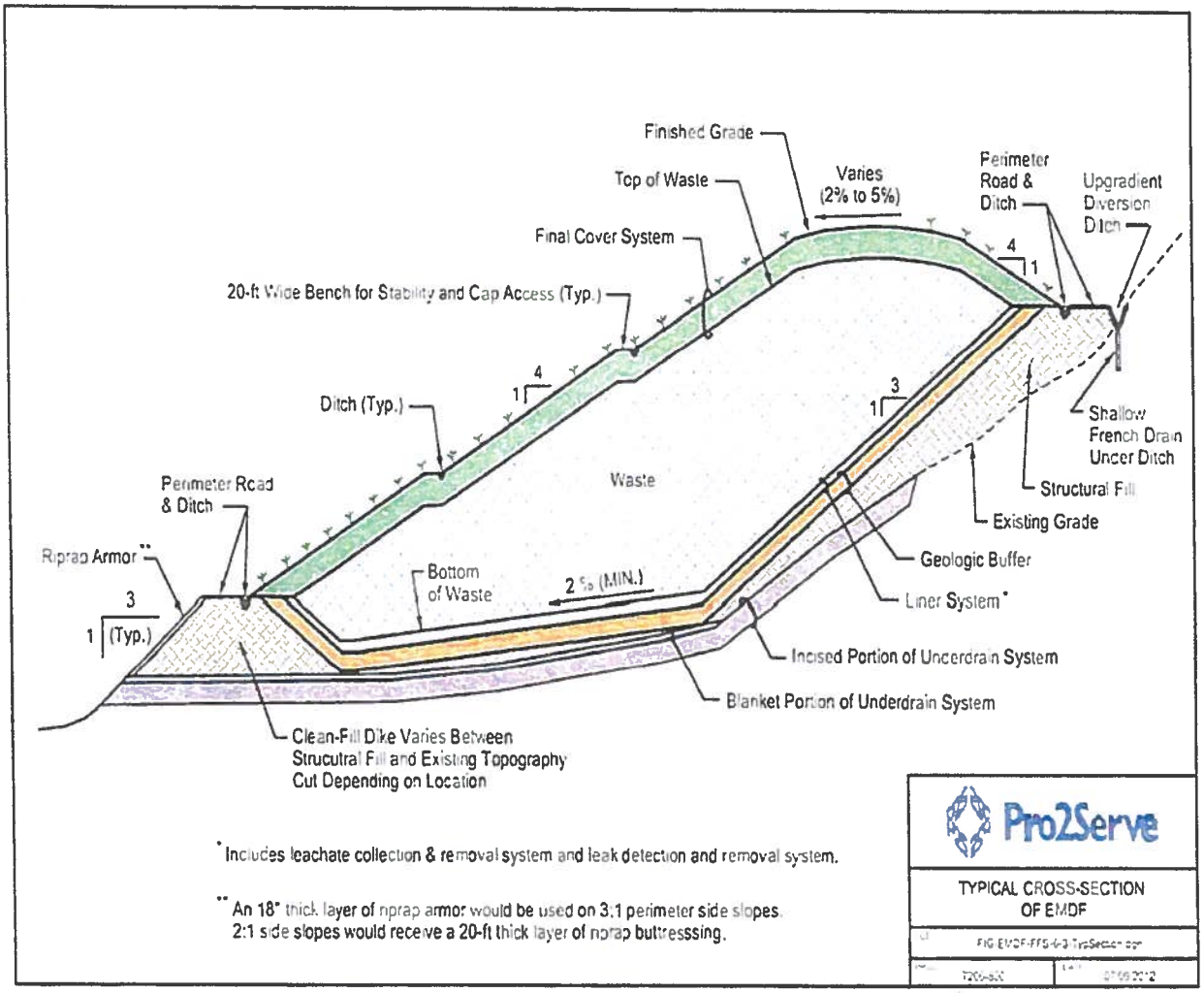


Figure 5. Cross Section view of the EMDF Landfill

The multi-layer final cover system for the EMDF landfill is designed to be eleven feet thick and consist of a protective soil layer, geotextile material, a leachate collection drainage layer, and a geomembrane liner.

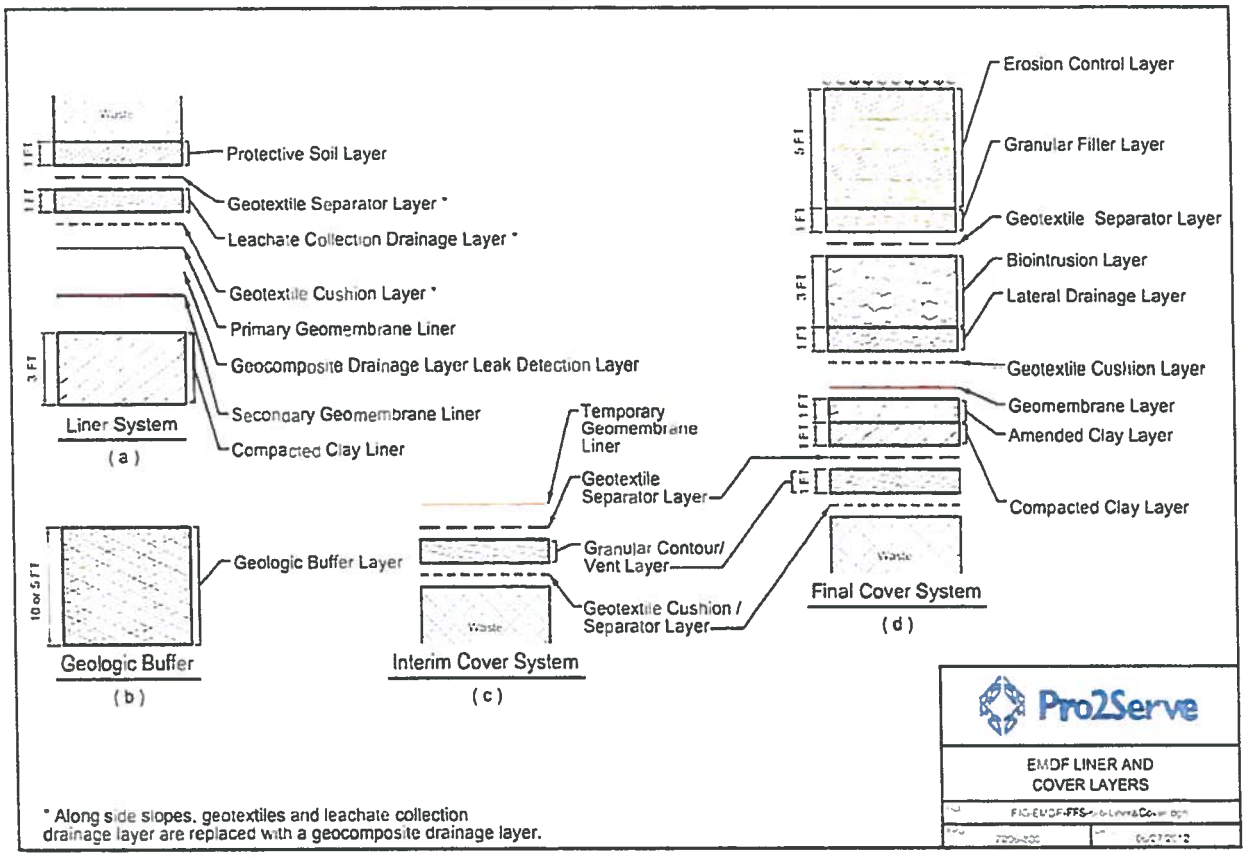


Figure 6. Detailed view of EMDF Liner and Cover Layers

DOE did not exclude from the on-site landfill screening process certain hydrogeologic constraints. Specifically, Federal and State requirements for geologic buffers underlying landfills were not used as a basis to delete sites from evaluation because DOE believes these buffers can be engineered to meet the standard of "equivalent or superior protection." According to DOE, "The Toxic Substance Control Act of 1976 geologic buffer requirement was not used as a threshold criterion because, although a buffer of such thickness may not reasonably be constructed, a waiver of this requirement is considered to be achievable on the basis of the design-achieving equivalent protection. Strict application of this requirement in the screening phase of the process would result in premature elimination of otherwise viable locations." Therefore, DOE will be requesting a waiver of the TSCA geologic buffer for the proposed EMDF site.

TSCA, 40 CFR 761.75(b)(3), requires a 50 foot geologic buffer between the bottom of the landfill liner system and the historical high water table level. DOE anticipates that the depth to the historical high water table for the EMDF would be less than 50 feet below the bottom of the landfill liner system. Therefore, a waiver from the TSCA requirement would be requested from the regulators based on "equivalent protectiveness" per NCP guidelines (40 CFR 300.430[f][1][ii][C][4]).

To provide equivalent protectiveness, the EMDF conceptual design includes at least a 10 foot thick geologic buffer between the landfill liner and ground water table per TDEC Rule 0400-11-01-.04(4)(a)(2). The thickness of the geologic buffer is measured from the bottom of the landfill liner to the top of the seasonal high water table of the uppermost unconfined aquifer, or to the top of the formation of a confined aquifer. The geologic buffer would consist of the geologic formation (i.e., in situ soil or rock) or an engineered structure (e.g., compacted native soil) meeting the following criteria:

- At least 10 ft thick with saturated hydraulic conductivity ≤ 1.0×10-5 cm per second; or
- At least 5 ft thick with saturated hydraulic conductivity ≤ 1.0×10-6 cm per second; or
- Other equivalent or superior protection.

The actual thickness and hydraulic conductivity of the geologic buffer will depend on subsurface conditions determined during the hydrogeological and geotechnical investigations for the EMDF. The geologic buffer could be comprised of compacted native soil or in situ fine-grained native soil, saprolite, or combinations of these geologic materials, depending on measured in situ hydraulic conductivity and layer thickness.

The proposed site has some obvious advantages. The site's proposed location would allow use of a $20 million "haul road" that was built several years ago to transport wastes from K-25 and other demolition projects at ETTP. In addition, the Bear Creek Valley where EMWMF is located is not a pristine environment. Within Bear Creek Valley there are other contaminated sites. Therefore, the placement of the EMDF in an already contaminated area of the ORR would not be considered a significant short-term incremental impact to either human health or the environment if the landfill construction is effective in containing wastes. The EMDF proposed location is also near the Oil Landfarm. The Landfarm is a closed sanitary landfill. Another former disposal site called the Boneyard/Burnyard is located downgradient of the proposed EMDF site.

TFG toured the EMWMF landfill site with DOE officials in September 2014. Our assessment of site operations was that the facility was well managed. In addition, a review of the leachate water derived from the underdrain system indicates that the landfill construction has been effective in isolating waste from the groundwater and sub-soil media. The current wastewater treatment system has consistently met State water quality standards for recreational water use and for protection of aquatic biota.

The EMDF EBCV site presents several challenges for construction of a low level nuclear waste and hazardous waste landfill. First, the site will require an extensive underdrain to manage and divert near-surface ground water (springs, seeps, and NT-2 and NT-3) and maintain low water table elevations. Second, in the conceptual design, a small portion of the NT-3 watershed on the upper slopes of Pine Ridge will remain, and a french drain and ditch

will be need constructed to convey surface water around the landfill. Finally, portions of the landfill and cap will be constructed into the steep sides of Pine Ridge.

Tributaries NT-3 and NT-2 will also be directly impacted by landfill construction. The main (east) branch of NT-3 would be entirely covered by the landfill, as would some smaller branches of NT-2 and NT-3. Four to six springs and seeps would also be covered. Direct impacts to streams and wetlands outside the landfill area should be mitigated by proper planning and implementation of storm water control systems. The intent of the underdrain system would be to intercept potentially upwelling ground water and prevent it from rising up into the geologic buffer and liner system.

Provided below is a schematic design of the french drain system in cross-section view. The french drain will include a 10 foot base composed of high permeability Number 57 stone to collect shallow groundwater.

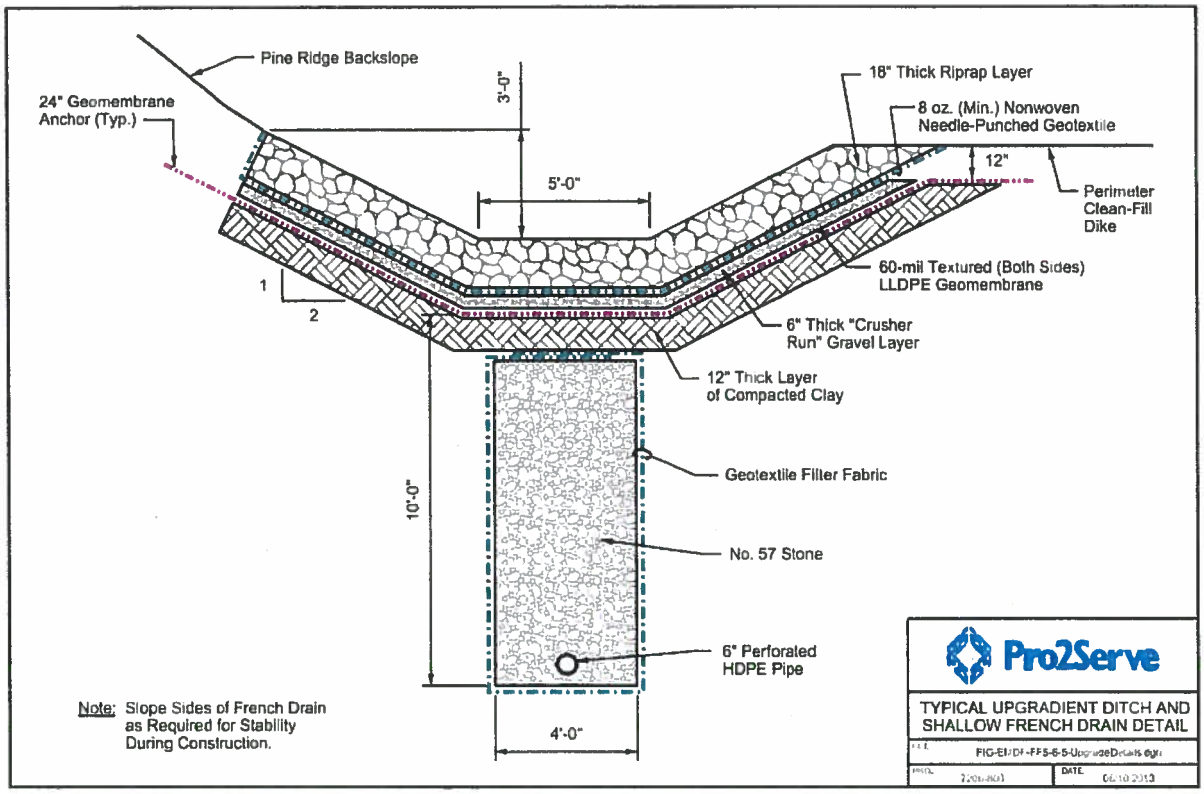


Figure 7. Schematic Diagram of the French Drain System for the EMDF

The construction of the EMDF is estimated to cost $817M and would encompass a 92-acre tract. It would be located just east of the EMWMF. Approximately 70 acres of the site would be dedicated to waste disposal. The conceptual design capacity of the proposed EMDF site is 2.5M yd3 and includes a 25% uncertainty allowance. The waste volume estimate was developed by using DOE's Waste Generation Forecast data. DOE incorporated

into the cost estimate projects and corresponding waste volume estimates based on an annual funding of $420 Million for ORR cleanup projects through Fiscal Year (FY) 2043.

DOE's plan is to start construction of the EMDF in mid-2017. From TFG's discussion with the DOE Environmental Manager for ORR in September, 2014, we understand that DOE is seeking to have the EMDF construction completed by 2021 and ready to accept waste by 2022. This timetable would provide a two-year window before the EMWMF is projected to be filled and closed in 2024.

DOE acknowledges that other uncertainty factors will impact the timing of when the EMWMF will be filled including funding, project sequencing and waste volume estimates. A lower annual funding could delay the EMWMF reaching maximum capacity and the operational start of a new facility. Conversely, a higher annual DOE funding for ORR site cleanup could result in the EMWMF reaching capacity sooner. In addition, the CERCLA waste to be generated during future cleanup actions will likely be somewhat different from the CERCLA waste generated to date, given that both Y-12 and ORNL sites will be the sources of this waste, whereas ETTP has been the major source of CERCLA waste to this point in time. DOE notes that detailed characterization data does not exist for many of the individual deactivation and decommissioning sites and, therefore, remediation projects and characterization of future waste streams are based on available data for waste disposed at EMWMF.

Limited Phase I Site Characterization

DOE undertook a limited Phase I Site Characterization of the EMDF site which included a characterization of the surface and subsurface soil, surface water, groundwater and geologic formations. The geology of the EMDF site is composed of fine-grained clastic bedrock units of the Pumpkin Valley, Rutledge, Rogersville, and lower Maryville formations. These units are located north of the carbonates of the Maynardville Limestone and Copper Ridge Dolomite.

The Rome Formation underlies the Pumpkin Valley Shale and forms the crest of Pine Ridge. The lower Rome Formation is composed of yellow-brown or green micaceous fissile shale with thin interbeds of gray clayey limestones and dolomites. The upper units of the Rome Formation consist of interbedded maroon sandstone, siltstone, and shale. A geologic map of the EMDF site is provided below.

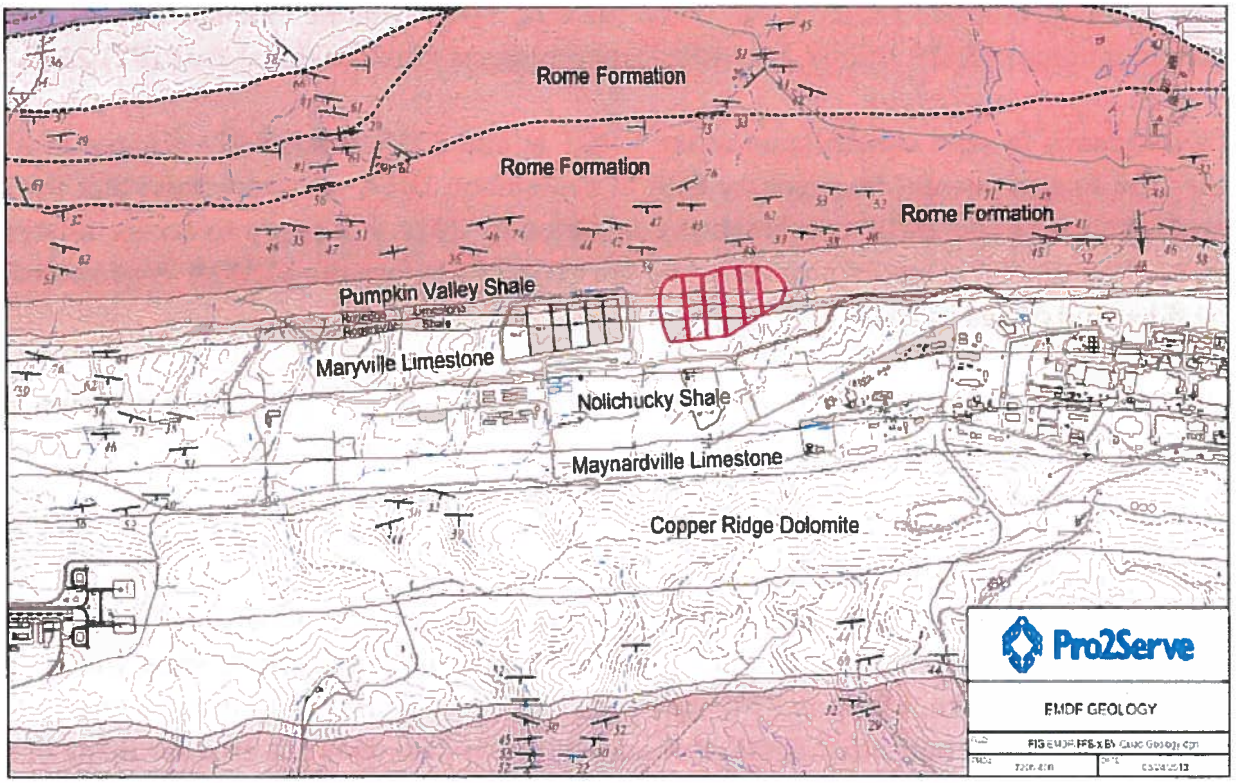


Figure 8. Geologic Map of the area near the EMDF site

The RI/FS report indicates that there is no evidence of active earth movement processes. "As defined in 10 CFR I00, Appendix A, a seismically capable fault is one that has had movement at or near the ground surface at least once within the past 35,000 years, or recurrent movement within the past 500,000 years. The nearest capable faults are approximately 300 miles northwest in the New Madrid (Reelfoot Rift) Fault Zone (DOE 20lla). Historical earthquakes occurring in the Valley and Ridge are not attributable to fault structures in underlying sedimentary rocks, but rather occur at depth in basement rock."

The RI/FS report documents the highly complex groundwater geometry of the site area. "The majority of groundwater flow on the ORR occurs in fractures (Solomon et al. 1992; Moore 1988). Overall, fracture spacing and density was found to be highly complex and anisotropic, because some fracture sets and orientations are more well developed than others. Sledz and Huff (1981) attempted without success, to use linear regression to find relationships between fracture length, density, lithology, and bed thickness. The result indicated little correlation between the parameters evaluated..... Hydraulic conductivity is difficult to measure in fractured or karstic aquifers, and its significance as a measure of gross hydraulic behavior is arguable."

A limited Phase I Site Characterization was conducted of the proposed EMDF to provide site-specific geological and hydrogeological data. The Phase I Site Characterization

included installation of five shallow-deep well pairs at strategic locations and three flumes to monitor surface water. Two wells were cored throughout the bedrock interval, and geophysical logging was conducted in all deep wells. Packer tests were carried out in all deep wells, and slug tests were conducted in the four shallow wells that encountered the water table. The nine wells that encountered ground water and all three flumes were instrumented to continuously monitor and record water level and water quality data. The locations of the well pairs and the surface water flow monitoring stations are depicted on the figure below.

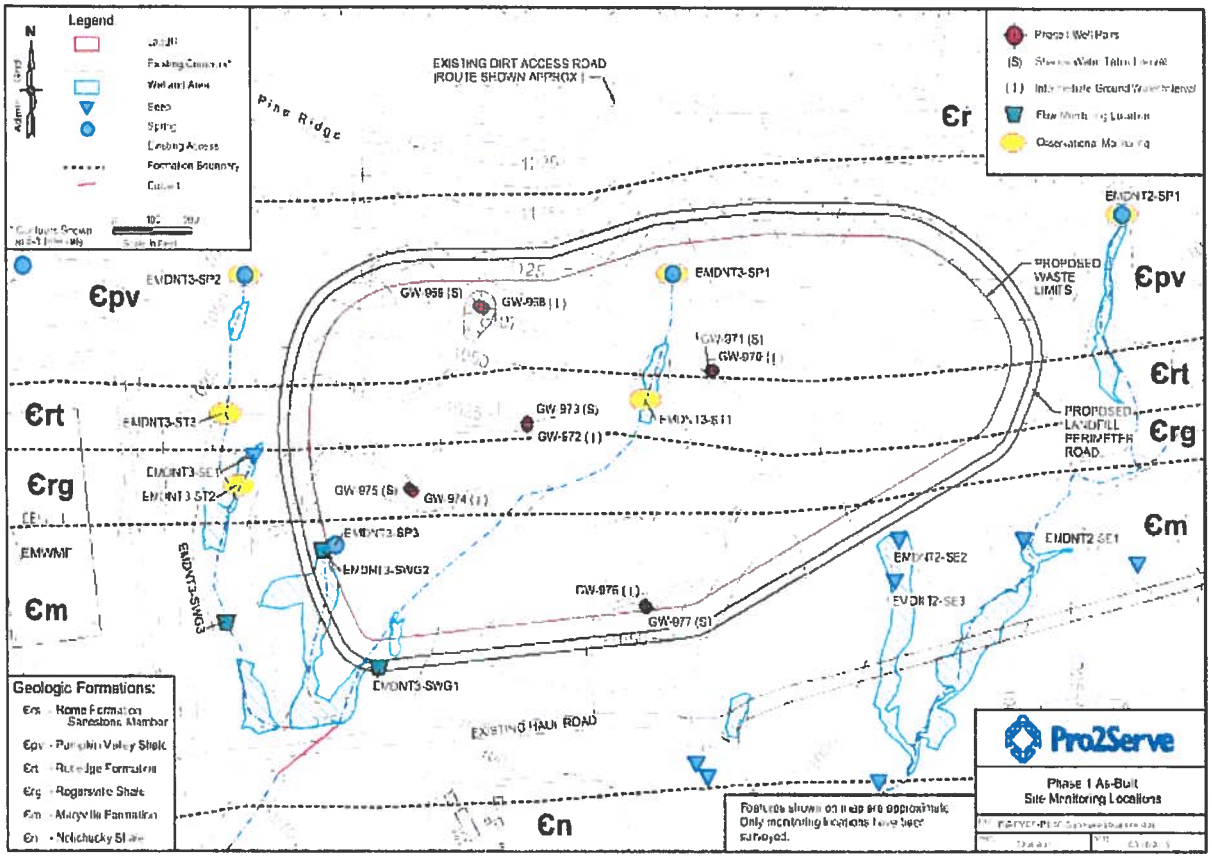


Figure 9. Locations of monitor well pairs and surface water flow monitoring stations

The Phase I Limited Site Characterization found that depth to ground water at the EMDF site ranges from less than 3 feet to greater than 40 feet, depending on topographic position. The northern section of the EMDF is topographically higher than the southwestern area. The northern area is a groundwater recharge area and as such the depth from the ground surface to the water table is around 40 feet. Conversely, the southwestern part of the site is topographically lower and is where the shallow groundwater discharges to surface water (NT-3). The Limited Phase I Investigation identified that shallow ground water responds rapidly to rainfall by rising elevation. The figure below documents the relationship between shallow groundwater and land surface.

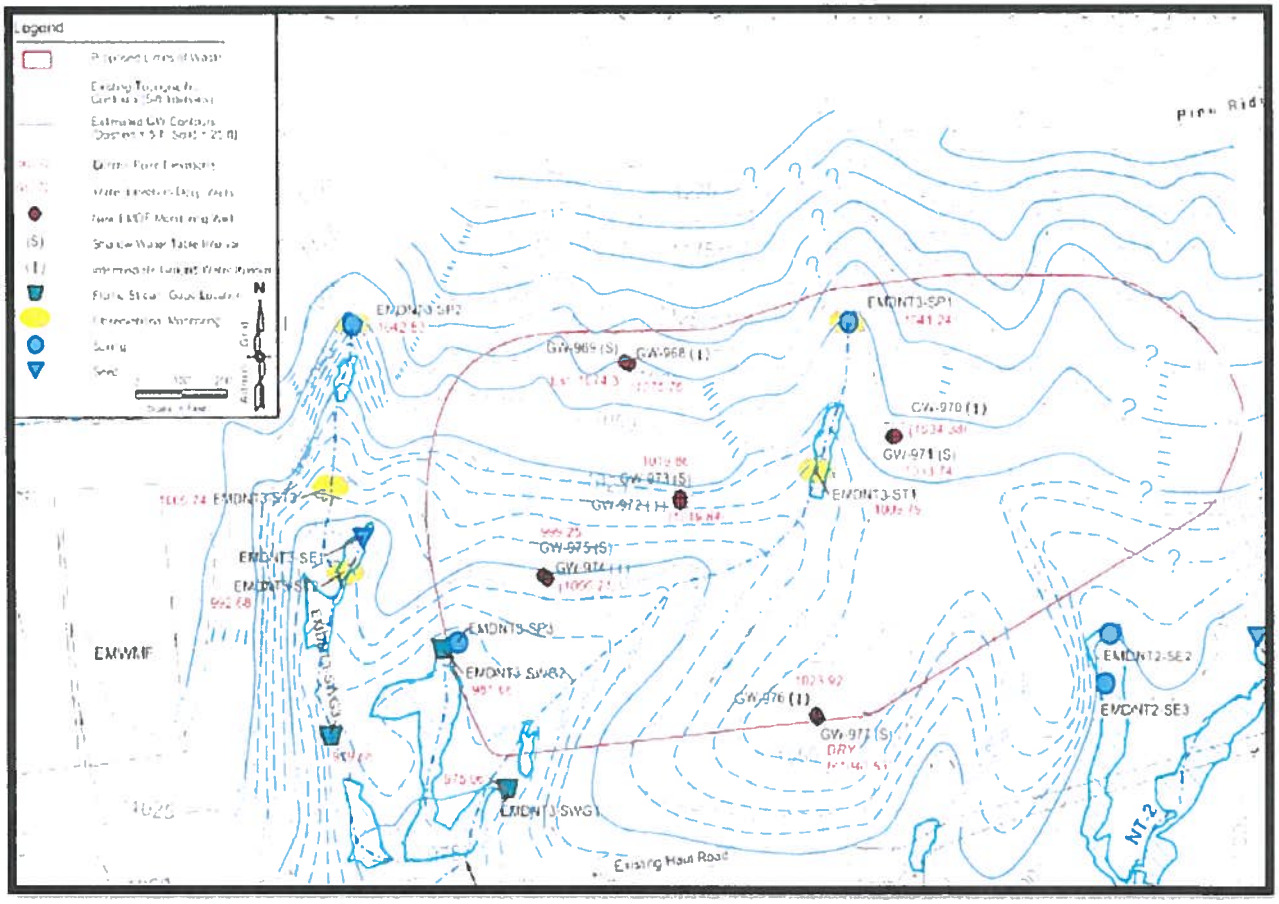


Figure 10. Topographic and Hydrogeologic Map of the EMDF site.

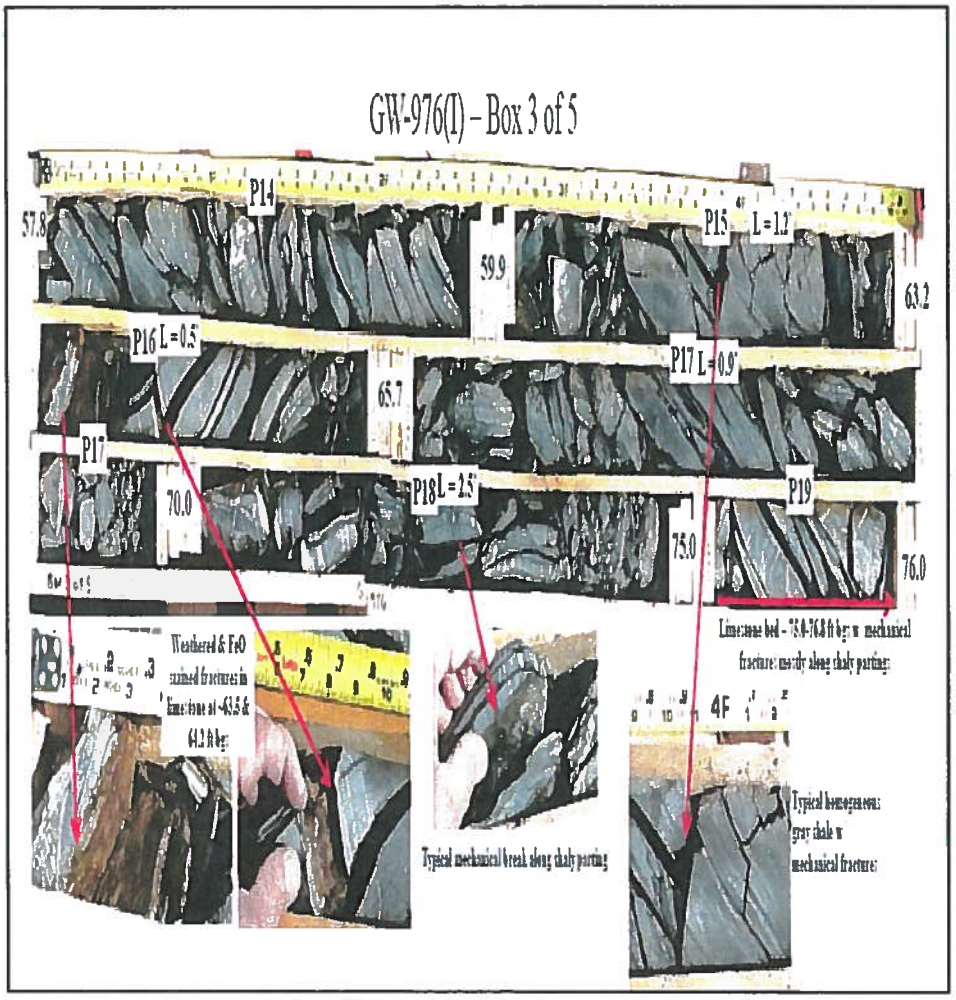
As part of the Phase I Limited Site Characterization DOE collected split spoon samples during the construction of the monitor wells. Split spoon samples collect soil at selected depth intervals. DOE tested the soil samples for geotechnical properties to understand the structural integrity of the site for placement of a landfill and to better understand the relationship between precipitation events and the effect on both surface water flow and groundwater flow and measurement. The pictures below are split spoon samples from monitor well GW-976. A section of rock core from a split spoon sampler was advanced ahead of the drill bit to collect an undisturbed soil sample. This is a sample of the regolith which is weathered bedrock - regolith is present at the EMDF below the soil horizon. This is a low permeability unit that is semi-consolidated.

4th Split-spoon (14-15.5 ft) Relic bedding at GW-976

Relic bedding in 5th Split-spoon (19-20.5 ft) at GW-976

Figure 11. Split Spoon samples from monitor well GW-976

As part of the Phase I Limited Site Characterization DOE collected deeper interval core samples from monitor well GW-976. This unit photograph below is from the 57 to 76 foot below ground surface interval. The rock is composed of grey shale to limestone. This section of rock core has a significant fracture pattern which is also reflected in the caliper log indicated in red. The caliper measures the borehole integrity. When the caliper log swings to the right it means that the borehole has large voids. These voids are confirmed on the drillers log and the tele-viewers to the right and the packer tests.


GW-976(I) – Box 3 of 5
P14
57.8
59.9
P15 L = 1.2'
63.2
P16 L = 0.5'
65.7
P17 L = 0.9'
P17
70.0
P18 L = 2.5'
75.0
P19
76.0
Weathered & FeO stained fractures in limestone at ~63.5 & 64.2 ft bgs
Typical mechanical break along chalky parting
Limestone bed - 75.0-76.0 ft bgs w mechanical fracture mostly along chalky parting
4F
Typical homogeneous gray shale w mechanical fracture

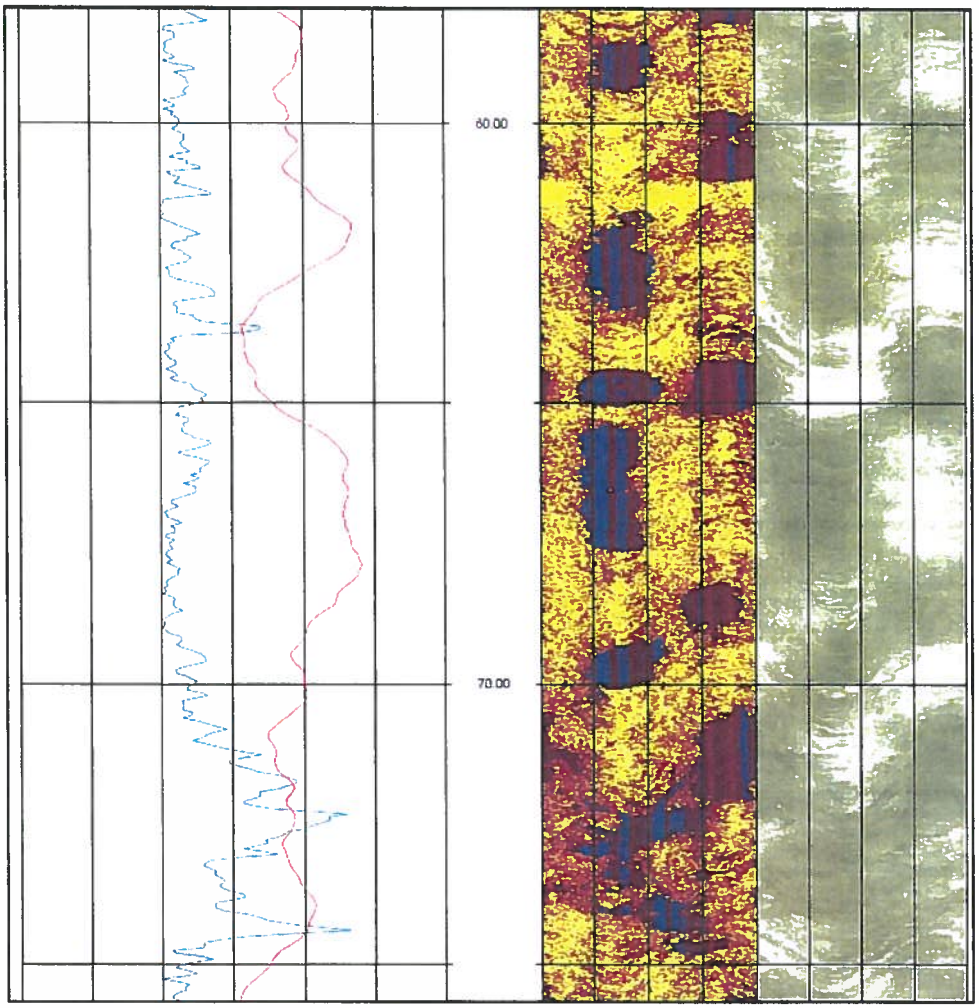


Figure 12. Rock Core section and Geophysical Logs

In addition to the geophysical and geotechnical study, DOE completed groundwater flow testing in selected intervals of bedrock through use of a packer test. A packer test is completed prior to the completion of the monitor well construction. During the drilling of a monitor well segment a section of the aquifer is isolated from above and below with the use of inflatable bladders. The groundwater present in the area between the bladders is then pumped to determine the hydraulic conductivity (K). The K defines the ability of the aquifer to transmit water and refines the understanding of the properties of the geologic formation - in this case with respect to the degree of fracturing. Highly fractured geologic formations will generally have higher K values and can be an indicator of its structural instability. K values in the range of 1 x E-4 are indicative of more productive intervals – K's on the order of 1 x E-6 are indicative of less permeable units.

As depicted below in the summary of packer test intervals, the core interval of 57 to 76 foot for monitor well GW-976 has a high K value which correlates well with the geotechnical and geophysical information collected for the interval – i.e., fractured bedrock. The K value from the packer test ranges from 1.21 E-5 to 5.93 E-5.

Open Bedrock Borehole (8-inch diameter)	Date of Test	Test Interval (ft)	Pressure (psi) with range in brackets	Hydraulic Conductivity - K (cm/sec)	Average Hydraulic Conductivity - K For Tested Interval (cm/sec)	Comments
GW-968	10/20/2014	23-33	15	3.12E-05	3.1E-05	No 30 or 45 psi tests
GW-970	10/22/2014	44-54	15 [15-16]	1.70E-04	1.5E-04	
			30	1.34E-04		
	10/22/2014	52-62	15 [15-16]	3.17E-05	3.1E-05	No 45 psi test
			30 [29-30]	2.94E-05		
	10/22/2014	65-75	15	1.59E-05	1.4E-05	
			30	1.36E-05		
			45	1.35E-05		
GW-972	10/16/2014	65-75	15 [14-16]	No or limited/erratic flow - K indeterminate	K indeterminate	
			30 [30-35]	No or limited/erratic flow - K indeterminate		
			45	No or limited/erratic flow - K indeterminate		
	10/15/2014	75-85	15	No or limited/erratic flow - K indeterminate	K indeterminate	Bottom packer failed to seat
			45	No or limited/erratic flow - K indeterminate		No 30 PSI test. No flow after initial 1.0 gal
GW-974	10/16/2014	33-43	15	No or limited/erratic flow - K indeterminate	K indeterminate	No flow after initial 0.5 gal
			30	No or limited/erratic flow - K indeterminate		
			45	No or limited/erratic flow - K indeterminate		
GW-976	10/21/2014	49.5-59.5	15	4.99E-05	5.6E-05	
			30 [26-29]	5.75E-05		
			45 [40-41]	5.93E-05		
	10/21/2014	68-78	15	No consistent flow/K indeterminate	K indeterminate	
			30	1.21E-05	1.2E-05	
			45	1.16E-05		

Table 3. Summary of Packer Test Results from Monitoring Wells at EMDF site

The data collected from the Limited Phase I Investigation at the EMDF site provides valuable information on local hydrogeologic conditions. Ground water flow occurs mainly in fractures, and the overall direction of flow is from North to South. The depth to ground water varies from less than 3 feet below ground surface in the low areas along the tributaries in the southern portion of the site to more than 45 feet deep along the higher elevations of Pine Ridge. In the southern portion of the site ground water has an upward gradient and discharges to the tributaries. The tributaries are natural discharge areas for both shallow perched (storm flow zone) ground water and ground water upwelling from bedrock. Shallow perched ground water moves laterally down slope where it discharges as "wet weather" seeps along the base of Pine Ridge. Numerous seeps and springs have been mapped within the site, including three seeps and springs which "daylight" near the contact

of the Rome and Pumpkin Valley Shale Formations, forming the headwaters of NT-2 and NT-3. Figure 13 is a schematic depiction of shallow groundwater flow at the EMDF site.

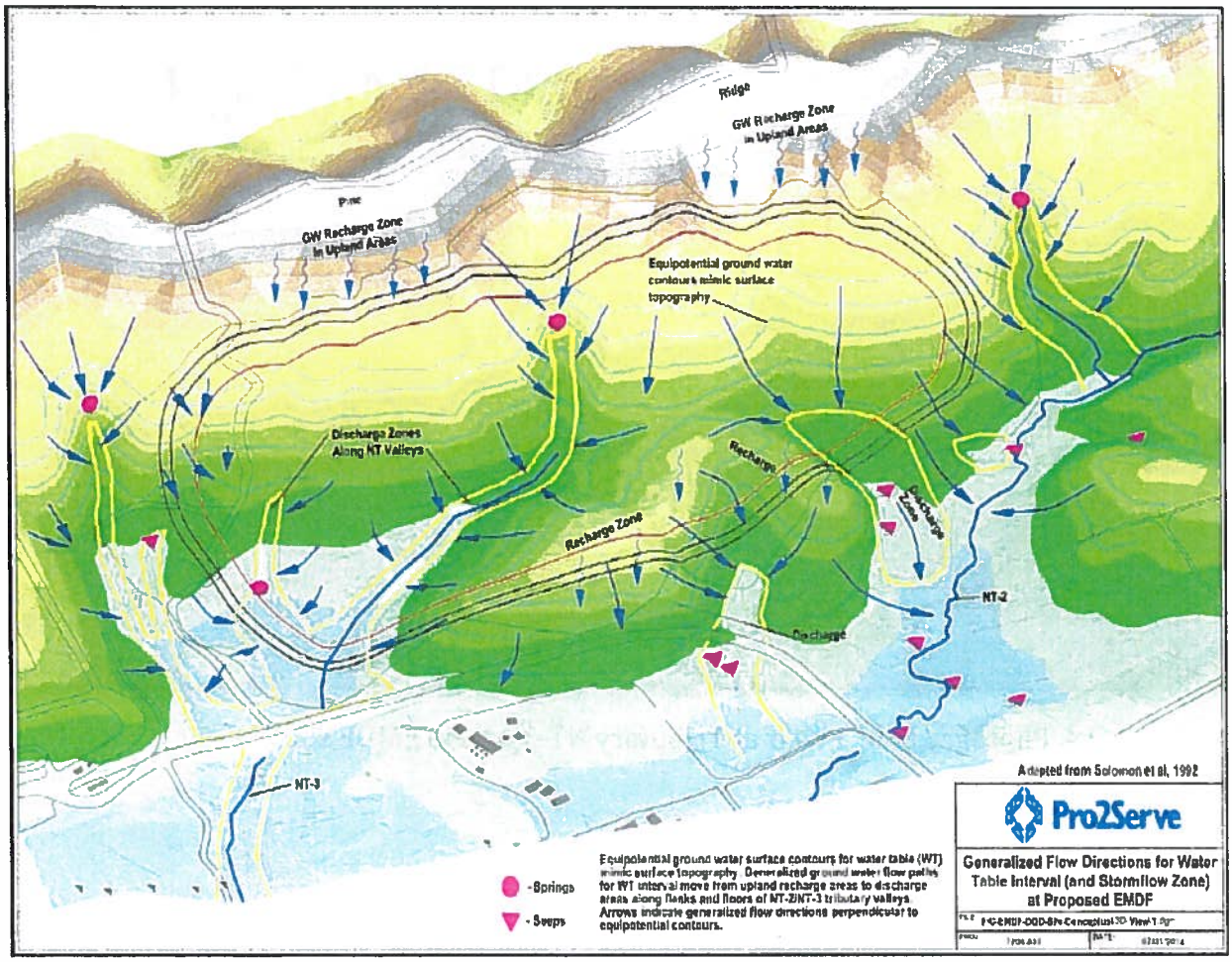


Figure 13. Groundwater elevation at the proposed EMDF site

As part of the RI/FS, DOE prepared a groundwater model to simulate future contaminant migration. The model treats the subsurface as an equivalent porous medium. DOE recognizes that this modeling effort over-simplifies fate and transport processes.

DOE completed a study of surface flow from tributaries on or proximate to the EMDF site location. To assess surface water flow during rain and non-rain events, DOE placed weirs in tributaries NT-2 and NT-3 and measured flow rates. The photograph below is of a V-Notch Weir in tributary NT-3 on the EMDF. Note that the soil at the EMDF site is composed of fine grained - primarily silt and clay size particles which will generally exhibit low permeability. This soil texture persists at the site from 0-10 feet below ground surface and transitions to regolith and then bedrock which is composed of shale and limestone.

Figure 14. Photograph of a weir at Tributary NT-3 on the EMDF site.

On-Site Hybrid Remedial Alternatives

DOE presents in the RI/FS report limited information on hybrid remedial alternatives - combined on-site disposal and off-site disposal. These hybrid options, however, are not adequately described to fully understand the cost basis for each of the options. Six scenarios are considered, ranging from all disposal occurring on-site, combined on-site and off-site disposal in 20% increments, and all wastes disposed off-site. The six scenarios considered are:

- All wastes disposed in an on-site landfill, with (<5%) volumes disposed off-site
- 80% of wastes disposed in an on-site landfill, and 20% disposed off-site.
- 60% disposed in an on-site landfill, 40% disposed off-site.
- 40% disposed in two smaller on-site landfills, 60% disposed off-site.
- 20% disposed in an on-site landfill, 80% disposed off-site.
- All waste disposed off-site (e.g., the Off-site Alternative).

The summary cost for each of these options is presented below in Figure 15.

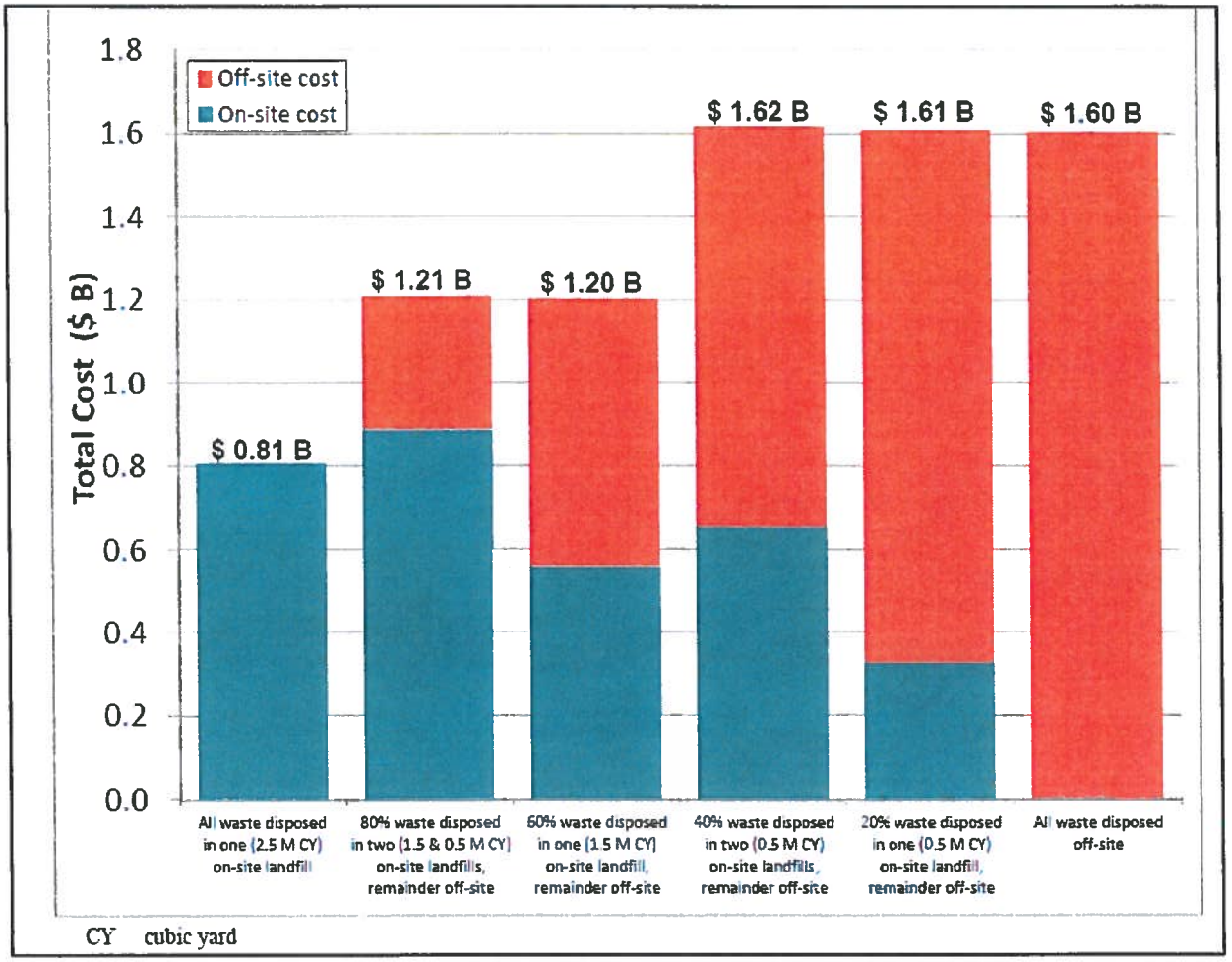


Figure 15. Costs Associated with On-site and Off-site Disposal Scenarios
Source: RI/FS - DOE/OR/01-2535&D3

Waste Volume Estimates

DOE prepares on an annual basis a Phased Construction Completion Report (PCCR) to estimate waste disposal volumes. The waste volume estimate DOE used in the RI/FS for FY 2022 through FY 2043 is 1.95 M yd3, including a 25% uncertainty allowance. Approximately 70% of the 1.95 M yd3 is debris. This estimate is used as the basis for analyzing waste shipments in the Off-site Disposal Alternative. With respect to the EMDF remedy, DOE calculates that the capacity required to dispose of this waste on-site to be 2.2 M yd3.

Off-Site Disposal Remedial Option

As described in the RI/FS document, the Off-Site remedial option would entail the transport of waste off-site of the ORR to approved disposal facilities. This process would primarily be undertaken by rail transport, but could also involve transport by truck. DOE identified prospective transportation routes to estimate the cost for this remedial option

and to complete an assessment of risk to both human health and the environment. The perspective routes of transport are depicted on Figure 16.

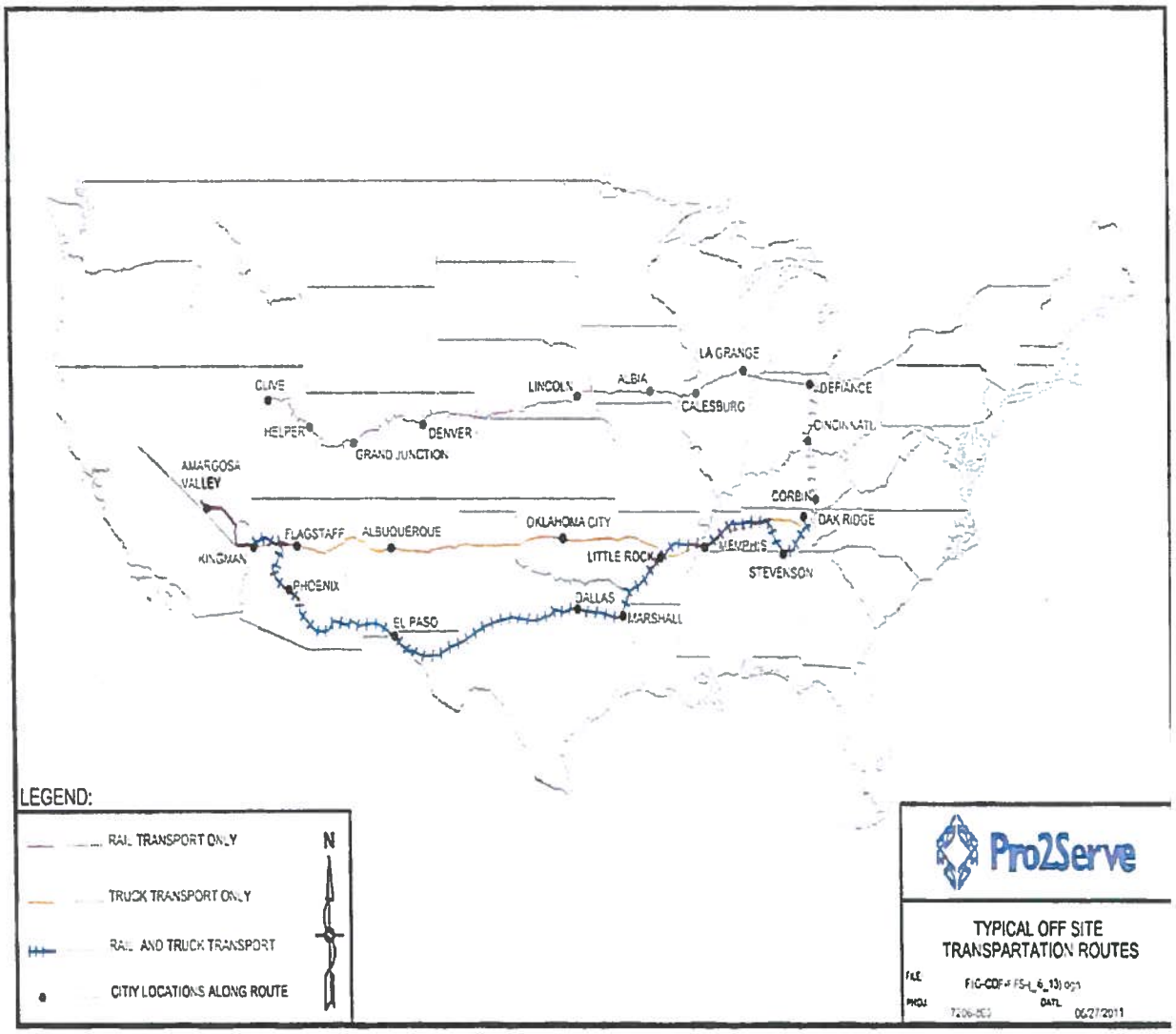


Figure 16. Off-Site Remedial Action Proposed Transportation Routes.

According to the RI/FS "approximately 98% of the waste is envisioned to be shipped to the Nevada National Security Site (NNSS) in Nye County, NV by rail transport from the East Tennessee Technology Park (ETTP) to a transfer facility in Kingman, AZ. Intermodal containers would then be transferred to trucks for the final leg of the shipment to NNSS. Mixed (LLW/RCRA) waste would be shipped for treatment and disposal by rail shipment from ETTP directly to the disposal facility at EnergySolutions, Clive, UT. Classified LLW waste would be shipped by truck to NNSS."

The sequencing of events that are contemplated for the off-site disposal of waste from the ORR by either railcar or truck is depicted in Figures 17 and 18.

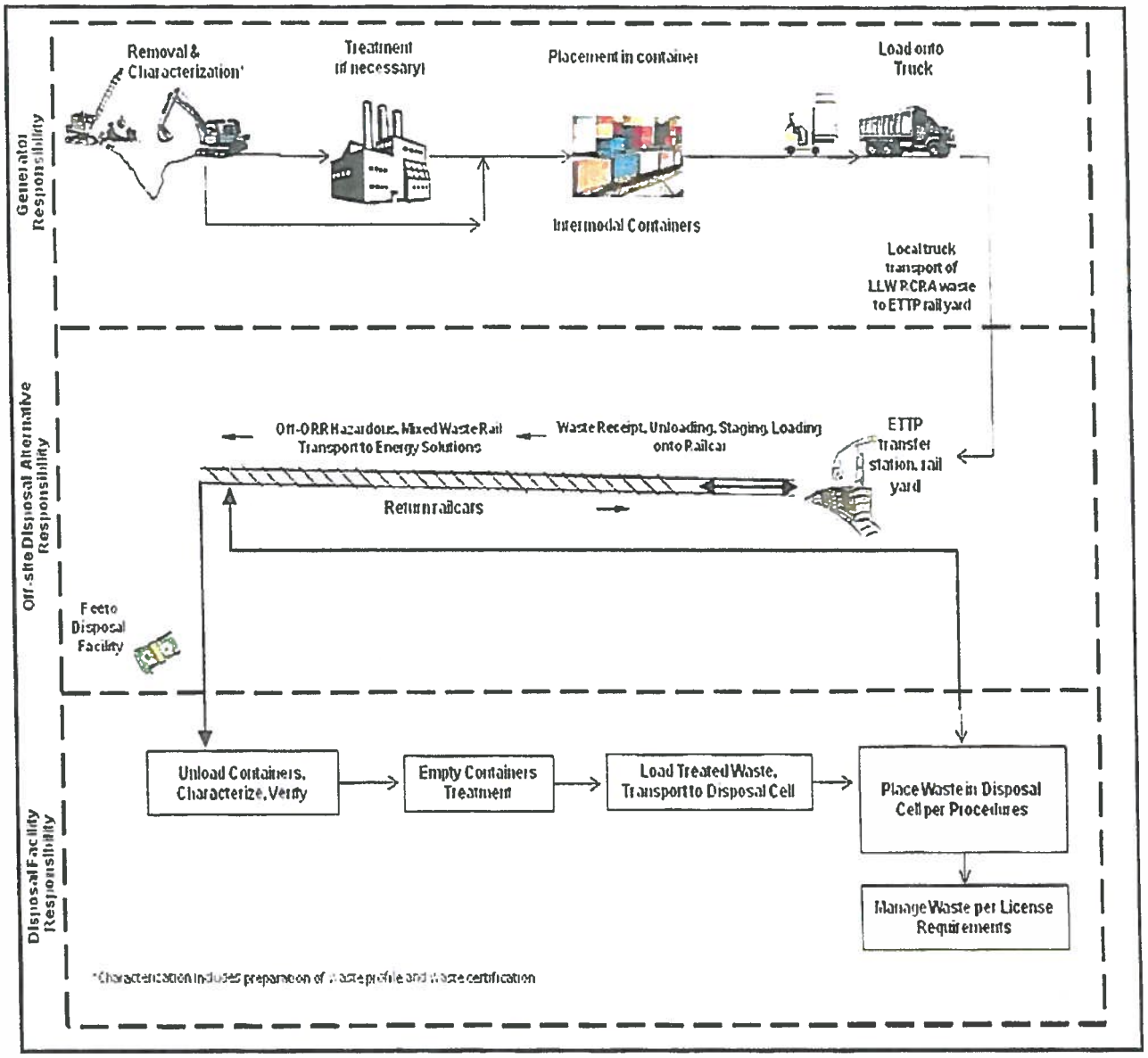


Figure 17. Process Diagram for Disposal of ORR Wastes at Off-Site Location by Trucks and Railcars

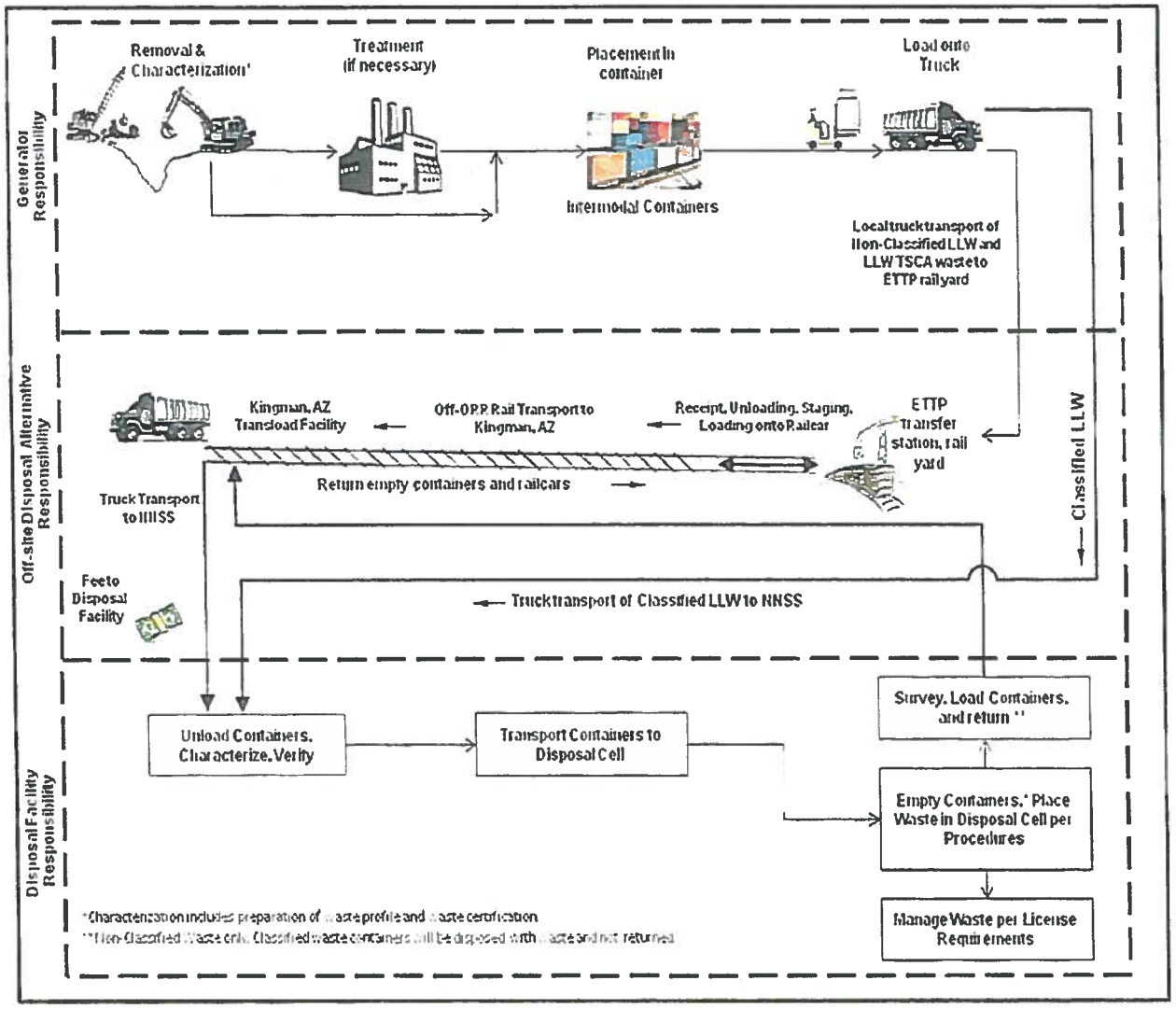


Figure 18. Process Diagram for Disposal of ORR Wastes at Off-Site Location by Truck Only

Human Health Risk Assessment

DOE prepared a human health risk assessment for both the Off-Site Disposal and EMDF proposed remedies for short term exposure to hazardous substances and low-level nuclear waste from transport to disposal facilities. The assessment was completed in accordance with EPA Risk Assessment Guidance for both carcinogenic risk and risk from non-cancer effects also referred to as systemic toxicity.

DOE prepared a prospective assessment of risk posed from either the construction and operation of the EMDF or, the off-site transport of waste material to landfills approved to accept low-level nuclear or hazardous waste. The transport of waste is a key element in both the On-site and Off-site Disposal Alternatives. The Off-Site option is further evaluated based on the presumed final destination of the waste to receiving facilities. DOE's risk assessment considered disposal at the NNSS facility located close to Kingman, Arizona and to the EnergySolutions site in Clive, Utah.

DOE did not undertake a risk assessment for the On-Site Disposal Alternative. This analysis represents a long-term risk analysis that can only be estimated when the types and amounts of contaminants are fully known.

The modeled risk to human health from the Off-site Disposal remedial alternative in the RI/FS for radiation exposure results in a "total cancer risk (fatal and non-fatal) for maximum exposed individuals that ranged from 1.03E-03 to 8.64E-02 (non-fatal) to 7.75E-04 to 6.48E-02 (fatal).

The modeled risk to human health from the On-site Disposal remedial alternative at the EMDF in the RI/FS for radiation exposure results in a "total cancer risk (fatal and non-fatal) for maximum exposed individuals that ranged from 6.63E-04 to 1.08E-02 (non-fatal) to 4.97E-04 to 8.10E-03 (fatal). DOE acknowledges that the risk assessment for the On-Site Disposal is not easily quantified since residual risk can only be estimated at the FS, since waste has not been landfilled and the types and amounts of contaminants are not yet fully known.

DOE has not evaluated the long-term risk associated with the disposal of waste under either remedial proposal. The implication is that the placement of waste in the landfills that meet regulatory requirements would not result in an unacceptable risk to both human health and the environment. Since the RI/FS report is a prospective plan to dispose of ORR reservation wastes (i.e., low level nuclear and hazardous), the approach undertaken by DOE appears defensible.

According to DOE's cost analysis, the On-site Disposal Alternative would be less costly than the Off-site Disposal Alternative. DOE's estimated total project cost for implementing the Off-site Disposal Alternative is $1.6 billion. DOE acknowledges that the Off-Site Disposal Alternative could isolate wastes more effectively long term than the EMDF Alternative due to the arid climate and fewer receptors at off-site disposal facilities, but the Department believes that long-distance waste transportation in the short-term could result in more accidents, causing injuries or fatalities.

Remedial Action Objectives

The RI/FS document identifies the remedial action objectives (RAOs) for this Superfund site. The RAOs are as follows:

- Prevent direct or indirect exposure of a human receptor to future-generated CERCLA waste that exceeds a human health risk of 10-4 to 10-6 Excess Lifetime Cancer Risk (ELCR) or Hazard Index (HI) of 1 to 3;
- Prevent releases of future-generated CERCLA waste, or waste constituents that exceed a human health risk of 10-4 to 10-6 ELCR or an HI of 1 to 3, or that do not

meet ARARs for environmental media. This is accomplished through compliance with chemical specific ARARs, MCLs in waters that are current or potential sources of drinking water considering site-specific background levels, or risk-based levels for chemicals without ARARs;

- Prevent ecological exposure to future-generated CERCLA waste; and
- Facilitate timely cleanup of ORR and associated facilities.

Most of these RAOs have been developed consistent with the requirements conveyed in CERCLA and the NCP. The one outlier RAO is the allowance of the HI to reach a risk tolerance of 3. The NCP provides for an unacceptable risk threshold of 1 or more. Therefore, a HI acceptable risk threshold of 3 would not be considered an acceptable level of risk. DOE's rationalization for increasing the HI risk to 3 is based on risk modeling uncertainty after 1,000 years, "Non-carcinogenic contaminant exposure is modeled to determine PreWAC limits based on an HI equal or less than 1.0 for up to 1,000 years. As the modeled time increases, prediction uncertainty increases and therefore the target HI is increased to 3.0 past 1,000 years. Likewise, an order of magnitude target ELCR increase (e.g., from 10-5 to 10-4) for the pre-1,000 year modeling to the post-1,000 year modeling is considered for carcinogenic contaminant modeling."

DOE's rationalization reflects the limitation of using the Superfund law and NCP regulation to determine the efficacy of siting a low-level nuclear and hazardous waste landfill. Superfund was developed only to address the adverse impact of hazardous substance release(s) into the environment and the consequent impact to either human health or ecologic receptors. The use of this law in this context draws into question the public benefit.

Analysis of Remedial Options

The following provides analysis of selected elements of the On-Site EMDF and Off-Site Remedial Options.

Underdrain System for Shallow Groundwater

According to the RI/FS report, the underdrain system at the EMDF "would act as a preferred migration pathway for contaminant movement ...if a failure of the liner system occurred." This structural requirement as part of the remedy has previously been documented to be a challenge when the EMWMF was being constructed. The fact that an underdrain system will also be required at the EMDF suggests that DOE should have given greater weight to other more suitable site locations that would not require the construction of an underdrain system (i.e., sites not located off a steep ridge area where the hydrologic regime is a high energy/force environment for the transmission of both surface water and groundwater).

Drawing from the problems that were encountered at the EMWMF site with respect to management of shallow groundwater, representatives from the EMWMF landfill construction firm and the DOE prepared a technical report on the issue. In the 2004 technical report on the construction of the first two cells for the EMWMF by J. Williams, J. Patterson, R. D. George Bechtel Jacobs Company LLC, and J. M. Japp, Oak Ridge Operations, U.S. Department of Energy, provided critical information on the problems that were encountered in the construction of the EMWMF facility which is located adjacent to the proposed EMDF site. The report entitled "OAK RIDGE ENVIRONMENTAL MANAGEMENT WASTE MANAGEMENT FACILITY DOE-EM's FIRST ON-LINE PRIVATIZED DISPOSAL FACILITY" was published as part of the WM'04 Conference, February 29 – March 4, 2004. Among the findings in the study were the following challenges: High groundwater; copious precipitation; steep topography; and a limited footprint for facility development. "One of the challenges presented by the site location, high groundwater, is the source of several lessons learned that have impacted all aspects of the project. For the design aspect, the project learned that there is no such thing as too much independent subject matter review of the groundwater model. The facility footprint was bisected by a small tributary to Bear Creek, Northern Tributary NT-4. To make efficient use of the site, a diversion ditch was designed upslope of the facility on Pine Ridge in an attempt to redirect the flow of NT-4 near its headwaters and the balance of the NT-4 channel was filled. The designers correctly predicted that the groundwater level in the fill at the NT-4 channel would rise, but the magnitude of the rise exceeded predictions. As a result, an underdrain was constructed in 2003 that essentially reestablished the old NT-4 channel in the form of a 3.7 m wide x 1.8 m high rock-filled drain 7.6 m below the site. Groundwater levels started dropping immediately upon construction of the underdrain.....In addition, the impacts of the previously mentioned high groundwater at the site could have been accommodated better with a more thorough site characterization. During bidding for the EMWMF subcontract, bidders requested the opportunity to perform their own site investigations. These requests were denied due to time constraints."

The 2000 ROD for the EMWMF provided for a groundwater waiver of the TSCA 15 meter vertical separation between the bottom of waste and the water table. The EMWMF site has a shallow perched groundwater table and the TSCA requirement was waived in lieu of either one of the following: 1.5 m of soil having a permeability no greater than 1 x 10-6 cm/sec between waste and groundwater or 3 m of soil having a permeability no greater than 1 x 10-5 cm/sec. The RI/FS for the EMDF contemplates requesting the same groundwater waiver. TDEC would also have to issue a waiver because a "LLW disposal unit cannot be constructed where groundwater discharges to surface water." Based on this known groundwater site constraint, DOE should expand their explanation for advocating for the proposed EMDF as the preferred remedy. It seems odd that DOE would propose construction of a landfill in a land area with a known shallow water table, surface tributary and wetlands present.

On-Site Leachate Treatment System for Mercury Contaminants

DOE's plan to treat and dispose of Mercury contaminated wastes is through macroencapsulation followed by disposal in the EMDF. DOE's macroencapsulation approach is not fully described. DOE has not determined whether a centralized facility would be used to treat Mercury waste or whether multiple sites at the Y-12 complex would be used. In either scenario, DOE indicates that multiple macroencapsulation methods and technologies would be used to render the Mercury immobile. Mercury release from media is well understood in industry. DOE should expand their discussion of Mercury treatment options to describe the conditions when certain technologies would be employed. It is important to reflect that the Lower Watts Bar has been impacted from Mercury contamination release.

Groundwater Modeling of Contaminant Fate and Transport

DOE's use of ground water modeling to simulate future contaminant migration should not be heavily relied upon based upon the highly complex nature of the fractured bedrock hydrogeology at the EMDF site and the model's oversimplification of flow systems. DOE's groundwater model treats the subsurface as an equivalent porous medium, which is not consistent with the data collected from the on-site groundwater study completed. Hydraulic conductivities determined from various tests of soil and bedrock units ranged from 1 x 10-7 cm/sec to 1 x 10-4 cm/sec conducted. These tests also did not differentiate hydraulic conductivities in the X, Y or Z planes. The groundwater model requires hydraulic conductivity values for the X, Y, and Z coordinate planes.

Ecological Resources

The RAOs in the RI/FS specify a standard of care for ecological resources that is not measureable "Prevent ecological exposure to future-generated CERCLA waste". Section 300.430 (a) (1) (ii) (C) of the NCP requires that "Site-specific data needs, the evaluation of alternatives, and the documentation of the selected remedy should reflect the scope and complexity of the site problems being addressed." Section 300.430 (d) (2) of the NCP requires that "The lead agency shall characterize the nature of and threat posed by the hazardous substances and hazardous materials and gather data necessary to assess the extent to which the release poses a threat to human health or the environment." The RAO for ecological risk in the RI/FS does not appear to address the requirements of the NCP. Moreover, the preferred remedy would impact a tributary, NT-3, and wetlands that flow where the landfill is proposed to be constructed. In addition, there are springs and seeps indicative of a shallow water table.

Long-Term Monitoring

The RI/FS document provides an extensive description of long term monitoring and maintenance requirements for the EMDF. The costs associated with monitoring and maintenance are not, however, well documented. The RI/FS states that long-term

monitoring and maintenance would include post-closure operation of the leachate/contact water treatment facility for 10 years followed by demolition and disposal of the facility. Also included is a perpetual care fund ($22M or $1M per year of facility operation) that would be paid into an escrow account to be used for long-term facility surveillance, maintenance and monitoring after the facility is closed. It is unclear as to whether the perpetual care fund would be adequate to cover annual costs for monitoring and active management of the landfill, in particular, the underdrain system and water treatment system.

The value of the proposed EMDF Trust Fund for long-term maintenance also appears to be underfunded relative to NRC regulated facilities. The bond required for the nuclear waste landfill at the WCS in Andrews, TX is much higher than the Trust Fund for the EMWMF site. The WCS site has the following financial assurance amounts for the post-closure period:

- Post-Closure: $10.5 million
- Institutional Control: $21.5 million
- Corrective Action: $25.9 million

The corrective action amount is an important funding source for the WCS site and is noticeably not provided for at the EMDF site. This fund would be used for unplanned maintenance during the post-closure period. This same type of approach should be considered for the EMDF facility should it be the selected remedy.

NRC and TDEC Siting Criteria

The EMDF site would also not meet NRC siting criteria for low-level nuclear waste disposal. Pursuant to 10 CFR 61.50 for NRC licensing of low-level nuclear waste landfills the following requirements must be adhered to:

"(a) Disposal site suitability for near-surface disposal. (1) The purpose of this section is to specify the minimum characteristics a disposal site must have to be acceptable for use as a near-surface disposal facility. The primary emphasis in disposal site suitability is given to isolation of wastes, a matter having long-term impacts, and to disposal site features that ensure that the long-term performance objectives of subpart C of this part are met, as opposed to short-term convenience or benefits.

o ...

o (5) The disposal site must be generally well drained and free of areas of flooding or frequent ponding. Waste disposal shall not take place in a 100-year flood plain, coastal high-hazard area or wetland, as defined in Executive Order 11988, "Floodplain Management Guidelines."

o (6) Upstream drainage areas must be minimized to decrease the amount of runoff which could erode or inundate waste disposal units.

Based on NRC licensing requirements, the EMDF site would not be considered a viable site location as a consequence of its proposed location to wetlands and upstream drainage areas that could erode or inundate waste disposal cells.

10 CFR 61.41 also includes NRC's regulations for "Protection of the general population from releases of radioactivity." Environ notes that this part of the regulation does not currently include a specific performance period, but at least as far back as 2000, the NRC's Performance Assessment Working Group (PAWG) recommended a performance period of 10,000 years. From NUREG-1573, A Performance Assessment Methodology for Low-Level Radioactive Waste Disposal Facilities: "The PAWG recommends a time period of 10,000 years for analyzing performance with respect to 10 CFR 61.41."

Environ also notes that a 10,000 year period was also used during the final EIS for 10 CFR 61 for the assessment of potential groundwater impacts. In addition, the NRC is in the process of revising 10 CFR 61.41. The new proposed rule explicitly contains a 10,000 year assessment period, "Compliance period is the time during which compliance with the performance objectives specified in §§ 61.41, 61.42, and 61.44 must be demonstrated. This period ends 10,000 years after closure of the disposal facility."

The EMDF site does not meet several of TDEC Licensing Requirements for Land Disposal of Radioactive Wastes. TDEC regulations require disposal facilities be selected so that projected population growth and future developments are not likely to affect the ability of the disposal facility to meet performance objectives. The disposal site must be generally well drained and free of areas of flooding and frequent ponding. Waste disposal shall not take place in a 100-year floodplain or wetland. Upstream drainage areas must be minimized to decrease the amount of runoff which could erode or inundate the disposal unit.

The EMDF site is located in southwest area of the city center of Oak Ridge. This area located to the North of the proposed EMDF site is one of the most economically disadvantaged areas in Oak Ridge. The nearest resident is approximately 0.84 miles north of the proposed EMDF site, and a larger residential subdivision is about 1.1 miles to the northwest. Census data indicates that 125 people in 83 homes live within two kilometers (1.2 miles) of the EMDF. These subdivisions have a higher percentage of low-income and minority populations which DOE should take into consideration with respect to potential impact concerns.

The southwest area of the City has been targeted for economic growth; however, there are at least two large yet incomplete housing developments that have been abandoned or severely slowed down. The City believes that several projects would likely be negatively impacted as a result of their close proximity to the EMWMF and proposed EMDF.

The US NRC technical document entitled "Low-Level Waste Licensing Branch Technical Position - Site Suitability, Selection, and Characterization" prepared in 1986 indicates that "Disposal sites should be located in areas which have low population density and limited population growth potential. Disposal sites should be at least two kilometers from the property limits of the closest population centers." Areas surrounding the EMWMF are part of the City Oak Ridge's growth zone and are located within the two kilometer area as defined by the NRC. The City of Oak Ridge has also confirmed that new apartment homes and a planned subdivision, off Groves Park Blvd are currently being developed. All of these individuals could be impacted in the event of a chemical or radiological spill or other incidents, e.g., explosion at the proposed disposal facility.

With respect to the Off-Site Disposal Remedial Option, TFG notes that the regulation on transportation of low-level nuclear waste has been in place as early as 1935. Regulations to control the transport of radioactive material were first initiated by the Postal Service in 1935. Over the years, the Interstate Commerce Commission (ICC), now the Surface Transportation Board became involved in the regulation of nuclear waste shipment. Today, there are at least four Federal agencies and State governments that regulate the transport of radioactive materials. These groups are DOT, NRC, the Postal Service, DOE, and the States. Of these agencies, DOT and the NRC are the primary issuers of regulations based on the standards developed by the International Atomic Energy Agency.

The NRC and DOT share responsibility for the control of radioactive material transport. Transportation of low-level radioactive waste is regulated by DOT under authority of the 1974 Transportation Safety Act, and the NRC under authority of the Atomic Energy Act of 1954 and the Energy Recovery Act of 1974. The regulations for DOT are in the Hazardous Materials section of Title 49 of the Code of Federal Regulations (CFR).

DOT regulations cover all aspects of transportation, including packaging, shipper and carrier responsibilities, documentation, and all levels of radioactive material from exempt quantities to very high levels. NRC regulations are primarily concerned with special packaging requirements for higher level quantities.

Radioactive materials must be packaged for transportation in one of four types of containers. All containers which contain nuclear waste must meet DOT General Design requirements. Rigorous testing of containers is required to ensure the safe transportation of radioactive materials of all concentrations of radiation.

More than 3,000 shipments of spent nuclear fuel from nuclear power plants, government research facilities, universities and industrial facilities have crossed the United States,

"without a single death or injury due to the radioactive nature of the cargo."[1] Shipments include 719 containers from the Naval Nuclear Propulsion program between 1957 and 1999, and 2,426 highway shipments and 301 railway shipments from the U.S. nuclear industry between 1964 and 1997. In addition, since 1996, shipments of spent nuclear fuel have been safely transported to the United States from 41 countries to the DOE facilities;[2] again, without a single death or injury.

With respect to the calculation of cost for the Off-Site Disposal Remedial Option, the RI/FS states that in general, disposal fees at EnergySolutions depend on the classification of the waste (e.g., LLW or mixed waste), the type of the waste (e.g., soil, debris, etc.) and packaging. TFG contacted a representative from EnergySolutions to discuss disposal fess options. Our understanding is that fees at the EnergySolutions facility are also determined based on the timing and volume of material that can be guaranteed to be delivered to the facility. These factors were not taken into consideration in the calculation of cost ranges for the Off-Site Disposal option.

Waste Recycling and Volume Reduction

We also wish to make note of concerns that TDEC has recently raised with respect to the disposal of non-nuclear and non-hazardous waste in the EMWMF and the resulting consumption of landfill capacity. According to TDEC, about 30 to 50 percent of the waste materials going into the current facility are "clean" — without radioactive elements or hazardous chemicals — and could be sent elsewhere for disposal. The disposal of clean wastes at facilities other than EMWMF would provide more space for contaminated wastes and extend the lifetime of the landfill. Moreover, "clean material" going into the landfill seems to contradict DOE's argument of cost savings associated with on-site disposal, especially due to the higher costs of having security for classified waste. TDEC recommended DOE make greater efforts now to reduce the volume of non-nuclear and non-hazardous wastes going into the existing facility in order to extend the use of the EMWMF. We concur with this recommendation primarily because it would provide the Oak Ridge community and the parties to the FFA additional time to develop other options for disposal of waste material and perhaps other more site areas for placement of the EMDF than the site chosen by the DOE.

The D3 RI/FS provides additional information on DOE efforts to recycle non LLW and non-hazardous wastes and/or to dispose of these wastes in a nearby solid waste landfill including DOE's on-site ORR Industrial Landfill V. DOE's stated practice in the D3 RI/FS report is to handle waste material in a hierarchical manner. The testing and segregation of waste material precedes disposal decisions. Once the characterization of material is

[1] National Conference of State Legislatures' Report, January 2000.

[2] U.S. Department of Energy Report to the Committees on Appropriations, January 2001.

completed for hazardous waste and nuclear waste identification, DOE's top priority action is to segregate waste material for recycling or beneficial reuse. The second priority is to make use of onsite ORR Industrial Landfill V for final disposal of waste.

DOE also analyzed in the RI/FS the cost/benefit of employing size reduction for both the EMDF and Off-Site remedies. DOE determined that it was not cost effective for the EMDF Disposal Alternative. However size reduction was retained for the Off-site Disposal Alternative because it reduces transportation and disposal costs by increasing bulk density and the mass of waste material per shipment.

DOE undertook an extensive analysis of implementing volume reduction activities for both the EMDF and an Off-Site remedy because the Department recognizes that size-reduction processing of waste has merit in that it reduces debris void space and also reduces the fill requirements for waste placement. DOE's study relied upon waste generation forecast data to estimate potential quantities of the types of waste materials that could be recycled, segregated, or size reduced. Preliminary estimates were developed for deployment of size-reduction equipment in the calculation of costs of implementation.

The cost effectiveness of volume reduction options was evaluated by comparing the cost of implementing the method to the cost of the EMDF and Off-Site disposal of unprocessed material. DOE's calculation of debris volume that would be generated as a result of the cleanup at the ORR is 1,341,090 yd3. This figure includes a 25% uncertainty allowance. When contaminated soil is added to the debris volume the total amount of waste is 1,948,558 yd3.

Figure 19. DOE Forecasted Waste Volumes at Oak Ridge Reservation

Waste Type	Material Type	Total FY 2022–FY 2043 yd^3
LLW (includes LLW/TSCA)	Debris	921,152
	Debris/Classified	28,489
	Soil	432,092
Mixed (LLW/RCRA, LLW/RCRA/TSCA)	Debris	119,534
	Debris/Classified	3,697
	Soil	53,882
Subtotal		**1,558,847**
25% Uncertainty		389,712
Total Waste Volume with Uncertainty		1,948,558
Total Debris Volume with Uncertainty		1,341,090
Total Debris Volume with Uncertainty (not including Classified or Mixed LLW)		**1,151,440**

Source: US DOE D3 RI/FS Report, March, 2015

From the information provided in Figure 19 DOE reduced the amount of material that could undergo volume reduction by eliminating from consideration classified debris and debris that is mixed with hazardous constituents. This reduction results in 1,151,440 yd3 being available for volume reduction. DOE then further reduces the waste material available for volume reduction to 758,299 yd3 based on "assumption(s) that a lower fraction of the debris would not be processed by VR due to logistical limitations, contamination issues, or other unexpected circumstances." These assumptions are identified in Table 4 below.

Table 4. DOE Predicted Debris Types and Quantities for Volume Reduction

Debris Type	Fraction of Total	Total Volume Projected (yd^3)	Fraction for Processing	Volume for Processing (yd^3)	Bulk Density (lb/yd^3)	Weight for Processing (tons)
Thick walled steel, glove boxes, hoods, heavy-walled equipment, cranes*	18.28%	210,539	0.3	63,162	680	21,475
Piping, tanks, structural steel*	24.48%	281,886	0.75	211,415	1,040	109,936
Concrete and masonry: reinforced concrete, block, brick, shield walls	42.26%	486,647	0.75	364,985	2,600	474,481
Small structures: small cooling towers, structural framing, interior and exterior finishes, wood	7.02%	80,807	0.75	60,605	1,620	49,090
Metal (light gauge): ventilation ductwork, small diameter piping, siding, panels*	3.01%	34,683	0.75	26,012	1,040	13,526
Roofing materials: shingles, built-up roofs, vapor barrier, insulation, roof vents, flashing	3.52%	40,562	0.75	30,422	1,520	23,121
Legacy material: containers, furniture, trash, wood	0.20%	2,265	0.75	1,698	640	544
Total	98.8%	1,137,389		758,299		692,172

DOE does not provide references that support the assumptions used to reduce the available waste volume from 1,151,440 yd3 to 758,299 yd3. This information would be useful in evaluating the impact on EMDF landfill sizing requirements for disposal of waste material from the ORR cleanups, as well as the presumed cost reduction for the Off-Site remedial option from increased volume reduction and consequent reduction in truck/rail transport to receiving disposal facilities.

DOE notes that volume reduction activities implemented at the EMDF would reduce the landfill space requirement, but not sufficiently to eliminate the construction of a cell. As a consequence, landfill construction costs would not be reduced because the anticipated size of the cell and associated labor and materials would be the same. Landfill operating costs would also be the same because the waste generation schedule and resource levels would not change if the same quantity of waste (smaller volume, but same mass) was managed. The DOE analysis indicates that implementing volume reduction at the EMDF would result

in an added $8.87M to the overall cost of the project. DOE developed additional scenarios for volume reduction that are provided below. Each one of the scenarios results in a higher cost to implement than constructing the EMDF with six cells (See Table 5).

Table 5. Summary of Size Reduction Cost/Benefit Study Results for the On-Site Disposal Alternative

Deployment Approach	Avoided Costs	Size Reduction Cost (Capital and Operating)	Net Cost
Size reduction of equipment and heavy structural steel	$5.22M	$13M (K-33 project capital cost only)	(-$7.78M)
Size reduction facility for concrete and general debris deployed at the EMDF	$33.89M	$42.76M	(-$8.87M)
Size reduction facility for concrete and general debris deployed in existing facilities at the Y-12 and ORNL sites	$37.5M	$48.8M	(-$11.3M)
Size reduction facility for concrete and general debris deployed within EMDF landfill site	$33.89M	$38.94	(-$5.05M)

DOE's analysis brings into focus the need for all interested parties (including DOE) to scrutinize volume reduction and waste management practices. It may be that additional measures such as enhanced waste segregation, recycling, and better sequencing of use of debris material for fill material can be undertaken to reduce the use of clean fill. These measures could also result in DOE and other interested parties agreeing that the size for the proposed EMDF can be reduced, thereby reducing project costs.

DOE's analysis for use of volume reduction methods does result in cost savings for the Off-Site Disposal remedy. DOE calculates a net $80.5M in cost savings from using volume reduction with this remedy.

EMDF Site Selection v. Off-Site Options

The site chosen by the DOE, East Bear Creek Valley-Option 5, does not arguably meet some of the criteria that the Department specified in the RI/FS. These criteria are: 1) the presence of karst features, 2) insufficient area for placement of the landfill, 3) surface water impacts, 4) unfavorable topography (excessive cut and fill), 5) known site contamination, and 6) sites being located in a the Bear Creek Valley Watershed Zone 1 which has been designated for future unrestricted land use. East Bear Creek Valley-Option 5 clearly does not meet the criteria for surface water impacts and sites with unfavorable topography. We are also troubled that such a high emphasis has been placed on preservation of the Bear Creek Valley Watershed Zone 1 which has been designated for future unrestricted land use when it can be documented on hydrogeologic maps produced by DOE that there are land areas that are both devoid of surface tributaries and wetlands, and where the depth to groundwater is in excess of the TSCA regulatory standard of 50 feet. These areas are generally the ridge areas in the Bear Creek Valley that are considered groundwater recharge zones.

A decision to site a low-level nuclear waste landfill that will arguably require on-going active management for over 1,000 years suggests to TFG that more extensive efforts should be undertaken by DOE to identify sites that are located either inside the ORR or off-site that do not require tributaries to be re-routed, groundwater springs to be controlled, wetlands to be destroyed or federal and state requirements to be waived for separation of groundwater to landfills that would contain low-level nuclear waste.

It is not lost on TFG that many of the nation's nuclear waste disposal sites are located in western parts of the country in areas distant from population centers and where high grade natural resources are also not proximate to the site disposal area. In areas such as Yucca Mountain, NV and Clive, UT the depth to groundwater is measured in hundreds of feet below ground surface and surface water bodies and wetland habitats are not proximate. In Hanford, WA the nearest population center (Yakima) is about 40 miles to the West. These siting areas for placement of low-level nuclear waste make all too much good sense in comparison to the EMDF site that is being proposed by DOE.

Efficacy of Using Federal Superfund Law to Site a Low-Level Nuclear Waste Landfill

We believe the relevant State and Federal agencies with regulatory responsibilities over the disposal of low-level nuclear waste should evaluate the efficacy of using the Federal Superfund process to guide the siting decision for the EMDF. We do not believe the Superfund law, regulations, and process can effectively document or determine the siting of low-level nuclear waste landfills such as the EMDF because the program is not structured to prospectively evaluate potential future releases of hazardous and nuclear waste. Superfund was enacted in the wake of the discovery of toxic waste dumps such as Love Canal and Times Beach in the 1970s. The NCP describes a very prescriptive methodology

for evaluating risk posed by a site to human health and the environment based upon laboratory analytical data collected from the testing of environmental media, and data from the testing of environmental receptors such as flora, fauna and invertebrates. This data and other site-specific investigations are then evaluated relative to risk based criteria for human health and ecologic receptors as well as ARARs to determine the degree of risk posed by site contaminants and, the degree to which a proposed remedy is in compliance with ARARs. In the case of this RI/FS, DOE has prepared a prospective assessment of risk based on the type, quantity and concentration of waste contaminants that are presumed to be either transported off-site to a facility approved to accept these wastes, or for placement of these wastes in the proposed EMDF on the ORR.

CERCLA Integration with NEPA

We also recognize that the DOE process for siting the EMDF integrates NEPA requirements within the CERCLA process per DOE Order 5400.4, issued October 6, 1989. However, as documented in Scope of Services Item 3, there appears to have never been a thorough assessment of the potential socio-economic impacts on the surrounding communities of the EMWMF or the proposed EMDF. This lack of a thorough NEPA assessment underscores need to re-examine DOE's policy of using NEPA-like criteria in CERCLA decision making. In this case, the policy is not covering the necessary aspects of NEPA relevant to facility siting. We recommend that DOE supplement this RI/FS to incorporate a much more comprehensive NEPA analysis of the potential impact of the EMDF on the greater Oak Ridge community in order to fulfill the requirement of DOE Order 5400.4.

Scope of Services Item 2

Life cycle cost analysis (LCA) of the proposed facility that incorporates additional factors/alternatives not evaluated in the DOE RI/FS such as short-and long-term economic opportunity costs, and costs and benefits associated with alternatives not considered in the RI/FS

The operation of landfills is known to be associated with direct costs such as surface and groundwater management, as well as indirect costs such as local depressions in property values and community growth through social stigma (Hirshfeld et al. 1992). These indirect cost and stigma issues may be particularly pronounced for radioactive waste landfills such as the proposed EMDF. As an example, public perception and concerns associated with low-level waste landfills have contributed to the abandonment of nearly all low-level waste landfills proposals since the enactment of the Low-Level Waste Radioactive Waste Policy Act in 1980.

Given the range of potential indirect costs and public perception risks, the assessment of costs associated with placement of a radioactive waste landfill should consider a number of socioeconomic impacts on the surrounding communities, including the impact of the proposed facility on local employment trends, housing, social services, and the local tax base (see, for example, NUREG-1748). These impacts should be evaluated separately for potentially disadvantaged communities to ensure their risk perceptions and actual risks borne are not substantially different than those of the overall population. As discussed further in the following section, DOE did not consider potential indirect, off-site impacts associated with the proposed EMDF during preparation of the RI/FS. Consideration of these costs could substantially modify the comparison of the on-site and off-site disposal options. The consideration of these costs is particularly important for the proposed EMDF, because the facility lies within 1 mile of the closest residential area in the City of Oak Ridge. For many previously constructed radioactive waste landfills, such as the EnergySolutions facility in Clive, Utah and the Waste Control Specialists facility in Andrews, Texas, these potential indirect costs have been ameliorated by the much longer distances from the facility to the nearest residences (see, for example, TCEQ 2008). For example, the Hanford disposal site is located more than 40 miles from residential areas. In addition, in prior studies of the socioeconomic impacts of shallow radioactive waste landfills (e.g., Bezdek and Wendling 2006), the potential impacts of the facilities (e.g., Barnwell and EnergySolutions) are likely ameliorated by the direct, non-payroll contribution of the facilities to the local tax base (through disposal fees and taxes), which will not be the case with the proposed EMDF.

TFG analysis focused on an assessment of potential issues with the cost analysis approach used in the RI/FS, such as the lack of consideration for indirect, socioeconomic costs. TFG's review identified the following additional issues of concern that should be addressed

during on-going option analysis. First, during operation of the EMWMF, surface water and groundwater management has been a more substantial cost than originally estimated, based in part on incomplete initial characterization of the EMWMF site (Patterson and George 2004). It is not clear that DOE has incorporated these actual operational cost issues into its assessment of EMDF costs. Second, the off-site disposal cost estimates for commercial facilities (i.e., the EnergySolutions facility in Clive, Utah) were based on a simplistic analysis that compared the volume of waste bound for the proposed EMDF to the Department's current contractual rates for waste disposal at the EnergySolutions facility. However, given the volume of material under consideration, it is likely that lower rates would be offered by disposal facilities for a guarantee of certain waste receipts. These discounts could substantially reduce off-site disposal costs.

In addition to this issue assessment, the TFG Team discussed with Oak Ridge providing a preliminary analysis of injuries and damages associated with the construction of the proposed 92-acre EMDF site. This type of assessment is referred to as a Natural Resource Damage Assessment (NRDA). Section 120 of CERCLA could potentially subject DOE to liability for natural resource damages resulting from hazardous substance releases at its sites. A NRDA process is used to determine whether natural resources have been injured and to calculate compensatory monetary damages to be used to restore affected natural resources. In addition to restoration costs, damages may include costs of conducting the damage assessment and compensation for interim losses of natural resource services that occur before resource restoration is complete.

Any attempt to fully assess potential natural resource damages associated with the EMDF would be premature. Construction of the proposed EMDF is expected to disturb approximately 92 acres of second-growth forest, result in the permanent re-location of an intermittent hillside tributary to Bear Creek, and destroy approximately 1.1 acres of forested wetland. Operation of the site could also result in impacts to local groundwater and to Bear Creek, if the site's liner fails or if leachate collected and discharged from the site contains contaminants at concentrations above acceptable limits.

While operation of the facility may result in damage to surrounding natural resources; permitted landfills are not typically subject to natural resource damages claims as the result of permitted operations. In this case, natural resource damages could only be claimed under CERCLA if releases of hazardous substances exceeded any permitted limits. For example, leachate discharged to Bear Creek would only subject the site to a natural resource injury claim if the leachate contained contaminants at concentrations above permitted discharge limits. As long as the landfill operates within its design parameters presumably no natural resource injury claim could be made.

Specifically CERCLA 107(f)(1) specifies that no liability shall be imposed where it can be demonstrated that " the damages to natural resources complained of were specifically

identified as an irreversible and irretrievable commitment of natural resources in an environmental impact statement, or other comparable environmental analysis, and the decision to grant a permit or license authorizes such commitment of natural resources, and the facility or project was otherwise operating within the terms of its permit or license...." In other words, where specific resource tradeoffs are identified and considered in making the decision to issue a permit or license, no liability for the permitted or licensed releases exists. Similarly, Section 107(j) specifies that "Federally permitted releases," or releases that conform to the terms of permits issued under the Clean Water Act (CWA), Clean Air Act (CAA), Resource Conservation and Recovery Act (RCRA), Atomic Energy Act, and other laws, are ineligible for recovery under CERCLA provided that these releases are in compliance with permit or other licensing terms. Injuries that occur due to releases that are not expressly permitted (e.g., releases from a system malfunction), that exceed permit limitations, or that occur when a permit is not in force are not excluded (Martin Marietta, 1993).

While natural resource damage claims may not be relevant for permitted facility operations, these operations will result in natural resource damages to the surrounding second growth forest and wetlands. Such impacts should be more fully assessed as part of the siting analysis for the EMDF, and the relative impacts of the proposed site should be compared to the impacts associated with other on-site and off-site disposal locations to ensure that the overall siting decision has properly considered all factors.

As a bounding exercise, we consider the potential ecological losses associated with establishing the landfill. For example, if 92 acres of secondary forestland ecological services are permanently removed, the resulting loss would require approximately 1,000 acres of similar forested habitat to be preserved into perpetuity using past NRD settlements as a guide. Current land prices and management operations costs indicate the compensation required would range from $2 to $4 million. DOE has incorporated these costs in the pricing model for the EMDF.

In addition, the landfill construction will require an Aquatic Resource Alteration Permit, which governs surface waters (streams and wetlands). Approximately 1.1 acres of forested wetlands would be lost in the construction of the landfill. This would require a minimum of 2.2 acres of wetlands restoration, and may require 3.3 acres depending upon the quality of the disrupted wetland. Mitigation bank credits range from $50,000 to $60,000 per acre. The amount of lineal feet of surface streams affected is unknown at this time. However, the affected area appears to have many seeps and streams. The Tennessee Stream Mitigation Program charges $200 per lineal foot for stream credit. DOE has also incorporated these costs in the pricing model for the EMDF.

NRDA regulations under CERCLA call for public participation at various stages. See 43 C.F.R. §§ 11.32(c), 11.81(d)(4), 11.93(c). In addition, US DOE and US Department of Interior

must follow NEPA regulations, which require early public involvement in agency decisions or actions that may affect the environment. See 42 U.S.C. § 4332. From publically available TDEC documents, the Trustee Council is pursuing a final settlement for damages on the entire ORR. The current NRDA process cannot constitute a final determination of injuries and damages associated with the ORR. There are still many sites and areas where characterization of contaminants, their fate, transport and ultimate remediation remain unknown. As an example, the US DOE, EPA, and TDEC are undertaking an ever expanding off-site groundwater investigation due to contamination being detected in over 60 domestic wells.

Damages associated with the injury determination should also be dedicated to the improvement of natural resources in the immediate geographic area. This area by virtue of the nuclear processing operations that have occurred at ORR has received a disproportionate impact of injuries to natural resources. Given the geographic restrictions on development of the surrounding community, as described above, preservation grants in the surrounding area should also be designed after balancing future economic development needs and preservation goals.

For example, in 2010, DOE and TDEC signed an Administrative Order on Consent (AOC) to settle the CERCLA NRD claims associated with contamination of the Lower Watts Bar Reservoir resulting from operations at the ORR. The Lower Watts Bar Reservoir, located approximately 10 miles south of the City of Oak Ridge was affected by releases of mercury and PCBs from the ORR, resulting in ecological impacts to soils, piscivorous mammals, and piscivorous birds. Contamination has also resulted in human use losses, including commercial and recreational fishing losses (IEC, 2008). To offset the identified damages, DOE has committed to establishing a permanent conservation easement comprising approximately 3,000 acres (and conducting certain fishing related restoration projects within the reservoir itself). This easement was established from land on the ORR, and one portion of the easement lies immediately west of the City of Oak Ridge.

As noted below, the City's opportunities for new growth and development are substantially limited by Melton Hill Lake, Y-12, and surrounding municipalities, such as Oliver Springs. In addition, with the existing developed footprint of the city, re-development activities are limited by the large number of legacy homes constructed for the Manhattan Project. Renewal of these legacy housing areas requires substantial funding to either demolish the legacy homes or bring them up to modern expectations and codes. By selecting a section of the ORR contiguous to the City for the Watts Bar conservation easement, DOE severely limited growth options on the western end of the City; this portion of the City had already been identified by City planners as the most attractive area for future growth, and, in fact, planning and infrastructure development to support this growth had already begun. Other areas on the reservation could have provided the same upland forest ecological benefits as the area selected for the easement without adversely impacting the long-term

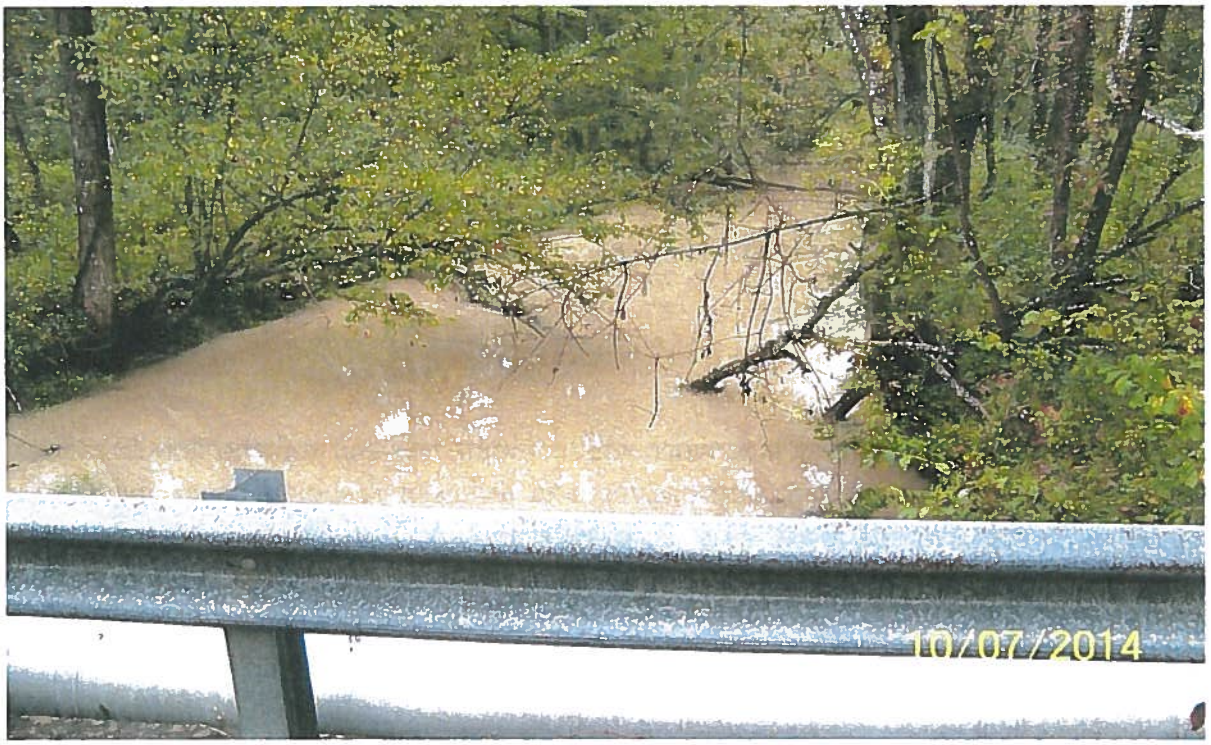
sustainability and quality of life in the City of Oak Ridge. Any additional conservation easements considered as part of the broader NRDA for the ORR should consider the socioeconomic impacts of the easements on the City and the potential aggravating impacts of any compensatory easements on the long-term sustainability of the City of Oak Ridge, particularly given the special circumstances that the City must contend with as the result of legacy housing constructed by the government for the Manhattan Project (as discussed in more detail below).

Conclusions

The goal of an impact assessment is to work with communities and stakeholders to identify and value the impact of different alternatives, and different response scenarios, so that informed decisions can be made and accurate compensation can be offered. The preliminary analysis presented in the preceding sections raises more questions than it answers and highlights the need for a comprehensive impact assessment as outlined in Appendix B.

Community Feedback

TFG received valuable information from an Oak Ridge resident who has documented the degradation of the Bear Creek watershed from ORR operations. As the resident correctly notes, the watershed is forested except for the public improvements as well as more proximate to the EMDF site of consideration by the Haul Road and EMDF. The fact that these areas are off limits to the public draws into question the degraded nature of the Creek from a crystal clear flowing stream in the 1970s to a water body that is silt laden as a consequence of the construction of the Haul Road – please note the pictures provided.


10/07/2014


06/11/2009


2014/04/03

Scope of Services Item 3

An analysis of factors that would assist the Oak Ridge community in determining whether the community could accept the proposed EMDF. The analysis will include NEPA-type criteria such as potential human impacts, socioeconomic impacts, cultural and cumulative impacts, and off-site effects.

Background

The decision by the parties to the FFA on whether to cite an additional landfill disposing of low level radioactive waste and wastes that are regulated under RCRA and TSCA is not one that is made lightly. Materials that are deposited in these facilities have the potential to harmfully impact ecosystems, individuals and communities for 10,000 years or more. Paradoxically, in some circumstances, these facilities may create the potential for stable, long-term economic prosperity for those individuals directly involved in long-term management and monitoring functions. In the words of one author, "Accepting this type of facility represents either an intergenerational threat to public health or a perpetual revenue stream that could promote long-term economic development." (Merrett, 1997, pg. 2).

Because the impacts of siting decisions like those involving the proposed EMDF are long-term, and because they are likely to spark radically disparate opinions from many quarters (e.g., from those who may directly benefit from long-term operation of the facility vs. those who perceive no direct economic benefit), Congress, through the National Environmental Policy Act of 1969 (NEPA), established a framework for the review of remedial actions carried out by the federal government and has imposed on federal agencies the obligation to assure a "safe and healthful environment" (Geneslaw, 1995, pg.1). NEPA was enacted not only to force federal agencies to consider the environmental impacts associated with projects under federal jurisdiction, but, more importantly, to establish procedures by which members of the public would be afforded the opportunity for meaningful participation in the agency's consideration of proposed actions (Geneslaw, 1995, pg. 2).

While NEPA does not directly apply to the EMDF siting decision, in October 1989, the DOE called for integrating the requirements of NEPA with those of the CERCLA[3] for DOE remedial actions conducted under CERCLA (DOE Order 5400.4, issued October 6, 1989), which resulted in the creation of the RI/FS process used by DOE to assess the proposed landfill. While the DOE RI/FS process does include "community acceptance" as one of its

[3] In 1980, the passage of CERCLA authorized funds for the Environmental Protection Agency (EPA) to clean up abandoned hazardous waste sites where wastes were being released into environment or where such a threat existed. Through the years there has been significant debate, and legal action, associated with the question of whether or not there is functional equivalency between the analysis and public input processes associated with a CERCLA remediation and those outlined in NEPA.

nine elements, it does not provide for, or mandate, the type of robust socioeconomic analysis that is routinely associated with a NEPA process.

The proposed EMDF is effectively an expansion of the existing Environmental Management Waste Management Facility (EMWMF), which is immediately to the west of the proposed location of the EMDF. The process of approving the EMWMF began in 1996 and was supported by a number of public meetings and opportunities for public comment. A number of organizations including the city of Oak Ridge, Environmental Quality Advisory Board, Local Oversight Committee, SSAB, the Oak Ridge Environmental Peace Alliance (OREPA) and Friends of ORNL, as well as the general public, participated in the process that led to the decision to pursue the development of an on-site waste management facility and the selection of the East Bear Creek site for the EMWMF.

Given this historical record, it is tempting to assume that the addition of one more storage facility would not have any significant socio-economic impact on the City of Oak Ridge or on the region and would not require a substantive attempt to involve the community. This is not the case.

A review of publically available documents prepared in support of the siting decision for the EMWMF (See Appendix A for full listing) demonstrates that while there was an evaluation of the human health and environmental risks, costs and benefits associated with the EMWMF and various disposal alternatives (including different "on-site" and "off-site" alternatives), **there appears to have never been a thorough assessment of the potential socio-economic impacts on the surrounding communities of the EMWMF or the proposed EMDF.** In fact, the RI/FS document states that "while this RI/FS incorporates NEPA values throughout, the evaluation of alternatives presented here highlights, as appropriate, values that are not specifically included in the CERCLA criteria: socioeconomic impacts, land use, environmental justice, irreversible/irretrievable commitment of resources, and cumulative impacts."

The scope and nature of such an assessment are described further in Appendix B.

Almost 20 years have passed since the decision to site the EMWMF. Economic conditions globally and in the region have changed, the industrial and economic profile of the region has changed, population densities and growth patterns have changed, and the region has emerged as a major destination for nature-based recreation and tourism. These realities support the need for a more comprehensive impact assessment before the affected communities can make an informed decision regarding whether to host the proposed EMDF.

Assessing Potential Community Impacts

There are three questions that warrant further analysis before a decision is made to site the proposed EMDF:

1) What impact has the presence of a large, long term, LLRW disposal facility (the EMWMF) had on economic and social conditions for the city and the region;[4]
2) What impact will the continued presence of the EMWMF have on the economic and social conditions in the city and the region into the future; and
3) What impact will the additional disposal facility have on the economic and social well-being of the city and the region?

The starting point for an analysis of this type would be a comprehensive review of any limited economic or social analysis that was conducted or contracted by DOE/EPA in support of the 1999 decision.[5] In order to estimate the impact that the construction and ongoing operation of the EMWMF facility (including phased expansions that were part of the original project design) has had on economic and social conditions in the city and the region, DOE (or DOE engaged contractors) would need to provide supporting data related, but not limited to employment, construction, labor and materials expenditures for the initial construction as well as operation and maintenance costs that have been incurred since the inception of the project. Information on projected future costs in these areas would also be required.

These data could then be paired with information obtained from public data sources including Census data found at http://www.census.gov/; data from the State Bureaus of Economic Research -http://tndata.utk.edu/; and data collected by local Chambers of Commerce, the City of Oak Ridge, and surrounding counties, to develop an economic and social profile of the city and the region.

The economic and social profile of the city and region would incorporate spatial data in order to identify any disproportionately burdened neighborhoods or areas within the broader city and region (particularly any such areas where there might be Potential impact concerns). Spatial analysis would also support the assessment of whether the current

[4] Oak Ridge is part of a larger geographic area that includes numerous opportunities for outdoor recreation and ecotourism, including the Great Smoky Mountain National Park (a UNESCO World Heritage Site and the most visited National Park in the United States). Because of Oak Ridge's proximity to major urban and natural areas of importance, a current comprehensive social and economic impact assessment of the proposed EMDF facility would adopt a broader footprint than the boundaries of the City of Oak Ridge and the Oak Ridge Reservation. The same variables that are examined and tools that are used in the context of the community impact assessment can also be used to gage the benefits and costs at a broader, regional level.

[5] In addition to any benefit-cost analysis done in support of the review of EMWMF siting alternatives, the results of any social or economic impact assessments that may have been done, either by or under contract to DOE/EPA, at a regional level should also be reviewed.

proposed location for the EMDF has a more significant economic or social impact than possible alternative sites, due to the potentially greater disincentives for future development near the proposed disposal facility and the relatively limited areas available to the surrounding communities for residential development (given natural and political boundaries and the other, existing DOE facilities).

Comparison of the constructed profile against the profile of a community or region that was not host to, or impacted by a project or did not possess an attribute (for example, a comparison of communities that were similar in every way, except for the fact that one is on the water and another is land locked) would provide insight into the impact (either beneficial or negative) that a particular project or attribute has had on a community, a city or a region. In the case of Oak Ridge, a complete analysis would compare Oak Ridge to a community or a set of communities that were not host to a large number of nuclear facilities or long term waste disposal sites.

A series of community meetings or focus groups would be appropriate in order to review the results of the above analysis and to identify changes in the region that have occurred since the 1999 decision to site the EMWMF, which might result in differing conclusions for the EMDF.

A thorough impact assessment of the EMWMF and the proposed EMDF would allow DOE and the affected communities to make a more informed decision about site hosting. Further, such an analysis may indicate that other on-site or off-site disposal locations are more preferred when potential impacts are considered more holistically.

Economic Impact- Preliminary Findings

While insufficient information is currently available to perform a thorough impact assessment, as described above and in Appendix B, it is possible to conduct a preliminary assessment of certain economic indicators by evaluating readily available data. As outlined in Appendix B, there are a number of potential variables that can be evaluated in order to understand the economic impacts of a project such as the EMDF on a community and a region. Some of the more commonly selected variables focus on housing and housing stock.

There is a long history of using changes in the quality and quantity of housing stock as a proxy for the economic and social health of a community. On an individual basis, homeownership is a widely accepted measure of personal wealth and economic stability for the homeowners and the community. Changes in home prices and rental rates correlate with changes in demand. Demand shifts can occur as a result of changes in demographics, as a result of changes in the industrial make up of an area or as a result of the addition (or subtraction) of a physical amenity. Home values change in proximity to positive amenities (ski-in/ski-out homes are priced higher, on a per square foot basis than those that require a bus ride to access the slopes, as an example). Evaluating changes in housing market

composition and characteristics, as well as price, can shed significant light on the economic health of a community or region. Examination of housing related variables is also an attractive study option because of the relative ease of access to relevant, reliable, publicly available data collected by the US Census Bureau. Such data are collected at least every ten years throughout the United States, easing the comparison of a study area to other, similar locations and enabling the analysis of temporal trends in the data

In the context of an economic and social impact assessment, a quantifiable change (either positive or negative) in the price of housing or the composition of housing stock (between owners and renters) can be an indicator of a change and can be attributed to the project that has motivated the impact assessment, all other variables being equal. The difference between what is observed in a study area and what is observed in nearby or comparison areas can be used as a measure of the impact of the project (e.g., construction of the EMDF) on the community in question.

Housing stock and the value of housing stock are also proxy indicators for larger community characteristics. Property tax revenues often fund education and other public services. Communities with strong housing bases and robust property tax profiles often have healthy, or exceptional, public services. Homeowners also often have more disposable income, spending more on goods and services in communities where they reside. As housing demand, and associated prices, increase, so do the second and third order economic impacts. Conversely, a demand (and price) decrease can result in a negative multiplier effect for communities and regions.

Using US Census data, we have conducted an initial, exploratory analysis of housing data for the Oak Ridge community. From this analysis, it is possible to draw some general, albeit preliminary, conclusions regarding the potential impact of constructing the EMDF on the Oak Ridge community.

Demand Impacts

The Oak Ridge community came into being in support of the Manhattan Project. As a result, as shown in Figure 20, 38% of the housing stock that is currently available in the area was constructed between 1940 and 1949. Sixty-five percent (65%) of the total housing stock in Oak Ridge is at least 45 years old, with nearly forty percent (40%) approaching 60 years old.

Figure 20. Housing Stock by Construction Year as Percentage of Total Available Housing Stock

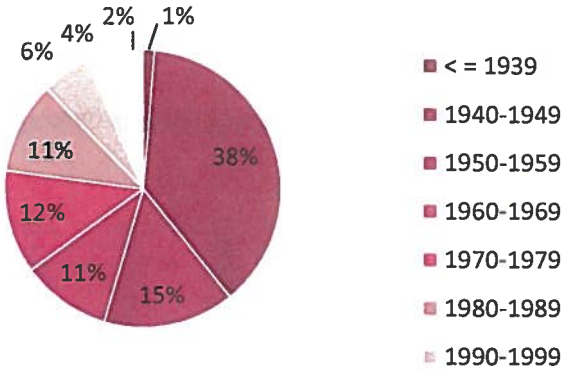
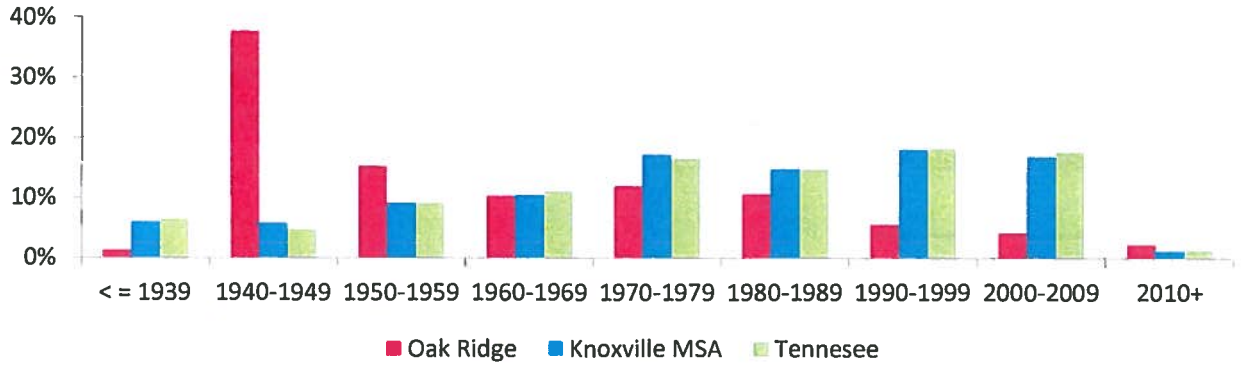


Figure 21 compares the age distribution of housing stock in Oak Ridge to the Knoxville metropolitan area and the state as a whole. As Figure 21 shows, Oak Ridge has a disproportionally higher percentage of older housing stock relative to the broader Knoxville metropolitan area and the state as a whole. Given the original construction of a substantial portion of the community to support the Manhattan Project and follow-on activities, this is not an unexpected result.

Age in and of itself is not a defining factor of housing value, and, depending on the demographic and the demand profile of an area, it may have positive bearing on housing value. For example, in Old Town Alexandria, Virginia (an area known for pre-revolutionary war housing stock), housing age is a premium, with older, rehabilitated homes that retain their antique characteristics fetching a price premium among buyers.

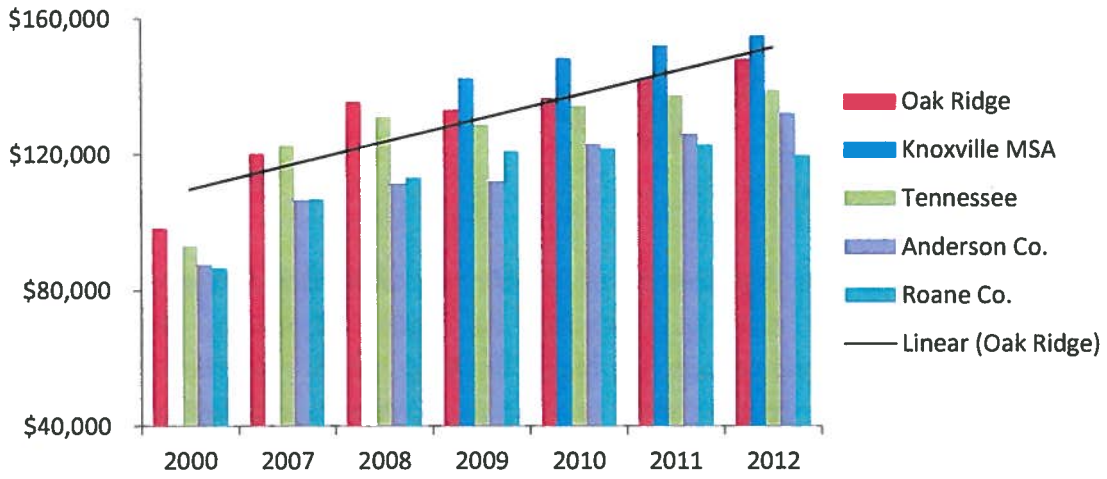
An evaluation of home values in Oak Ridge, relative to nearby areas in the region offers some insight into not only the quality of available housing in Oak Ridge, but the demand for

Figure 21 - Structures by Year Built As A Percentage of Total Housing Stock



it as well. As shown in Figure 22,[6] since 2000, median home values in Oak Ridge have consistently been lower than median home values in the broader Knoxville metropolitan area, though higher than median values in Anderson and Roane Counties and Tennessee as a whole. Median home values in Oak Ridge overall are increasing at rates similar to those in the broader Knoxville metropolitan area. This suggests that housing age may not have historically been a significant determinant of demand for housing in Oak Ridge.

Figure 22 - Median Housing Values through Time



Assuming that "housing value" is a proxy for demand, these data suggest that while demand for housing in Oak Ridge has outpaced demand for housing in Anderson and Roane Counties as a whole, it has not outpaced demand in the broader Knoxville metropolitan area.

As Figure 22 notes, overall median housing values in Oak Ridge increased by approximately 51% between 2000 and 2012. However, a brief analysis of changes in median housing values across the community indicates that not all portions of Oak Ridge have experienced this increase in housing values. In certain portions of the community, median housing values increased by less than 20%, and, in other portions, median housing values actually decreased between 2000 and 2012. Such variation in housing value changes across a community may be due to differences in housing and lot size, housing age, the proximity of assets such as schools and parks, rental and owner occupancy rates, or local crime rates, among other factors. Housing value changes may also be affected by the proximity of industrial facilities and disposal sites such as the Y-12 site and the existing EMWMF. As shown in Figure 23, some of these areas with declining housing value or relatively slow growth in housing values are directly adjacent to the existing EMWMF.

[6] Figure 3 provides a comparison of median home values in Oak Ridge and in surrounding areas. Data for the Knoxville Metropolitan Statistical Area (MSA) prior to 2009 was not readily available. The figure also displays a linear trend line based on housing values in Oak Ridge.

Figure 23 – Census Block Groups near the EMWMF with a Negative Change in Median Housing Values between 2000 and 2013 (Red) or an Increase of Less than 20%

While it is impossible to draw verifiable conclusions regarding the underlying reasons for this demand profile from Census data alone, there are some hypotheses that can be developed. For example, looking at the city of Oak Ridge overall in comparison to the surrounding counties, if the DOE facilities near Oak Ridge have historically been a major source of employment for the counties, and if the assumption is made that proximity to work is a preferred housing attribute, then it stands to reason that houses closer to the DOE facilities may have been in greater demand (and have higher value) than those that were further from the DOE facilities. As employment patterns in the area shift, this value proposition may change.

In the same way that a positive attribute can increase housing demand/value, a negative attribute can drive demand/value down. For example, since the inception of the Manhattan Project, the public's concern regarding long-term exposure to low levels of radiation has grown. Additionally, as employment patterns in the Oak Ridge area change, it is possible that local residents are less familiar with DOE operations and feel less comfortable with operation of the facility and on-site waste disposal. What was once a positive attribute-proximity to the DOE facilities – may now have become a negative attribute. Further expansion of on-site waste disposal could increase the detrimental effect of proximity to the DOE facilities. However, it is impossible to tell the full story from Census data alone. For example, declining or slowly increasing housing values near the existing EMWMF may be due to the existing waste management facility or to a number of other socioeconomic

characteristics in these areas. To understand these influences more completely, additional survey and focus group analyses will have to be conducted.

The original decision to site and begin operation of the EMWMF facility was made in 1999. The socioeconomic impacts of these decisions were not fully evaluated at the time, but it is reasonable to assume that these impacts have been absorbed by the community and are reflected in current housing values, rental rates, occupancy rates etc. Going forward, the question for analysis becomes one of understanding the impact and magnitude of construction of a separate facility, the EMDF. While a community may accept, and not be disproportionally adversely impacted by, a certain level of exposure to and presence of a negative influencer, there may be a point beyond which the level of harm is unacceptable- the proverbial "straw" that "breaks the camel's back." Census data can offer some insights into what has happened, but it is insufficient for understanding what *might* happen going forward without complementary investigation into community attitudes, preferences and risk perceptions.

A preliminary analysis of Census data suggests that median housing values across the Oak Ridge community have generally lagged values in the overall Knoxville metropolitan area, though they are higher than median housing values in Roane and Anderson Counties. Within the Oak Ridge community, some areas have experienced substantially lower (or negative) housing value growth. This preliminary analysis cannot distinguish between the impacts of the EMWMF and other existing DOE facilities on surrounding housing values as compared to other socioeconomic features, but declining and slowly growing housing values near the existing disposal facility are a cause for concern. Further, more detailed socioeconomic analysis is necessary to evaluate the contribution of the EMWMF to current trends in housing values and to assess whether the proposed EMDF may have more substantially detrimental effects on nearby areas.

Economic Impacts Associated with Older Housing Stock in Potentially Affected Areas

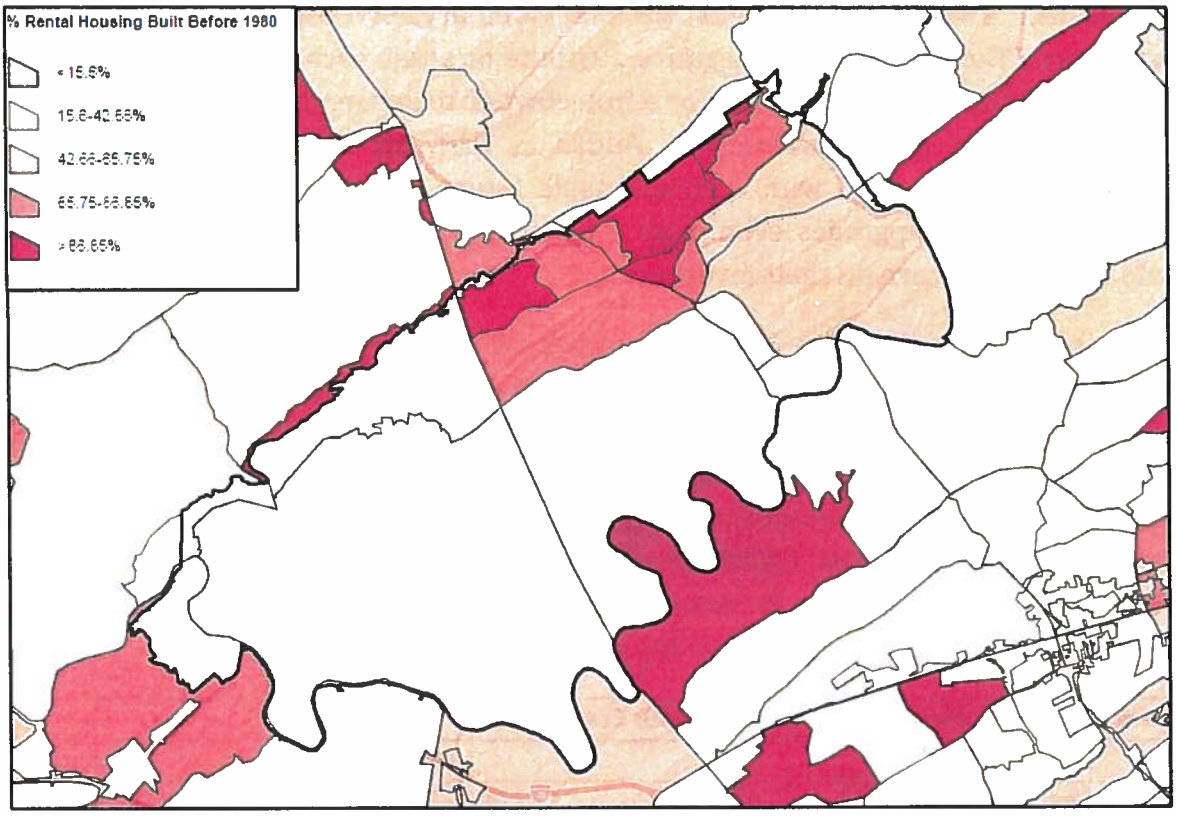
Renters, by definition, have more potential flexibility than those who own their homes. They are more mobile and are able to relocate as employment opportunities change. Homeowners do not have the same level of flexibility. If the introduction of a negative attribute into an area causes desirability to drop, those who own their homes are not likely to be able to relocate. If they are able to sell their homes, they are not likely to recoup the full value of their investments.

Based on 2010 US Census data, over 50% of the homes in Oak Ridge are owned, single family dwellings[7], and 93% of those are owner occupied. However, the percentage of rental

[7] Census data uses the term "homeowner" to identify "single family"/"owner occupied" housing units. To insure that this analysis can be replicated by a third party, census nomenclature has been retained.

housing has been documented by HUD to be highest in the land area located closest to the EMWMF site, See Figure 24.

Figure 24 - Percent Rental Housing Built Before 1980 by Census Block Groups near the EMWMF 2013



In the community (within the area shaded in dark red immediately adjacent to the Y-12 plant), the percentage of rental housing built before 1980 is 98.53%, the median home value is $102,400, median contract rent is $443, and the vacancy rate is 15.10%. The value of homes in this area of Oak Ridge is significantly lower than the median for the city of Oak Ridge which is $148,400 as of 2013. Median rents in Oak Ridge are $736 and the rental vacancy rate is 9.2%. From this data analysis, it is clear that the community nearest the EMWMF is lagging in all housing parameters relative to other areas in the City of Oak Ridge and surrounding areas, and it is reasonable to suggest a positive correlation between the introduction of a negative attribute (i.e., EMWMF) into an area which causes desirability to drop. As a consequence, homeowners may not recoup the full value of their investments.

If the construction of the proposed EMDF has a negative impact on home values, homeowners, representing more than 50% of the surrounding population, will suffer as a result. If the construction of the EMDF has a negative impact on home values in all or a part of the Oak Ridge community, it will be exceedingly difficult for these homeowners to relocate or rebound without assistance.

Homeowners who live in Oak Ridge are potentially in a double bind due to the age of the overall housing stock. Older homes require significant investments to bring them up to current code standards. Lead paint, asbestos, lead pipes, etc. were all commonly used in construction 50 years ago and are not acceptable today. In order to sell a home (or immediately after an older home is purchased) upgrades must be made to these and many other items. These improvements are not voluntary, or cosmetic, and they are not inexpensive. The presence of a negative attribute or asset, such as the EMDF, potentially makes it difficult, if not impossible for a homeowner to secure the necessary financing to make these types of improvements. Added to that, the uncertainty associated with demand/price in an area with a questionable future, makes the decision to invest in improvements and upgrades even more dubious, as it is doubtful that the homeowner would ever see a return on their investment.

In the case of Oak Ridge, some 60% of the homes are more than 40 years old. A review of a number of publically available sources yielded the following cost data for the collective rehabilitation older homes in Oak Ridge (based on rehabilitation of a typical 1940s era home). As shown in Table 6, the total cost to bring older homes in Oak Ridge up to code ranges from over $50 million dollars on the low end to nearly $175 million dollars on the high end. If the proposed EMDF adversely affects housing values in the community, homeowners may be unable to bear these rehabilitation costs, severely limiting their ability to sell their homes and recover any equity.

Table 6. Representative Repair Costs for 1940s Era Homes

	Low	***High***
Asbestos Test and Removal	$17,893,359	$21,661,535
Window Replacements	$24,646,500	$53,236,440
Electrical Rewiring	$8,215,500	$98,586,000
Total (based on total estimated number of homes in Oak Ridge)	***$50,755,359***	***$173,483,975***

The decision to rehabilitate or demolish an older home is a complex one, without the addition of the potential impacts of an additional nuclear waste disposal facility. It is unclear whether or not rehabilitation of older homes near a detrimental disposal facility would result in increased investment value for homeowners, provided it could be financed at all. In cases where communities are subject to significant negative impacts as a result of the siting of a facility, the best alternative may be to demolish affected structures. If there is no evidence that rehabilitation of housing stock will improve economic conditions, then buy-out and demolition are logical alternatives to consider.

For the city of Oak Ridge, demolition of 1940s era housing stock carries a potential price tag ranging from $16 million dollars on the low end to upwards of nearly $100 million dollars as shown in Table 7.[8]

Table 7 – Representative Demolition Costs for 1940s Housing (values based on estimated total number of 1940s homes in Oak Ridge)

Basis	*Low*	*High*
Small Home	$16,431,000	$43,816,000
Average Home	$54,770,000	$136,925,000
FEMA Estimates	$26,031,369	$98,862,816

Depending on the preferences of the community and the cost and value of alternative uses for the land in the area where these houses are located, demolition may be the most cost effective, highest/best use alternative for the area, but further analysis and discussions with community members would be necessary to determine whether this is a reasonable approach.

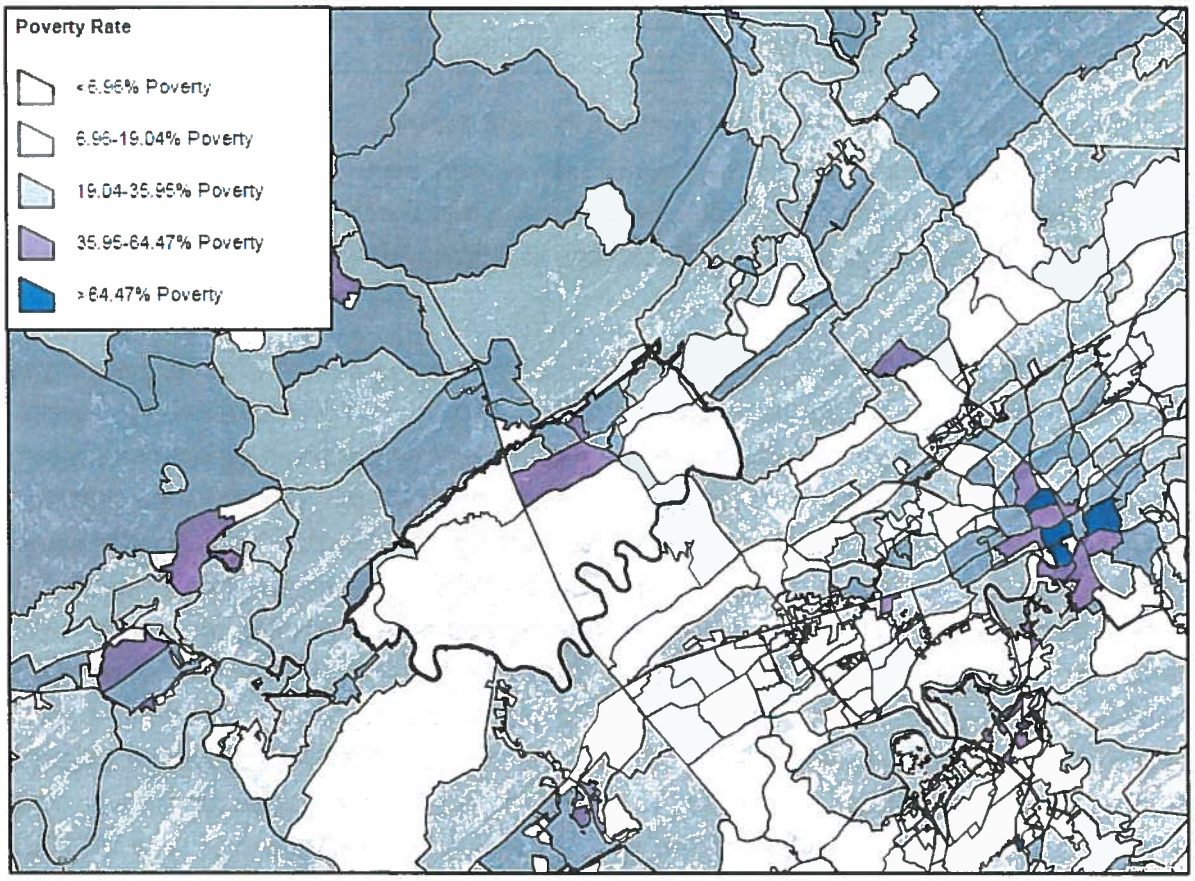
Issues associated with rehabilitation or demolition and replacement of older housing stock are particularly pertinent for the Oak Ridge community. As noted above, property tax revenues typically fund public education and public services, and homeowner spending in a community is likely to result in secondary and tertiary economic effects in the community. The Oak Ridge community is bounded to the east by Melton Hill Lake, to the south by Melton Hill Lake and DOE facilities, to the west by DOE facilities, and to the north by the city of Oliver Springs and other areas where city expansion is restricted by State law. There is little open land within the City that is available for future development. Notably, land available for development is actually concentrated on the northwestern side of the City, directly adjacent to the existing EMWMF and the proposed EMDF (within and adjacent to the shaded areas in Figure 4 that are experiencing slow or negative growth in housing values). Should further analysis confirm existing detrimental effects from the EMWMF on nearby housing values or the potential for additional negative effects from the proposed EMDF, these negative impacts would be exacerbated by the existing restrictions on development. In effect, even a limited radius of impact from the EMWMF and EMDF could severely affect future development of the City and lead to larger than anticipated declines in city services as existing housing stock continues to age and decline in value (without substantial rehabilitation) and future development is restricted. If further analysis confirms the presence of a localized detrimental effect from the EMWMF or proposed EMDF, the loss of future development capacity in open areas may require an offset in the

[8] Values in rows one and two based on CostHelper.com, Cost Helper, Home & Garden, House Demolition Cost, available at: http://home.costhelper.com/house-demolition.html, accessed December 2, 2014. Values in row three from Krupa, Michelle, The Times-Picayune, 2011, "FEMA to restart program for demolishing Katrina-damaged buildings in New Orleans", available at: http://www.nola.com/politics/index.ssf/2011/03/fema_to_restart_program_for_de.html, accessed December 2, 2014.

form of targeted funding for the mass rehabilitation or demolition of older homes (freeing areas for future development).

Another factor that can be used to evaluate economic impact to the area proximate to the EMWMF is through comparison of the poverty rate. As seen on Figure 25 the highest percent poverty rate is located in the area of Oak Ridge located closest to the EMWMF.

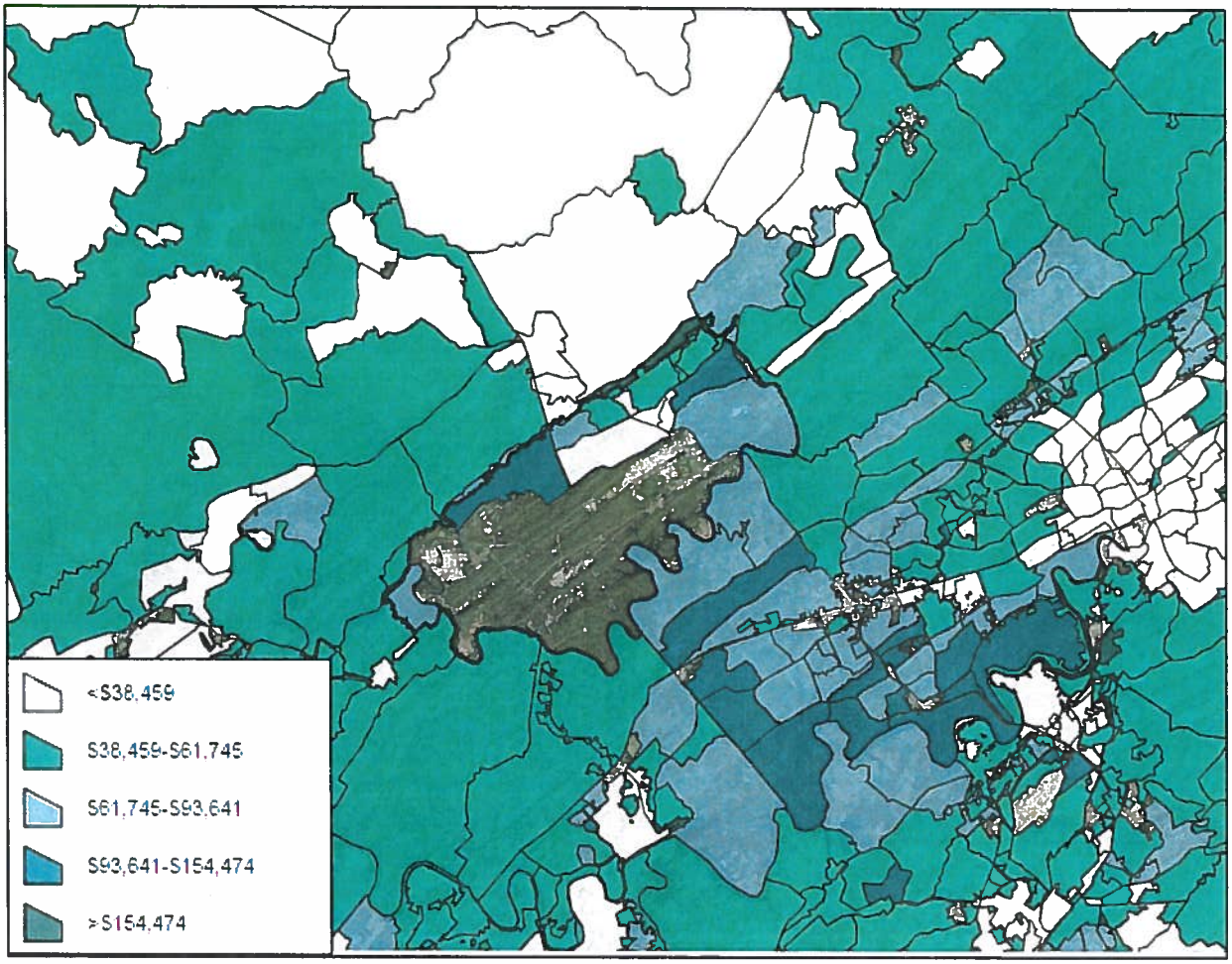
Figure 25 - Percentage of Persons Living at the Poverty Level, 2013 (US Census)



The poverty rate for this section of Oak Ridge is 37.39% whereas the poverty rate for the City is 17.7%. In Roane and Anderson Counties the 2013 poverty rates are 15% and 18.2%, respectively.

The concentration of poverty in this area is also reflected in the lowest median household incomes being recorded in the region. As depicted on Figure 26, the census tracts located closest to the EMWMF and proposed location of the EMDF has the lowest median incomes in the City of Oak Ridge. Southern Anderson County also reflects a low median income which is likely a consequence of the area having a low population density.

Figure 26 - Median Household Income, 2013 (US Census)



The negative socioeconomic impact of the operations at ORR in the southwestern portion of the City of Oak Ridge is also apparent in the high percentage of resident population that lacks health insurance and the low percentage that have not attained a bachelor degree. In this area of the City both of these indices are lower than the surrounding area - See Figures 27 and 28.

Figure 27 - Percent Population with Bachelor's Degree, 2012 (US Census)

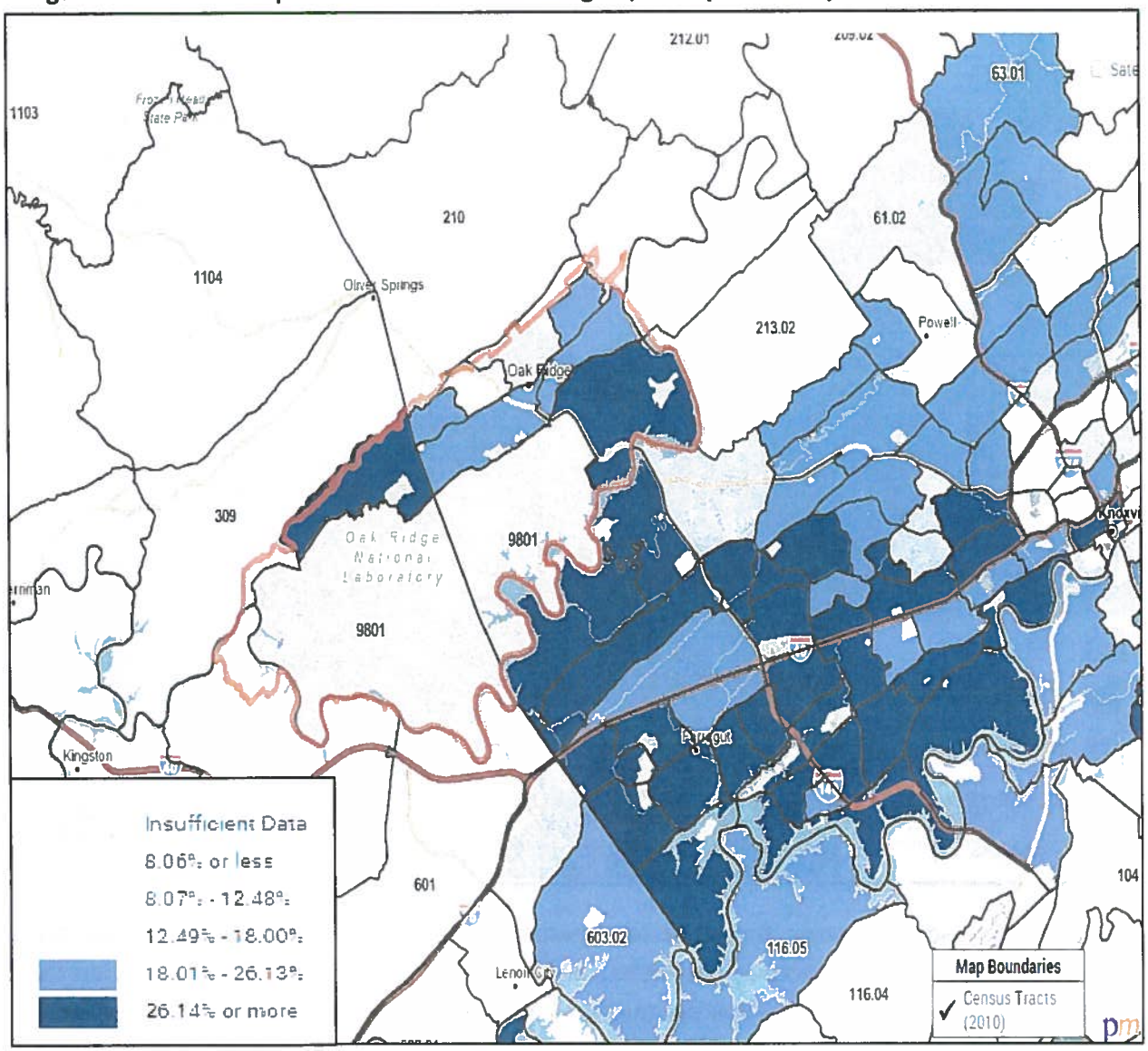
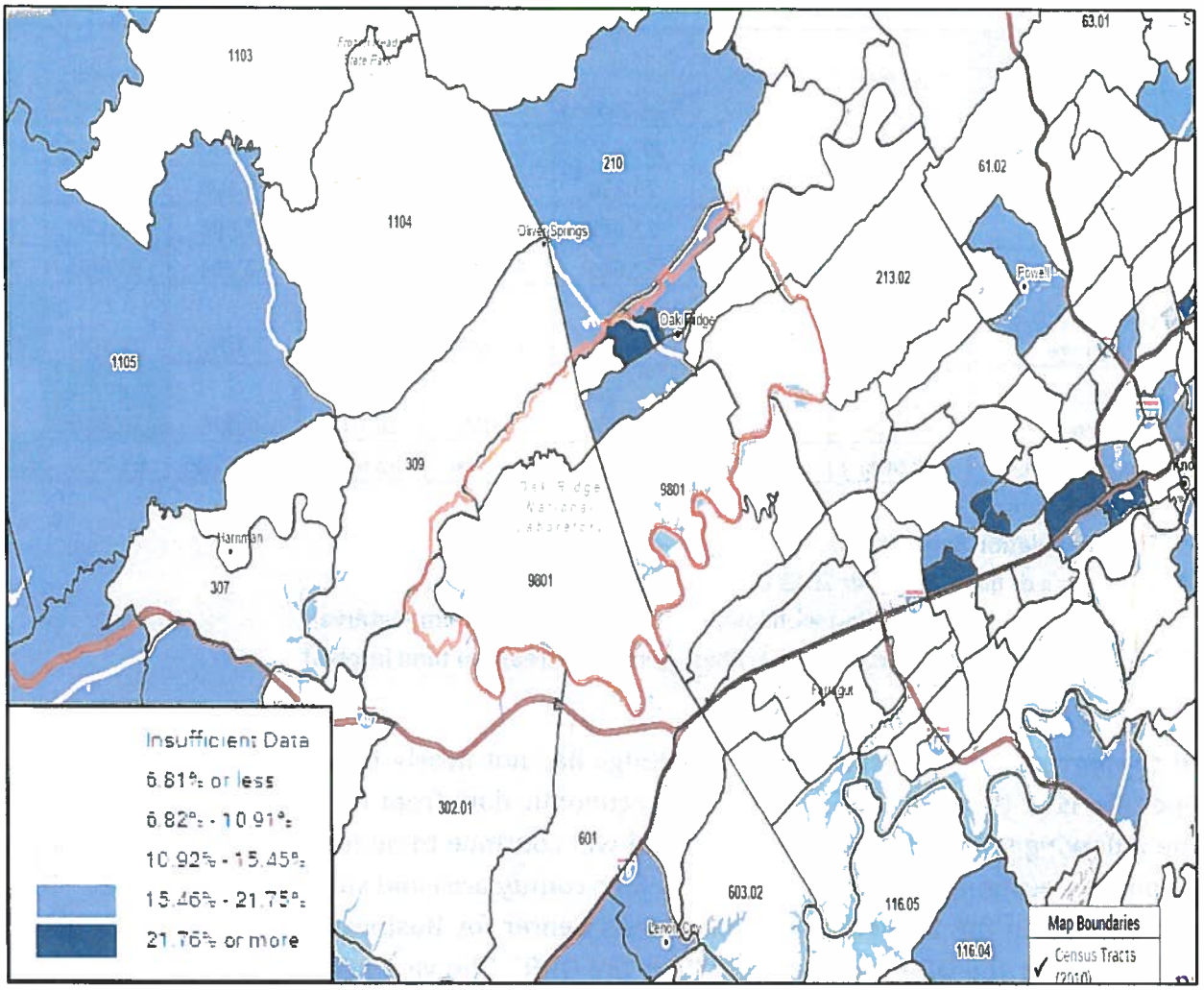


Figure 28 - Percent Population without Health Insurance, 2012 (US Census)



Finally, the TFG Team believes it is also important to include in this report a comparison of population growth in the area of the ORR. We recognize that this comparison cannot be used to quantify the impact from the EMWMF or the proposed EMDF on the City of Oak Ridge, yet it appears reasonable to us to reflect a causational impact of ORR operations on population growth in Oak Ridge. Oak Ridge has experienced marginal growth in population from 1990-2010. During this time period Oak Ridge's population increased by only 1,943 people, and the rate of population growth in Oak Ridge has trailed all the counties in the Knoxville Metropolitan Area. (Table 8). The closest county to population growth during this time period is Anderson County at 10.6% with Oak Ridge at 6.57%. Other counties such as Sevier, Loudon, and Blount Counties have experienced significant growth during this time interval. These counties have witnessed growth of 83.20%, 61.4% and 46.90%, respectively. The population growth lag that persists in Oak Ridge does not correlate with the City being a very large employment center unless ORR workers are consciously deciding not to reside in the City.

Table 8. Population Growth for Knoxville Metropolitan Area

Population Over Time	Anderson County	Roane County	Oak Ridge	Blount County	Knox County	Union County	Sevier County	Loudon County
2014 Estimate	75,528	53,047 *	29,419 *	126,339	448,644	19,109 *	93,570 *	50,448 *
2010	75,126	54,181	29,330	123,010	432,226	19,109	89,889	48,556
2000	71,330	51,910	27,387	105,823	382,032	17,808	71,170	39,086
1990	68,250	47,227	27,605	85,969	335,749	13,694	51,050	31,242
2000 to 2010 % Change	5.30%	4.40%	7.00%	16.20%	13.10%	7.30%	26.30%	24.20%
1990 to 2000 % Change	4.50%	9.90%	-0.80%	23.00%	13.70%	30.00%	39.00%	25%
1990 to Present **	10.60%	12.30%	6.57%	46.90%	33.60%	39.50%	83.20%	61.40%

Source: US Census

* 2013 Population Estimate

** Present is defined as either 2013 or 2014 data

Jurisdiction with lowest percent increase in time interval

Jurisdiction with highest percent increase in time interval

In support of this assessment that Oak Ridge has not nearly benefitted as much from the operations at the ORR, TFG has included economic data from DOE operations. As seen in the following tables, the DOE has been and will continue to be for the foreseeable future a significant economic driver in the greater four county area and surrounding counties. Data provided from the University of Tennessee's Center for Business and Economic Research indicates that the ORR employs 11,230 at the ORR. The vast majority of the workforce is classified in the professional services. This same research reveals that State and local tax receipts from both indirect and direct jobs created as a result of DOE operations in Tennessee are valued at $142M for federal fiscal year 2013.

The epicenter for DOE's financial commitment in the State of Tennessee is the ORR. Yet in spite of this concentration of federal resources in the City of Oak Ridge, it is evident from our analysis that the ORR workforce seeks to live elsewhere and spend the majority of their earned income elsewhere.

Table 9. DOE Direct Employment in TN - 2013

Division/Contractor	*Employees*
B&W Y-12, LLC	4,398
UT-Battelle, LLC	4,330
ORAU	862
UCOR	618
NSPS	215
USEC Inc.	137
WAI	162
OREM	129
BEI-JES Oak Ridge	83
Isotek	76
NNSA Y-12	72
Alliant	42
US DOE-OSTI	41
GET-NSA	28
ES&H	19
SUMMIT	18
Total direct employment	**11,230**

Source: University of Tennessee's Center for Business and Economic Research, FY 2013

Table 10. DOE Employment & Payroll by County, 2014

COUNTY OF RESIDENCE	TOTAL EMPLOYEES December 31, 2014	ANNUAL PAYROLL DOLLARS ($) Jan. 1, 2014 - Dec. 31, 2014
Anderson	2,576	235,293,277
Blount	377	33,703,561
Campbell	196	15,050,043
Claiborne	30	2,277,998
Cumberland	71	5,390,032
Grainger	14	1,131,522
Hamblin	13	1,158,596
Hamilton	10	1,731,502
Jefferson	31	2,448,628
Knox	5,030	507,487,243
Loudon	595	57,480,764
McMinn	41	3,552,625
Meigs	44	3,137,248
Monroe	99	8,134,053
Morgan	395	28,684,623
Rhea	32	2,743,539
Roane	1,641	146,889,050
Scott	63	4,161,769
Sevier	59	4,880,475
Union	51	4,008,902
Misc. Counties w/less than 10 employees	69	5,145,938
TOTAL	11,437	1,074,491,386

Source: US DOE Employment Report, 2014

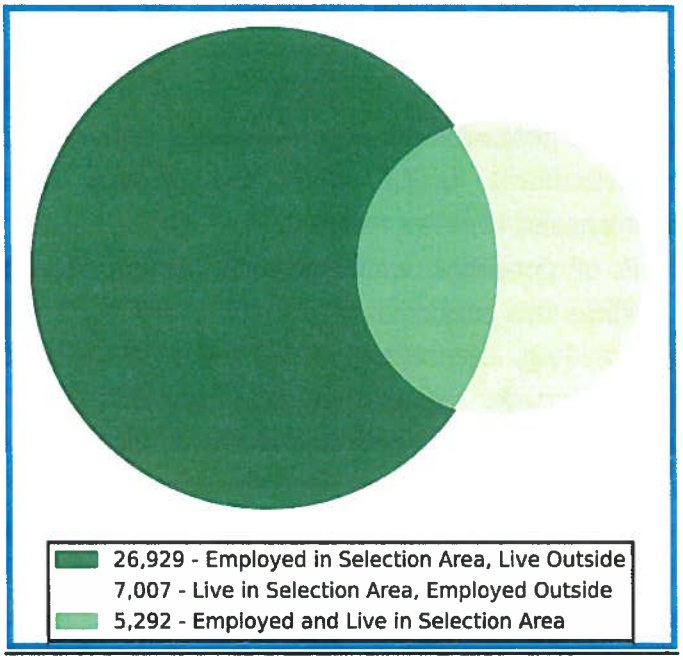
Table 11. DOE Sales Tax Revenue in TN - 2013

Direct Payments	
State	$66,692,133
Local	22,471,891
Indirect/Multiplier	
State	39,401,677
Local	13,565,435
Total sales tax revenue benefit	**$142,131,137**

Source: University of Tennessee's Center for Business and Economic Research, FY 2013

The commuting pattern of the ORR workforce is a particularly interesting metric when this information is compared to the commuting pattern of the workforce that lives in Oak Ridge. Oak Ridge is identified as a gaining area for employment which means that more workers commute to work to Oak Ridge than residents commute out of the City for work. Approximately 26,929 people work in Oak Ridge but live elsewhere. This is contrasted by the 7,007 Oak Ridge residents that work outside the City, and 5,292 who live and work in Oak Ridge. The analysis also reveals that a large segment of the workforce is commuting 10 to 50 miles to work in Oak Ridge from locations originating to the East and Southeast – US Census 2010. This reflects a strong correlation with workers commuting from Knoxville to Oak Ridge for employment (See Figure 29).

Figure 29. Inflow/Outflow Job Counts for Oak Ridge, TN (US Census 2010)



The fact that Oak Ridge (ORR) is a major employment center but that population growth has significantly lagged in comparison to surrounding Roane and Anderson counties, suggests a good correlation exists between workers negative perception of wanting to live in close proximity to the operations at ORR. The construction of the EMWMF must be considered a factor in the perception and the proposed addition of the EMDF would certainly reinforce this negative perception.

Finally, the City of Oak Ridge for more than a decade has raised concern with the funding DOE has provided to the City for revenues lost from the presence of the ORR in the city limits. As recently as October 20, 2014, City Council requested DOE revisit the Community Assistance Review as allowed within AECA 1955, PL 84-221, DOE Order 2100.12A. DOE currently provides a funding subsidy to Oak Ridge based on an agricultural land use. The activities being undertaken at the ORR at Y-12, ORNL and ETTP should not be classified as

an agricultural use. DOE should revisit this designation and revise the subsidy payments higher to reflect the use of the ORR for industrial uses.

Conclusions

Based on this analysis, a number of issues pertaining to the potential cumulative socioeconomic impacts of the proposed EMDF have been identified. These issues are summarized below.

- DOE did not conduct an assessment of off-site socioeconomic costs potentially associated with construction of the EMWMF, nor has it conducted such an analysis for the proposed EMDF. The absence of such an assessment is particularly notable given the common inclusion of such analyses during the assessment of other landfills and given local economic changes, changes in the DOE work force, and the shift toward nature-based tourism in the surrounding areas.
- DOE has not conducted an analysis of public perceptions of the EMWMF or proposed EMDF, nor of the potential stigmas associated with the facilities. Such an analysis could be particularly useful given the general reduction in local employment by DOE compared to other employers.
- A preliminary analysis of potential socioeconomic issues has identified several markers of concern. While this preliminary analysis is not sufficient to identify the cause of these concerns (e.g., operation of the EMWMF, operation of the DOE complex in general, other broader regional issues), it underlines the importance of a more careful look at socioeconomic impacts and the assessment of these impacts during disposal option selection. These areas of concern include:
    - Lower housing costs and lower housing value appreciation rates in communities nearest the landfills;
    - Lower housing value appreciation rates in Oak Ridge as a whole compared to the broader Knoxville metropolitan area; and
    - The concentration of a number of other socioeconomic indicators of concern in the communities nearest the landfills.
- The prevalence of legacy homes dating from the Manhattan Project era limits the growth and redevelopment of Oak Ridge within its current developed footprint, and geographic and jurisdictional barrier restrict growth beyond the current footprint in most directions. Many of the areas open for future development in Oak Ridge adjoin the DOE reservation and are near the landfills. This issue could magnify the potential impacts of the EMDF to the City of Oak Ridge. This issue should also be considered during any future NRDA decision-making on the selection of DOE lands for permanent easements, since such selections, by their very location, could have an undue impact on the future of Oak Ridge.

Recommendations

Based on the foregoing analysis of the two remedial options evaluated by the TFG Team in the RI/FS report and the possible impact to the Oak Ridge community, we offer the following recommendations for undertaking next steps on this project.

- TFG commends the DOE for undertaking the D3 Limited Investigation of the EMDF site. A decision to construct a low-level nuclear waste and hazardous waste landfill should be made only after completing an extensive on-site investigation that includes the comprehensive sampling of environmental media, undertaking both a geophysical and geotechnical investigation to determine the adequacy of the site from a structural perspective, and completing an assessment of risk to public health and the environment using on-site data.

- DOE's Limited Phase I Study must clearly demonstrate that the underlying bedrock units of the Maryville Limestone and other shale and limestone formations are structurally suitable for placement of a low-level and hazardous waste landfill.

- The EMDF site location does not meet some of the criteria that the Department specified in the RI/FS for an acceptable location. The EMDF site clearly does not meet the criteria for surface water impacts and sites with unfavorable topography.

- The EMDF remedy contemplates construction of an underdrain system under the landfill to convey groundwater. This structural requirement as part of the remedy has previously been documented to be a challenge when the EMWMF was being constructed. The fact that an underdrain system will also be required at the EMDF suggests that DOE should have given greater weight to other more suitable site locations that would not require the construction of an underdrain system (i.e., sites not located off a steep ridge with a hydrologic regime that is a high energy/force environment for transmission of both surface water and groundwater).

- The preferred remedy would require a groundwater waiver of the TSCA 50 foot vertical separation between the bottom of waste and the water table. TDEC would also have to issue a waiver because a "LLW disposal unit cannot be constructed where groundwater discharges to surface water." Based on this known groundwater site constraint, DOE should expand their explanation for advocating for the proposed EMDF as the preferred remedy.

- The RAOs in the RI/FS specify a standard of care for ecological resources that is not measureable to "Prevent ecological exposure to future-generated CERCLA waste".

The RAO for ecological risk in the RI/FS does not appear to address the requirements of the NCP. The RAO lacks clarity with respect to characterizing the threat and extent posed by hazardous substances. Moreover, the preferred remedy would impact a tributary, NT-3, NT-2 and wetlands that flow where the landfill is proposed to be constructed. In addition, there are springs and seeps indicative of a shallow water table.

- Another RAO established by DOE provides for an acceptable level of risk of the Hazard Index (HI) to reach a risk tolerance of 3. The NCP provides for an unacceptable risk threshold of 1 or more. Therefore, a HI acceptable risk threshold of 3 would not be considered an acceptable level of risk. DOE's rationalization for increasing the HI risk to 3 is based on risk modeling uncertainty after 1,000 years.

  DOE's rationalization reflects the limitation of using the Superfund law and NCP regulation to determine the efficacy of siting a low-level nuclear and hazardous waste landfill. Superfund was developed only to address the adverse impact of hazardous substance release(s) into the environment and the consequent impact to either human health or ecologic receptors. The use of this law in this context draws into question whether the public will be adequately protected in the future from this facility siting.

- The RI/FS document provides an extensive description of long term monitoring and maintenance requirements for the EMDF. The costs associated with monitoring and maintenance are not, however, well documented.

- DOE presents in the RI/FS report limited information on hybrid remedial alternatives - combined on-site disposal and off-site disposal. These hybrid options, which range in 20% increments of off-site disposal from 20% to 100%, however, are not adequately described to fully understand the cost basis for each of the options. DOE should fully describe the assumptions/estimates used to calculate these cost ranges.

- DOE's cost estimate for the EMDF is based on a conceptual design that yields an approximate landfill waste disposal capacity (i.e., air space volume) of 2.5 M yd3, but does not include the cost for construction of the sixth cell as the current waste generation forecast (with a 25% volume contingency) would only fill five cells. DOE should revise the cost estimate for the On-Site EMDF upward to reflect the cost of constructing a sixth cell.
- The EMDF site would not meet NRC siting criteria for low-level nuclear waste disposal. Pursuant to 10 CFR 61.50 for NRC licensing of low-level nuclear waste, landfills must be sited in areas that are generally well-drained and free of areas of

flooding or frequent ponding. Waste disposal shall not take place in a 100-year flood plain, coastal high-hazard area or wetland, and upstream drainage areas must be minimized to decrease the amount of runoff which could erode or inundate waste disposal units. NRC regulations include a performance period of 10,000 years. NRC technical documents indicate that disposal sites should be located in areas which have low population density and limited population growth potential. Disposal sites should be at least two kilometers from the property limits of the closest population centers. DOE should include in the RI/FS a more robust discussion as to why NRC siting criteria are not ARARs.

- The EMDF site does not meet several of TDEC Licensing Requirements for Land Disposal of Radioactive Wastes. TDEC regulations require disposal facilities be selected so that projected population growth and future developments are not likely to affect the ability of the disposal facility to meet performance objectives. A disposal site must be generally well-drained and free of areas of flooding and frequent ponding. Waste disposal should also not take place in a 100-year floodplain or wetland. Upstream drainage areas must be minimized to decrease the amount of runoff which could erode or inundate the disposal unit. DOE should expand their discussion on how they believe the EMDF complies with these State regulations.

- The value of the proposed EMDF Trust Fund for long-term maintenance appears to be underfunded relative to NRC regulated facilities. The bond required for the nuclear waste landfill at the WCS in Andrews, TX is much higher than the Trust Fund for the EMWMF site. The WCS site has the following financial assurance amounts for the post-closure period:
    - Post-Closure: $10.5 million
    - Institutional Control: $21.5 million
    - Corrective Action: $25.9 million

  The corrective action amount is an important funding source for the WCS site and is noticeably not provided for at the EMDF site. This fund would be used for unplanned maintenance during the post-closure period. DOE should expand their discussion of the Trust Fund to include an assessment of the need for a Corrective Action funding line.

- A decision to site a low-level nuclear waste landfill that will arguably require on-going active management for over 1,000 years suggests to TFG that more extensive efforts should be undertaken by DOE to identify sites that are located either inside the ORR or off-site that do not require tributaries to be re-routed, groundwater springs to be controlled, wetlands to be destroyed or federal and state requirements

to be waived for separation of groundwater to landfills that would contain low-level nuclear waste.

- The DOE process for siting the EMDF requires the integration of NEPA requirements within the CERCLA process per DOE Order 5400.4, issued October 6, 1989. However, a thorough assessment of the potential socio-economic impacts on the surrounding communities of the EMWMF or the proposed EMDF has not been undertaken. We recommend that DOE supplement this RI/FS to incorporate a much more comprehensive NEPA analysis of the potential impact of the EMDF on the greater Oak Ridge community. This recommendation is fully described in Appendix B.

- With respect to NRDA, CERCLA 107(f)(1) specifies that no liability shall be imposed where it can be demonstrated that " the damages to natural resources complained of were specifically identified as an irreversible and irretrievable commitment of natural resources in an environmental impact statement, or other comparable environmental analysis, and the decision to grant a permit or license authorizes such commitment of natural resources, and the facility or project was otherwise operating within the terms of its permit or license...." While natural resource damage claims may not be relevant for permitted facility operations, these operations will result in natural resource damages to the surrounding second growth forest and wetlands. Such impacts should be more fully assessed as part of the siting analysis for the EMDF, and the relative impacts of the proposed site should be compared to the impacts associated with other on-site and off-site disposal locations to ensure that the overall siting decision has properly considered all factors.

- NRDA regulations under CERCLA call for public participation at various stages. In addition, US DOE and US Department of Interior must follow NEPA regulations, which require early public involvement in agency decisions or actions that may affect the environment. From publically available TDEC documents, the NRDA Trustee Council is pursuing a final settlement for damages on the entire ORR. The current NRDA process cannot constitute a final determination of injuries and damages associated with the ORR. There are still many sites and areas where characterization of contaminants, their fate, transport and ultimate remediation remain unknown. As an example, the US Department of Energy, EPA, and the TDEC are undertaking an ever expanding off-site groundwater investigation due to contamination being detected in over 60 domestic wells.

  Any additional conservation easements considered as part of the broader NRDA for the ORR should consider the socioeconomic impacts of the easements on the City

and the potential aggravating impacts of any compensatory easements on the long-term sustainability of the City of Oak Ridge, particularly given the special circumstances that the City must contend with as the result of legacy housing constructed by the government for the Manhattan Project.

- Finally, we believe the relevant State and Federal agencies with regulatory responsibilities over the disposal of low-level nuclear waste should evaluate the efficacy of using the Federal Superfund process to guide the siting decision for the EMDF. We do not believe the Superfund law, regulations, and process can effectively document or determine the siting of low-level nuclear waste landfills such as the EMDF because the program is not structured to prospectively evaluate potential future releases of hazardous and nuclear waste.

Bibliography

Branch, K., D.A. Hooper, J. Thompson and J. Creighton. "A Guide to Social Assessment: A Framework for Assessing Social Change. " Westview Press: Boulder. 1984.

Burdge, R.J., "A Community Guide to Social Impact Assessment." Middleton, WI: Social Ecology Press. 1994.

Brudge, R.J., P. Fricke, K. Finsterbusch, W.R. Freudenberg, R. Gramling, A. Holden, L. Llewellyn, J. S. Petterson., J. Thompson and G. Williams. "Guidelines and Principals for Social Impact Assessment." Environmental Impact Assessment Review 15:11-43. Elsevier Science, Inc. New York. 1995.

Geneslaw, Howard. "Cleanup of National Priorities List Sites, Functional Equivalence, and the NEP Environmental Impact Statement. Journal of Land Use & Environmental Law. 1995.

Guidelines and Principles for Social Impact Assessment. Interorganizational Committee on Guidelines and Principles for Social Impact Assessment. U.S. Department of Commerce, National Oceanic and Atmospheric Administration National Marine Fisheries Service. May 1994.

Industrial Economics, Inc. (IEC). Oak Ridge Reservation Natural Resources Damage Assessment Evaluation of Contaminant-Related Losses in Watts Bar Reservoir and Gains from the Black Oak Ridge Conservation Easement. September 2008.

Kearney, Richard, A. Smith. "The Low-Level Radioactive Siting Process in Connecticut: Anatomy of a Failure." Policy Studies Journal. Vol 22. NO. 4. Pgs. 617-630. 1994.

Martin Marietta Energy Systems, Inc. 1993. "Integrating Natural Resource Damage Assessment and Environmental Restoration Activities at DOE Facilities." contract No. DE-AC05-90OR21851 October.

Masson, Peter, T. "CERCLA Remediation's and the NEPA Process-Are Environmental Cleanups Forgetting the Socioeconomic Issues. Capstone Paper Prepared for Duke Environmental Leadership Program, Nichols School of the Environment and Earth Sciences. August 2005.

Merrett, Christopher. "Low Level Radioactive Waste in Rural Illinois: Social and Economic Impacts on Community Development". Rural Research Report. University of Illinois, Institute for Rural Affairs. Volume 8, Issue 5. Spring, 1995.

Taylor, C., C. Nicholas, C. Hobson Bryan, and C. Goodrich. Social Assessment: Theory, Process and Techniques." Studies in Resource Management. NO. 7., Center for Resource Management, Lincoln University, New Zealand. 1990.

White, G.F., et. al. "Review: Socioeconomic Studies of High-Level Nuclear Waste Disposal". Proc. Natl. Acad. Sci. USA. Vol. 91, pp. 10786-10789, November 1994.

Williams, J., J. Patterson, R. D. George- Bechtel Jacobs Company LLC; J. M. Japp- Oak Ridge Operations, Oak Ridge Environmental Management Waste Management Facility DOE-EM's

First On-Line Privatized Disposal Facility. U.S. Department of Energy. WM'04 Conference, February 29 – March 4, 2004, Tucson AZ WM-4537.

Appendix A

DOE 1998a. Remedial Investigation/Feasibility Study for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee, DOE/OR/02-1637&D2.

DOE 1998b. Addendum to the Remedial Investigation/Feasibility Study for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee, DOE/OR/02-1637&D2/A1.

DOE 1999a. Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee, DOE/OR/01-1791&D3.

DOE 1999b. Proposed Plan for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee, DOE/OR/01-1761&D3.

DOE 2001b. Explanation of Significant Difference from the Remedy in the Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee, DOE/OR/01-1905&D2.

DOE 2005a. Explanation of Significant Differences for the Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee, DOE/OR/01-2194&D2.

DOE 2009. Explanation of Significant Differences for the Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee, DOE/OR/01-2426&D1

Appendix B

Approach for Analysis of Social and Economic Impacts

An "impact assessment "is the primary vehicle for assessing the social and economic impacts of project alternatives. An impact assessment involves the processes of analyzing, monitoring and managing the intended and unintended social and economic consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions. The Inter-organizational Committee on Guidelines and Principles for Social Assessment (1994) defines social impacts as 'the consequences to human populations of any public or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs, and generally cope as members of society' (pg. 1).

It is difficult, and not cost effective, to attempt to identify and evaluate all of the dimensions of social and economic impacts of a project, in part because of the synergies between elements and the associated multiplier effects. Within the field of "impact assessment" there is a standard set of variables that are typically evaluated in order to understand the social and economic impacts of project(s)/alternatives (Branch et. al., 1984, Brudge, 1994, Brudge et. al., 1995 and Taylor et. al, 1990). These generally include:

- Changes in community **demographics**;
- Results of retail/service and housing **market analyses**;
- Demand for **public services**;
- Changes in **employment** and **income levels and opportunities**; and
- Changes in the **aesthetic quality** of the community
- Changes in community **perceptions of social well-being**.

Demographics

Changes in the demographic profile of a community will have impacts on a number of elements within a community (demand for social and physical services, education, housing, etc.). Demographic variables include the number of new or seasonal residents that may be introduced into an area as a result of an alternative, changes in the density or distribution of people already in an area as a result of the selection of an alternative, and changes in the composition (age, gender, ethnicity, education, wealth, income, health status) of the population. An impact assessment looks at both the magnitude and rate of change of these variables in response to an alternative and across the life cycle of a project.

Market Analysis

As populations change in number and composition, demand for goods and services changes as well. Changes in the housing market often serve as a key indicator for understanding the impacts of a proposed alternative on a community. Examining housing stock (availability,

type- single family or apartment etc., affordability- in terms of rental rates or mortgage rates relative to wage rates), and value and changes to stock and value provide good quantitative indicators of the impact that a particular proposal may have on a community or a region.

Property value provides another indicator of the impact of a project. If a particular property is located in proximity to a desirable or an undesirable feature, this reality can be reflected in the value of that property. If a previously desirable property (as reflected in the sale value), loses value after a project is sited nearby, then the project can be said to have had a negative economic impact on the homeowner and the local economy.

A third type of market analysis that can shed light on the impact that a project may have on a community or region is an evaluation of retail market dynamics. Also tied to population, if the quantity and/or composition of a population changes, that will have implications for the cost and availability of goods and services in an area. An analysis of vacancy levels, property values, store turn-over rates, retail mix (e.g., mall vs. mom & pop vs. big box, food/drug, entertainment, etc.), tax revenue, etc. can provide insight into the impact a project may have on a community.

Public Services

There are two types of "public services" that may be impacted by a particular alternative; those that the private sector provides (hospitals, dentists, physicians, cultural and youth programs, etc.), and those that the government/public sector provides (police, fire, ambulance, trash pickup, parks and recreation facilities, etc.). These may all be impacted through changes in demand for these services, and through changes in available funds to support their provision. An impact assessment looks at both. Questions to be examined include: what is the current level and distribution of services; what are the anticipated needs and accessibility; what are the implications of changes in demand on tax levels, fiscal balance and service quality.

Employment Opportunities and Income

Projects that require a NEPA type impact assessment are expected to have some effect on income and employment opportunities in the affected area. The construction, operation and maintenance of alternatives will typically have short-, medium- and long-term impacts on levels and rates of employment in the affected area. Shifts in demand for goods and services in sectors related to or affiliated with the project may also impact employment opportunities and associated wage rates. This "multiplier" effect will be influenced by the level and duration of demand for primary wage earners and inputs to support the project.

While a project alternative may have a positive economic impact within a sector and its associated secondary and tertiary markets, there is the potential for a project to have

negative economic impacts on sectors that are not necessarily tied to the intervention itself. For example, locating a large waste water treatment plant next to a body of water that is known to be a prime fishing spot for recreational anglers may have a negative impact on decisions to fish in those waters into the future. If fishers alter their fishing behavior because of the presence of the plant, all of the associated income and economic benefits from that activity will be lost to the region. For this reason, it is important to develop a regional profile of the economic activity in an area and to identify and evaluate industries (and their associated benefits), that may be impacted by the project.

Aesthetic Impacts & Perceptions of Well-Being

Unlike the other items, this category focuses on capturing "intangible" impacts a project may have on a community. Aesthetic impacts are important for a number of reasons and can impact not only a community's sense of well-being, but may have real, quantifiable impacts (as in the case of changes in property value and associated tax revenue), that result from a major change in the way an area looks, or is perceived in terms of health. A sense of job security, ease of movement through populated areas, wait times for public services- these are all potential measures of perceptions of well-being that may translate into either a positive or a negative impact for a proposed project at an individual or community level.

Methodologies

A well-done impact assessment engages communities (and segments within communities), and provides an opportunity for communities to identify and evaluate both tangible and intangible characteristics that may be impacted by a particular option or set of options.

A common method for quantifying the future impact of a particular alternative on a community is to identify a community with similar characteristics where a similar project has already occurred, and to retrospectively examine the impacts of key variables in those situations. In economic analysis, this approach is referred to as a "benefit transfer."

A second approach would be to utilize secondary data sources (U.S. Census Data found at: State Bureaus of Economic Research -http://tndata.utk.edu/, and data collected by local Chambers of Commerce), to collect existing data on key variables and to then apply a regional impact assessment tool (IMPLAN is a commonly used package, see http://implan.com/), to estimate the changes to this suite of variables if one or more changed (for example, employment) as a result of the implementation of a particular alternative.

Intangible characteristics are best captured through focus groups, opinion polls, surveys and public workshops.

THE FERGUSON GROUP LLC

1130 Connecticut Avenue, N.W., Suite 300
Washington, DC 20036
Phone: (202) 331-8500
www.thefergusongrop.com