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U. S. DEPARTMENT OF ENERGY (DOE); PRE-APPROVED DRAFT ENVIRONMENTAL ASSESSMENT, MIXED WASTE DISPOSAL OPERATIONS AT THE NEVADA TEST SITE, NYE COUNTY - (USED AS A REFERENCE IN OU1 FS)

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REPORT

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ENVIRONMENTAL ASSESSMENT

MIXED WASTE DISPOSAL OPERATIONS

AT THE

NEVADA TEST SITE

NYE COUNTY, NEVADA

OCTOBER 1993

Prepared by

U.S. DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE
ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT DIVISION
LAS VEGAS, NEVADA 89193

DOE/EA-0461

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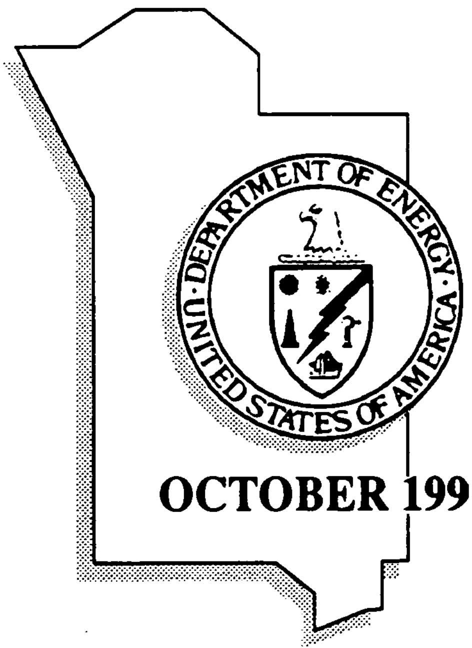

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Environmental Assessment

Mixed Waste Disposal Operations
at the
Nevada Test Site
Nye County, Nevada

October 1993

Prepared by

U.S. Department of Energy
Nevada Operations Office

Waste Management Division
Las Vegas, Nevada 89193

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ACRONYMS

AEA	Atomic Energy Act
ALARA	As Low As Reasonably Achievable
AQCR	Air Quality Control Region
As	Arsenic
Be	Beryllium
BEIR	Biological Effects of Ionizing Radiation
CEDE	Committed Effective Dose Equivalent
CFR	Code of Federal Regulations
CH	Contact-Handled - refers to TRU waste not requiring shielding or remote handling
CO	Carbon Monoxide
DOD	Department of Defense
DOE	U.S. Department of Energy
DOE/NV	DOE Nevada Operations Office
DOT	U.S. Department of Transportation
DSEIS	Draft Supplement Environmental Impact Statement (WIPP site)
DWCF	Defense Waste Consolidation Facility
DWMD	Defense Waste Management Department
EA	Environmental Assessment
ECS	East Coast Site
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ER&WM	Environmental Restoration and Waste Management
ERDA	Energy Research and Development Agency
FEIS	Final Environmental Impact Statement
FFCA	Federal Facility Compliance Act
FR	Federal Register
ft	Feet (or foot)
ft^3	Cubic feet
FY	Fiscal Year
GCD	Greater Confinement Disposal
GCDT	Greater Confinement Disposal Test
ha	Hectares
H_2S	Hydrogen Sulfide
Hg	Mercury
HSA	High-Specific-Activity
HVAC	High Volume Air Circulation

HW	Hazardous Waste
HWAS	Hazardous Waste Accumulation Site
ICC	Interstate Commerce Commission
ICRP	International Commission on Radiological Protection
IDLH	Immediately Dangerous to Life or Health
km	Kilometers
km^2	Square Kilometers
LCF	Latent Cancer Fatalities
LGF	Liquified Gaseous Fuels
LET	Linear Energy Transfer
LLMW	Low-Level Mixed Waste
LLNL	Lawrence Livermore National Laboratory, California
LLW	Low-Level Waste
LLWMU	Low-Level Radioactive Waste Management Unit
LSA	Low-Specific-Activity
m	Meters
m^3	Cubic Meters
mg/m^3	Milligrams per Cubic Meter
mi	Miles
mi^2	Square Miles
MCi	Megacuries
MW	Mixed Waste
MWDU	Mixed Waste Disposal Unit
NAAQS	National Ambient Air Quality Standards
NAC	Nevada Administrative Codes
NAFR	Nellis Air Force Range
NCRP	National Council on Radiation Protection and Measurement
nCi/g	Nanocuries per gram
NDEP	Nevada Division of Environmental Protection
NEPA	National Environmental Policy Act
NO_x	Oxides of Nitrogen
NVO	Nevada Operations Office Order
NRC	Nuclear Regulatory Commission
NTS	Nevada Test Site
O_3	Ozone
PA	Performance Assessment
Pb	Lead
PEIS	Programmatic Environmental Impact Statement
PLO	Public Land Order
PM_{10}	Particulate Matter <10 micrometers

RCRA	Resource Conservation and Recovery Act
REECo	Reynolds Electrical and Engineering Co.
RFP	Rocky Flats Plant; Colorado
RH	Remote-handled - refers to TRU waste >200 mR/hr that requires shielding .... of waste containers or remote handling
RTR	Real-Time Radiography
RWMS	Radioactive Waste Management Site
SEIS	Supplemental Environmental Impact Statement
SHPO	State Historic Preservation Officer
SLD	Shallow Land Disposal
SNLA	Sandia National Laboratory-Albuquerque, New Mexico
SO_2	Sulfur Dioxide
TI	Transport Index
TRU	Transuranic
TSP	Total Suspended Particulates
TWA-TLV	Time-Weighted Average-Threshold Limit Value
$\mu g/m^3$	micrograms per cubic meter
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
VOC	Volatile Organic Compound
WEB	Waste Examination Building
WEC	Waste Examination Complex
WIPP	Waste Isolation Pilot Plant
WSC	Waste Storage Cell

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) is proposing to expand and operate its mixed waste disposal unit (MWDU) at the Nevada Test Site's (NTS) Radioactive Waste Management Site (RWMS), and transport mixed waste to this facility for a period of 5 years or up to a fixed volume limit of 120,000 cubic meters (m^3). The quantity of waste proposed to be disposed of the MWDU is estimated from the physical capacity of the MWDU. Quantities of waste in storage or projected for future generation at DOE facilities is addressed in separate documents prepared pursuant to the Federal Facilities Compliance Act of 1992 (P.L. 102-386).

This Environmental Assessment (EA) addresses the potential impacts of the proposed action and alternative actions in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended, 42 USC Section 4321 *et seq.*, and follows the applicable policies and procedures of the DOE NEPA compliance rule (57 FR 15122, April 24, 1992; codified at 10 CFR Part 1021) and related DOE guidance.

1.1 DESCRIPTION OF PROPOSED ACTION

Mixed wastes (MW) are those wastes containing both radioactive and hazardous components as defined by the Atomic Energy Act (AEA) and the Resource Conservation and Recovery Act (RCRA). In 1987, the State of Nevada confirmed that DOE had interim status authority under State hazardous waste regulations to dispose of low level MW at the Area 5 RWMS (Figure 1-1). However, the waste must meet LDR requirements. The MWDU is a part of the RWMS. In 1988, DOE submitted a Part B permit application to the state to expand the MWDU at the RWMS, and DOE revised that permit application in July 1992.

The proposed action consists of:

1. Continuation of the use of the existing shallow land disposal cell (P-3) pending State approval of DOE's Waste Analysis Plan for disposal of hazardous waste under RCRA, and the expansion and operation of the MWDU upon approval of the pending RCRA Part B permit application; and
2. Transportation of low-level MW for disposal at the MWDU from Sandia National Laboratory - Albuquerque, New Mexico (SNLA), the Rocky Flats Plant, Colorado (RFP), other DOE sites as may be necessary, and Federal generators of classified MW.

The proposed action would continue for a period of 5 years, or up to a volume cap of 120,000 m^3 (156,800 yd^3) whichever occurs first. The five-year period would begin upon completion of the NEPA process. The purpose of the time or volume limit is to meet near-term needs while longer-term needs are addressed in the Programmatic Environmental Impact Statement (PEIS) for Environmental Restoration and Waste Management (ER&WM) that DOE is preparing (Notice of Intent October 5, 1990, 55 FR 42633) and the Environmental Impact Statement (EIS) for ER&WM that DOE/NV is preparing. DOE has an immediate need for additional MW disposal capacity, regardless of how DOE resolves long-term MW disposal needs. Moreover, the proposed action would not require a large capital investment or commitment of resources (e.g., new MW storage cells would be opened only as required), would not determine whether other MW disposal sites would be developed at NTS or elsewhere, and would not limit program alternatives to be addressed in the PEIS. Under these circumstances, DOE believes that the proposed action is independently justified and

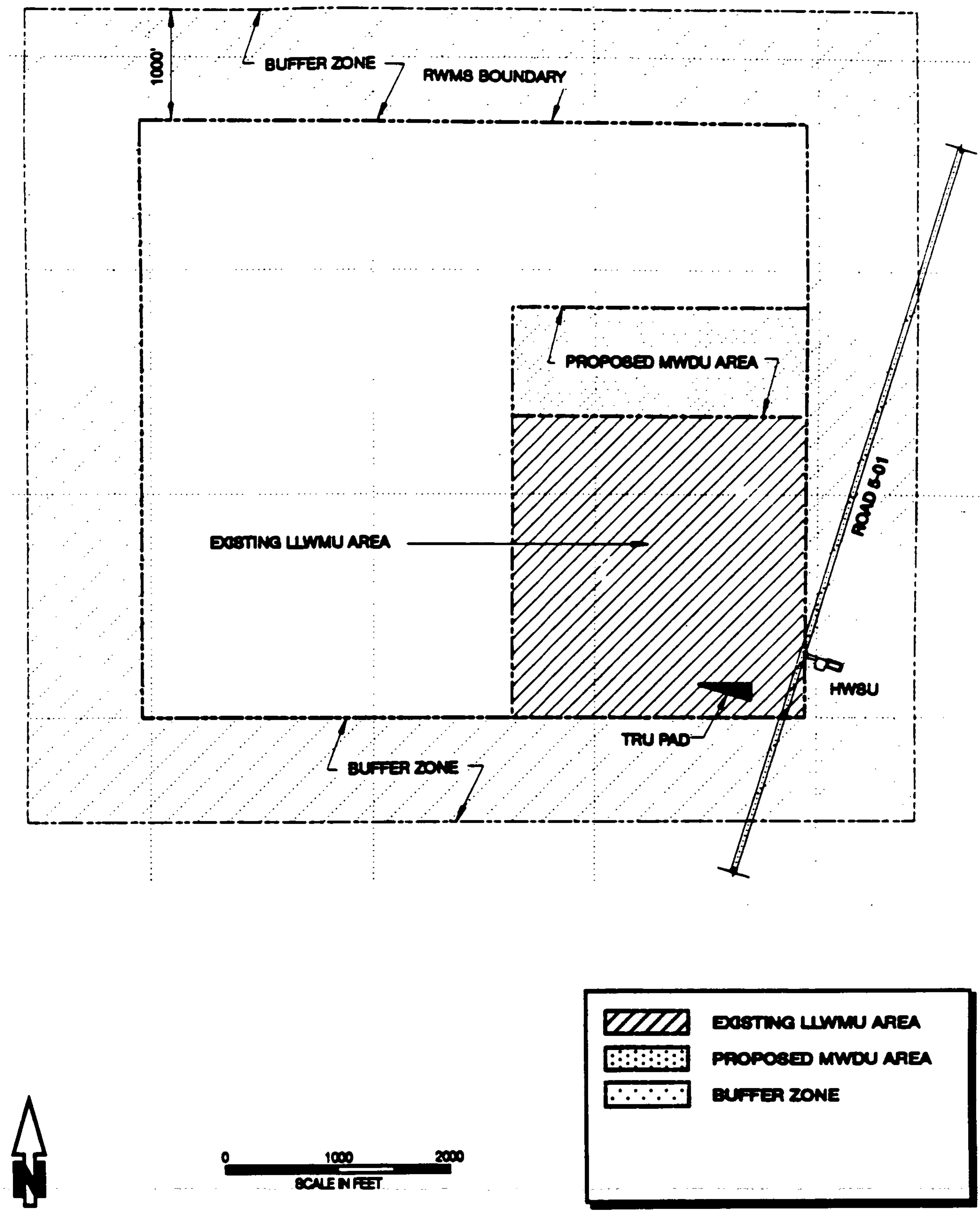

Figure 1-1. Layout of the Area 5 RWMS Showing the Area Designated for the Proposed MWDU.

would not prejudice any ultimate decision to be reached on the basis of the programmatic ER&WM PEIS or the ER&WM EIS for the NTS.

After all requirements have been satisfied for expansion and use of the MWDU, the existing MW disposal cell either would continue to be used for MW disposal or would revert to its previous use as a low-level waste (LLW) disposal pit depending on decisions made in connection with the Part B permit process. A schematic of the proposed action is presented in Figure 1-2.

1.2 PURPOSE AND NEED FOR AGENCY ACTION

DOE proposes to dispose of MW generated by environmental restoration and other activities at the Area 5 RWMS. At the same time, MW are currently being stored at DOE generator facilities that do not have on-site MW disposal areas permitted under RCRA. These sites are reaching storage capacity limits. Therefore, appropriate disposal facilities are immediately needed to satisfy provisions of RCRA, the AEA, the Federal Facility Compliance Act (FFCA), and applicable State laws and regulations. As a partial solution to the MW disposal problem, DOE proposes to dispose of a limited quantity of MW generated by approved DOE facilities at the NTS Area 5 RWMS.

1.3 SCOPE OF EA

This EA considers MW disposal operations for a 5-year period or the disposal of wastes up to a fixed-volume cap of 120,000 m^3, whichever occurs first. The 5-year period commences upon completion of the NEPA process for the proposed action or the granting of a RCRA permit, whichever occurs later. The disposal volume is estimated to be less than 25 percent of the total DOE MW that is in the current inventory plus the amount expected to be generated over the next 5 years. The current estimate for NTS generated wastes will be presented in the Site Treatment Plans (STP) for the NTS. The first STP is planned for release in late 1993. The EA also addresses closure of the MWDU.

1.4 BACKGROUND

1.4.1 Nevada Test Site History

The NTS is a DOE facility occupying nearly 3,500 square kilometers (km^2) (1,350 square miles (mi^2)) in southern Nevada, approximately 105 kilometers (km) (65 mi) northwest of Las Vegas. The NTS is bordered on the north, west, and east by Nellis Air Force Range (NAFR), a restricted access area. Figure 1-3 illustrates the location of the NTS.

Since its establishment in 1952, the primary mission of the NTS has been to serve as a proving ground for the testing and development of nuclear weapons. Over the years, the NTS has been used for many secondary missions, which are mostly related to nuclear energy or to the study of the effects of radioactivity. The NTS serves as a principal disposal site for LLW generated by several DOE defense facilities and as a small storage site for transuranic (TRU) wastes pending opening of the Waste Isolation Pilot Plant (WIPP) in southeastern New Mexico. In addition, Yucca Mountain, which is at the western edge of Area 25, is being investigated as a potential location for disposal of high-level radioactive waste.

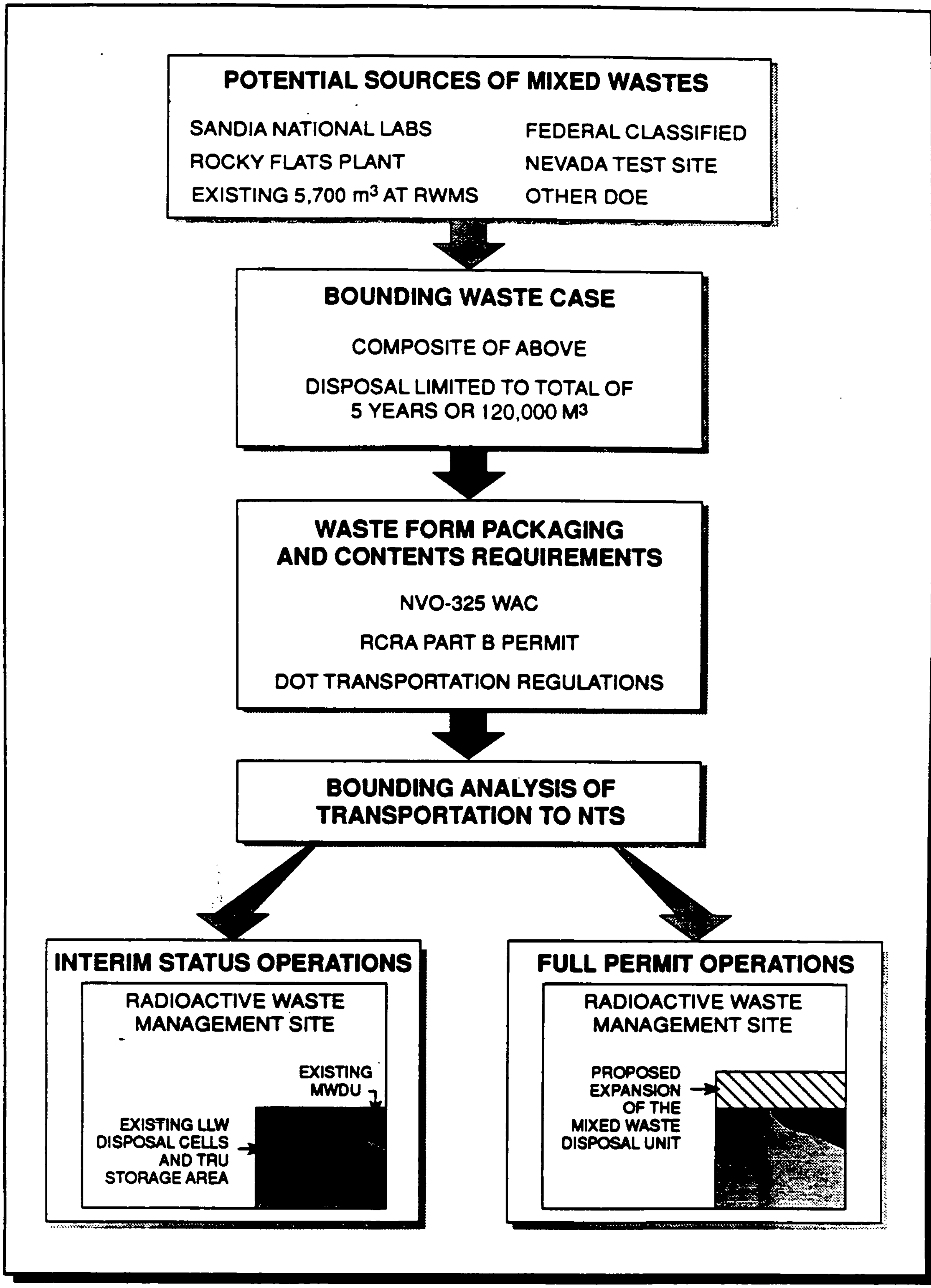

Figure 1-2. Schematic Layout of Proposed Action.

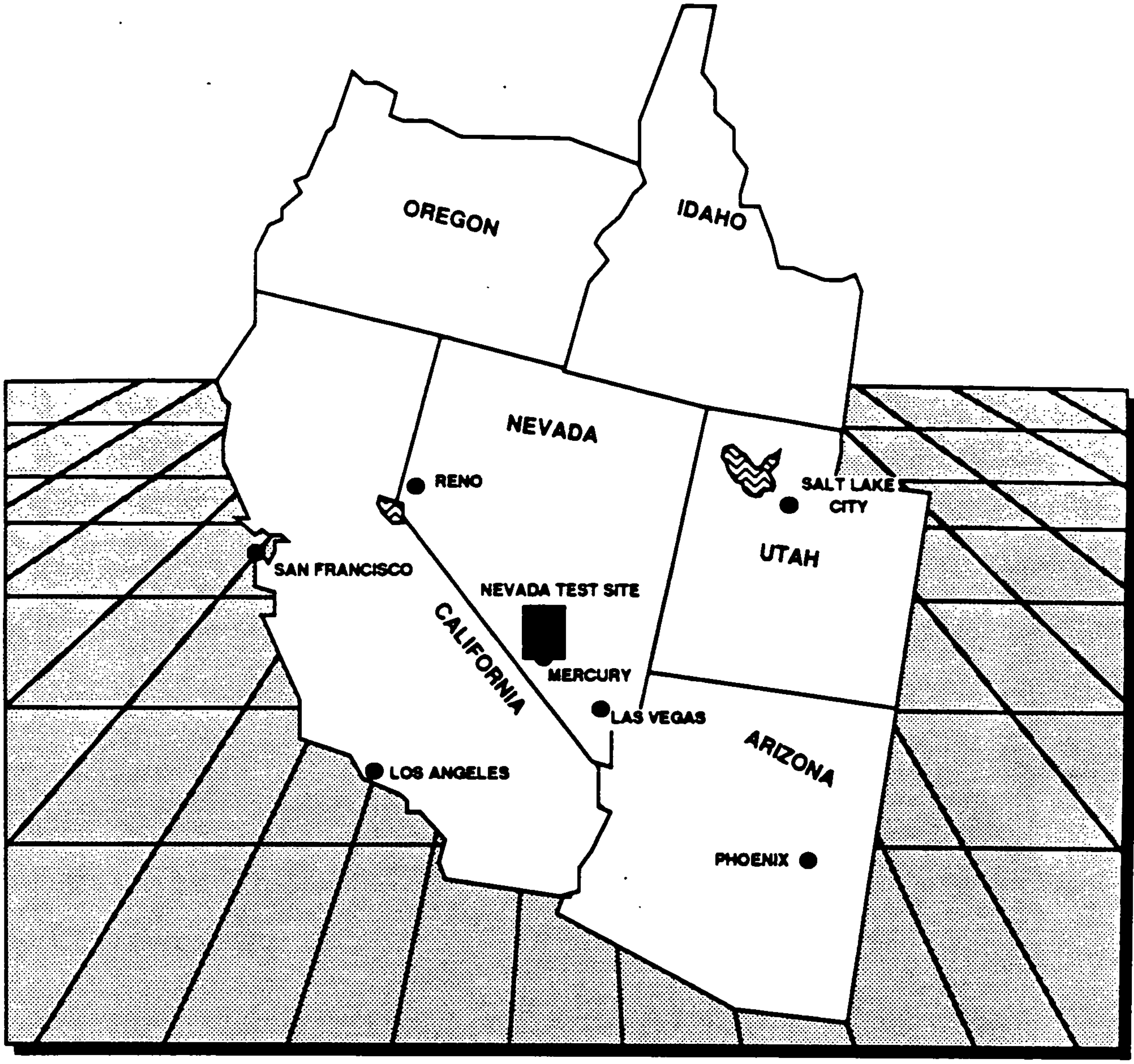

Figure 1-3. General location map of Nevada Test Site.

To date, there have been in excess of 700 announced nuclear tests at the NTS. Between 1952 and late 1962, a total of 84 atmospheric tests were conducted. Since that time, all tests conducted at the NTS have been below ground (ERDA, 1977). Most nuclear weapons testing has been conducted in Areas 2, 3, 4, 7, 9, 10, 12, 19 and 20, though some tests were conducted in Areas 5 and 25. The nuclear testing programs at the NTS have resulted in the creation of significant amounts of radioactive materials at depth beneath the land surface and some residual radioactive material at land surface, as well as other types of radioactive wastes and contaminated equipment. Environmental restoration (ER) activities are being implemented at NTS to clean up these areas of contamination and much of the MW generated would be disposed of in the proposed MWDU. The principal features and operating areas of the NTS are shown in Figure 1-4.

1.4.2 Area 5 Radioactive Waste Management Site Operations and Site Conditions

In 1961, an area northwest of Frenchman Lake in Area 5 was reserved as a LLW disposal site under regulatory provisions derived from the AEA. In 1977, the area was designated the Area 5 Radioactive Waste Management Site. On-site staff were assigned to the RWMS to begin controlled waste management operations. Site characterization of the RWMS began in 1979 (Case and French, 1984). More detailed site characterization studies began in 1988, primarily as a result of comments on the 1988 RCRA permit application.

Currently, the Area 5 RWMS encompasses approximately 296 hectares (ha) (732 acres) which are used for the following purposes:

- Emplacement of LLW generated by DOE facilities. Approximately 37 ha (92 acres) in the southeast corner of the Area 5 RWMS have been designated a the Low Level Waste Management Unit (LLWMU) and have been developed for this use (Figure 1-5).

- Emplacement of MW generated by DOE facilities in one disposal cell within the LLWMU.

- Storage of mixed TRU waste from Lawrence Livermore National Laboratory, California (LLNL). This waste is stored in the Area 5 RWMS waste storage cell (WSC) pending opening of the WIPP facility (Figure 1-6).

- Disposal of high-specific activity LLW using Greater Confinement Disposal (GCD) boreholes.

In May 1987, DOE clarified the applicability of RCRA to DOE radioactive wastes by issuing an interpretive rule which defined the term "by product material" under the AEA. The clarification resulted in many wastes previously regulated solely under AEA becoming MW and subject jointly, to the provisions of RCRA and the AEA. It has been determined that some of the LLW disposed at Area 5 RWMS prior to 1987 contained hazardous waste and may, therefore, be MW under current regulatory definitions. In June 1987, the NTS submitted a Part A Permit application for MW management operations at the Area 5 RWMS. This Part A was revised periodically throughout the years with the latest revision being submitted with the July 1992 Part B application.

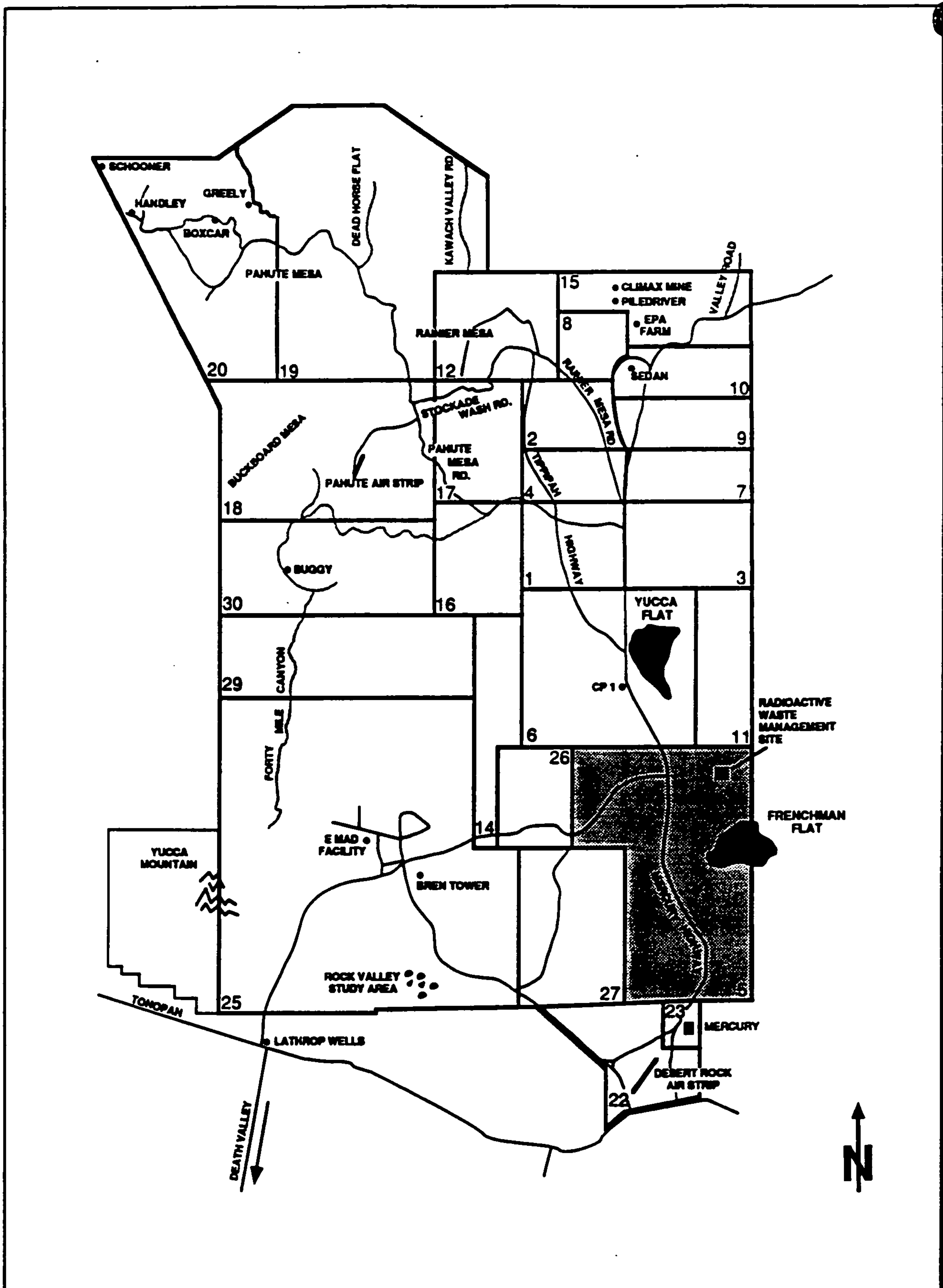

Figure 1.4. Principal features and operating areas of the Nevada Test Site (Area 5 shaded).

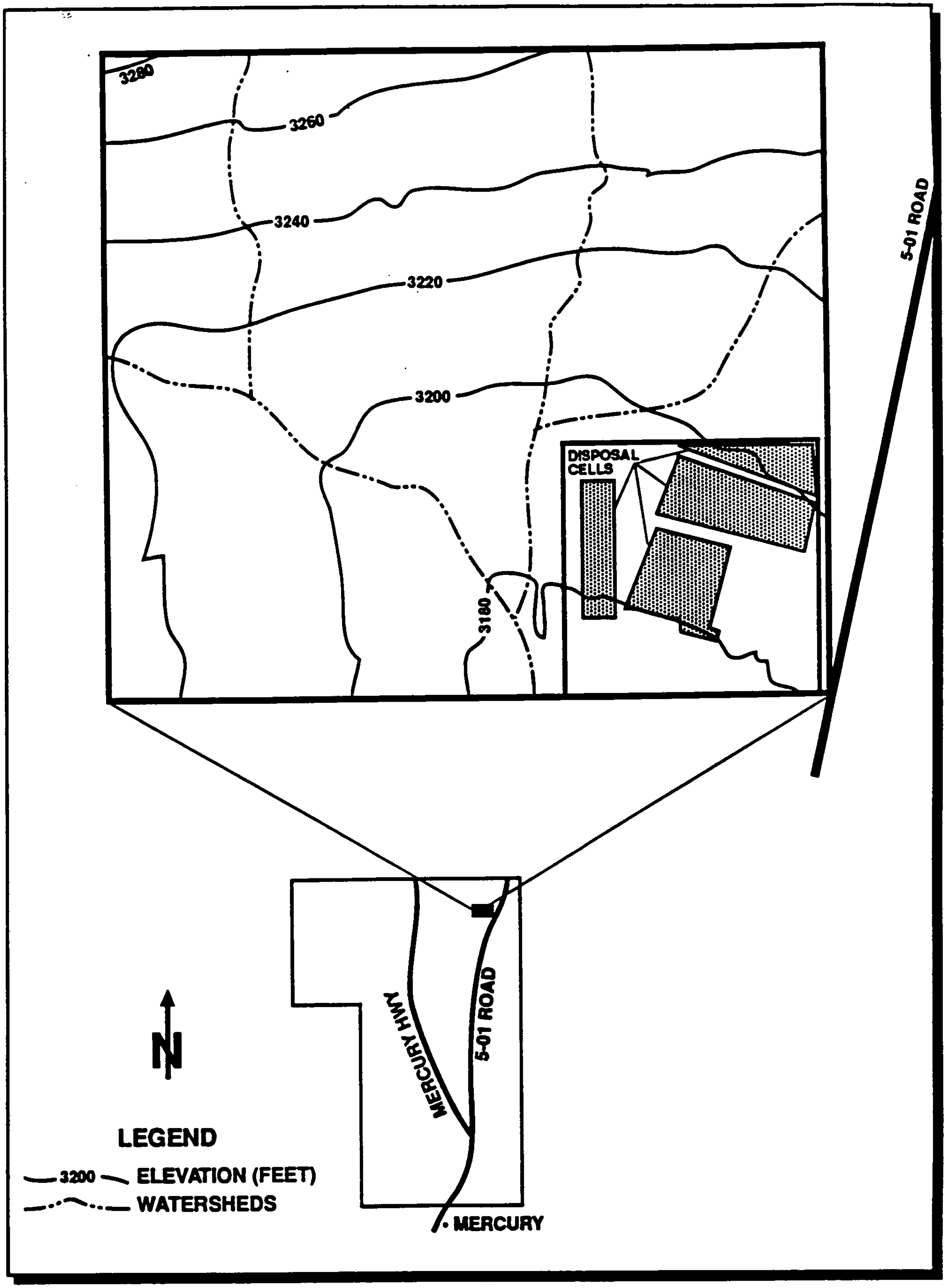

Figure 1-5. Area 5 Radioactive Waste Management Site, Nevada Test Site

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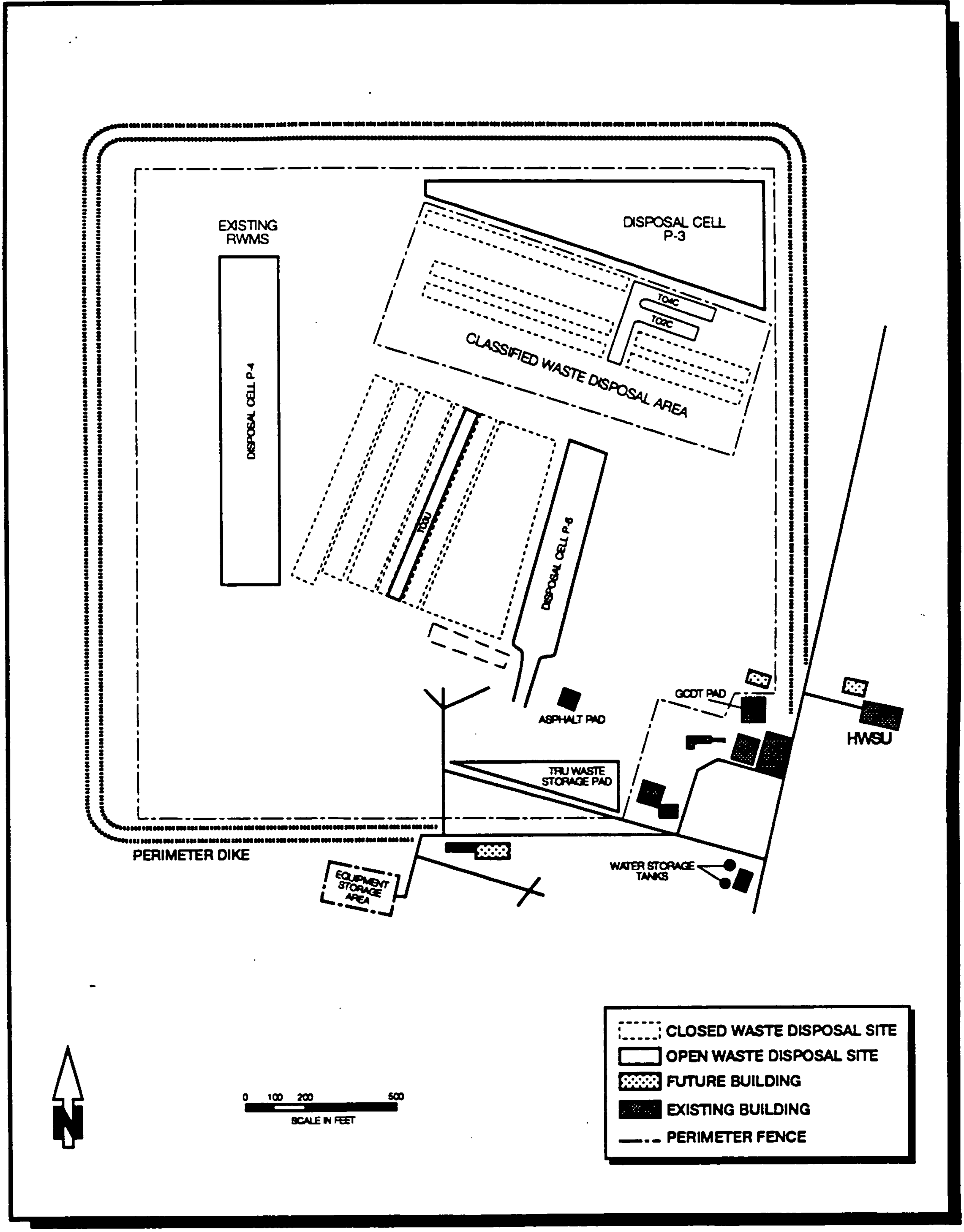

Figure 1-6. Facilities at the Existing Area 5 Radioactive Waste Management Site

In September 1987, the State of Nevada confirmed that DOE had interim status to dispose of MW at the Area 5 RWMS. Disposal cell P-3 within the LLWMU (Figure 1-6) was used, under interim status, for disposal of MW until May 8, 1990. Approximately 7,900 m^3 of MW were disposed of in cell P-3. On May 8, 1990, the U.S. Environmental Protection Agency (EPA) issued regulations implementing the Land Disposal Restrictions of RCRA for the Third Thirds wastes. The potential impact of these new regulations on NTS MW operations was not known and a unilateral decision was made by DOE to stop receiving MW at the RWMS until regulatory compliance requirements could be evaluated. DOE would not dispose of additional low level MW at P-3 until the State approved DOE's Waste Analysis Plan for disposal of hazardous waste under RCRA.

1.4.2.1 Low-Level Waste Management Unit (LLWMU)

The LLWMU contains two types of disposal cells: (1) shallow land disposal cells, and (2) GCD boreholes. The shallow land disposal cells range from 85 to 205 meters (m) (280 to 672 feet [ft]) in length, 12 to 75 m (41 to 245 ft) in width, and average 7.3 m (24 ft) in depth. Approximately 5.8 m (19 ft) of waste may be stacked in the bottom of each cell. Closure of storage and disposal cells involves two phases: partial closure (Phase I) and final closure (Phase II). Of the 17 cells constructed, 6 are currently open. It is known that some radioactive waste containing a hazardous constituent was buried in cell P-2 and some is believed to be buried in P-1. Cell P-1 was closed in April 1985, and cell P-2 was closed in December 1987.

Thirteen GCD boreholes have been drilled. Each borehole is 3.0 m (10 ft) in diameter and 37 m (120 ft) deep. Approximately 15 m (50 ft) of waste may be emplaced in a GCD hole which is then backfilled with 21 m (70 ft) of soil. A 1.8 m (6 ft) long concrete monument indicating the location and contents of the hole is placed approximately 1.5 m (5 ft) below grade in each hole. Of the 13 GCD holes constructed, 6 have been closed, and the remainder are either partially filled or are empty. The GCD holes are used for disposal of defense low-level radioactive wastes considered unsuitable for routine disposal in disposal cells. These wastes include those with high levels of environmentally mobile nuclides (e.g., tritium) or wastes with high radiation levels outside their packaging (Dickman et al., 1984).

The majority of the LLW disposed at the existing facilities typically consists of contaminated laboratory waste, soil, nitrate salts, magnesium fluoride, and building materials. Common radioactive constituents of this waste are depleted and enriched uranium, mixed fission products, high-specific-activity tritium, and TRU at less than 100 nanocuries per gram (nCi/g) concentrations. Most of this waste is buried in 208-L (55 gal) metal drums, 1.6- and 3.2-m^3 (56- and 112- cubic feet [ft^3]) plywood boxes, 0.7- and 2.6-m^3 (24- and 90-ft^3) metal boxes, 0.8- and 0.9-m^3 (27- and 32-ft^3) triwall, fiberboard containers, and other nonstandard containers. The total volume of LLW disposed of at the Area 5 RWMS between 1961 and 1988 was 6.0×10^5 m^3 (1.2×10^7 ft^3) containing 9.2 megacuries (MCi) of radioactive material, the majority of which was tritium.

1.4.2.2 Area 5 Radioactive Waste Management Site Transuranic Waste Storage Pad

From 1974 to 1985, NTS received TRU wastes from LLNL for storage. These wastes are being stored pending opening of the WIPP. The TRU Waste Storage Pad consists of a curbed asphalt pad which meets RCRA construction standards. The current volume of TRU is approximately 600 m^3. In 1991, it was determined that the TRU wastes are mixed. These wastes will be certified to meet WIPP quirements. The waste will remain at the TRU Waste Storage Pad until it can be shipped to the WIPP another approved location. The site is being managed under a Settlement Agreement with the State.

l.5 REGULATORY AND COMPLIANCE REQUIREMENTS

The proposed action is subject to a broad range of federal, state, and local laws and regulations signed to prevent or minimize adverse public health or environmental effects associated with the anagement of radioactive materials and chemically or biologically hazardous/toxic materials. DOE tends to comply with applicable requirements of RCRA. Operations at the MWDU will conform to l provisions of the RCRA Part B permit when issued by the State. DOE would also ensure that the oposed action would comply with all internal requirements, including compliance with DOE Order 20.2A. A summary of regulatory and compliance requirements related to the handling, storage, sposal, and transportation of defense LLW and MW at the NTS is provided in Appendix I.

l.6 LAND USE POLICIES AND PLANS FOR THE AFFECTED AREA

Area 5 of the NTS is a portion of the land withdrawn from the public domain under Public ınd Order 805 issued in 1952. Since that time, the land has been used for national defense and energy-lated purposes. The NTS is not open to public entry for any purposes, e.g., agriculture, mining, mestead, and recreation. Because of the nature of land use at the NTS over the past nearly four cades, it is highly doubtful that the area will be returned to public use in the foreseeable future.

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 PROPOSED ACTION

Mixed wastes (MW) are those wastes containing both a radioactive waste component regulated under the Atomic Energy Act (AEA) and a hazardous waste component regulated under the Resource Conservation and Recovery Act (RCRA). In 1987, the state of Nevada confirmed that the U.S. Department of Energy (DOE) had interim status authority to dispose of MW at the Area 5 Radioactive Waste Management Site (RWMS). However, the waste must meet LDR requirements. In 1988, DOE submitted a RCRA Part B permit application to the State to expand the MWDU at the RWMS, and DOE revised that permit application in July 1992. The proposed action addressed by this Environmental Assessment (EA) is to:

1. Continue the use of the existing shallow land disposal cell (P-3) pending State approval of DOE's Waste Analysis Plan for disposal of hazardous waste under RCRA, and expand and operate the MWDU upon approval of the pending RCRA Part B permit application; and

2. Transport low level MW for disposal at the MWDU from Sandia National Laboratory - Albuquerque, New Mexico (SNLA), the Rocky Flats Plant, Colorado (RFP), other DOE sites as may be necessary, and Federal generators of classified MW.

The proposed action would continue for a period of 5 years, or up to a volume cap of 120,000 m^3, whichever occurs first. The five-year period would commence upon completion of this NEPA process. Approximately 7,900 m^3 of MW are currently emplaced at the RWMS and are considered as part of the 120,000 m^3 volume cap. Environmental restoration activities at NTS are expected to generate an unknown quantity of MW that would be disposed of at the RWMS if it meets the waste acceptance criteria. This EA describes the expected impact from the operation of the MWDU under conditions which represent plausible extreme assumptions about the operation. This approach provides the most conservative data upon which decisions may be made. For example, assuming that most of the waste to be disposed is transported over the greatest distance provides an upper boundary on the estimated impact due to transportation. Transportation of lesser quantities over shorter distances will have less impact than the projected upper boundary.

MW would be accepted from DOE sites that have a history of shipping LLW to NTS and from federal classified activities for which there is no other disposal facility. RFP MW is analyzed in this EA because it is part of the proposed action and is representative of a large DOE production facility, and SNLA is included because it is part of the proposed action and is representative of a large research facility. Waste characteristics of future-generated MW, such as material resulting from environmental restoration activities at the NTS, are unknown but assumed for the purpose of this assessment to be similar in nature to the MW from the above sources. The waste to be disposed of is expected to be predominately contaminated soils and construction debris. Other waste forms may include solidified contaminated sludges and fluids (without free liquids) and various lead contaminated items.

None of the MW expected to be generated from environmental restoration activities at NTS were considered in calculating potential transportation impacts. Instead, to bound the potential impacts of transportation it was assumed that 18% of the total volume of off-site waste to be transported to the MWDU would be transported from the RFP near Denver, Colorado, and the rest from the U. S. Army Material Commands Defense Waste Consolidation Facility (DWCF) near Barnwell, South Carolina (approximately 82%). These assumptions were used to provide an "upper bound" for estimating the environmental consequences of transporting MW to the facility.

These two offsite locations have been selected for this analysis because they encompass the following factors: the longest transportation route, the greatest distance travelled in an urban population zone, the maximum volume of waste to be disposed, the maximum number of waste shipments and a maximum radionuclide source term for risk calculations. In addition, the transportation impact analysis was performed on an estimated total waste volume of 150,000 m^3. Subsequently to the analysis the DOE reduced the estimated waste volume to 120,000 m^3 and requested a RCRA part B permit for the lesser volume. The analysis was not repeated on the lesser volume because the 20 percent reduction in volume would cause a reduction in the postulated impact. The quantity of waste received for disposal at the MWDU will not exceed the limitations imposed by the RCRA permit. The actual environmental consequences are expected to be less than those estimated in this EA for these reasons. Therefore, the estimated consequences of transporting MW as presented in this EA represent an upper bound for the proposed action.

After the Part B permit application has been approved for expansion and operation of the MWDU, the existing disposal cell containing mixed waste (P-3) will either continue to be used for MW disposal or will revert to its previous use as a low-level waste (LLW) disposal pit (depending on decisions made in connection with the permit renewal process). After closure, all MW cells would remain under DOE institutional control for the foreseeable future; however, for environmental impact analysis purposes, it is assumed that institutional control would cease after 100 years.

The MW disposal operations are proposed for a period of 5 years or until a volume of 120,000 m^3 is received, whichever occurs first. Although the proposed MWDU described in the Part B permit application would be designed to operate for a longer period and receive greater volume, the scope of this EA is limited to these interim actions because the state of Nevada and RCRA require that the permit for a land disposal facility be reviewed 5 years after the date of permit issuance.

The following sections describe proposed expansion of the MWDU facility, including design considerations, construction activities, operational activities, and closure activities. MW transportation requirements and transportation routes also are described.

2.1.1 Mixed Waste Disposal Unit Facility Design Considerations

Based on the site's low precipitation and thick unsaturated zone, DOE's 1988 Part B Application requested waivers from installation of a double liner and leachate collection system in the cells and installation of a groundwater monitoring system. However, based on the State's comments on that application, DOE's revised RCRA application (DOE, 1992a) provides designs for double liners, leachate collection, and groundwater monitoring. DOE is evaluating the site to determine if waivers could be appropriate. Assuming that waivers are requested and granted, the proposed MWDU would affect approximately 0.2 square kilometers (km^2) (0.08 square miles (mi^2) of the Area 5 RWMS as shown in Figure 2-1. Approximately 0.17 km^2 (45 acres) consisting of 10 landfill cells and associated facilities would be laid out inside flood protection dikes as shown in Figure 2-2.

Each landfill cell would measure approximately 91 m by 30 m (300 ft by 100 ft). The average depth of each cell would be 7.6 m (25 ft). Each cell would have a design capacity for 17,000 m^3 (600,000 ft^3) of waste. Assuming an average annual MW disposal rate of 30,000 m^3 (1,059,300 ft^3) per year (bulking factor of 1.3), approximately two cells per year would be required. The actual open period for a cell would vary, depending upon delivery rates. Construction of the first expansion cells for the MWDU is proposed to begin when the permit application is approved.

Figure 2-3 shows the proposed design for a typical MW landfill cell assuming the waivers are granted. The bottom of the cell would be sloped to the corner nearest the entry ramp at an average slope of approximately two percent. At that location, a sump would be constructed to collect any excess precipitation that falls within the cell. Accumulated precipitation would be sampled and analyzed to determine appropriate disposal procedures. If only radioactive contamination is detected, the water would be collected and transported to the Area 6 Decontamination Facility on the NTS for treatment. If hazardous waste contamination is detected the accumulated precipitation would be collected, packaged and sent to an approved treatment facility.

A 6-m (20 ft) wide ramp at 10 percent slope would be excavated at one end of the landfill either off to the side as illustrated or off of the long axis of the excavation, depending on local operational requirements. The ramp would be maintained during waste placement operations and would be filled with compacted soil when the waste placement in a landfill cell is finished.

If the waivers are not pursued, three to five monitoring wells would be installed around the proposed MWDU and a double liner and leachate collection system would be installed during construction of the MWDU. The monitoring wells would be designed to withstand the 140-year return period flood, precluding the possibility that surface water could reach the groundwater via these wells. Surveys would be conducted for desert tortoise and archaeological resources prior to installation of the wells and all site characterization activities. If a liner and leachate collection system are required, the MWDU would expand in size to accommodate the more gradual slopes required by the liner system. Total surface area for the MWDU and associated facilities (roads and wells) could increase by as much as 30 percent. The issues of monitoring well requirements and disposal cell liner usage will be resolved in the RCRA permitting process. These issues will have minimal impact on the analyses in this EA.

Auxiliary facilities would include dikes and flood channels to divert flash flood waters away from the disposal area and drainage ditches and culverts within the area to divert sheet-flow away from the open landfill cells, as previously illustrated on Figures 2-3 and 2-4. A summary of the design criteria and parameters for the flood diversion dikes and channels is presented in Appendix II. Typical cross sections are also shown. This design considers not only the flood flows but also the sediment deposition or erosion in the diversion channels that would be associated with those flows.

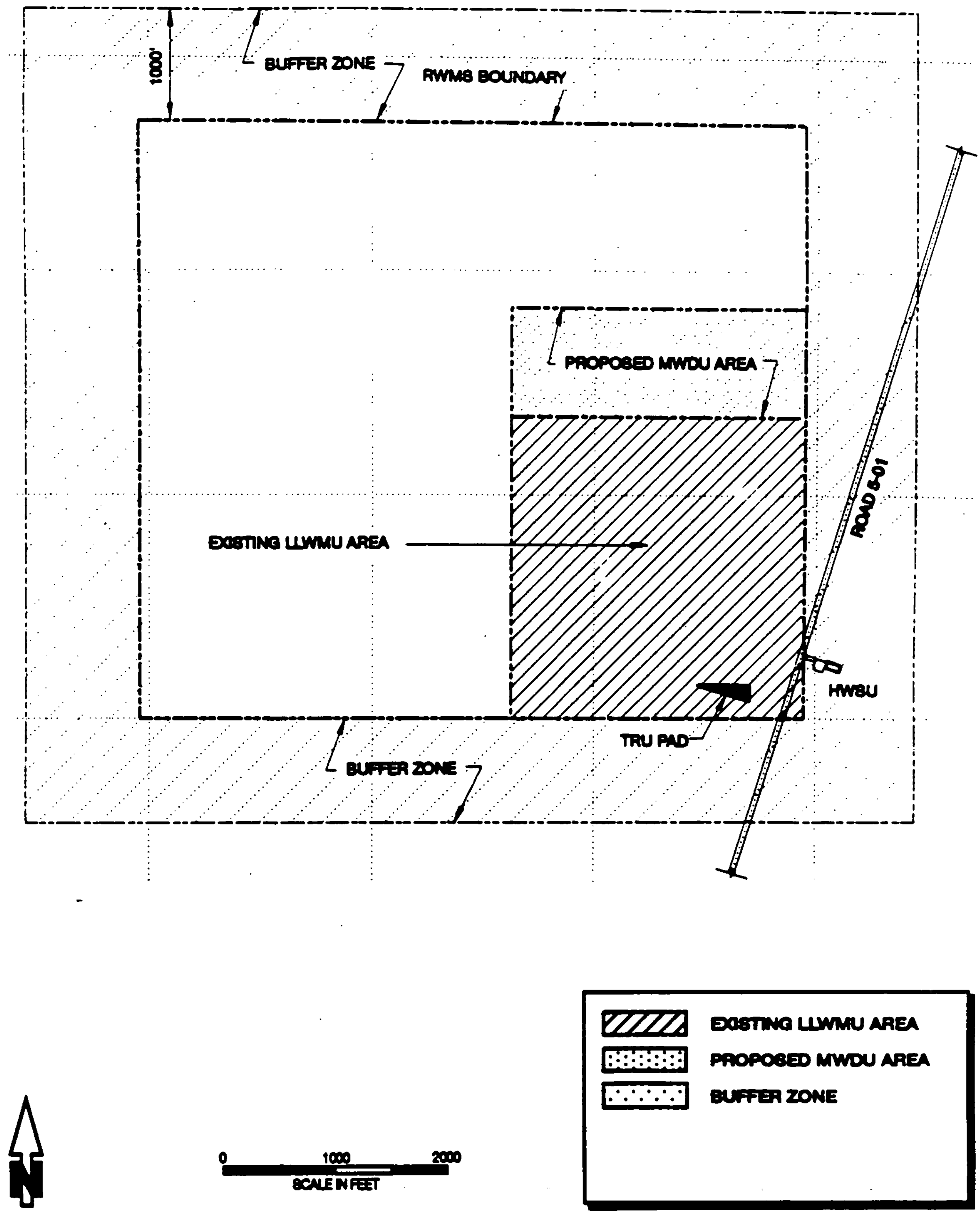

Figure 2-1. Layout of the Area 5 RWMS Showing the Area Designated for the Proposed MWDU.

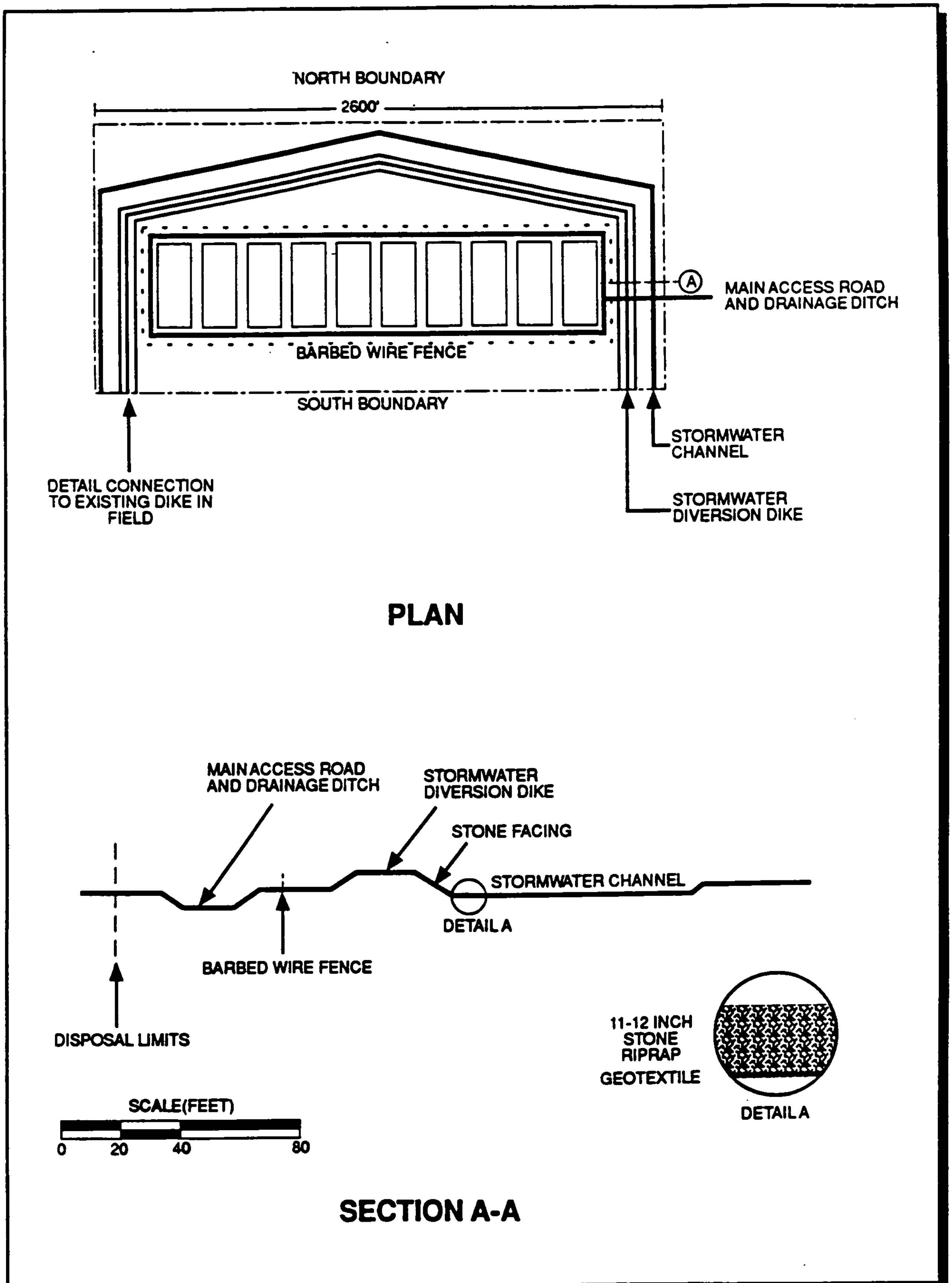

Figure 2-2. Layout of Mixed Waste Cells and Major Stormwater Diversion Features Within the Proposed Mixed Waste Disposal Unit

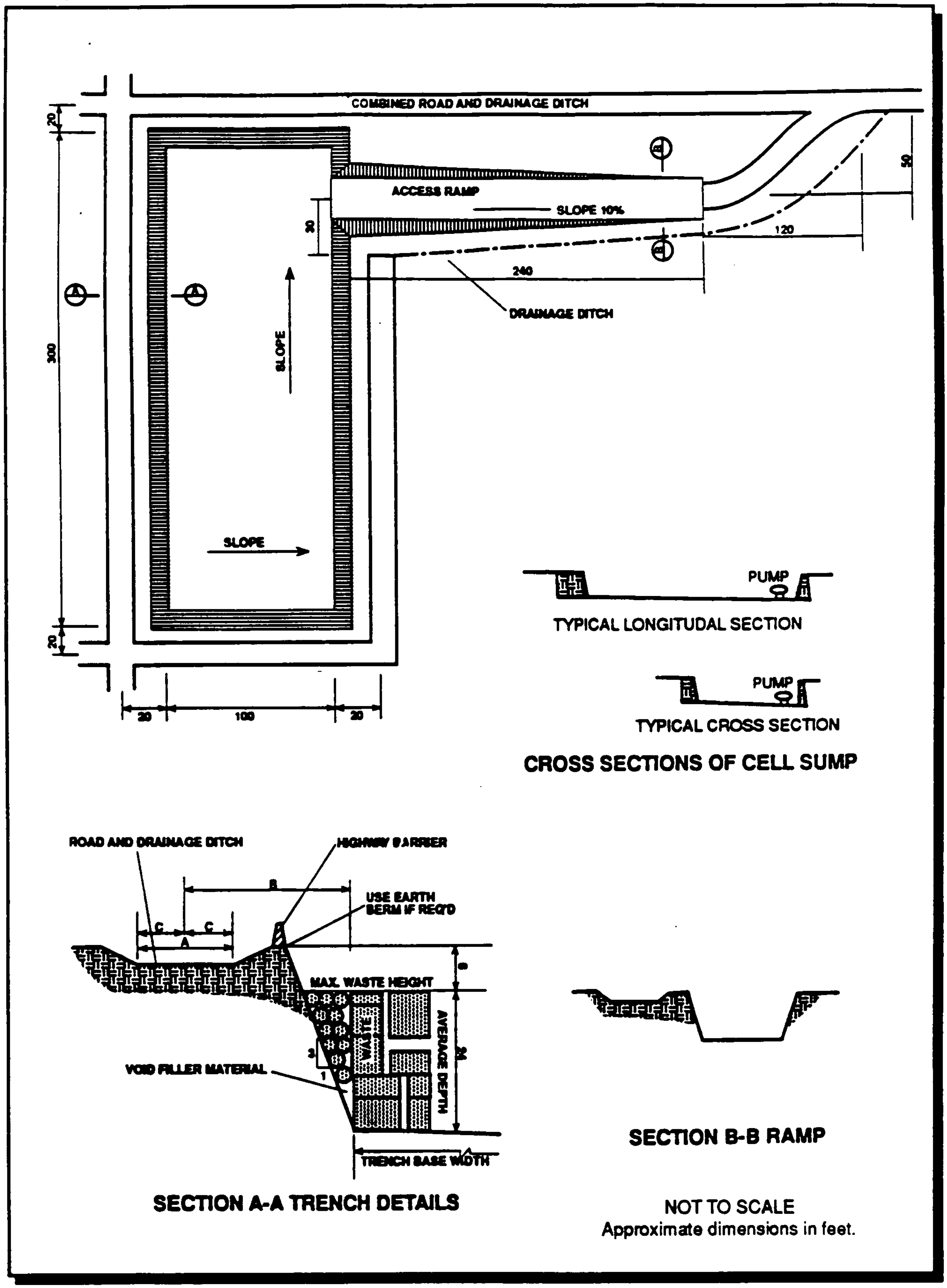

Figure 2-3. Proposed Design of Typical Landfill Cell

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A network of temporary roadways would provide access for waste delivery trucks to the ramps of each open landfill cell and for fire trucks and emergency vehicles to drive around the perimeter of each open landfill cell. Roadways would also be located along the tops of the flood control dikes for inspection vehicles and maintenance equipment. Permanent paved roads would be constructed from existing Road 5-01 to the perimeter of the expansion area.

2.1.2 Mixed Waste Disposal Unit Construction Activities

With the landfill cell layout shown in Figure 2-3, the sequence of cell excavations would be to open the first cell on the east side and then proceed from east to west. This will confine all earth-work operations (ramp and spoil pile) within the area immediately to the south of the open cell. This would preclude the ramp cutting into future cell spaces. The spoil pile would cover the remainder of the area to a thickness of approximately 4.8 m (16 ft) (with 2 horizontal to 1 vertical side slopes). The construction time necessary to complete a new cell is estimated to be three to ten weeks.

In addition to the disposal cells, a new storm-water control dike would be constructed around the perimeter of the MWDU expansion area. The dike would rise to approximately 3 m (10 ft) above grade on the north side and to 1.5 m (5 ft) above grade on the other sides, and would be 3.7 to 6 m (12 to 20 ft) wide on top to allow room for emergency traffic and inspection vehicles. Outer slopes would be no steeper than one to three. Storm-water control channels would be constructed outside of the storm-water control dikes. Dikes would be faced with riprap to within approximately 0.3 m (1 ft) of their tops. Construction time for the storm-water control dike is estimated to be approximately two months.

Because of the strict waste acceptance criteria (Section 2.1.3), segregation of waste is not anticipated and, therefore, only two cells would need to be open at any one time: one for classified waste and one for non-classified wastes. However, should future regulatory changes require segregation, additional cells could be opened. As cells become filled to capacity, new cells would be opened while the filled cell is being covered. Thus, operations within the expansion area could be at different stages within several cells.

Site preparation activities prior to construction of the first disposal cells would consist of the following:

1. Install ground water monitoring wells, if required.

2. Build an access road from Road 5-01 to the expansion area perimeter, a distance of approximately 180 m (600 ft).

3. Build flood diversion dikes and ditches upslope from the cells to be excavated.

4. Build access roads from the entry roadway to the cells that are to be excavated.

5. Build the combination fire road/drainage ditches and extend drainage ditches so runoff would flow off site.

6. Excavate the initial cells and stock pile the excavated materials.

7. Install double liners and leachate collection systems, if required.

8. Install security fence and signs around perimeter of the expansion area.

During all site preparation construction activities, water trucks would be used to wet the disturbed soils, minimizing construction-related fugitive dust.

2.1.3 Mixed Waste Disposal Unit Operational Activities

Stringent criteria have been developed for acceptance of MW and LLW delivered to the Area 5 RWMS. The criteria are published by DOE/Nevada Operations Office (NV) as document NVO-325 (DOE, 1992b). The criteria for MW include the following:

1. The waste must not contain free liquids. Waste-containing liquids must be solidified so that there is no free liquid during packaging, handling, transport, and/or disposal. The test to determine whether or not a waste contains free liquid is specified in 40 CFR 264.314(c). Ion exchange resins must be dewatered and solidified to be considered a solid waste. Liquid waste solidified by the urea-formaldehyde process is not accepted.

2. Fine-particle wastes must be immobilized so that the waste package contains no more than 1 weight percent of less-than-10-micrometer-diameter, or 15 weight percent of less-than-200-micrometer-diameter particles with radioactive contamination. When immobilization is impractical because of cost or volume, use of a sealed liner or overpack container to provide containment is required.

3. Radioactive gases must be stabilized (chemically reduced or oxidized) or absorbed. Compressed gases, including unpunctured aerosol cans, will not be accepted for disposal at the MW facility.

4. MW must meet Land Disposal Restriction (LDR) standards of 40 CFR 268, including notification and certification requirements.

5. Wastes that, if mixed, could cause adverse chemical reactions (excessive heat, fire, explosion, toxic gases, or fumes) must not be combined in individual containers or be shipped together.

6. The following wastes are not accepted for storage or disposal at the NTS:

    a. Cyanide- and sulfide-bearing wastes, in concentrations greater than 10 percent by weight as cyanide or sulfide, because of the chance of toxic fume generation if even mildly acidic conditions are encountered.

    b. Explosives, pyrophoric materials, or high-heat generators.

    c. Polychlorinated biphenyl materials with a concentration greater than that allowable for placement in municipal disposal sites.

    d. Pathogens, infectious wastes, or biological wastes.

e. Dioxin-containing wastes (EPA code F020, F021, F022, F023, F026, F027, or F028 wastes), unless treated to meet the treatment standards in 40 CFR 268.41.

f. Wastes containing chelating and/or complexing agents greater than 1 percent by weight, without undergoing special review and approval.

g. Unpackaged, bulk MW. Bulk waste must be compacted and packaged before shipment to the NTS.

7. Wastes must be placed in containers approved by the U.S. Department of Transportation (DOT).

In addition to these stringent waste acceptance criteria, there are formal hazard prevention programs and contingency response plans for the Area 5 RWMS that further ensure safe and environmentally sound operation of the site. Hazard prevention includes facility security to preclude entry by unauthorized personnel, equipment inspection and maintenance, and operating procedures. The contingency plan lays out procedures and responsibilities in the event an accident or fire does occur. The NTS Fire Department has stationed two tanker trucks with pumps at Area 5 RWMS. These are backed up by additional fire-fighting equipment in Area 23 and Area 6. Heavy earth-moving equipment is also available at Area 5 RWMS, which can quickly cover a fire in the unlikely event one should break out in a disposal cell.

The estimated radiologic and chemical characteristics of the MW that would be accepted from on- and off-site locations for disposal at the proposed Area 5 RWMS are presented in Appendix III and summarized in Tables 2-1 and 2-2, respectively. These waste characteristics were summarized from generator facility waste stream characterization data sheets, filed with DOE/NV in accordance with the NTS waste acceptance criteria (DOE, 1992b). Due to uncertainties in the radiological components of the MW, radionuclides with estimated total quantities below 1 millicurie are not included. Wastes accepted for disposal are expected to be primarily construction debris and contaminated soils.

Approximately 30 people are currently employed by Reynolds Electrical and Engineering Co., Inc. (REECo) to operate the Area 5 RWMS site. These individuals are responsible for the handling, storage, or disposal of LLW, transuranic wastes (TRU), and MW. When the MWDU is fully operational, it is estimated that approximately 12 additional employees would be required. It is DOE policy that all personnel involved in MW handling and management (i.e., all persons who routinely work at or service the MWDU) be trained in the proper and safe management of MW. This policy also requires all persons working at or servicing the MWDU to be trained in emergency procedures and in accordance with 29 CFR 1910.120 to ensure their safety.

The training program for MWDU personnel consists of briefings, formal classroom training, on-the-job training, exercises, drills, and weekly safety meetings. Security, general safety, and radiological safety indoctrinations are provided to all REECo personnel at the time of employment and every two years thereafter.

Employee safety is achieved through the training program as well as through the stringent waste acceptance criteria specified in NVO-325, and the waste handling procedures outlined in the Detailed Standard Operating Procedures (REECo, 1990).

Table 2-1. Summary of Radionuclides to be Emplaced in Low-level Waste Management Unit and Mixed Waste Disposal Unit through FY-1995.

ISOTOPE	AVERAGE CURIES PER m^3
Am - 241	5.08×10^{-3}
Co - 57	1.25×10^{-3}
Co - 60	1.25×10^{-3}
Cs - 137	1.25×10^{-3}
H - 3	6.25×10^{0}
Mn - 54	1.25×10^{-4}
Pu - 239	1.25×10^{-3}
U - 238	6.25×10^{-2}
Zn - 65	4.38×10^{-4}

The current annual operating cost of the Area 5 RWMS is approximately $4.5 million, which DOE/NV estimates would increase to approximately $6 million when the MWDU is fully operational. Additionally, there are fees that must be paid to the state of Nevada by waste generators for disposal of the wastes. The state currently charges DOE $20.00 per ton of emplaced MW.

2.1.4 Closure Activities

Closure of MW storage and disposal cells would involve two phases: partial (interim) closure (Phase I) and final closure (Phase II). The closure plan applies to existing MW disposal cells in the LLWMU as well as the disposal cells in the proposed MWDU. The postclosure plan applies to these and to the currently closed cells P-1 and P-2. Each of the active and proposed landfill cells would receive a Phase I closure cap within 90 days after receiving its final load of waste material. Cell P-3 would receive Phase II closure after it has reached capacity.

Cell P-3 contains both LLW and MW. The cell was opened and began receiving LLW in 1987. Mixed waste was first emplaced in cell P-3 in 1988. The cell will continue to be used for interim status disposal until the MWDU is operational. Until then, all unclassified LLW is being disposed of in cells P-4, P-6, and TO3U. After the MWDU is operational, the remaining

Table 2-2. Expected Chemical Constituents in Mixed Waste From On- and Off-site Generators.

Constituent	EPA Waste Code(s)
Volatile Organics:	
Acetone	F003, U002
2-Butanone	F005, D035, U159
Chloroform	D022
Ethylbenzene	F003
Methylene Chloride	F001, U080
Toluene	F005
1,1,1-Trichloroethane	F001, F002
Trichlorofluoroethane	F001, F002
Trichlorofluoromethane	F001, F002
1,1,2-Trichloro-1,2,2-Trifluroethane	F001, F002
Xylenes (Total)	F003, U239
Metals	
Beryllium	P015
Cadmium	D006
Lead (particulate)	D008
Lead (metal)	D008
Mercury	D009
Arsenic	D004

capacity of P-3 either would be used for LLW or would continue to be used for MW; Phase II closure is expected in about 1996.

Closure of the LLWMU disposal cells will conform to requirements specified under RCRA, DOE Order 5820.2A, and any state or local requirements applicable at the time of closure. Closure would be performed in phases, with the final closure surface sloped and revegetated with native plant species that do not require irrigation. This revegetation would help to stabilize the surface, to protect it from wind and water erosion, and to minimize infiltration through plant evapotranspiration. The two-phase closure system is shown in Figure 2-4.

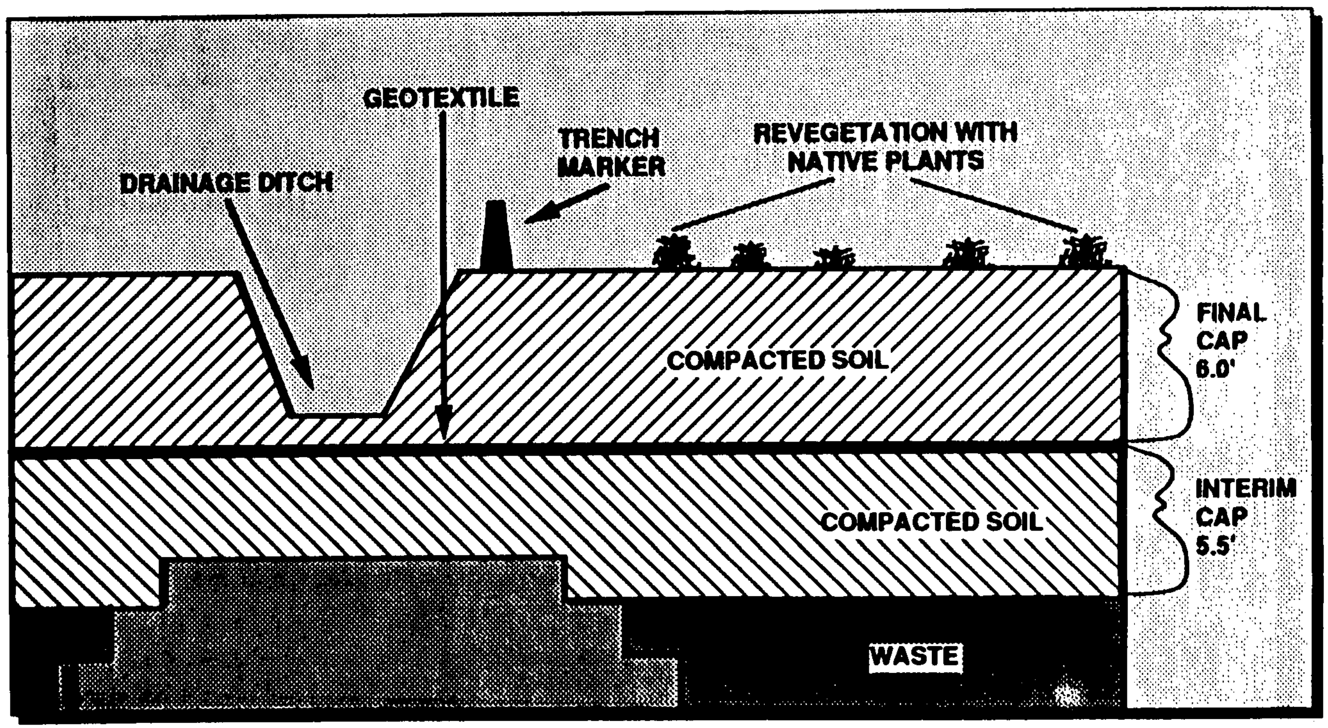

Figure 2-4. Landfill Cell Closure Cap Conceptual Design

2.1.5 Mixed Waste Transportation

There are two important aspects of MW transport under the proposed action. The first aspect is the packaging requirements to ensure safe routine transport. These requirements are enhanced by additional criteria related to DOE/NV waste acceptance criteria. The second aspect is the selection of transportation routes that maximize safe routine operations and thus minimize the chances for accidents. All MW shipments to the Area 5 RWMS are made in tractor-trailer trucks.

2.1.5.1 Mixed Waste Packaging

Defense MW shipped to the NTS Area 5 RWMS must be packaged in accordance with DOT regulations (DOE, 1992b). These packaging criteria also apply to all defense LLW shipped to the Area 5 RWMS. These packaging criteria, as listed in NV0-325, are shown in Table 2-3.

Not only does use of properly designed packaging reduce the chance of radiological/chemical or occupational safety occurrences during transportation, handling, and disposal it reduces the number of waste shipments required and the space required for disposal. To assure safe and efficient use of the Area 5 RWMS, DOE/NV has adopted in NV0-325 the additional packaging criteria that also serve to enhance transportation safety. These additional criteria are listed in Table 2-4.

Waste acceptance criteria established by DOE/NV for MW (and LLW) shipped to the Area 5 RWMS further enhance the packaging safety under both routine and accident transportation situations. As listed in Section 2.1.3, these criteria specify that all wastes must be in solid form and must not contain free liquids or compressed gases. This minimizes the chance of leaks occurring during transit or an accident. Particulates are also severely restricted under the criteria. This restriction minimizes the amount of material that would be available for release to the atmosphere in the event of an accident that breaches containers or results in a serious fire.

2.1.5.2 Mixed Waste Transportation Routes

Mixed wastes generated at NTS, primarily as a result of environmental restoration activities, are likely to be the largest source of MW to be disposed at the MWDU. These wastes will be identified in the Site Treatment Plan for NTS. These wastes would be transported directly to the RWMS and would not require off-site transportation. However, in order to bound the transportation impact analysis, the wastes likely to be generated at NTS were not considered and it was assumed for the purpose of this assessment that 18% of the total volume of off-site waste to be transported to the MWDU would be transported from the RFP near Denver, Colorado, and the rest from the DWCF near Barnwell, South Carolina (Appendix III lists detailed assumptions). The highway routes used to analyze the environmental consequences of MW transportation to the NTS Area 5 RWMS are shown in Figure 2-5. Although specific MW shipments may originate in other areas of the country, the use of these routes is considered to be bounding. The highway mileages for the truck transportation routes are provided in Table 2-5.

Table 2-3. Department of Transportation Mixed Waste and Low-Level Waste Packaging Criteria.

Design:	Type A packaging shall be designed to meet 49 CFR 173.411, "General Design Requirements," and 49 CFR 173.412, "Additional Design Requirements for Type A Packages." Type B packaging must meet the applicable requirements of 10 CFR 71. Strong, tight packaging used for shipping of limited quantities of LLW and low-specific-activity waste excepted by 49 CFR 173.421 and 173.425, respectively, must be constructed so that it will not leak during normal transportation and handling conditions.
Nuclear Safety:	The quantity of fissile materials within a package shall be limited so that an infinite array of such packages will remain subcritical. This quantity shall be determined on the basis of a specific nuclear safety analysis, considering credible accident situations, and taking into account the actual materials in the waste. (See 49 CFR 173.451, "Fissile Materials - General Requirements").
Nuclear Heating:	The quantity of radioactive materials shall be limited for each waste matrix and package type so that the effects of nuclear decay heat will not adversely affect the physical or chemical stability of the contents or package integrity. Also see 49 CFR 173.442, "Thermal Limitations," for temperature limits of accessible external package surfaces.
Radiation Levels:	The external radiation levels for packages shall not exceed 200 millirem per hour on contact during handling, shipment, and disposal, unless specifically excepted by DOT regulations. (See 49 CFR 173.441, "Radiation Level Limitations"). Type B containers that will be unloaded by remote procedures will be addressed on a case-by-case basis.
External Contamination:	Packages shall be within DOT contamination limits upon receipt at NTS. (See 49 CFR 173.443, "Contamination Control").
Activity Limits:	The activity limits listed in 49 CFR 173.431, "Activity Limits for Type A and Type B Packages," shall be met. Where applicable, the activity limits of 49 CFR 173.421, "Limited Quantities of Radioactive Materials," and 173.425, "Transport Requirements for Low Specific Activity Radioactive Materials," shall be met for strong, tight packages.
Multiple Hazards:	Waste shall be packaged according to the level of hazard, as defined in 49 CFR 173.2, "Classification of Material Having More than One Hazard." Incompatible MW shall be packaged in accordance with 40 CFR 264.177, "Special Requirements for Incompatible Wastes."
Marking and Labeling:	Waste shipped to the NTS from offsite must be marked and labeled, as required in 49 CFR 172, Subparts D and E. MW packages of 110 gallons or less must also be marked in accordance with 40 CFR 262.32(b). Marking and labeling of the waste packages shall be for chemically hazardous component, if present, in addition to the radioactive component. Limited quantity MW must be classified according to requirements for hazardous components, as defined by 49 CFR 173.2. Additionally, each waste package shall be marked with the shipment number, a package number, a waste stream identification number, the package weight, and must be barcoded according to standards specified in NVO-325.

Table 2-4. Additional Mixed Waste and Low-Level Waste Packaging Criteria.

Closure:	The package closure shall be sturdy enough that it will not be breached under normal handling conditions and will not serve as a weak point for package failure.
Strength:	Except for bulk waste, waste packaged in steel drums, or sealand containers, the waste package (packaging and contents) shall be capable of supporting a uniformly distributed load of 19,500 kg/m^2 (4,000 lb/ft^2). This is required to support other waste packages and earth cover without crushing during stacking and covering operations.
Handling:	All waste packages shall be provided with permanently attached skids, cleats, offsets, rings, handles, or other auxiliary lifting devices to allow handling by means of forklifts, cranes, or similar handling equipment. Lifting rings and other auxiliary lifting devices on the package are permissible, provided they are recessed, offset, or hinged in a manner that does not inhibit stacking the packages. The lifting devices must be designed to a 5:1 safety factor based on the ultimate strength of the material. All rigging devices that are not permanently attached to the waste package must have a current load test based on 125 percent of the safe working load.
Size:	DOE/NV recommends that 1.2 x 1.2 x 2.1 m (4 x 4 x 7 ft) or 1.2 x 0.6 x 2.1 m (4 x 2 x 7 ft) boxes or 210 liter (55 gallon) drums be used. While these sizes allow optimum stacking efficiency in disposal cells, other dimensions are acceptable with approval of DOE/NV.
Weight:	In addition to the weight limits set for specific packaging designs, NTS imposes limits of 4,082 kg (9,000 lbs) per box and 544 kg (1,200 lbs) per 210 liter (55 gallon) drum. Packages exceeding 4,082 kg require crane removal and, if approved for shipment, must be shipped in removable-top or removable-side trailers.
Loading:	Waste packages shall be loaded to ensure that the interior volume is as efficiently and compactly loaded as practical. High-density loading will allow efficient Area 5 RWMS space utilization and provide a more stable waste form that will reduce subsidence and enhance the long-term performance of the disposal site.
Nonstandard Type A Packaging:	Use of DOT Type A packages not previously evaluated under the DOE Type A Package Certification Program (see MLM-3245, etc.) will not be permitted.
Package Protection:	The generator shall take the following precautions to protect the waste package after closure. The requirements of 40 CFR 264, Subpart I, "Use and Management of Containers," shall be met for MW packages. · Each waste package shall be prepared for shipment so as to minimize damage during transit. · The pre-shipment storage environment shall be controlled to avoid adverse influence from weather or other factors on the containment capability of the waste packaging during handling, storage, and transport. The generator preparing waste for pre-shipment storage shall take all reasonable precautions to preclude the accumulation of moisture on or in packages prior to their arrival at the NTS. · A form of Tamper Indicating Device shall be applied to each waste container, once certification actions have been completed.

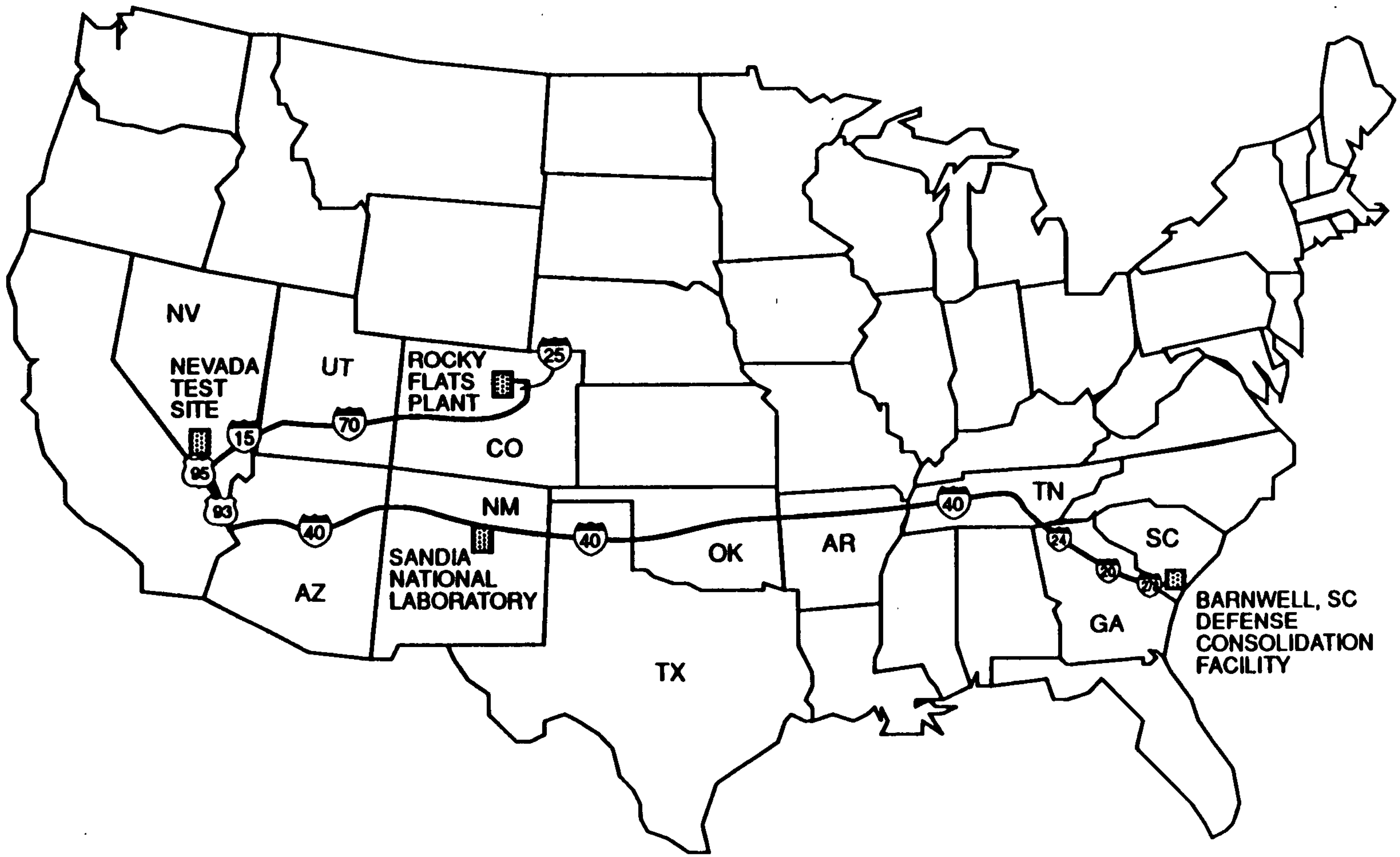

Figure 2-5. Bounding Proposed Mixed Waste Transportation Routes to Nevada Test Site Area 5 Radioactive Waste Management Site

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Table 2-5. Highway Mileage for Truck Transportation Routes.

Storage/Generator Site	Average Highway Mileage
Rocky Flats Plant, Colorado	873
U.S. Army Defense Waste Consolidation Facility[1]	2,451

[1]Located at Barnwell, South Carolina

All LLW and MW generators planning on shipping waste to NTS must first make application to DOE/NV. The application requires detailed information on the quantity and characteristics of that waste. Applications are reviewed thoroughly and, if DOE/NV is satisfied that all applicable criteria can be met, the applicant is issued a certificate allowing shipments. Any significant changes in the generator's waste stream or waste treatment requires a recertification.

All generators are responsible for shipping arrangements and costs. However, prior to each shipment, the generator must contact the Area 5 RWMS so that waste receipt and handling can be accomplished expeditiously and safely.

2.1.6 Operation of Mixed Waste Disposal Cells in the Low-Level Waste Management Unit

There are three types of waste storage and disposal facilities at the LLWMU: (1) shallow land disposal cells; (2) GCD boreholes; and (3) a TRU waste storage pad. Since September 1987, when DOE received interim permit status, all MW received has been placed in disposal cell P-3 and all LLW has been placed in cells P-4 or P-6. These disposal cells, as well as the GCD boreholes and WSC, were described in Section 1.4.2.

All waste transported to the Area 5 RWMS for disposal is received and inspected at the RWMS facilities. After receipt, the waste packages are inspected and assigned to their appropriate storage/disposal site. DOE/NV has developed stringent criteria for acceptance of LLW and MW at the Area 5 RWMS (Table 2-6). These criteria are complemented by packaging requirements (Section 2.1.5.1) and waste certification programs. All of these various criteria are published in NV0-325 (DOE, 1992b).

Exceptions to these criteria for specific waste streams are considered on a case-by-case basis. However, no exceptions are made that would compromise the integrity of the disposal units or that would result in safety hazards for Area 5 RWMS personnel. Bulk LLW is not accepted for disposal at the Area 5 RWMS.

Table 2-6. Defense Low-Level Waste Acceptance Criteria.

Transuranics:
LLW must have a transuranic nuclide concentration not greater than 100 nanocuries per gram.

Hazardous Material:
LLW offered for disposal at NTS waste management sites shall not exhibit any characteristics of, or be listed as, hazardous waste as identified in 40 CFR 261, "Identification and Listing of Hazardous Waste."

Free Liquids:
LLW disposed at NTS waste management sites must not contain free liquids. Waste containing liquids shall be solidified or have an absorbent, stabilizer, or both, added and mixed so that there will not be any free liquid during packaging, handling, transport, and disposal. Ion exchange resins must be dewatered and solidified to be considered as a solid waste. Liquid waste solidified by the urea-formaldehyde process will not be accepted. Minor liquid residue remaining in well-drained containers, or liquids which have been entrapped, are acceptable. In no cases shall free liquid content exceed 0.5 percent by volume.

Particulates:
Fine particulate wastes shall be immobilized so that the waste package contains no more than 1 weight percent of less-than-10-micrometer-diameter particles, or 15 weight percent of less-than-200-micrometer-diameter particles, with radioactive contamination. When immobilization is impractical, the waste packaging shall include a sealed liner and be overpacked.

Gases:
Radioactive gases shall be stabilized (chemically reduced or oxidized) or absorbed. Compressed gases as defined by 49 CFR 173.300, including unpunctured aerosol cans, will not be accepted for disposal.

Stabilization:
Where practical, waste shall be treated to reduce volume and provide a more physically and chemically stable waste form. If necessary, the waste shall be treated to assure that significant quantities of harmful gases, vapors or liquids are not generated. Wastes shall not significantly react with the packaging during normal storage, shipping, and handling time.

Etiologic Agents:
LLW containing pathogens, infectious wastes, or other etiologic agents as defined in 49 CFR 173.386 will not be accepted for disposal at NTS.

Chelating Agents:
LLW containing chelating or complexing agents at concentrations greater than 1 percent by weight will not be accepted.

When shipped wastes arrive at NTS, they are first inspected at Mercury, Nevada, before they are allowed to proceed to the Area 5 RWMS. Upon arrival at the Area 5 RWMS, waste management personnel subject the waste to the inspection procedures outlined in the Detailed Standard Operating Procedures (REECo, 1990). Criteria infractions result in the waste generator being required to implement remedial actions and also result in a review and possible termination of the generator's shipping certificate.

2.2 ALTERNATIVE ACTIONS

Any reasonable alternative to the proposed action must manage MW in an environmentally acceptable manner and in compliance with RCRA MW requirements. RCRA contemplates that hazardous wastes be disposed of properly and not stored indefinitely. Therefore, continued storage of MW would not be consistent with the regulatory scheme contemplated by RCRA.

A primary requirement of any disposal alternative is the capacity to obtain a RCRA disposal permit. There are no permitted facilities within the United States for disposal of the low level MW at issue. The Hanford Site and the NTS are the only DOE sites that have interim status for disposal of low level MW.

The alternatives to the proposed action identified for discussion are: (1) no action; (2) disposal at another DOE site; and (3) disposal at another NTS location. Each of these alternatives would result in impacts greater than those expected from the proposed action, or would involve delays that would pose regulatory compliance issues and may delay environmentally sound management of mixed wastes.

2.2.1 No Action

Under the no action alternative, the low level MW disposal facility would not be expanded. Low level MW disposal activities at the current MWDU would continue (after State approval of DOE's Waste Analysis Plan for hazardous waste disposal under RCRA), including transporting waste to the current disposal cell now operating under interim status until its capacity was reached. Disposal capacity would not be adequate for low level MW generated during near-term cleanup and remediation programs at the NTS or other DOE facilities. Shipping remediation wastes from NTS or other generators to the Hanford site would substantially increase transportation costs and risks. Accordingly, the no action alternative is not a reasonable alternative to the proposed action.

2.2.2 Disposal at Another DOE Site

DOE operates low-level waste disposal units at six sites and several of these sites have or are planning to apply for RCRA permits for MW disposal. Of these, only the NTS and Hanford have interim status for disposal of low level MW. The Hanford Site is planning to build a facility capable of disposing of approximately 10,000 m^3 of MW. This capacity will be sufficient to dispose of wastes generated by remediation efforts at Hanford. The facility is not designed to accept wastes generated at other sites. The capacity for continued disposal under interim status at the NTS would only be sufficient to meet current and future disposal needs for MW for the near-term. Table 2-7 presents a listing of the sites and status of MW permitting.

Table 2-7. DOE Installations With LLW Disposal Sites and Planned MWDUs.

Installation	MWDU Planned	Part B Application Submitted	Interim Status
Idaho National Engineering Lab.	Yes	No	No
Oak Ridge National Laboratory	No	No	No
Los Alamos National Laboratory	Yes	No	No
Nevada Test Site	Yes	Yes	Yes
Savannah River Plant	Yes	Yes	No
Hanford Reservation	Yes	Yes	Yes

Disposal at another DOE site would require the construction and operation of a new facility or facilities at a different DOE site. Because of the time required to complete new facilities, and the uncertainties associated with the permitting process, this alternative would not address the current and near-term need for disposal capacity. Accordingly, this alternative is not a reasonable alternative to the proposed action.

2.2.3 Disposal at Another NTS Location

The disposal at another NTS location would require the construction and operation of a new MW disposal facility at the NTS. The MW already emplaced in cell P-3 at the MWDU would remain there, but no additional MW would be accepted for disposal in cell P-3. The other operations of the RWMS would continue.

No other suitable NTS site has been identified. A siting study would therefore be initiated. A new facility presumably would require new access roads, utilities and new support buildings. These activities would result in costs and environmental impacts typically associated with construction and operations to duplicate infrastructure already available at the proposed site. Because of the regulatory requirements related to MW disposal, time delays (expected to be three to five years) associated with siting, permitting, and constructing at an alternative location would result in significant delays in planned and ongoing clean-up and remediation programs at DOE facilities. These time delays associated with another NTS site would not be consistent with the current and near-term need for disposal capacity. Accordingly, this alternative is not a reasonable alternative to the proposed action.

3.0 AFFECTED ENVIRONMENT

The following sections describe the aspects of the regional and local environment that could be affected by the proposed action. Because of the nature of planned activities, the discussion focuses on climate, air quality, geology and hydrogeology, biology, and transportation (Figure 3-1). Other environmental aspects addressed include topography and physiography, cultural resources, and socioeconomics.

3.1 TOPOGRAPHIC AND PHYSIOGRAPHIC SETTING

The Nevada Test Site (NTS) is situated in the Great Basin region of the Basin and Range Physiographic Province. The province is characterized by series of north-south trending mountain ranges separated by broad alluvial valleys. The Great Basin is characterized by its lack of external surface-water drainage. Many of the valleys within the Great Basin are themselves topographically closed and contain terminal playas. These playas are periodically flooded by precipitation and runoff from the surrounding mountains, but normally remain dry over the majority of the years. The Area 5 Radioactive Waste Management Site (RWMS) is located in one of these topographically closed basins, Frenchman Flat. The Frenchman Flat Hydrographic Basin extends into Nellis Air Force Range on the east and into other NTS operations areas. A fairly large playa, Frenchman Lake, occupies the central portion of the basin. The Area 5 RWMS, within which the mixed waste disposal unit (MWDU) would be built, is situated on the alluvial fan area, southeast of the Massachusetts Mountains and northwest of Frenchman Lake. The fan area slopes gently toward Frenchman Lake. The natural topography and drainage features within the Area 5 RWMS have been altered by construction and use of the existing LLWMU and Hazardous Waste Accumulation Site (HWAS) and associated facilities.

3.2 CLIMATE AND METEOROLOGY

This discussion of climate and meteorology is taken largely from an Environmental Assessment (EA) for the Liquified Gaseous Fuels (LGF) Spill Test facility on Frenchman Flat (Patton et al., 1986), which is 4 to 6 kilometers (km) south of the Area 5 RWMS and in the same basin.

Two major air-movement patterns affect the weather at the NTS. Pacific air flowing over the Sierra Nevada exerts its influence from fall through spring. As the Pacific high-pressure area dissipates in summer, the warm, moist air mass in the Gulf of Mexico exerts its influence. Although the precipitation is highly variable, two peaks in annual precipitation can be detected, the larger in winter and the smaller in late summer. The July and August summer rainfall often comes in intense thunderstorms that can cause local flash floods. Table 3-1 presents a summary of humidity, evaporation, and precipitation conditions for the Frenchman Flat area. Measurable amounts of precipitation only occur a few days a month. The highest average monthly precipitation occurs in January, with just over 1.5 cm (0.6 in.). The average annual precipitation is largely a function of elevation within this region, with higher elevations receiving more than lower elevations. Valley floors, such as Frenchman Flat, average approximately 10 cm (4 in.) of precipitation per year. The higher mesas and mountains on the NTS average 30 cm (12 in.), with some precipitation falling as snow. Standing water on the valley floor is common in winter, with the possibility of a frozen surface.

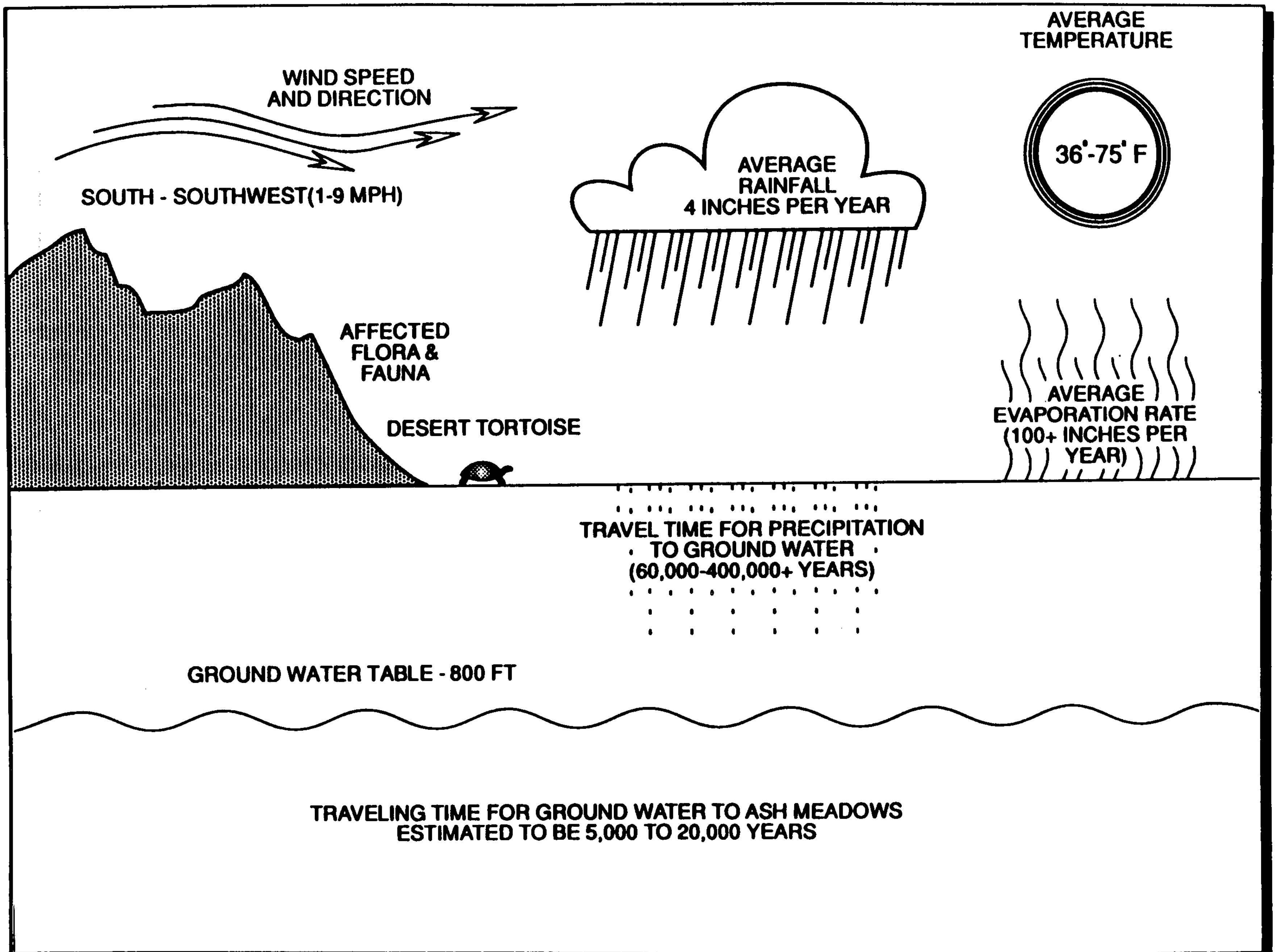

Figure 3-1. Potentially Affected Environment

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Table 3-1. Humidity, Evaporation and Precipitation Conditions of the Frenchman Flat area, Nevada Test Site.

Month	Mean Humidity Vapor Pressure (mb)	Pan Evaporation[b] (mm/day)	Precipitation[c] Average Ppt. days/mo	Average Ppt./Day (mm)[d]	Average Ppt./mo (mm)	CV (month)[e]
January	3.9	1.0	3.68	4.3	15.8	0.98
February	4.4	2.7	3.56	3.6	12.9	1.42
March	4.5	6.1	4.17	3.2	13.4	1.17
April	4.1	8.4	2.92	2.6	7.5	1.22
May	3.5	11.8	2.17	3.8	8.3	1.39
June	2.7	15.9	1.42	2.5	3.6	1.74
July	2.1	16.3	2.96	4.4	13.0	1.21
August	2.7	15.8	2.83	5.3	15.6	1.46
September	4.0	11.8	2.21	4.5	10.0	1.16
October	3.6	6.9	2.08	3.2	6.7	1.21
November	2.3	3.4	3.00	4.0	12.1	0.96
December	2.7	2.0	2.96	4.4	12.9	1.27

[a] Measured on Frenchman Flat, 1978-1979; coefficient of variation between hourly averages was 0.4 across all months.

[b] Pan evaporation, as measured by Reynolds Electrical and Engineering Co., Inc., on Frenchman Flat 1956-1958 and Jackass Flat 1967-1969.

[c] Precipitation at Well 5B, from 1963 to 1988. All precipitation data taken from Statistical Analysis of Precipitation Data from Well 5B in Area 5 of the Nevada Test Site, by Gerald A. Harris, EG&G Idaho, Inc.

[d] Average amount of precipitation on days in which precipitation occurred.

[e] Coefficient of variation for the monthly precipitation amounts.

Average daily temperatures range from 2°C (36°F) in January to 24°C (75°F) in August. Large daily fluctuations in temperature are common, especially on the valley floors. January temperatures at Frenchman Flat vary from -3°C to 12°C (27°F to 54°F) during a 24-hour period. July temperatures range from 17°C to 36°C (63°F to 97°F).

Three main influences on the directional wind patterns occur at the NTS: (1) large-scale movement of major air-pressure systems; (2) intermediate-scale air movements due to regional topographic features; and (3) localized effects due to terrain (Quiring, 1968). As with rainfall, the Pacific air mass influences the winds from fall through spring, whereas the Gulf of Mexico air mass controls the summer wind pattern. Northerly winds predominate in winter and southerly winds in summer. Since there is a general topographic trend toward higher elevations in the northern portion of the NTS, the differential heating of the surface results in southerly (upslope) winds during the day and northerly (downslope) winds at night. This intermediate-scale effect is most pronounced during the summer; it frequently overrides the large-scale pattern. In turn, this regional pattern is strongly influenced by local terrain effects, especially by the orientation of valleys and ridges (ERDA, 1977).

Wind patterns in Frenchman Flat have been studied in some detail (Quiring, 1968; Cramer and Hogan, 1978; Shinn and Cederwall, 1981). Here local topographic features modify the general pattern previously described for the NTS. The basin is essentially flat; devoid of enough relief to give rise to eddies or local convection currents. However, wind-flow patterns related to two nearby drainages exert considerable influence. The larger drainage, Mid Valley, lies to the northwest of Frenchman Flat; the smaller, Nye Canyon, adjoins Frenchman Flat to the northeast. Since little afternoon sun strikes Mid Valley, it begins to cool soon after sunset. During the night, cool air flows southeasterly out of Mid Valley across Frenchman Flat. In conjunction with the prevailing summer southerlies, this results in northwest-to-west winds throughout the night at Frenchman Flat. The Area 5 RWMS is sheltered from Mid Valley air flow and may be more influenced by air flow from Nye Canyon. This could cause more nighttime flow from the northeast at the Area 5 RWMS. By midmorning, prevailing winds are out of the south and are from the southwest by midday. There is a consistent southwesterly wind through the afternoon. As the sun sets, cool air flowing downslope out of Mid Valley causes the wind to shift to a westerly direction at Frenchman Flat. The diurnal flow pattern is most pronounced and consistent during the summer months.

The annual pattern of wind speeds on the NTS is marked by strong winds in the spring and mild winds in the fall. Ten years of wind data from Yucca Flat show highest monthly average wind speeds in April (4 m/s, 9.1 mph) and lowest monthly average wind speeds in November (2.7 m/s, 6.1 mph). Figure 3-2 is an annual wind rose from data collected at Frenchman Flat. It shows the prevalence of strong southwest winds, as well as a secondary peak from strong north winds. These two peaks are caused by the seasonal patterns over the region which frequently dominate the diurnal pattern. Figure 3-4 is based on the 1988 RCRA Part B Permit Application for the Area 5 RWMS and is similar to the wind rose in the 1992 application. This earlier document did not contain hourly meteorological data that would permit seasonal wind roses. However, tabulated wind frequency distributions from five years of hourly data from Yucca Flat, collected by the National Oceanic and Atmospheric Administration from 1961-1964, show the same type of annual pattern and were used in this EA. Yucca Flat is in a different basin, just north of Frenchman Flat, and the seasonal trends should be similar, although Yucca Flat data do show a more pronounced northerly component. During the winter (December-February), wind patterns at Yucca Flat are dominated by north winds, and winds are between the northwest and north-northwest directions 58 percent of the time. During the summer (June-August), this figure was 32 percent, while 43 percent of the time summer winds are from the south-southeast through the southwest. The daily cycle shows little wind at night, increasing wind speeds from morning to afternoon, and declining wind speeds in the evening. Average hourly wind speed may reach 9 meters per second (m/s) (20 mph)) on spring afternoons. Wind gusts are often much stronger than hourly averages. Gusts occur throughout the year, but are often recorded in conjunction with late summer thunderstorms. Gusts of 28 m/s (62 mph) are noted every few years; very rarely have wind speeds exceeded 45 m/s (100 mph) (Quiring, 1968; Shinn and Cederwall, 1981).

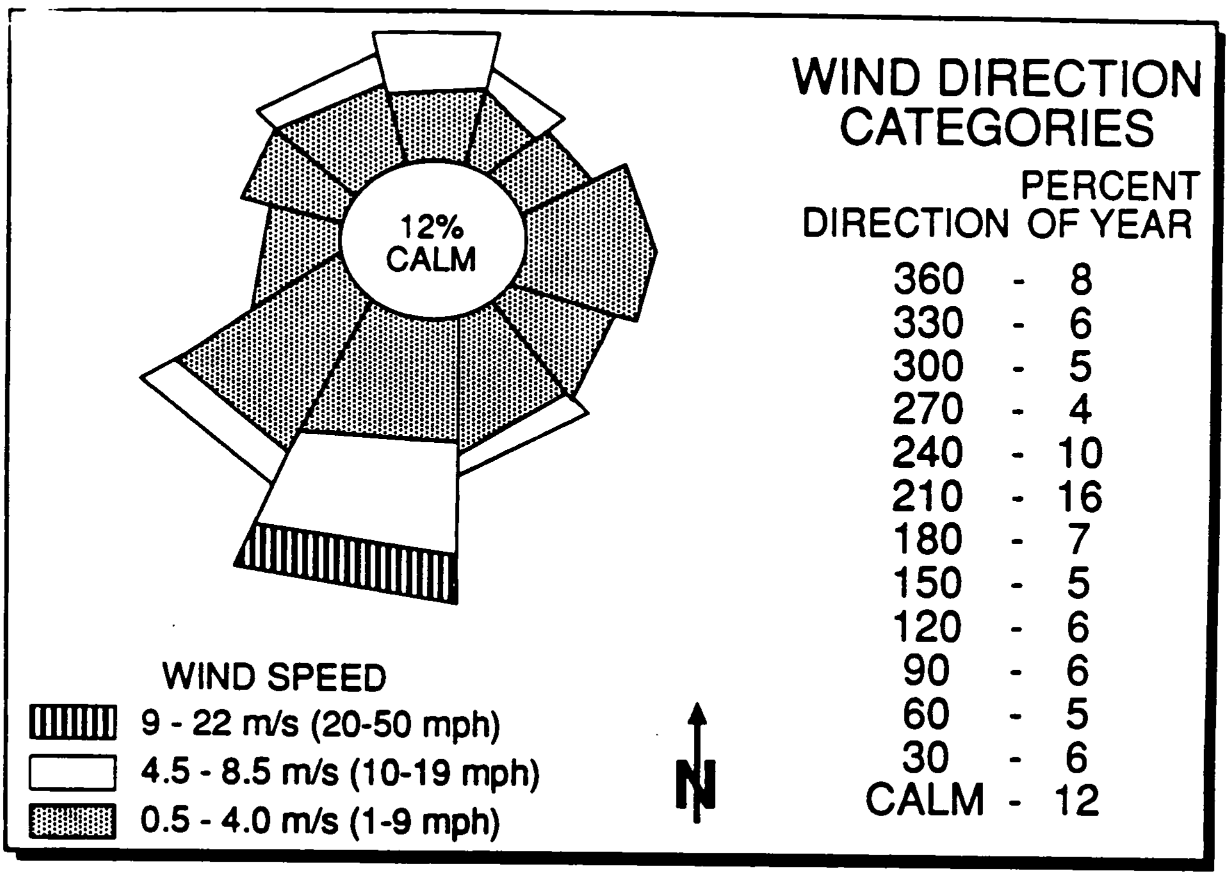


Figure 3-2. Annual Wind Rose for Frenchman Flat

3.3 AIR QUALITY

3.3.1 Ambient Air Quality Standards

State and National Ambient Air Quality Standards (NAAQS) for criteria pollutants, or those pollutants specifically named for review in the Clean Air Act Amendments of 1977, and for which national air quality standards exist, are given in Table 3-2. Table 3-2 also lists standards for lead (Pb) and hydrogen sulfide (H_2S).

The EPA and the State of Nevada have replaced total suspended particulates (TSP) with PM_{10}, or particulate matter less than or equal to 10 microns in aerodynamic diameter, as the indicator for particulate matter for ambient standards. Nevada adopted a PM_{10} standard, which superseded the former TSP standard, on December 26, 1991. The National and State standards are 150 micrograms per cubic meter ($\mu g/m^3$) for a 24-hour average and 50 $\mu g/m^3$ for an annual arithmetic mean.

The Area 5 RWMS is located within Nevada Intrastate Air Quality Control Region 147 (AQCR-147) and is approximately 6 km (4 mi) from the extreme northwest corner of AQCR-013, the Las Vegas Intrastate AQCR. The Las Vegas Valley Air Basin, in AQCR-013, has been designated a non-attainment area for carbon monoxide (CO) and TSP. The Area 5 RWMS is contained within the Frenchman Flat Air Basin. The 1978 EPA's review of states' attainment status of NAAQS, which is still applicable, indicates the following status for Frenchman Flat and adjoining air basins for criteria pollutants: TSP and sulfur dioxide (SO_2) are lower than national standards; CO, nitrogen oxides (NO_x), and ozone (O_3) are either lower than standards or cannot be classified.

3.3.2 Estimated Air Quality at Area 5 Radioactive Waste Management Site

There are no significant sources of SO_2, NO_x, or CO; the nearest source is Las Vegas, approximately 105 km, (65 mi) to the southeast. Although no data have been collected that give concentrations of the criteria pollutants, based on comparison with remote areas of the southwest that have air quality similar to the NTS, present air quality is good in most instances. TSP and O_3 probably have high concentrations at times. Measurements of O_3 in remote areas of the southwest show increases in the spring and summer months, reaching concentrations over 173 $\mu g/m^3$. Instances of high TSP in remote areas are usually caused by high winds which raise amounts of soil particles into the air. These high winds can be either short-term in whirlwinds or they can be longer-term winds associated with frontal passages. Whatever the cause, the particles put into the air by wind are generally large compared to those produced by combustion, and thus fall out rather quickly when the wind subsides. A rural area might have an annual average TSP concentration of 25 $\mu g/m^3$. One factor in the amount of TSP is the degree of disturbance of the land. An undisturbed high desert area will have less wind-blown dust than areas where dirt roads have been built or where the soil has been disturbed by agriculture or mining.

3.3.3 Measurements in Similar Areas

There have been studies of air quality in rural areas of southern Nevada that have characteristics similar to the Area 5 RWMS. The Nevada Division of Environmental Protection

Table 3-2. Ambient Air Quality Standards (Micrograms Per Cubic Meter).

Pollutant and Averaging Time	National Ambient Air Quality Standards Primary	Secondary	Nevada Ambient Air Quality Standards
Sulfur Dioxide			
3-Hour[a]	---	1,300	1,300
24-Hour[a]	365	---	365
Annual Arithmetic Mean	80	---	80
Particulate Matter:			
As TSP[b]			
24-Hour[b]	260	150	150
Annual Geometric Mean	75	60	75
As PM_{10}[b]			
24-Hour	150	150	[d]
Annual Arithmetic Mean	50	50	[d]
Nitrogen Dioxide[c]			
Annual Arithmetic Mean	100	100	100
Ozone			
1-Hour[a]	235	235	235
Carbon Monoxide			
1-Hour[a]	40,000	40,000	40,000
8-Hour[a]	10,000	10,000	6,570[e]
Lead			
Quarterly Arithmetic Mean	1.5	1.5	1.5

[a] Short-term national standards (24 hours or less) not to be exceeded more than once per year, at any location.

[b] TSP is in the process of being superseded by PM_{10} (particulates matter with aerodynamic diameter less than 10 microns) as the ambient standard indicator for particulate matter.

[c] Although there are no Nevada or National short-term NO_2 standards, California has adopted a one-hour standard of 470 μg/m³.

[d] Nevada has not yet adopted PM_{10} standards, but the standards are expected to be at least as stringent as the Federal Standards.

[e] At elevations above 1,524 m (5,000 ft) MSL. At lower elevations the Nevada eight-hour CO standard is 10,000 μg/m³.

(NDEP) has compiled a list of estimated TSP emissions for each hydrographic sub-basin. This was done by estimating the soil type and vegetation along with wind speeds and published emission factors. Results show that natural sources of TSP in rural areas are larger than other sources.

The Desert Research Institute collected ambient air quality data 70 km (44 mi) northeast of Las Vegas as a part of the permitting process for a power plant expansion (DRI, 1979). Background concentrations of SO_2 appear to be below 23 $\mu g/m^3$. NO_2 concentrations never exceeded 17 $\mu g/m^3$ for monthly averages. Ozone showed a seasonal trend, having one-hour values over 173 $\mu g/m^3$ in late spring and early summer and near 60 $\mu g/m^3$ in winter. The 24-hour TSP concentrations had a variation between 8 and 123 $\mu g/m^3$ and an annual geometric mean near 30 $\mu g/m^3$. The causes for specific high values were not given.

3.3.4 Visibility

As with other air quality parameters, visibility in remote regions of the Southwest is good, but with variability. Measurements of visibility have been made to the east and south of the NTS in such areas as the Grand Canyon and Southern California desert. Visibility has been found to range between 50 and 350 km (30 and 220 mi). Lower values are associated with southerly winds, whereas higher values occur with northerly and westerly winds. Visibility is better during winter than summer. During certain summer periods, most of the Southwest has hazy conditions, with relatively low visibility. While the causes of this haze are not clear, there is evidence that small particles are transported from urban areas and copper smelters and that fine soil particles also contribute (Pitchford et al., 1981). There is also an effect on visibility because of local windblown dust, which will last as long as soil particles remain suspended, and seasonally from wild fires in the western U.S.

3.3.5 Toxic/Hazardous Substances

In addition to criteria pollutants discussed in Sections 3.3.1 and 3.3.2, seven substances have been listed as hazardous under Section 112 of the Clean Air Act for which EPA has issued proposed or final emission standards for a number of sources: beryllium (Be), mercury (Hg), arsenic (As), vinyl chlorides, benzene, asbestos, and radionuclides. Nevada regulations (NAC 445.717-7205) define a substance as toxic or hazardous if it is listed in "Threshold Limit Values for Chemical Substances in the Work Environment," (ACGIH, 1986) and if it gives an "acceptable concentration," to be used as a screening tool, as $^1/_{42}$ of the Threshold Limit Value, Time Weighted Average (TLV-TWA), where the TWA is for an eight-hour period. As applied to the Area 5 RWMS, the acceptable concentration, as defined in the Nevada regulations, is not to be exceeded at the point of the nearest public residence or public campground.

The MW to be disposed of would contain any one of a number of approximately 15 substances listed as hazardous waste (HW) under Title 40 U.S. Code of Federal Regulations (CFR) Part 261. Airborne concentrations of these substances are probably minimal based on the absence of nearby sources. Airborne concentrations of most of the substances have not been measured.

Radioactivity measurements have been made throughout the NTS for a number of years. Gross beta analysis of air samples, the most useful analysis for detecting trends in gross radioactivity, is performed at nine locations around the Area 5 RWMS. In 1985, the average from these stations was 1.8 x 10^{-14} μCi/cc, and in 1992 were 2.1 x 10^{14} μCi/cc, which is approximately 0.002 percent of DOE's Concentration Guide (Gonzales, 1986). The 1992 report concluded that there were no atypical releases of radioactive material from the Area 5 RWMS. The average dose rate at the Area 5 RWMS in 1985 was 100 to 120 millirems per year (mrem/yr) including background; in 1992 139 mrem/yr. This is approximately two percent of the prospective annual limit for whole-body occupational exposure of five rems in any one year, recommended by the National Council on Radiation Protection and Measurements (NCRP, 1971), and is comparable to the dose rate from ambient ionizing radiation experienced by the population as a whole (EPA, 1976).

3.4 GEOLOGY, SOILS, AND MINERAL RESOURCES

3.4.1 Geology

The Area 5 RWMS area is covered with Holocene to Pleistocene age alluvial sediments. Geophysical work (Carr et al., 1975) and boreholes in this area indicate that one or possibly more, basalt flows are intercolated in the alluvium. The depth to tuff is 470 m (1500 ft.), and 1,000 - 1,300 m (3,300 - 4,300 ft.) to Paleozoic carbonate rocks and quartzite. The closest rock outcrops consist of Tertiary welded and nonwelded ash-flow tuffs, on the western edge of Massachusetts Mountains northwest of the Area 5 RWMS. These tuffs originated at the Timber Mountain caldera 128 km (80 mi.) northwest of the RWMS.

The Area 5 RWMS is situated near a technically active area based on historic seismic records. The Massachusetts Mountain earthquake of 1971 was located near the intersection of the Cane Springs fault zone and the Yucca-Frenchman flexure, approximately 8 km (5 mi) to the northwest of the Area 5 RWMS. Approximately 9.7 km (6 mi) to the east, the Frenchman Lake earthquake of 1973 occurred near the intersection of the Rock Valley fault zone and the Yucca-Frenchman flexure. The focus of both earthquakes was beneath alluvial areas, and both occurred where a northeast-trending left-lateral fault intersects a northwest-trending right-lateral fault.

However, there is no evidence in any published geologic study, aerial photograph, or field reconnaissance, of any faults or linements which displaced Holocene alluvium within 0.9 km (3,000 ft) of the Area 5 RWMS. The closest inferred fault, near the southeast flank of the Massachusetts Mountains, is over 2 km (7,000 ft) to the northwest of the Area 5 RWMS.

The alluvial deposits which comprise Area 5 RWMS, are composed of middle alluvial fan sediments. The middle alluvial fan includes both erosion and deposition, but on a long-term basis net deposition is expected. Middle fan deposits exposed in the RWMS pits include sheet flood, stream channel, and debris flow sediments. These types of deposits represent periodic flood events when precipitation is high over a short period of time. Only debris flow deposits represent catastrophic events. These flood events are commonly described as "flash floods".

3.4.2 Soils

Soils in the area surrounding the Area 5 RWMS consist dominantly of gravelly sand. Romney et al., (1973) indicated typically A and C horizons, generally less than 15 cm and less than 2 m in thickness, respectively. Several studies of the soils and alluvium in the vicinity of Area 5 RWMS analyzed samples for chemical and physical characteristics.

Kearl (1982) studied the infiltration characteristics of the soil surface and movement of moisture in the soil profile. Using a ring infiltrometer, Kearl measured an infiltration rate of approximately 0.04 cm/sec (0.9 in./hr) on the undisturbed soil surface. Kearl also measured the moisture content within the soil profile and found that it was very low at the surface, increased to a maximum from 1 to 2.3 m (3 to 7 ft) and then decreased with depth down to 5.2 m (17 ft).

Romney et al., (1981) studied the relationships between soil moisture and vegetation on disturbed soils. They found that vegetation evapotranspiration on disturbed soils depleted soil moisture more rapidly than evaporation did on unvegetated disturbed soils. Romney et al., (1981) also estimated the field capacity of these soils to be approximately 13 percent by volume.

Romney et al., (1973) described calcic horizons, based on a large number of soil pits, from 0 to 50 cm (0 to 20 in.) and 75 to 150 cm (30 to 60 in.), which they interpreted to reflect, respectively, modern and Pleistocene depths of soil moisture penetration from precipitation.

Holmes and Narver, Inc. (1983) collected soil samples at minimum intervals of 3 m (10 ft) over the 37 m (120 ft) depth of the two boreholes they studied. Laboratory analyses were performed to determine grain-size distributions, soil moisture content, saturated hydraulic conductivity, porosity, and bulk density. Their results were as follows:

- soil moisture in upper 5 m (15 ft) : 5 to 9 percent by weight
- saturated hydraulic conductivity : 0.0011 to 0.0044 cm/sec; average 0.002 cm/sec
- average porosity : 34 percent
- average bulk density : 1.7 g/cm^3

Recently completed test wells (REECo, 1993a) and test borings (REECo, 1993b) provide data specific to Area 5 RWMS soils and depth to water. Preliminary analysis of these data is consistent with the studies cited above. The new data have not, however, been subject to peer review and publication and are therefore not used in this EA. The data do indicate that the water table is at 794 feet below ground surface and is flat (i.e., there is no discernable gradient). The data further indicates that the moisture flux gradient in the upper 30 m of the soil is upward, probably under the influence of evapotranspiration.

3.4.3 Mineral Resources

A review of available geologic literature covering northern Frenchman Flat, followed by a reconnaissance field examination of the area was made to provide an assessment of the mineral potential of the Area 5 RWMS and immediately surrounding area.

3.4.3.1 Metallic Mineral Potential

There are no known mines, prospects, or mineral occurrences in this area and no indications of extensive hydrothermal alteration or mineralization were found during the field examination. However, pediment gravels in one area were noted to contain a fairly large percentage of rock fragments with thin coatings of clear quartz crystals. These coatings represent hydrothermal quartz deposited on fracture surfaces; the source of this material is probably the Halfpint Range southeast of Puddle Peak and the fractured rock no doubt lies along one of the northeast-trending fault structures of the Cane Springs structural system.

3.4.3.2 Industrial Mineral Potential

No sand or gravel or other industrial minerals have been produced from the Area 5 RWMS area although both have been mined from the south side of Frenchman Basin. In addition, welded tuffs have been mined from the Massachusetts Mountains to be used as riprap. Loss of access to these types of resources that may be present within the project area is not considered significant.

3.4.3.3 Oil and Gas Potential

The area has very low potential for oil and gas; the complex structural setting of the area and its proximity to the large Timber Mountain caldera complex indicate very low favorability for the presence of oil and gas resources.

3.4.3.4 Geothermal Potential

Unusual warm water temperatures have been encountered in deep wells on the southeast side of Frenchman Flat, southeast of the Area 5 RWMS, and in Yucca Flat, northwest of the Area 5 RWMS. There is, however, no evidence of hot spring activity in or near the Area 5 RWMS and potential for the development of geothermal resources is rated as low.

3.5 HYDROLOGY AND WATER RESOURCES

3.5.1 Surface Water

The overall watershed area which could impact Area 5 RWMS is approximately 140 square miles. It is bounded to the northwest and north by the Massachusetts Mountains and to the northeast and east by the Halfpint Range. Schmeltzer et al., (1993) divided this watershed area into 16 subbasins of which 7 potentially feed the Area 5 RWMS. Case et al., (1984) identified five principal watersheds that potentially affect the Area 5 RWMS. Additional previous studies of the surface hydrology of the Area 5 RWMS included French (1984); French and Lombardo (1984); Cox (1986) and Rawlinson (1991).

Regardless of which watershed designation is utilized, there are no perennial streams in this watershed area. Flows in stream channels are ephemeral, occurring only after significant precipitation events.

Extensive analysis has been done on the flash flood characteristics of the watershed upgradient of the Area 5 RWMS and the alluvial fans created by the flooding (Schmeltzer et al., 1993; French and Lombardo, 1984; Case et al., 1984; French, 1984 and 1983).

3.5.1.1 Watershed and Alluvial Fan Characteristics

The location and physical characteristics of the watershed are shown in Figure 3-3 after Schmeltzer, (1993), and are presented in Table 3-3.

The Area 5 RWMS is located at the approximate intersection of a southeast-facing alluvial fan and a southwest-facing alluvial fan, respectively - the Barren Wash Fan and the Scarp Canyon Fan (according to Case et al., 1984). Water and sediment contributed from certain parts of watersheds bypass the Area 5 RWMS entirely. Whereas other sections of the watersheds form confluences directed toward specific parts of the site.

Table 3-3. Physical Characteristics of Watershed Subbasins Upgradient From the Area 5 RWMS.

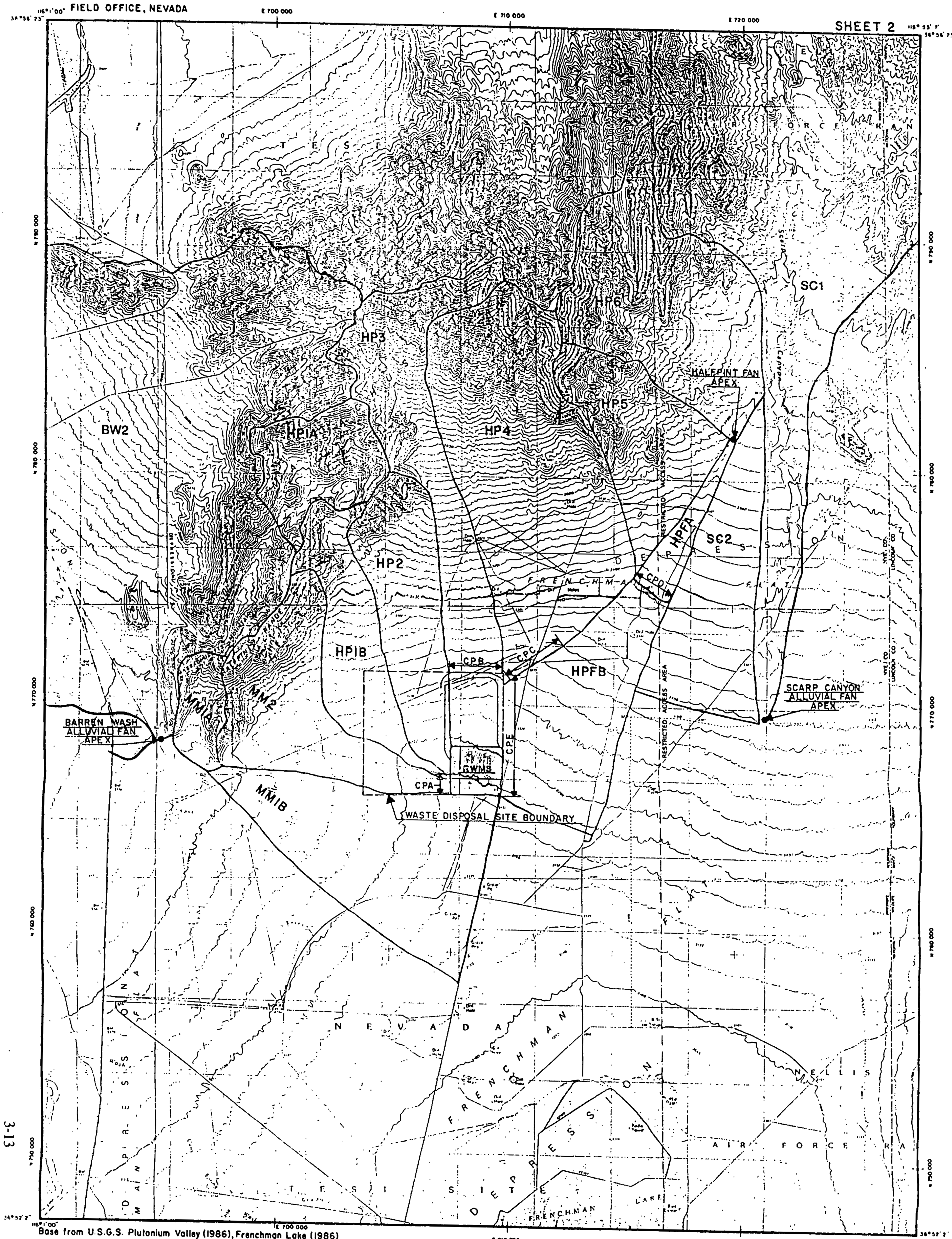
Watershed	Area
Barren Wash Alluvial Fan	81.3-square miles
Barren Wash 1	60.5-square miles
Barren Wash	220.8-square miles
Scarp Canyon Alluvial Fan	40.9-square miles
Scarp Canyon	139.4-square miles
Scarp Canyon 2	1.5-square miles
Halfpint Alluvial Fan	4.1-square miles
Halfpint Fan A	0.3-square miles
Halfpint Fan B	1.6-square miles
Halfpint Range 6	2.2-square miles
Massachusetts Mountains/Halfpint Range Subbasins	13.6-square miles

Barren Wash Alluvial Fan

Schmeltzer et al., (1993) describe the Barren Wash watershed as covering 81.3-square miles and being located northwest of the Area 5 RWMS (Figure 3-3). The wash drains to Frenchman Flat from an area that is bordered to the east by the Massachusetts Mountains, to the north by the CP Hogback, and to the west by the CP Hills. The watershed has been divided into two separate subbasins: Barren Wash 1 (BW1, 60.5-square miles) and Barren Wash 2 (BW2, 20.8-square miles).

. REPARED BY RAYTHEON SERVICES NEVADA FOR
U.S. DEPARTMENT OF ENERGY,
FIELD OFFICE, NEVADA

SHEET 2



Base from U.S.G.S. Plutonium Valley (1986), Frenchman Lake (1986)
Yucca Lake (1986), and Cane Spring (1986) Quadrangles, Nevada

SCALE 1: 24 000

CONTOUR INTERVAL 20 FEET
SUPPLEMENTARY CONTOUR INTERVAL 10 FEET

QUADRANGLE LOCATION

EXPLANATION

- ——— WATERSHED BOUNDARY
- SC2 ——— WATERSHED NAME
- ☐ ——— RADIOACTIVE WASTE MANAGEMENT SITE (RWMS)
- – – – – BOUNDARY OF AREA PROPOSED FOR RWMS EXPANSION

John S. Schmeltzer, Julianne J. Miller
and
Dennis L. Gustafson
1992

Figure 3-3. Flow Directions of Water on Unconsolidated Deposits in Watersheds Around the Nevada Test Site Area 5 Radioactive Waste Management Site

The Barren Wash Alluvial Fan is the dominant landform in the watershed. The proximal part of the fan (the area on the alluvial fan near the apex) is deeply entrenched by a stream channel. Significant parts of the fan surface are covered by desert pavement with desert varnish, and vegetation covers 15-25 percent of the surface. Erosion is the primary geomorphological process occurring on the proximal part of the fan, as shown by scalloping of the fanhead trench.

Continued trench incision has shifted deposition to a distal part of the fan (the outermost area, or lower zone of the fan). The Barren wash channel captures the channel draining from the Massachusetts Mountains 1A (MM1A) subbasin at the southwestern corner of the Massachusetts Mountains (Figure 3-3). At this point a new, secondary fan is being formed which extends east toward the Area 5 RWMS and south to Frenchman Flat. The RWMS is located on the lower-mid part of this secondary fan.

Case et al., (1984) defines the Barren Wash Alluvial Fan as Watershed 4. Flood flows from Watershed 4 should pass below the MWDU and thus should not impact the site, although some portion could pass into Watershed 5 (aka Halfpint Range Subbasin HP1B) and through the unused, southwestern corner of the Area 5 RWMS.

Scarp Canyon Alluvial Fan

Schmeltzer et al., (1993) describe the Scarp Canyon watershed, located northeast and east of the RWMS, as covering about 40.9-square miles (Figure 3-3). This watershed drains onto Scarp Canyon Alluvial Fan from an area that extends north to Carbonate Ridge (French and Lombardo, 1984), west to the Massachusetts Mountains, and east to Raysonde Butte. The watershed is divided into two subbasins: Scarp Canyon 1 (SC1, 39.4-square miles), the drainage area above the active apex; and Scarp Canyon 2 (SC2, 1.5-square miles), the area between the channel that drains SC1 and the eastern boundary of Halfpint Alluvial Fan (Figure 3-3).

A large fanhead trench, ranging to a depth of 40 feet, cuts through a thin layer of alluvium and bedrock above the active apex. Below the active apex, the channel cuts through unconsolidated and calcrete-cemented alluvium. Parts of the fan surface are covered by desert pavement with desert varnish. Vegetation density is 15 to 25 percent over the fan surface.

The channel within the trench of Scarp Canyon is braided. Relatively flat interchannel bars and side terraces are approximately 1 to 5 feet above the stream beds, and covered by fine-grained sediment. High-water indicators are present on the bars and terraces several feet above the stream bed. These indicators include large clasts and boulders, small logs and sticks, and uprooted Joshua trees found snagged in the vegetation. The vegetation also shows signs of being washed over by water. Concurrence of the high-water indicators with the fine-grained deposits are fluvial rather than eolian.

Case et al., (1984) define the Scarp Canyon Alluvial Fan as Watershed 3, Zones A and B. Flood flows along the western margin of Watershed 3 would impact the southeastern portion of the proposed MWDU.

Halfpint Alluvial Fan

Schmeltzer et al., (1993) describe the Halfpint Alluvial Fan as located northeast of the Area 5 RWMS, and developing from a channel that collects flow from the drainage area (HP6, 2.2-square miles) along the eastern front of the Halfpint Range (Figure 3-3). The alluvial fan is divided into two separate subbasins: Halfpint Fan A (HPFA, 0.3-square miles) and Halfpint Fan B (HPFB, 1.6-square miles).

The channel located above the apex of the Halfpint Alluvial Fan is incised 2 to 3 feet in depth. The apex of the fan was located where the flowpath of the channel becomes unpredictable. Below the apex of the fan, a very braided channel system has developed. Relatively little desert pavement or desert varnish is found on this fan surface; vegetation cover density is approximately 20 percent. The Area 5 RWMS is located in the lower-mid part of this fan.

Case et al., (1984) define the Halfpint Alluvial Fan as part of Watershed 3, Zone A. Flood flows along the western margin of watershed 3 would impact the southeastern portion of the proposed MWDU.

Massachusetts Mountains/Halfpint Range Subbasins

Schmeltzer et al., (1993) describe this 13.6-square mile watershed that drains from the Massachusetts Mountains/Halfpint Range toward the RWMS as divided into seven subbasins (Figure 3-3). These subbasins included (MBA/MM1B), MM2, (HP1A/HP1B), HP2, HP3, HP4, and HP5. The upper parts of these subbasins are located in bedrock consisting of several different tuffs. From a geomorphic viewpoint, the drainages in the lower regions extending into Frenchman Flat form coalescing alluvial fans along the mountain front. From a hydraulic engineering viewpoint, the flow system of these landforms are distributary-flow systems. Hjalmerson and Kenna (1991) state that the "...major physiographic characteristics used to identify and categorize distributary-flow area... include (1) vegetation density and soil color, (2) drainage texture, and (3) the random nature of channel links."

The proximal parts of these coalescing alluvial fans (geomorphic viewpoint) are characterized by channels incised 5 to 10 feet across the surface. Vegetation density on the fan surface is 20 to 35 percent. Undisturbed deposits covered by desert pavement with desert varnish are present.

Channel incisions, averaging 1 to 3 feet, decrease near the middle part of the fan. Debris flow deposits from the HP1A and HP1B subbasins in part compose the coalescing alluvial fans (geomorphic viewpoint). Channel depths decrease down gradient until sheetflow occurs.

Sheetflow, typical of areas of low relief and poorly established drainage systems, occurs on the distal parts of the coalescing alluvial fans (geomorphic viewpoint). The RWMS is located in the lower-mid parts of these coalescing alluvial fans where channel depths average less than 1 foot. Vegetation covers 20 to 30 percent of the fan surface. There are relatively few undisturbed areas of relic deposits covered by desert pavement with desert varnish.

Case et al., (1984) describe the Massachusetts Mountains/Halfpint Range subbasins as Watersheds 1, 2, 5 and parts of 4. Watershed 1 correspond to HP1B and HP2. Flow from Watershed 1 would impact the western edge of the proposed MWDU. Watershed 2 corresponds to HP3 and HP2. Flows from Watershed 2 would directly impact the proposed MWDU site, with flood flows being routed through the center of the site from the north and northeast via Watershed 3. A portion of Watershed 4 corresponds to MM2 and MM1B. Flood flows from this portion of Watershed 4 should pass below the MWDU and thus should not impact the site.

Watershed 5 also corresponds to HP1B. The alluvium of Watershed 5 is bordered and being encroached on the alluvium from Barren Wash Fan and the fan from water shed 1. This has resulted in a "funneling" of flow toward the southeast, directly toward the Area 5 RWMS. There is evidence of recent flows and channeling in watershed 5; however, because of its small drainage area, those flows are not believed to have been significant. Also, although flood flows from Watershed 5 will pass through the central portion of Area 5 RWMS, they should have minor impact on the MWDU due to the small drainage area of Watershed 5.

3.5.1.2 Estimated Flood Flows

There are no direct measurements of flood flows from the Area 5 RWMS watersheds and, in fact, there are very few measurements of any flash floods in the desert southwest. Most flood-flow estimates have been calculated based on post-flood measurements of channel geometries, flood depths, debris discharge, and related flood effects. In the arid Southwest, rainfall-runoff models are often used to estimate flood discharges. French (in Case et al., 1984) studied three regional peak flow relationships based on regressions between observed flow and watershed area (two relationships), plus watershed elevation and latitude (one relationship). Using these relationships, French calculated the maximum potential flood peak for each watershed and the peak flows for return periods of 10, 25, 50, 100, and 500 years. Schmeltzer et al., (1993) utilized rainfall runoff models developed by the U.S. Army Corps of Engineers (COE) and accepted by the Clark County Regional Flood Control District to develop hydrologic models for 2-year, 10-year, and 100-year discharges at the Area 5 RWMS.

French (in Case et al., 1984) used these peak flow estimates, together with flow-channel geometry relationships developed by Dawdy (1979), to estimate flood channel top widths and flow depths. Dawdy's estimates apply to single channel flow and do not consider roughness and slope. French (in Case et al., 1984) carried the flood flow analysis one step further to estimate the risk (or probability) of a flood event hitting the Area 5 RWMS. He based this analysis on Dawdy's (1979) hypothesis that an alluvial fan channel caused by a flood event was equally likely to cross an elevation contour at any point and Bull's (1962) observations that there is a medial tendency for alluvial fan channel development. French's flood-flow analysis for the Area 5 RWMS watersheds is summarized in Tables 3-4 and 3-5. In Table 3-4, for each watershed, the flood parameters and risk were calculated for a series of return periods. For example, in Watershed 2 (col. 1) on average once in 10 years (return period of 10 years - col. 2) a flood peak (col. 3) of 4.9 m^3/s (16 ft^3/s) is expected to be experienced. The flood channel width (col. 4) would be 24 m (79 ft) and the flood water depth (col. 5) would be 0.18 m (0.6 ft). The velocity of the flood flow (col. 6) would be 1.2 m/s (3.9 ft/s). The probability of this event occurring during a 100-year design life for the Area 5 RWMS would be between 1.0 (col. 7) and 0.99 (col. 8).

In Table 3-5, the return periods expected for a given facility design life are calculated for a series of risks that such an event would occur. For example, there is a 50 percent risk that during a design life of 140 years, the Area 5 RWMS would experience a flood that occurs on average once in 217 years. Referring back to Table 3-4, in Watershed 2 that flood would have a peak flow of approximately 83 m^3/s (2,940 ft^3/s), which is a logarithmic interpolation between the flows for return periods (col. 2) of 100 and 500 years. Based on this analysis, it can be concluded that there is a 50 percent risk that the Area 5 RWMS will experience a flood with a 200-year return period magnitude at least once, but potentially more times, during its 140 year active life. However, because of the location of the MWDU within Area 5 RWMS and with respect to the tributary watersheds, the magnitude of flood events impacting the MWDU should be less than those impacting the entire site.

Schmeltzer et al., (1993) determined through modeling 2-year, 10-year, and 100-year discharges. Their model combined flow data from adjacent subbasins to simplify and conservatively estimate the potential flooding. The 2-year model generated discharges for the subbasins close to zero with a highest discharge being 0.7 m^3/s. The 10-year model generated discharges for the subbasins between 2.5 m^3/s to 30.9 m^3/s. The 100-year model generated discharges for the subbasins between 7.5 m^3/s to 171 m^3/s. The highest numbers were utilized in determining 100-year flood plains.

Schmeltzer et al., (1993) delineated the 100-year flood hazard zones for the Barren Wash, Scarp Canyon, and the Halfpint alluvial fans. They concluded that the proposed southwest corner of Area 5 RWMS has a probability of 0.01 (a 100-year event) to be impacted by channelized flow of the Barren Wash Fan averaging 1 foot of depth and having a velocity of 3 feet/second. That corner is in the 100-year floodplain. However, the proposed MWDU is not within the Barren Wash Fan 100-year floodplain. The Area 5 RWMS is not in the 100-year floodplain of the Scarp Canyon or Halfpint fans.

Table 3-4. Flood Parameters and Risk* at Area 5 Radioactive Waste Management Site for a 100-Year Design Life and Characteristic Length of 853 Meters (2,800 ft) (After Case et al., 1984, Table 17).

Estimated Flood Parameters***						Risk	
Watershed/ Alluvial Fan****	Return Period Years	Flow Rate m^3/s	Channel Width m	Depth of Flow m	Velocity of Flow m/s	p(x/f) by Equal Probability	p(x/f) by Medial Tendency
1	10	2.6	18	0.12	1.2	1.00	1.00
(HP1B; HP2)	25	8.1	27	0.21	1.5	0.97	0.94
	50	17.0	37	0.27	1.8	0.83	0.77
	100	33.0	49	0.37	1.8	0.59	0.52
	500	86.0	70	0.52	2.4	0.17	0.14
2**	10	4.9	24	0.18	1.2	1.0	0.99
(HP3, part)	25	14.0	34	0.24	1.8	0.96	0.87
	50	29.0	46	0.34	1.8	0.82	0.64
	100	53.0	58	0.43	2.1	0.58	0.41
	500	150.0	88	0.67	2.4	0.17	0.42
3	10	22.0	34	0.30	2.1	0.96	0.63
(HP3 [part] + HPFB)	25	56.0	61	0.46	2.1	0.75	0.36
	50	100.0	76	0.55	2.4	0.50	0.20
	100	170.0	95	0.70	2.4	0.31	0.10
	500	450.0	140	1.01	3.4	0.08	0.02
4	10	36.0	52	0.37	1.8	0.94	0.76
(MM2)	25	87.0	73	0.52	2.1	0.70	0.45
	50	160.0	91	0.67	2.4	0.46	0.25
	100	260.0	110	0.82	2.7	0.27	0.15
	500	670.0	170	1.19	3.4	0.07	0.03
5	10	1.3	12	0.09	1.2	1.00	1.00
(HP1B)	25	4.2	21	0.02	1.2	0.98	0.98
	50	9.1	31	0.21	1.5	0.87	0.87
	100	18.0	40	0.27	1.5	0.63	0.63
	500	53.0	58	0.43	2.7	0.18	0.18

* Risk is the probability of the site experiencing, at least once during its design life, a flood whose magnitude is expressed in terms of return period.

** This series of lines summarized the risk to the Area 5 RWMS from floods originating in Watershed 2. For example, the event which on the average occurs once every ten years (column 2), has an estimated magnitude of 4.9 m^3/s (column 3); will form a channel 24 m wide (column 4) with a depth of 0.18 m (column 5); the velocity of flow will be 1.2 m/s (column 6); and the risk that the Area 5 RWMS will experience in this event ranges from 1.00 to 0.99 (columns 7 and 8).

*** Dimensions are approximate metric conversions from the original English (f,p,s) units.

**** Schmeltzer et al., (1993) subbasins are identified in parentheses under the identified Case et al., (1984) watersheds. The watershed/subbasin designations overlap in some areas.

Table 3-5. Flood Peak Return Period (T_R) as a Function of Risk (R) and Design Life (N) for the Area 5 Radioactive Waste Management Site Watersheds. (Based on Case et al., [1984] Data).

Risk Percent	Return Period, Years Design Life N=100	Design Life N=150	Design Life N=200
50	144	217	289
40	196	294	392
30	281	421	561
20	448	673	897
15	615	923	1,230
10	950	1,420	1,900
5	1,950	2,920	3,900
2	4,950	7,420	9,990
1	9,950	14,900	19,900
0.1	100,000	150,000	200,000

3.5.2 Groundwater

The Frenchman Flat groundwater system is composed of two major components: the unsaturated zone and the saturated zone. In the unsaturated, or vadose, zone the communicating void spaces (porosity) are not all full of water (saturated) and thus, the water within those voids is under capillary tension. In the saturated zone beneath the water table, all the void spaces are full and the water is at least under hydrostatic pressure. The vadose zone is extremely important to questions of MW disposal since it represents the barrier through which leachate from disposal cells must move to reach the water table.

3.5.2.1 General Hydrogeology

The unsaturated-saturated groundwater system in the vicinity of the Area 5 RWMS is composed of three hydrostratigraphic units: (1) the unconsolidated Quaternary and Tertiary valley fill; (2) Tertiary volcanic ash and lava flows; and (3) the Paleozoic carbonate basement rock (Winograd and Thordarson, 1975). Several deep holes (≥300 m(1,000 ft)) have been drilled in Frenchman Flat that fully penetrate one or more of these units (Figure 3-4), including three within the Area 5 RWMS boundaries. Seven shallow (≤37 m (120 ft)) holes have been drilled at the Area 5 RWMS itself. Thus, the full hydrostratigraphic sequence beneath the Area 5 RWMS is known. Several investigators have studied these relationships. Boughton (1984 as cited by Case et al., 1984) developed a computer-generated map of depth to the water table which indicates that beneath the MWDU in Area 5 RWMS the unsaturated zone ranges from 260

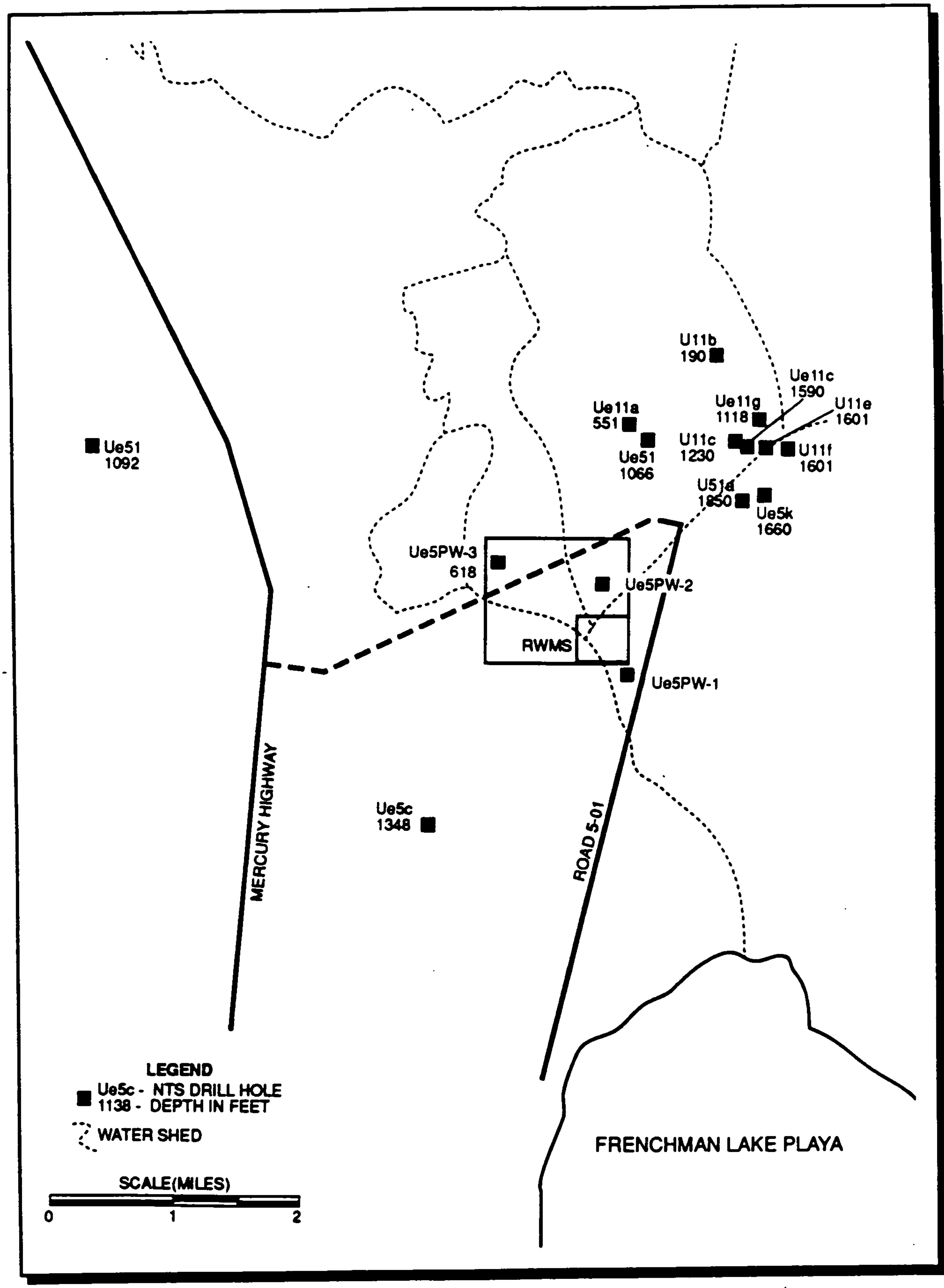


Figure 3-4. Location of Exploratory Holes on Frenchman Flat in the Vicinity of the Area 5 Radioactive Waste Management Site

to 290 m (850 to 940 ft) in thickness. Similar mapping by Winograd and Thordarson (1975) suggest a thickness of approximately 240 to 270 m (800 to 900 ft). Regional monitoring well data indicate that the water table lies within the alluvium and that it is in hydraulic communication with the underlying volcanic ash/lava flow. Published regional monitoring well data suggest that the carbonate unit is in hydraulic communication with the overlying volcanic unit. Data from the three Area 5 Pilot Wells and seven boreholes have not been published but preliminary review indicates that the alluvium under Area 5 RWMS is isotropic and similar to the published data (REECo, 1993a).

3.5.2.2 Saturated Zone

The deep carbonate rocks constitute a regional aquifer system that moves groundwater southwest and across the NTS from areas of recharge to discharge areas in the Amargosa Desert (Ash Meadows) and possibly Death Valley. Alluvium and volcanics also provide connections to regional systems and may be just as important. This regional system is referred to as the Ash Meadows Regional Groundwater Flow System (Figure 3-5). The groundwater potentiometric surface in the carbonates is little affected by the mountain ranges and valleys beneath which the groundwater flows. However, on a local basis there are perturbations that reflect recharge, changes in permeability, and fault systems. In the vicinity of the Area 5 RWMS, Winograd and Thordarson (1975) found that water levels in the volcanic unit are 3 to 10 m (10 to 30 ft) above the water level in the carbonates. Thus, there is an apparent gradient for downward movement of water from the volcanics into the carbonates. Data from the three Pilot Wells indicate that there is no discernable gradient in the alluvial aquifer (REECo, 1993a).

3.5.2.3 Unsaturated Zone

Estimating the flux and velocity of moisture movement in the unsaturated zone is complicated by the fact that unsaturated hydraulic conductivity is a function of the soil moisture content. Furthermore, the energy gradient must account for capillary forces (i.e., matric potential) in addition to the gravity force. All of this is further complicated by the difficulty of obtaining accurate measurements of the hydraulic parameters. Tyler (1987) reports that, in general, the natural flux and velocity rates in the NTS alluvial soils are very low. Using data collected by others, Tyler (1987) calculated downward flux rates ranging from approximately 10^{-6} to 3×10^{-1} cm/yr and velocities ranging from approximately 3×10^{-5} to 3 cm/yr. These values reflect the soil properties and the low average precipitation of the area. According to Tyler these rates indicate that less than 1 percent of the average annual precipitation is moving downward through these soils. Preliminary review of the data from the Area 5 Pilot Wells indicates that the flux gradient within the upper 100 feet of soil is upward, suggesting that evapotranspiration is the dominant effect (REECo, 1993b).

Tyler (1987) used the data from Kearl (1982) and Romney et al., (1973) to estimate the flux and velocity rates near the Area 5 RWMS. From the measurements made, Tyler calculated flux rates ranging from 1.3×10^{-6} to 1.2×10^{-2} cm/yr and velocities ranging from 3×10^{-5} to 1.8×10^{-1} cm/yr (Table 3-6).

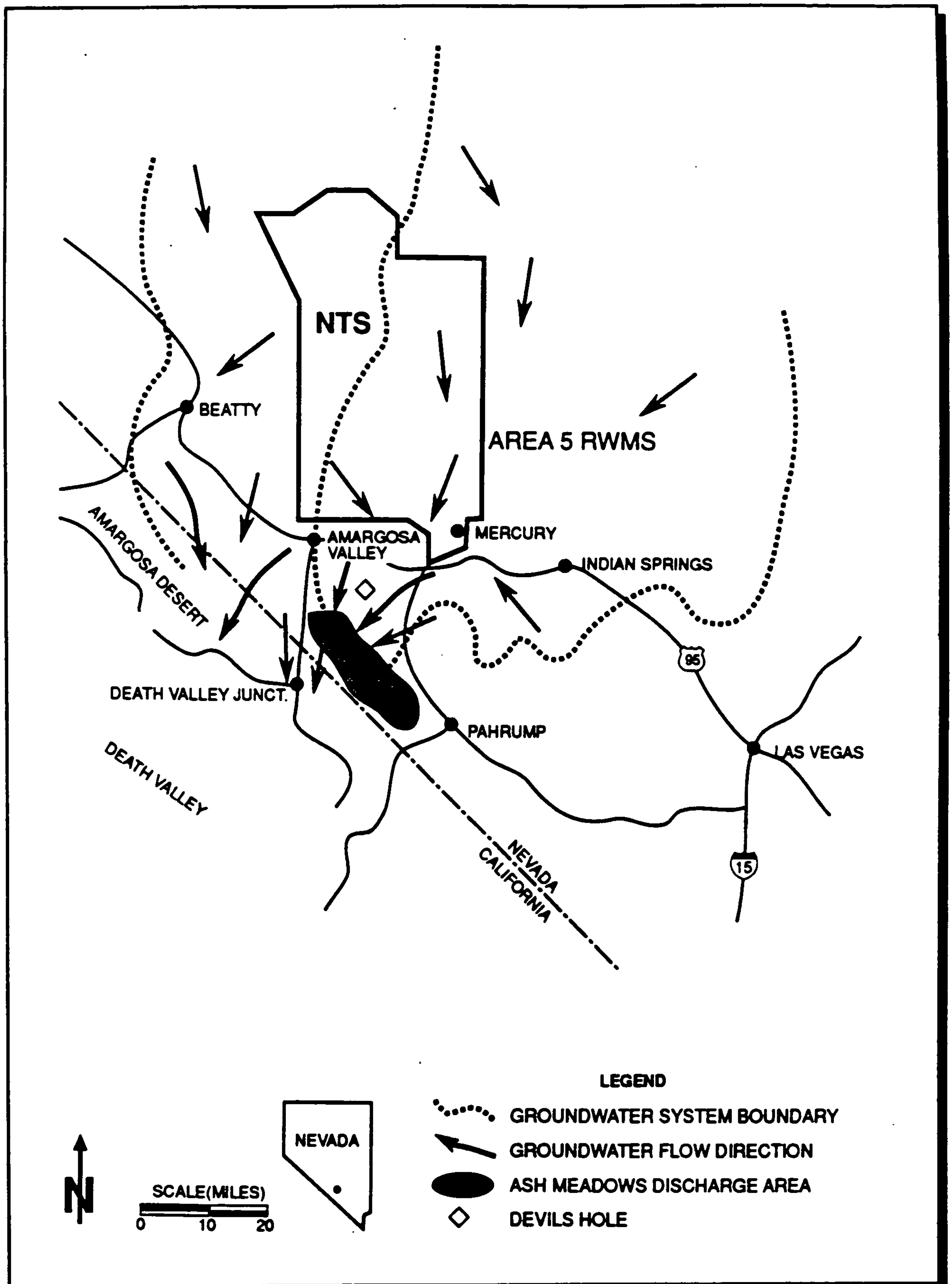


Figure 3-5. Regional Groundwater Flow Systems

Table 3-6. Calculated Unsaturated Zone Soil Moisture Fluxes and Velocities (From Tyler, 1987).

Volumetric Water Content (θ)	Matric. Pot. ψ (bars)	K (θ) (cm/sec)	dh/dz	Flux (cm/sec)	Flux (cm/yr)	Velocity (cm/yr)
0.066	-5	1.3×10^{-11}	0.5	6.5×10^{-12}	2.0×10^{-4}	3×10^{-3}
0.066	-5	1.3×10^{-11}	30	3.9×10^{-10}	1.2×10^{-2}	1.8×10^{-1}
0.046	-35	9×10^{-14}	0.5	4.5×10^{-14}	1.4×10^{-6}	3×10^{-5}
0.046	-35	9×10^{-14}	30	2.7×10^{-12}	8.5×10^{-5}	1.8×10^{-3}

Norris et al., (1985), using Chlorine 36 profiles from Yucca Wash in Area 25, determined that infiltration has proceeded vertically over a thirty year period to a depth no greater than 170 cm. For an average moisture content of 0.10, the calculated flux rate is approximately 5.6×10^{-1} cm/yr with a corresponding flux velocity of 5.6 cm/yr.

Nichols (1985), using a soil physics approach, calculated the average soil water flux below 10 m at a site near Beatty, Nevada (just north of the NTS) to be approximately 3.7×10^{-3} cm/yr. Assuming an average moisture content of 0.10, this corresponds to a flux velocity of 3.7×10^{-2} cm/yr.

Fouty (1989), using the chloride mass balance method, calculated the upper and lower bounds of recharge for a site near Beatty, Nevada. The values determined were 4.0×10^{-2} cm/yr and 6.0×10^{-3} cm/yr, respectively. Again assuming an average moisture content of 0.10, these recharge rates correspond to flux velocities of 4.0×10^{-1} cm/yr and 6.0×10^{-2} cm/yr.

Some of the above reported analyses have been done for situations in which runoff from precipitation is not allowed to pond and generally with the assumption of an average daily rate for the annual precipitation. However, precipitation falls in discrete storms that can cause floods and ponding of water on the soil surface. The ponding can create transient pulses of soil moisture that move downward through the soil profile at velocities greater than these calculated averages. The high velocities result from increases in the soil moisture content and thus the unsaturated hydraulic conductivity. Ponding has the effect of increasing the effective annual precipitation by concentrating it to a smaller area. This precipitation concentration also occurs in the surface runoff process which creates flow in the washes and channels. In the wash and channel environment, highly localized groundwater recharge may occur on NTS. In the interfluvial areas between washes, very little recharge is thought to occur. Preliminary analysis of the data from the Pilot Wells and boreholes indicates that recharge does not occur at all.

At the Area 5 RWMS, the natural topography does not lend itself to ponded water conditions that would be of concern. Also, the relative infrequency of surface water runoff events at the Area 5 RWMS does not provide opportunity for significant recharge to occur in the wash and channel areas. At the existing low-level waste management unit (LLWMU), all runoff from the drainages upgradient of the facility is diverted around the LLWMU and thus even this component of recharge does not occur.

3.5.3 Water Supply

Groundwater beneath, or adjacent to, the Area 5 RWMS has not been developed for water supply. The closest water supply well is Well 4 (approximately 3 km (2 mi) distant). Water is hauled by tanker truck to two 227-m^3 (60,000 gal) tanks at the Area 5 RWMS facility for fire fighting purposes at the LLWMU. That well taps the volcanic aquifer zone. Well 5C, which is approximately 4.2 km (2.5 mi) from the Area 5 RWMS, supplies water to Mercury. This well also produces from the volcanics.

3.6 BIOLOGICAL RESOURCES

The proposed MWDU site is located on a broad alluvial fan between 974 and 992 m (3,195 to 3,255 ft) elevation in northern Frenchman Flat. It lies approximately 33 vertical meters (108 ft) above the basin playa on a gentle (2 percent) slope, which is topographically uniform except for a few minor washes. There are no vertical banks over 1 m (39 in.) high.

Portions of the site are fairly disturbed by unimproved bladed roads, abandoned structures, earth mounds, and vehicle tracks. Recent surface disturbance is the result of staking and flagging activities for a soils study. In these disturbed portions of the site, the vegetation is a combination of native and introduced species. In those portions of the site that are presently undisturbed (Figure 1-5), the natural surface pavement is intact and cryptogamic crust is present.

3.6.1 Vegetation

The vegetation of Frenchman Flat has been described previously by Allred et al., (1963); Beatley (1976); Leitner et al., (1983); O'Farrell et al., (1982); and Romney et al., (1973). It is a mosaic of typical northern Mojave Desert shrub communities.

The vegetation on the proposed MWDU site is composed solely of one northern Mojave Desert shrub community: *Larrea-Ambrosia* (creosote bush-bursage). The shrub layer of this homogeneous community provides approximately 15 percent total cover and is codominated by *Larrea tridentata* and *Ambrosia dumosa*. Several shrub species are common associates, including *Acamptopappus shockleyi* (Shockley goldenhead), *Ceratoides lanata* (winterfat), *Hymenoclea salsola* (cheese-bush), *Krameria parvifolia* (Pima ratany), and *Lycium andersonii* (desert thorn). Two perennial grasses, *Erioneuron pulchellum* (fluffgrass) and *Oryzopsis hymenoides* (Indian ricegrass), codominate the herbaceous layer. A botanical field survey for this EA was conducted in November, 1989 which precluded the observation of annual plant species in the herbaceous layer. However, a survey of annual plants was conducted in April 1987, just 5.6 km (3.5 mi) southwest of the proposed MWDU site in an area at the same elevation and in the same community type as the proposed site (R. Hunter, personal communication). Annual plant densities were estimated at 78 individuals per square meter (m^2) in a year of average rainfall. The proposed MWDU site is expected to have comparable densities of annual plants. It should be noted that annual plant species composition and densities are highly rainfall dependent and vary widely from year to year.

In the areas that have been disturbed by human activities, the vegetation is comprised of a mixture of native plants that do well in disturbed ground and introduced plant species. *Ambrosia dumosa*, *Hymenoclea salsola*, and *Salsola australis* (Russian thistle) codominate these disturbed areas.

3.6.2 Animals

Allred et al., (1963) and O'Farrell and Emery (1976) have reported on the animal species of the NTS. O'Farrell (1983) and Patton et al., (1986) have reported on the animal species of Frenchman Flat. The MWDU site is considered typical animal habitat related to the *Larrea-Ambrosia* vegetation association. Total species composition and density for the proposed MWDU site have not been determined.

All the reptiles listed by O'Farrell (1983) are expected on the proposed site. The side-blotched lizard (*Uta stansburiana*) and the whiptail lizard (*Cnemidophorous tigris*) would probably be the most abundant species.

Birds found in Frenchman Flat have been listed by O'Farrell (1983). All species listed, except those normally associated with water or riparian habitats, might occur at the proposed MWDU site. No features of the proposed site suggest critical habitat for bird species. Turner and McBrayer (1974) reported only two regularly breeding bird species, the black-throated sparrow (*Amphispiza bilineata*) and LeConte's thrasher (*Toxostoma lecontei*), in a *Larrea-Ambrosia* community in Rock Valley, located in NTS Area 25 approximately 40 km (25 mi) southwest of the proposed MWDU site. Both species probably also breed on the site of the proposed MWDU. Small flocks of horned larks (*Eremophila alpestris*) commonly are seen around disturbed areas of the existing LLWMU.

Most of the mammals listed by O'Farrell (1983) for Frenchman Flat might be found on the proposed site. Many small mammal burrows are found at the base of the shrubs; these are mostly attributable to kangaroo rats (*Dipodomys* sp.), pocket mice (*Perognathus* sp.), and ground squirrels (*Amnospermophilus leucrus*). Larger burrow-like excavations evident on the site are probably the work of kit foxes (*Vulpes macrotis*), which are known to regularly breed within the boundaries of the Area 5 RWMS. Badgers (*Taxida taxus*) are likely to have created some of these excavations also. Black-tailed jackrabbits (*Lepus californicus*) are common residents of the site, and coyotes (*Canis latrans*) are frequently seen in the area.

3.6.3 Sensitive and Protected Species

3.6.3.1 Sensitive Plant Species

There are no federally listed nor candidate plant species for threatened or endangered status known to occur on the proposed MWDU site. Additionally, there are no state protected plant species for critically endangered status known to occur on the proposed site.

3.6.3.2 Protected Animal Species

The Area 5 RWMS is located within the range of the desert tortoise on the NTS. The tortoise is a federally listed threatened species. From 1989 through 1992, six biological surveys for desert tortoises have been conducted in conjunction with various projects at the RWMS. No tortoises or their burrows were found during any of the surveys. Although the RWMS is within the range of the tortoise, survey information to date does not indicate that tortoises inhabit the area.

In August 1991, DOE/NV submitted a programmatic biological assessment and request for formal Section 7 consultant to the US. Fish & Wildlife Service (FWS) for NTS activities for 1991-1995. Present and future RWMS activities were included in the biological assessment. DOE/NV received a biological opinion (Opinion) from the FWS in May 1992. The Opinion sets forth the terms and conditions that DOE/NV must comply with to ensure tortoise protection and compliance with the Endangered Species Act. The construction and maintenance of the proposed expansion of the MWDU will be conducted in compliance with the terms and conditions of that Opinion. No impact to the desert tortoise is anticipated.

Results of the biological surveys conducted from 1989-1992 show that no other federally listed threatened, endangered or candidate species or State sensitive species are known to occur in the area.

3.7 CULTURAL RESOURCES

3.7.1 Previous Cultural Resource Surveys in Project Vicinity

In 1982, two geophysical test lines were surveyed northwest of Frenchman Lake. No archaeological sites were found on the bajada, but a small camp site was found at the base of a rock outcrop on the west side of Frenchman Flat (Reno, 1982). DRI conducted reconnaissance of several backhoe trench locations in Frenchman Flat in 1984, but no cultural remains were found. Also in 1982, a proposed device assembly facility in the northwest corner of Frenchman Flat was surveyed. A small number of isolated artifacts and a small opportunistic quarry were found (Henton, 1984).

3.7.2 Cultural Resource Surveys of the Mixed Waste Disposal Unit Site

On November 12-13, 1987, a cultural resources survey was conducted at the proposed MWDU site (Reno and Henton, 1987). The purpose of the survey was to locate any cultural resources predating governmental use of the area. The northwest corner (N771,280 E706,925 Central Zone, Nevada Foot Coordinate System) and northeast corner (N771,280 E709,500) of the project area are marked with permanent concrete monuments with brass caps. The southern boundary of the survey area is marked by the dike at the northern end of the existing LLWMU (N 768,300).

A 30.5 m (100 ft) interval grid system marked with laths is in place over the entire project area. Each line of laths was walked north-south by an archaeologist, resulting in parallel transects 30.5 m (100 ft) apart. No cultural resources pre-dating government use of the area were found. This scarcity of cultural remains is consistent with results of previous cultural resource surveys undertaken within Frenchman Flat (Reno, 1982) and within mid-bajada areas on Yucca Flat (Reno and Pippin, 1985). DOE correspondence with the Nevada State Historic Preservation Officer (SHPO) under Section 106 of the National Historic Preservation Act is provided in Appendix IV.

3.8 SOCIOECONOMICS

To operate the current Area 5 RWMS, Reynolds Electric and Engineering Company (REECo) currently employs approximately 30 persons with a total payroll of approximately $4.5 million per year. The proposed MWDU will require 12 additional employees and will increase the total Area 5 RWMS payroll to approximately $6 million per year. These expenditures flow through the southern Nevada economy and contribute to the overall economic well being of the state of Nevada. While the manpower and expenditures for the operations of the Area 5 RWMS are important, they represent only about 1 percent of the greater than 5,000 NTS employees and greater than $460 million per year NTS operating budget.

4.0 ENVIRONMENTAL CONSEQUENCES

There are both adverse and beneficial effects associated with the proposed action at the Area 5 Radioactive Waste Management Site (RWMS). The RWMS would provide a hydrologically good location for disposal of mixed wastes (MW) because the presence of a thick unsaturated zone beneath the site, combined with the low average precipitation, would result in long travel times for any contaminants that may be released to the groundwater. Additionally, the site is located far from major population centers. The proposed facility would provide for disposal of MW generated on the NTS as a result of environmental restoration activities. The facility may also provide for the disposal of MW currently being generated and stored at Sandia National Laboratory, Albuquerque (SNLA), Rocky Flats Plant (RFP), and other defense facilities where environmental conditions are far less conducive to disposal of these wastes than at the NTS. Implementation of the proposed action would provide an environmentally sound disposal site that would mitigate the environmental and public hazards inherent in the storage or disposal at other generator facility locations. Potential environmental consequences are described in the following sections and summarized in Figure 4-1.

4.1 TOPOGRAPHY AND PHYSIOGRAPHY

The proposed Mixed Waste Disposal Unit (MWDU) would alter the superficial appearance of the natural topography and drainage features of an approximately 0.2 km^2 (51 acres) area within the eastern portion of the Area 5 RWMS. Requiring liners and monitoring wells may increase surficial disturbance by as much as 30 percent. The essentially uniform topography would eventually be transformed by the MWDU to a series of parallel, uniform, low mounds with intervening drainage channels. Drainages now leading into the area would be truncated and diverted around the area by a chevron-shaped ridge and parallel drainage channels.

4.2 CLIMATE AND METEOROLOGY

The proposed action would not cause any change in local climate or meteorology.

4.3 AIR QUALITY IMPACTS

This section addresses potential air quality impacts from proposed construction, operations, and closure of the proposed MWDU. Dust from activities at existing Low-Level Waste Management Unit (LLWMU) facilities at the Area 5 RWMS are included in particulate concentration estimates. A more detailed discussion of analytical assumptions and potential atmospheric releases during accident conditions is provided in Appendix V.

4.3.1 Nature of Surface Disturbances

4.3.1.1 Construction Activities

Expansion of the MWDU would entail the following sequence of construction: (1) stormwater control dike; (2) fence; (3) northeast waste cell; and (4) placement of equipment trailer. Subsequent adjacent cells would be opened one at a time, as needed. During construction, the primary air quality impact would be from particulate matter entrained into the air as a result

Environmental Issues	Concerns	Potential Impact: Significant	Intermediate	Moderate	Minor	None	Explanation
PHYSIOGRAPHY/ TOPOGRAPHY	• Land form alteration				●		• Minor local changes in topography
CLIMATE/ METEOROLOGY	• Climate change					●	• No effect
AIR QUALITY	• Construction dust and emissions				●		• Minor, short-term • Moisten exposed soils • Revegetate
GEOLOGY/SOILS/ MINERAL RESOURCES	• Seismic activity • Soil displacement • Mineral extraction				●		• Severe seismic event could cause waste handling accident
SURFACE WATER	• Flash flood flows • Drainage pattern alterations • Contamination				●		• Design criteria • No perennial or ephemeral water bodies • Collection and treatment of excess water, if necessary
GROUNDWATER	• Regional water table contaminations					●	• Design criteria • Waste acceptance criteria • Low average annual precipitation • Thick unsaturated zone • Closure Plan
PUBLIC EXPOSURE	• Public exposure to radiological materials through: - Surface water contamination - Groundwater contamination - Airborne contaminants - Intruder construction - Intruder agriculture				●		• Remote location • Restricted access • Packaging requirements
BIOLOGICAL RESOURCES	• Threatened and endangered species/habitat					●	• No effect on desert tortoise population
CULTURAL RESOURCES	• Significant historical/archaeological resources					●	• No facilities of historical value • No significant archaeological resources
SOCIOECONOMICS	• Employment levels • NTS budgetary impacts • State of Nevada revenues				●		• Slight increase in employment and payroll • Tonnage fees to the state of Nevada
TRANSPORTATION	• Public/worker exposure - Routine transportation - Accidents				●		• Waste acceptance criteria • Packaging requirements • Transportation routes
WORKER EXPOSURE	• Exposure to radiological/hazardous materials through: - Routine handling - Accidents				●		• Contingency response plans • Formal hazard protection programs • Strict acceptance criteria • Radiation dosimetry • Worker monitoring

Figure 4-1. Potential Environmental Impact Summary

of construction activities and through wind erosion of exposed surface areas. However, water trucks would be used to moisten the soil to reduce airborne particulate during construction. Additional minor impacts would result from heavy equipment exhaust emissions.

4.3.1.2 Operational Activities

Air quality impacts from surface disturbance activities during MWDU operation would be primarily from particulate matter generated by heavy equipment during cell construction, wind erosion of the top surfaces of dikes and piles of fill and cover material in the absence of vegetation. Again, the use of water trucks should help reduce the resuspension of airborne particulate by heavy equipment activity.

4.3.1.3 Closure Activities

After closure and covering of completed cells, surfaces would be planted with indigenous vegetation, thus reducing wind erosion to natural levels. At the end of the lifetime of the MWDU expansion, all remaining exposed surfaces would also be planted with indigenous vegetation. Consequently, air quality impacts during the closure would be minimal and would consist only of wind erosion of exposed surfaces prior to complete reclamation by vegetation.

4.3.2 Assessment of Surface Disturbances

4.3.2.1 Methods

The methods used to assess impacts due to surface disturbing activities are primarily screening methods as described in EPA (1986). Screening methods are intended to provide conservative estimates of ambient concentrations resulting from source emissions of atmospheric contaminants and consist of the application of Gaussian models using conservative assumptions. Resulting concentration estimates thus represent upper limits to concentrations that may occur in real conditions. Source emission rates were estimated using emission factors published in AP-42, "Compilation of Air Pollutant Emission Factors (EPA, 1985)."

4.3.2.2 Results

Table 4-1 gives estimated maximum annual particulate emissions resulting from surface disturbance in the construction and operation phases. Additional assumptions are given as footnotes to Table 4-1.

Table 4-2 summarizes screening results in terms of maximum 24-hour average total suspended particulates (TSP) concentrations resulting from construction and wind erosion of exposed areas. In the worst case, with simultaneous dike erosion, erosion from four exposed cell areas, and one cell under construction, the maximum estimate was 86.7 micrograms per cubic meter ($\mu g/m^3$) for a 24-hour average TSP concentration. In all cases, the maximum concentration occurred less than 250 m from the edge of the Area 5 RWMS boundary.

To estimate maximum particulate matter less than 10 microns in aerodynamic diameter (PM_{10}) concentrations, screening estimates were multiplied by 0.75 as the upper limit for the

Table 4-1. Maximum Annual Fugitive Dust Emissions (T(metric)/Year).

	First Year	Subsequent Years
Construction		
Dike	19 [1]	0
Cells	5.4[2]	5.4[2]
Operation (Wind Erosion)		
Active Cells	16.1[3]	16.1[3]
Dike	17.5[4]	3.5[5]
TOTAL	58	25

[1]Dike construction dust during first year only.
[2]Worst Case: Four cells constructed during any given year. Emissions from construction of one cell equals 1/4 of this value.
[3]Worst Case: Four cells nearly filled and covered, with no revegetation.
[4]Assuming no control from revegetation during first year.
[5]Assuming vegetation and stone facing reduce wind corrosion to natural levels, but with top surface uncovered and exposed.

Table 4-2. Screening Results for Particulate Emissions from Construction and Wind Erosion, Maximum 24-Hour Average Concentrations.

	TSP ($\mu g/m^3$)	[1]PM_{10} ($\mu g/m^3$)	[2]Percent of Standard TSP	PM_{10}
Storm-water Dike Construction				
Construction	21.5	16.1	14.3	10.7
Exposed Surface Emission	10.8	8.1	7.2	5.4
TOTAL	32.3	24.2	21.5	16.1
Cell Construction (one cell)				
Construction	51.3	38.5	34.2	25.7
Exposed Surface Emission	18.7	14.0	12.5	9.3
TOTAL	70.0	52.5	46.7	35.0
Surface Erosion				
Four Exposed Cell Areas Plus Unvegetated Storm-water Dike	40.0	30.0	26.7	20.0
Worst Case, Dike Erosion				
Plus Cell Construction (one cell) Plus Cell Area Erosion (four cells)	86.7	65.0	57.8	43.3

1 PM_{10} concentrations estimated as 75 percent of TSP concentrations.
2 For TSP, 24-hour standard is 150 $\mu g/m^3$. For PM_{10}, anticipated 24-hour standard is also 150 $\mu g/m^3$.

PM_{10} component of TSP. These values are also shown in Table 4-2. The last two columns of Table 4-2 give screening results as a percentage of the 24-hour TSP and anticipated PM_{10} standards, respectively. In the worst case, the maximum estimate for 24-hour average TSP concentrations resulting from surface disturbances was 86.7 μg/m^3, or 57.8 percent of the Nevada standard. Interpolating to PM_{10}, this represents 43.3 percent of the standard.

Screening results shown in Table 4-2 represent only contributions from surface disturbances at the Area 5 RWMS. Actual concentrations would include background concentrations, which in a typical desert environment are 20 to 30 μg/m^3, as an annual geometric mean. Dust from activities at existing low-level waste management facilities at the Area 5 RWMS (Figure 1-5) are included in these estimates. Thus, the particulate concentrations from existing and proposed facilities would not exceed the standards. Estimates in Table 4-2 are very conservative, appropriate to screening techniques using conservative assumptions, and represent bounding limits.

4.3.3 Release of Constituents to the Atmosphere

All MW received for disposal are packaged solids and are not flammable in the solid state. Free liquids, bulk solids, or unpackaged material would not be accepted. Material packaging would conform to the requirements of Section 49 CFR and NVO-325 (DOE, 1992).

All MW disposed would contain hazardous waste materials listed in Title 40 of the U.S. Code of Federal Regulations (CFR) Part 261. The possible mechanisms by which hazardous and/or radioactive substances may be released into the atmosphere include:

- Breaching of containers and release of gas by-products of chemical reactions.
- Breaching of containers and atmospheric entrainment of solid waste as suspended particles (aerosols).

Due to the limited handling and processing activities at the RWMS, the above are the most probable means of accidently releasing MW constituents to the atmosphere. These accidental releases may pose some hazards to workers (see Section 4.6.2) but are not significant with respect to atmospheric releases.

4.4 GEOLOGY, SOILS AND MINERAL RESOURCES

4.4.1 Geology

The proposed action would not affect the local geology, and geologic seismicity is not expected to affect either the operation or integrity of the Area 5 RWMS facilities. There are no known active faults through the site. The existing shallow land disposal cells have repeatedly been subjected to seismic events of up to magnitude 5 related to the nuclear testing program. These events have not caused side wall or waste stack problems. Cells have been designed (side wall slopes and heights) to maintain their stability during such events.

All surface buildings and systems that are essential for the safe handling of low-level waste and mixed waste are designed to withstand any earthquake accelerations that might be expected to occur at the site during the life of the facility. Therefore, earthquake-induced releases of waste materials to the environment are not likely.

4.4.2 Soils

The proposed action would disrupt the existing natural soils surface at the proposed MWDU site, and outside the MWDU site if monitoring wells are installed. Each well may disturb up to an acre of soil, if the road construction, equipment lay-down area, and other work areas are included in the estimate. Since there is no apparent intrinsic value attributable to these soils (e.g., agricultural value), this disruption would not represent an adverse impact.

4.4.3 Minerals

There are no known metallic, industrial or energy minerals on or beneath either the proposed MWDU or at the Area 5 RWMS. Thus, removal of this area from mineral exploration and development into the foreseeable future (next 100 years at minimum) would have no adverse effects on availability of those types of mineral resources.

4.5 HYDROLOGY AND WATER RESOURCES

4.5.1 Surface Water

Since there are no perennial streams, or lakes and ponds that are on or adjacent to the Area 5 RWMS, there can be no adverse effects from the proposed action to surface-water resources. The only plausible interaction of the proposed action with surface water relates to potential flooding of the site as a result of extremely heavy precipitation and consequential flash-flood flows.

Based upon Schmeltzer et al., (1993), the southwest corner of the Area 5 RWMS is within the 100-year flood hazard zone (Figure 3-3). The MWDU is not located within this 100-year flood plain however. Neither the Area 5 RWMS nor the MWDU are within the 100-year flood plains of either the Scarp Canyon or Halfpint alluvial fans or the remaining subbasins.

Without proper flood protection, if a major flood event were to occur which filled and overflowed any open cells, the emplaced waste containers could become saturated. The saturation could lead to production of contaminated water that could subsequently flow off the site and infiltrate to the unsaturated zone.

However, the existing LLWMU is protected from such an occurrence by a flood-water diversion dike that routes all flood waters around the facility toward their natural sink, Frenchman Lake playa. The expanded MWDU also would be protected from upgradient flooding by construction of a similar flood diversion dike and drainage channels to route any flood waters around the site. This system is described in Appendix II. With completion of the MWDU flood protection dike, the existing LLWMU north dike would be removed and the material would be used to close disposal cell P-3. The LLMWU would continue to receive the same (or higher) level of flood protection as it has now. The grading along the 5-01 road to the east of the site also provides a drainage channel for flood flow coming of the western portion of Watershed 3.

Additionally, a drainage network would be constructed within the proposed MWDU to quickly carry on-site precipitation away from the cells and off the site. Surface runoff from precipitation that falls within the flood control dikes would be routed to the natural drainage downgradient of the site and would flow toward the Frenchman Lake playa. Precipitation that actually falls within a disposal cell would either infiltrate into the unsaturated zone or be collected by a sump at the lower end of the cell. Collected runoff would be monitored and released if clean, treated if contaminated. Because any LLW or MW that is spilled due to breached or leaking packaging is immediately cleaned up, precipitation falling within a cell would not be expected to leach any contaminants, and thus would not constitute an adverse effect. Spills of this nature would be rare because of stringent packaging requirements and handling procedures for MW and LLW.

The flood diversion dike and channels have been designed to handle the estimated 140-year return period flood (see Appendix II). This return period is conservative when compared to the operational life of the facility and to most other designs that utilize a 100-year return period. Review of the design parameters for the MWDU flood protection system indicates that significant armored and earthback freeboard has been incorporated above the calculated flood-flow depths impinging on the dike. The dike height would be approximately twice the calculated 140 year return period flood depths. Thus, the MWDU would be adequately protected from the design flood and consequently, there should be no adverse effects to, or from, surface water. However, the existing east- and west-side dikes at the LLWMU do not appear to provide the same degree of conservatism in their construction. These dikes would be evaluated further and appropriate modifications designed and implemented in conjunction with the MWDU expansion.

Erosion by surface-water runoff at the Area 5 RWMS is not expected to compromise the integrity of either the LLWMU or the MWDU during the operational or post-closure periods. The alluvial fans are long-term depositional features estimated to be 2.5 to 7 million years old, which have been aggrading at a net rate of approximately 7 cm per 1,000 years (2.8 inches/1,000 years). Under the recent (late Holocene) climatic conditions, the fan surfaces have been relatively stable. However, erosion can occur in segments of stream channels that course down the fan and concentration of storm runoff can accelerate channel erosion. Potential for such erosion was considered in design of the flood control dikes and channels.

Also, erosion of flood control dikes from direct precipitation under the current climate regime is not expected to compromise the site for an extended time beyond the institutional control period, which is assumed to be 100 years. The northern dike (which is most critical) would be a designed structure of compacted earth and riprap which, together with its conservative height above the 140-year return period, should provide long-term protection even with the unavoidable process of erosion.

4.5.2 Groundwater

The primary consideration with respect to adverse impacts on groundwater is the possibility of leachate being created, moving downward through the unsaturated zone, and eventually reaching the water table. However, the extensive depth of the unsaturated zone beneath the Area 5 RWMS (240 to 270 m) represents a significant natural barrier to that eventuality for both the existing LLWMU and the proposed MWDU. Waste is buried at a maximum depth of 37 m in greater confinement disposal (GCD) boreholes, which provides approximately 200 to 230 m of unsaturated material between the wastes and the regional water table. The most conservative estimates of travel time for fluids from Area 5 to the groundwater is approximately 60,000 years

(Fouty, 1989). A double liner system would be expected to extend the travel time estimate by another 30 to 40 years.

The waste acceptance criteria for MW and LLW specify that there can be no free liquids in any of the waste materials. Thus, in order to have fluids available for migration through the unsaturated zone, the wastes must be compromised by an influx of water to create a leachate. To evaluate this potential, two periods must be considered: (1) that period of time when a landfill cell is open and wastes are being emplaced; and (2) the open-ended time period following cell closure.

The most critical period is the time when the cell would be open and, thus, would collect precipitation or would be flooded. The flood protection system designed for the MWDU should preclude the latter consideration. With respect to direct precipitation, the worst situation would be to have water accumulate under the emplaced waste where it would be protected from evaporation and have an opportunity to saturate waste containers and enhance the potential for creating a leachate. This concentration of precipitation on the disturbed soils could greatly increase the flux and velocity of flow through the unsaturated zone toward the water table. Recognizing this potential, the MWDU cells have been designed to preclude this concentration and to minimize the infiltration of water into the disturbed soils. The bottom of each cell would be sloped away from the emplaced waste to the corner nearest the entry ramp where a sump would be constructed. Precipitation runoff would be collected in the sump and would be pumped to the surface drainage system.

After the cells have undergone closure, leachate could only be produced by infiltration of water through the waste cap. Given the low average annual precipitation (approximately 4 in./yr) and high potential evapotranspiration at the Area 5 RWMS, significant infiltration to the waste stack is not likely to occur. The worst-case situation would be to have water ponded on the cover surface or to have a significant number of animal burrows that would provide an avenue for water to quickly penetrate the surface. The final cap design calls for a sloped surface to quickly move precipitation off the cover. The maintenance program specifies that the surface would be kept free of swales or depressions that might result from consolidation or collapse of waste containers. The potential for significant collapse or consolidation is minimized by the packaging criteria which specify high density loading (minimum void space) and high strength (load capacity of 19,500 kg/m^2). However, it is reasonable to presume that all such consolidation might have occurred during the 100 year institutional control period.

The closure for the MWDU plan also calls for establishing native vegetation on the covers as is currently being done successfully for the LLWMU. Through evapotranspiration, this vegetation would help to remove water that does infiltrate into the cap. On the other hand, roots from surface vegetation are one type of potential intrusion into buried wastes. Roots, or permeable zones around roots, serve as paths for migrating water. Particular plant species used for revegetation may be selected based upon type of root system.

The landfill cell closure system design described in the RCRA Part B Application is intended to meet the waste cover system design of the joint U.S. Nuclear Regulatory Commission (NRC)-EPA Guidance on a Conceptual Design Approach for Commercial Mixed Low-Level Radioactive and Hazardous Waste Disposal Facilities (OSWER Directive 9487.00-3, EPA, 1987). This design, however, has not been tested or evaluated in the NTS environment. If the design does not perform as expected, the worst possible case would be for infiltration of the full annual precipitation into the waste.

Based on the studies of moisture flux rates cited in Section 3.5.2.3 (Unsaturated Zone), and a depth to water table of 240 m, travel times for any leachate to reach the water table are very long. Using the highest flux velocity cited (5.6 cm/yr) (Norris et al., 1985), the calculated travel time to the water table beneath the Area 5 RWMS would be 4,285 years. It should be noted that in their study, Norris et al., (1985) determined this flux velocity beneath a wash, which would therefore represent a worst-case travel time. Using the lowest flux velocity cited (3.0×10^{-5} cm/yr) (Tyler, 1987), the calculated travel time to the water table beneath the Area 5 RWMS would be 800 million years.

The recharge rates and corresponding flux velocities determined by Fouty (1989) probably represent the best estimates, since the method used, chloride mass balance, is a measure of the average rates and velocities over many thousands of years. Based on Fouty's (1989) reported bounding values for recharge, travel times to groundwater beneath the Area 5 RWMS range from 60,000 to 400,000 years.

Preliminary review of the data from the Area 5 Pilot Wells (REECo, 1993a) and the Science Trench boreholes (REECo, 1993b) indicates that the net flux gradient in the upper 100 feet of soil is upward, probably due to the influence of evapotranspiration. This suggests that recharge will not occur from wastes disposed of in the MWDU and the travel time to groundwater is infinitely long.

Wastes buried in GCD boreholes are deeper by approximately 30 m than that buried in disposal cells. However, given the depth to groundwater (236 m), this difference in burial depth is insignificant in terms of estimated travel times. The soil physics basis of flow in the unsaturated zone is discussed in Appendix VI.

A further conservative aspect of the Area 5 RWMS travel time calculations is the assumed vertically homogeneous nature of the alluvium. The alluvium does have a degree of stratification in that there are zones of both higher hydraulic conductivity (sands and gravels) and lower hydraulic conductivity (silts, clays, and calcic horizons). The higher conductivities tend to limit capillary moisture transport, and the lower conductivity zones tend to reduce gravity potential flow. There are thin, discontinuous caliche layers in the near surface that may serve as barriers (very low conductivity) to fluid movement.

Also, because of the large depth to groundwater, the calculated travel times would not be significantly reduced by any credible rise in the water table position. A 5 m rise would only reduce the travel time by approximately 2 percent. A water table rise of that magnitude would require a major climate change, which would invalidate all the assumptions made as to site performance (precipitation, temperature, surface runoff, floods, erosion, evapotranspiration, etc.).

Given the existing hydrologic and climatic setting of the proposed MWDU site and the design of the MWDU, it is highly unlikely that any adverse effects to the groundwater system would occur from the proposed action.

4.6 RADIOLOGICAL IMPACTS

4.6.1 Performance Assessment

As part of DOE Order 5820.2A compliance, an independent radiologic Performance Assessment (PA) was prepared for the Area 5 RWMS (EG&G, 1992). The purpose of the PA was to evaluate whether the facility would comply with appropriate radiologic performance objectives to ensure adequate protection of the public. In that assessment, the stated performance objectives for the Area 5 RWMS (both the LLWMU and the MWDU) are as follows:

1. The annual dose to any member of the public from all DOE-LLW facilities within the Area 5 RWMS site, via all effluent and exposure pathways (except airborne), shall not exceed 25 millirem (mrem) (from DOE Order 5820.2A.)

2. The airborne effluent pathway shall not result in any member of the public receiving, in a year, an effective dose equivalent greater than 10 mrem (from 40 CFR 61.)

3. a. An annual dose of no more than 4 mrem may be received by any person through ingestion of water from a drinking water supply operated by, or for, DOE. (DOE Order 5400.5)

   b. Radioactive materials in liquid effluents released from DOE facilities shall not cause public or private drinking water systems downstream of the facility discharge to result in any member of the public receiving an annual dose exceeding 4 mrem to the whole body or to any organ (from DOE Order 5400.5.)

   c. Groundwater resources shall be protected, consistent with Federal, State, and local water quality requirements (from DOE Order 5820.2A.)

4. Compliance with performance objectives 1 and 2 shall be measured at the NTS site boundary. Compliance with Objective 3 can only be measured at a NTS water supply near the Area 5 RWMS and at a public water supply downgradient of the facility outside the NTS.

5. The committed dose received by any individual who may inadvertently intrude into the facility after the loss of active institutional control (100 years following the end of operations) shall not exceed 100 mrem/yr for continuous exposure or 500 mrem for a single acute exposure (from DOE Order 5820.2A.)

The PA evaluated how well these objectives would be met over three separate assumed time periods:

1. An operational period until year 2011, at which time the Area 5 RWMS is assumed to be closed.

2. A 100-year institution control period (2011 to 2111), during which time it is assumed the site would be maintained and under surveillance monitoring.

3. A post-institutional control period during which time there might be unrestricted public access to the Area 5 RWMS. The period has an indefinite ending point. Groundwater analyses were made at 10,000 years and at the point of maximum impact which occurred after 10,000 years.

Radiological safety and dose rates were estimated using a pathway analysis that evaluated all potential pathways by which exposure might occur. The PA concluded that the surface-water, groundwater and airborne pathways did not represent a significant exposure potential through the post-institutional control period. That conclusion is consistent with the evaluations presented in Section 4.5.1 and 4.5.2 of this EA.

Surface water does not exist at the RWMS; therefore this exposure pathway is negligible. The greatest potential for exposure of potential receptors now and in the future is via airborne transport of resuspended contaminated surface soil particles and groundwater transport of radionuclides leached from buried wastes.

The PA calculated that airborne exposure to the public, represented by an agricultural intruder at 100 m from the RWMS, would be 0.6 mrem/yr. This is well below the 25 mrem/y performance objective.

The PA evaluated the groundwater exposure to an individual consuming 2 L/day of water and estimated the total dose would be approximately 0.054 mrem/y. This is well below the 4 mrem/y performance objective.

Since the surface water and groundwater pathways were not considered significant, the PA focused on airborne pathways and two intruder scenarios. The intruder scenarios considered were (a) intruder construction, where an individual excavates or constructs a building on the site; and (b) intruder agriculture, where an individual occupies a building on-site and ingests food grown in contaminated soil.

Based on the identified pathways and intruder scenarios, the PA calculated human radiation dose rates, as shown in Table 4-3. The calculated doses indicate that the Area 5 RWMS can be expected to perform as designed.

While the bounding intruder scenario used indicates that the maximum dose would be less than the dose criterion, the particular scenarios used are unlikely, at best. In the agricultural instance, a permanent residence is assumed in an area that has no readily available water resource. That assumption must presume a level of technological sophistication capable of getting water to the Area 5 RWMS, either through construction of a deep well or a very long pipeline. Under such a level of technological sophistication, it is difficult to assume that knowledge of the hazards would be lost or that the hazards would be undetectable. Given the nature of the NTS, it is difficult to envision any plausible intruder scenarios other than an attempt to mine the wastes themselves. That scenario, however, presumes a knowledge of the materials and, thus, the ability to safely deal with them. Therefore, the mining scenario is assumed to be an operational exposure and was not evaluated by the PA.

Table 4-3. Calculated Radiation Doses and Comparison With Criteria From the Performance Assessment (EG&G, 1992):

Regulatory Requirement	Limit	RWMS Performance
Protection of the General Public (Air-40 CFR 61)	10 mrem/y	0.6 mrem/y
Protection of the General Public (Air-DOE Order 5820.2a)	25 mrem/y	0.6 mrem/y
Protection of the General Public (Groundwater-DOE Order 5820.2A)	25 mrem/y	0.054 mrem/y at 10,000 years 20 mrem/y peak
Protection of the General Public (Groundwater-40 CFR 193)	4 mrem/y	0.033 mrem/y at 10,000 years 34 mrem/y at 1,000,000 years
Pits and Trenches Inadvertent Intrusion (Chronic-DOE Order 5820.2A)	100 mrem/y	71 mrem/y
Pits and Trenches Inadvertent Intrusion (Acute-DOE Order 5820.2A)	500 mrem	380 mrem
GCD Boreholes Inadvertent Intrusion (Chronic-DOE Order 5820.2A)	100 mrem/y	19 mrem/y
GCD Boreholes Inadvertent Intrusion (Acute-DOE Order 5820.2A)	500 mrem	35 mrem

4.6.2 Occupational Exposures

Occupational exposures at the Area 5 RWMS can include exposures to both radioactive materials and chemically hazardous substances. These potential exposures can occur both in the existing LLWMU and the proposed Waste Examination Complex (WEC) operations and MWDU operations.

The WEC will include two separate buildings; a real-time-radiography (RTR) building and a waste breaching building. The breaching building will be equipped with an air interlock and a controlled air system. All water from the floor drains will be collected in a sealed sump. The RTR building will be used for non-destructive testing by x-ray imaging and will be equipped with door interlocks to prevent the accidental intrusion of personnel into the room while the x-ray machine in on. Also, video cameras as well as operational procedures will be employed in the RTR building. Accidental irradiation of an individual is considered unlikely. The release of radioactive or hazardous material off-site from the WEC during normal operation and anticipated operational occurrences is projected to be negligible. The impact from WEC operations is the subject of a separate EA and is not a part of this EA.

The policy of DOE/NV is to receive, store, and dispose of radioactive wastes generated by DOE defense programs in a manner consistent with DOE Order 5820.2A, "Radioactive Waste Management", as well as applicable federal, State, and local laws. This policy is designed to ensure that present and future radiation exposures are kept as low as reasonably achievable (ALARA) and do not exceed the radiation protection standards established in DOE Order 5480.11 "Requirements for Radiation Protection," NV0-232, Radiation Safety Manual for the Nevada Test Site. This policy also is designed to protect the environment from any chemical hazards in the waste in accordance with RCRA and amendments.

Exposures can and do occur both in the course of normal operations and from minor incidences and significant accidents. As of 1989, there have been no recorded injuries, accidents or illnesses resulting in exposures related to the operation of the Area 5 RWMS (DOE, 1988, v. II). This safety record is due primarily to the established operating procedures, inspections, employee training, and the stringent criteria for waste acceptance and packaging.

The Area 5 RWMS inspection program addresses the inspection requirements for environmental monitoring equipment, fire protection systems, safety and emergency equipment, security devices, and operating or structural equipment that are important to prevent, detect, or respond to human health or environmental hazards.

The inspection frequencies are based on the rate of possible deterioration of the equipment and the probability of a human health or environmental incident, if the deterioration, malfunction, or operator error goes undetected between inspections. Inspections assess regular inventories of materials and ensure sufficient supply; regular testing and maintenance of infrequently used items; areas where materials are handled; and damage or water accumulation related to heavy wind and rain events. Any observed deterioration or malfunction of equipment or structures is remedied on a schedule that ensures that the problem does not lead to an environmental or human health hazard. Where a hazard either is imminent or has already occurred, remedial action is taken immediately.

All Area 5 RWMS personnel involved in managing MW receive mandatory training in the proper procedures for handling those wastes, performing facility operations, and responding to emergency situations. Most personnel hazards are either avoided or substantially mitigated in this way.

The employees at the NTS who work with these wastes are trained and are aware of all potential hazards. The employees are required to observe prescribed safety precautions and to follow procedures. Each employee is issued a hard hat, safety glasses, appropriate gloves, and work uniforms and must wear safety shoes. In addition, safety shields, safety goggles, respirators, protective clothing, and other safety items will be provided to and worn by appropriate personnel responding to emergency incidents. These procedures are explained during the training program, and each employee is required to follow them.

All Area 5 RWMS employees are also issued a radiation dosimetry badge. These dosimeters are analyzed on a monthly basis, or more frequently if the employee is believed to have received significant radiation exposure. The DOE/NV radiation exposure standards are presented in Table 4-4.

In 1982, DOE/NV performed a radiation safety assessment for the Area 5 RWMS (Hunter et al., 1982). The analysis considered both normal LLW management operations and various accident scenarios. The assessment is currently being updated and has been issued in draft status (Trinosky et al., 1989) for review by DOE.

4.6.2.1 Normal Operation Exposures

Using the approach developed by Hunter (1982), the normal operation occupational annual exposure was estimated and is presented in Table 4-5. Comparison of the average individual annual dose estimates in Table 4-5 with the dose standards in Table 4-4, indicate that under normal operations the average committed dose received is below the standard. Operating conditions under the proposed action would not be expected to be significantly different than those experienced in the past. Thus, the proposed action would not be expected to increase the committed dose to an individual beyond these levels. Total annual personnel dose (person-rem/yr) would, however, increase due to the greater number of employees that would be employed at the Area 5 RWMS; however, the estimated annual total population exposure for the workforce is less than that allowed by current standards.

4.6.2.2 Accident Exposures

Accident exposures would result if a box of mixed waste were to burn. Such an accident is highly unlikely to occur (less than one chance in a million), because there is a lack of significant amounts of flammable materials in the disposal facility which could contribute to an on-site fire. However for the purposes of this assessment an on-site fire of one box is considered. One possible way to start a fire would be to ignite spilled diesel fuel from a forklift beneath a waste box. In the scenario analyzed, it is assumed that a combustible/noncombustible waste box of high curie content waste is exposed to a fire and burns for 30 minutes before being extinguished. Due to the lack of combustible material and the limited supply of forklift fuel, it was assumed that the worst case would be a one box fire. Assuming the box contains 12.4 Ci of the radionuclide mix for DWCF-NTS transportation index (TI=4) waste and using the thermal release fractions calculated in Appendix VII, approximately 0.033 Ci are released in this scenario over the 30 minute duration of the fire. Using a dispersion coefficient of 5×10^{-3} sec/m^3 (Slade, 1968) and assuming that a worker is exposed for 60 seconds to the fire plume without a respirator and another 300 seconds with a respirator, the worker would receive an exposure of 5.04 mrem. A member of the public located 4 km from the accident, at the Eastern boundary of NTS, exposed to the plume for 30 minutes would receive an exposure of 1.77 mrem. Operational exposures from hazardous chemicals released in this scenario are less than the transportation accident case presented in Section 4.10.6 because that scenario assumes a fully engulfing fire involving 16 boxes while the on-site scenario assumes that only one box is involved. This is due principally to the lack of a significant fuel source and combustible materials on-site to perpetuate a high temperature, long fire event.

Table 4-4. Radiation Protection Standards for External and Internal Exposures to Individuals in Controlled Areas (NVO-232, Rev. 4, 1988).

Type of Exposure	Exposure Period	Dose Equivalent (Dose or Dose Commitment[a] [rem])
Whole body, head and trunk, gonads, lens of the eye[b], red bone marrow, blood forming organs	Year	5[c]
	Calendar Quarter	3
Unlimited areas of the skin (except hands and forearms), other organs, tissues, and organ systems (except bone)	Year	15
	Calendar Quarter	5
Bone	Year	30
	Calendar Quarter	10
Forearms[d]	Year	30
	Calendar Quarter	10
Hands[d] and feet	Year	75
	Calendar Quarter	25

[a] To meet the above dose commitment standards, operations must be conducted in such a manner that it would be unlikely that an individual would assimilate in a critical organ, by inhalation, ingestion, or absorption, a quantity of a radionuclide or mixture of radionuclides that would commit the individual to an organ dose that exceeds the limits specified in the above table.

[b] A beta exposure below a maximum energy of 700 KeV will not penetrate the lens of the eye; therefore, the applicable limit for these energies would be that for the skin (15 rem/yr).

[c] In special cases, with the approval of the Director, Office of Operational Safety, a worker may exceed 5 rem/yr provided his/her average exposure per year since age 18 will not exceed 5 rem/yr. This does not apply to emergency situations.

[d] All reasonable effort shall be made to keep exposures of forearms and hands to the general limit for the skin.

Table 4-5. Normal Operation - On-site Estimated Annual Dose[1].

RFP to NTS[2]

Normal Waste Operations	Average Dose Rate to Individual (mrem/hr)	Individual Exposure Time (hr/yr)	Exposed[3] Personnel (FTE)	Annual Personnel Dose (person-rem/yr)
MW WASTE HANDLING				
Shipping and Receiving	0.07	622	1.0	0.04
Container Preparation	0.14	622	2.0	0.17
Transfer Waste Containers to SLD Disposal Area 5	0.13	127	1.0	0.02
Transfer Drums (boxes) to SLD Pit 3	0.75	97	1.0	0.07
Inspection and Surveillance	0.14	622	1.0	0.09
General Supervision	0.04	622	1.0	0.02
Site Maintenance and Vehicle Decontamination	0.06	622	2.0	0.07
TOTAL				0.48

DWCF to NTS[4]

Normal Waste Operations	Average Dose Rate to Individual (mrem/hr)	Individual Exposure Time (hr/yr)	Exposed[3] Personnel (FTE)	Annual Personnel Dose (person-rem/yr)
MW WASTE HANDLING				
Shipping and Receiving	1.50	2796	3	12.6
Container Preparation	2.80	2796	6	47.0
Transfer Waste Containers to SLD Disposal Area 5	2.60	570	2	3.0
Transfer Drums (boxes) to SLD Pit 3	15.00	437	2	13.2
Inspection and Surveillance	2.80	2796	2	15.7
General Supervision	0.80	2796	2	4.5
Site Maintenance and Vehicle Decontamination	1.30	2796	6	21.8
TOTAL				117.8

Table 4-5. Normal Operation - On-site Estimated Annual Dose[1] (Continued).

DWCF to NTS[5]

Normal Waste Operations	Average Dose Rate to Individual (mrem/hr)	Individual Exposure Time (hr/yr)	Exposed[3] Personnel (FTE)	Annual Personnel Dose (person-rem/yr)
MW WASTE HANDLING				
Shipping and Receiving	6.0	31	1	0.19
Container Preparation	11.2	31	2	0.69
Transfer Waste Containers to SLD Disposal Area 5	10.4	6	1	0.06
Transfer Drums (boxes) to SLD Pit 3	60.0	5	1	0.30
Inspection and Surveillance	11.2	31	1	0.35
General Supervision	3.0	31	1	0.09
Site Maintenance and Vehicle Decontamination	5.2	31	2	0.32
TOTAL				2.00

(1) Total Person-hours: 59,944/1800 Person-hours per year = 33 total workers
Total Estimated Population Dose: 120.3 person-rems
Allowable Population Dose: 165 person-rems (33 workers X 5 rem per year)

(2) 205 MW Shipments, Includes NTS on site shipments

(3) FTE = Full Time Equivalents. For purposes of this analysis, it is estimated that 33 FTEs would be required. The individual tasks would be performed by numerous workers, ensuring that worker exposure is within allowable units set by DOE. This would be accomplished by administrative controls.

(4) 913 MW Shipments

(5) 10 MW Shipments

4.7 BIOLOGICAL RESOURCES

4.7.1 Vegetation

The Mojavean Larrea-Ambrosia plant community is the most extensive community in Frenchman Flat, where it encompasses 11,980 hectares (ha) (29,485 acres). Approximately 37 ha (92 acres) of desert shrubland has already been disturbed within Area 5 RWMS for LLW disposal and an additional 20 ha (49 acres) will be disturbed under the proposed action. As a result, 57 ha (141 acres) of this vegetation type, or 0.5 percent of its total acreage in the basin, would be removed. Initially, disturbed areas would be allowed to revegetate naturally. However, Phase II closure calls for revegetation with native plants, which should help re-establish the natural community faster than if the cell caps were left bare. No threatened and endangered species or their habitat would be impacted by the proposed action.

Research associated with the establishment of vegetation or seedlings on disturbed areas created by waste management activities has been carried out since the establishment of the RWMS. The Laboratory of Biomedical and Environmental Sciences of the University of California, Los Angeles has conducted research both for waste management and for other NTS work during this period. The findings were that seedling specimens have a 90-95% success ratio when the specimens were transplanted during the period of March through May, so that they can take advantage of the recharge soil moisture from fall and winter season precipitation (Hunter et.al, 1990). No supplemental irrigation was necessary to assure survival of these shrubs.

4.7.2 Animals

Approximately 37 ha (92 acres) of habitat has been lost from the existing LLWMU, and an additional 20 ha (49 acres) would be disturbed by the proposed MWDU. The endemic invertebrate and vertebrate animal populations would be lost with the destruction of habitat. The habitat that exists after the project is completed will determine the animal diversity and numbers. For example, horned larks would probably increase as this species prefers disturbed, sparse, weedy ground; and the elevated landfill cell caps would provide protection from the wind. Small mammal populations would probably decline initially since the subsurface soil used for the cell caps would contain few seed reserves. The elevated cell caps also might attract burrowing owls, kit foxes, or desert tortoises for burrow or den establishment; the 3 m (10 ft) depth to the waste should minimize chances of burrowing into the waste itself.

The loss of habitat on the Area 5 RWMS site represents only a very small percentage (approximately 0.5 percent) of similar Mojave Desert habitat in Frenchman Flat. Any loss of animal populations would be by habitat destruction, though many individual small burrowing animals would probably be killed directly by being trapped inside their burrows during construction activities. Radiation levels would not be expected to affect any animals either during the open or completed cell phase of the proposed action.

4.8 HISTORICAL AND CULTURAL RESOURCES

Based on the results of previous surveys within the Area 5 RWMS, it is unlikely that current or past activities have impacted cultural resources. Survey of the proposed MWDU area failed to disclose any cultural resources. Thus, the proposed action is not expected to have any adverse impacts to these resources. To ensure that currently unknown archaeological resources that may be present subsurface are not adversely impacted, construction crews will be instructed to stop all activities in the immediate vicinity and notify DOE/NV if cultural resources or artifacts are encountered during construction. The State Historic Preservation Officer (SHPO) would be consulted immediately so that the significance of the discovery could be evaluated.

4.9 SOCIOECONOMICS

The proposed MWDU operations would result in a small incremental increase in NTS employment and would increase total NTS annual budgetary expenditures by approximately $1.5 million (.25 percent). The most significant economic aspects of the project are associated with the State of Nevada imposed RCRA Application Permitting Fee of $50,000 and the disposal fee of $20 per ton of waste. The disposal fee must be paid to the State of Nevada by waste generators for disposal of wastes and could amount to an estimated $300,000 per year increase in revenues for the state.

4.10 TRANSPORTATION

Transportation effects of NTS-generated MW are not included in this section, but are presented in Section 4.6.2, "Occupational Exposures," since NTS MW is not moved over any public highways or offsite. Assuming that all unidentified MW would be transported to the NTS from off-site generators results in a conservative analysis and provides a "bounding scenario" for evaluation of transportation impacts. Potential environmental effects associated with the transportation of MW from off-site generators (RFP, SNLA, other DOE defense sites, and federal classified activities) is evaluated for both incident free and accident conditions.

Analysis of MW transportation environmental consequences for the generators is based on the transportation analysis methodology previously used in other documents. This methodology has been used in the Waste Isolation Pilot Plant (WIPP) Final Environmental Impact Statement (FEIS) and the WIPP Supplemental Environmental Impact Statement (SEIS), the Interim Transuranic (TRU) Storage Environmental Assessment, and the Fort St. Vrain Transportation Risk Analysis. For assumptions and detailed methodologies used to estimate the environmental consequences of transportation, the reader is referred to Appendices III and VII, respectively.

The basics of this analysis, as shown in Figure 4-2, are (1) the establishment of highway routes from generator sites to the NTS; (2) the identification of MW source terms and volumes (shipments); (3) the calculation of radiological exposures from incident-free transportation; (4) the calculation of radiological exposures from transportation accidents; (5) the estimation of hazardous chemical exposures from transportation accidents; and (6) the estimation of the consequences of traffic accidents and vehicle emission associated with the transportation of MW to NTS.

4.10.1 Transportation Routes

Transportation of the MW is not subject to Highway Route Controlled Quantity regulations. Highway Route Controlled Quantities are defined at 49 CFR 173.403(l)(1). The MW to be transported would qualify as "low specific activity material" under 49 CFR 173.403(n). The activity limits are presented in 49 CFR 173.433 and 49 CFR 173.435. It was assumed for

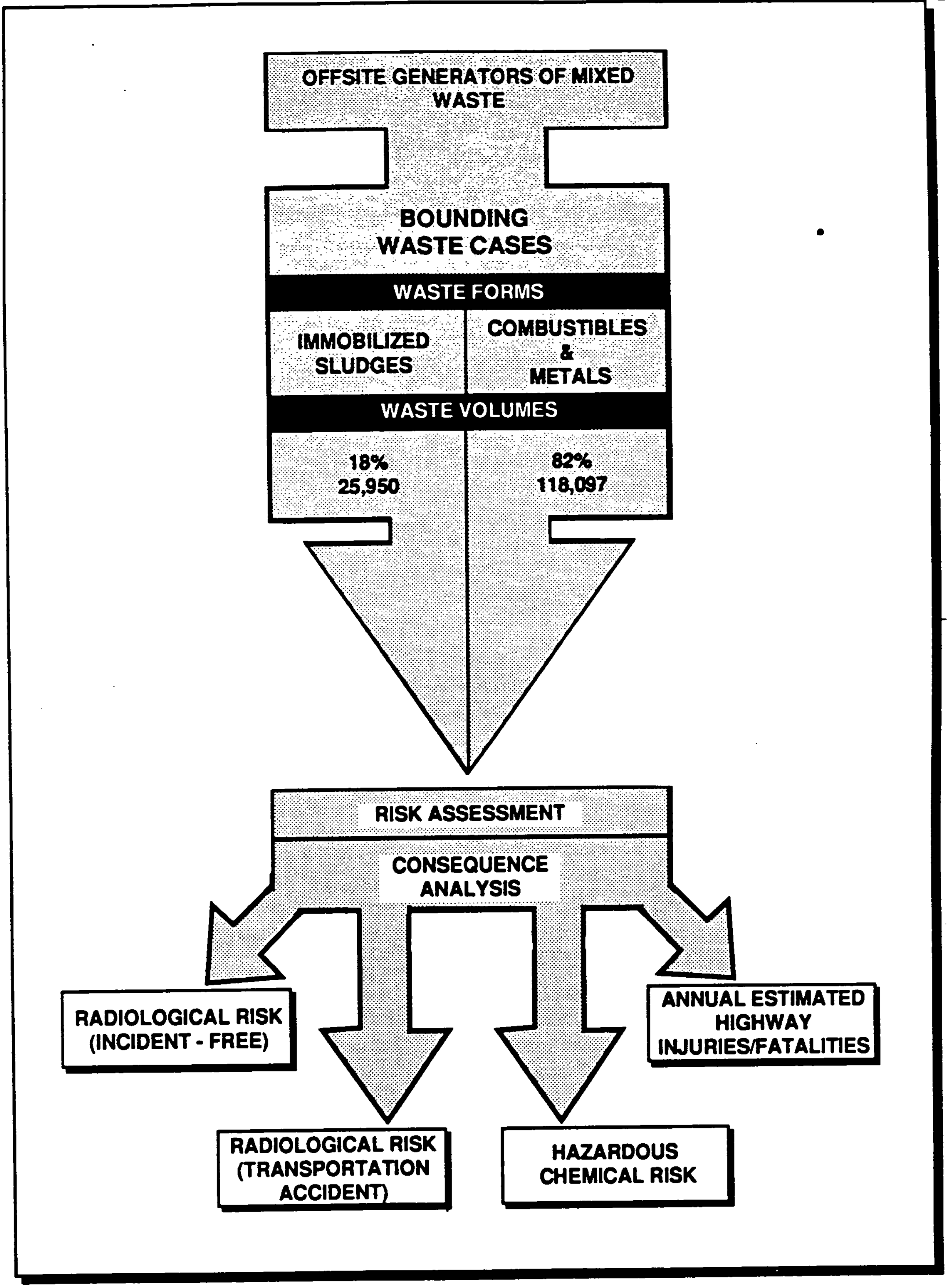


Figure 4-2. Transportation Risk Analysis Methodology

analysis purposes that all volumes of MW would be transported to the NTS from off-site generators and that these shipments would move over the shortest interstate route between the origin and destination points.

MW to be disposed at Area 5 RWMS could be generated from various federal classified activities and DOE facilities. Each of the facilities has previously shipped waste to NTS for disposal. RFP is presently identified as the single largest off-site generator of MW.

A portion of the classified MW will originate at DWCF located near Barnwell, South Carolina. Because of the distance from DWCF to NTS, the shipping route from Barnwell was selected to represent non-RFP MW to provide bounding transportation environmental consequences.

Figure 4-3 illustrates the generalized interstate highway routes from RFP to NTS and the DWCF to NTS. These routes were identified using the INTERSTAT model developed by Sandia National Laboratory. INTERSTAT estimates distances traveled within urban zones (avg. 10,000 person per sq. mi.), suburban zones (avg. 1,861 persons per sq. mi), and rural zones (avg. 15 persons per sq. mi.). Table 4-6 shows total distance traveled and percent of travel in each of these three population zones for MW shipments from RFP and the DWCF.

4.10.2 MW Source Terms and Volumes

The evaluation of generator site MW disposal applications submitted to NTS identified 33 separate waste streams. For the purpose of this EA, these individual waste streams were grouped into two waste forms: (1) Immobilized Sludges and (2) Combustible Waste and Contaminated Metals Mixture. A detailed description of the rationale for the source terms and assumptions and transportation risk assessment assumptions and methodology is presented in Appendices III and VII, respectively.

These two waste forms were evaluated to determine reasonable bounds on the transportation impacts. Waste forms are expected to be predominately construction debris and soils with lesser quantities of solidified fluids and lead contaminated wastes. The waste forms will undoubtedly change with the progression of environmental restoration activities over time. All wastes will be required to meet NVO-325 and the RCRA permit requirements.

Immobilized Sludges - The majority of the MW generated at RFP is pondcrete and saltcrete. These MW are comprised of residues from evaporated waste waters mixed with Portland cement. Other MW streams similar to this waste form include small amounts of sludge from process systems. These MW streams are contaminated with a variety of hazardous constituents in addition to radiological contaminants. Table 4-7 shows the radiological characteristics for this waste form which was compiled from waste stream characteristic data sheets supplied to DOE/NV by generator sites. Hazardous constituents are addressed in Section 4.10.6.

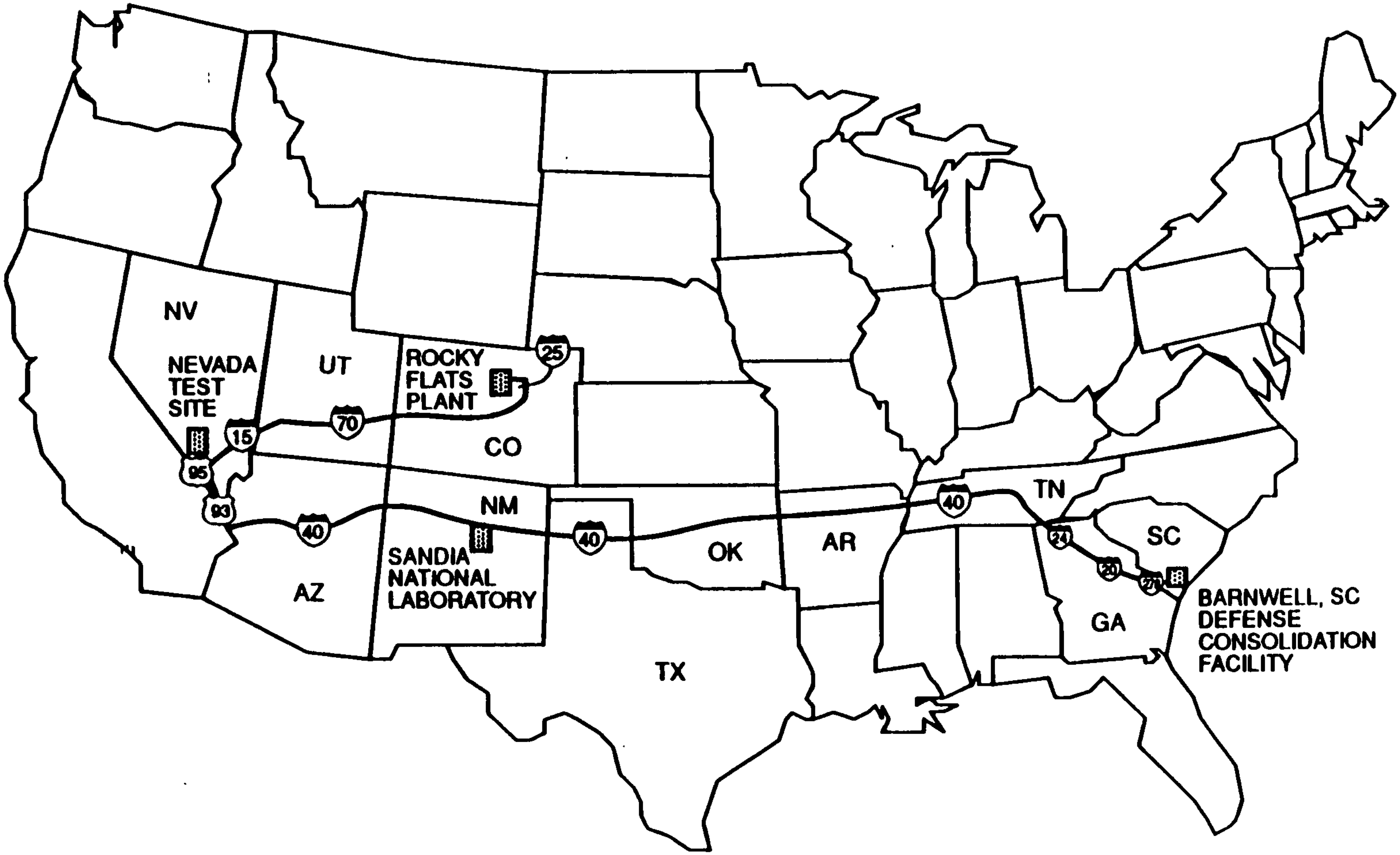


Figure 4-3. Bounding Mixed Waste Transportation Routes to Nevada Test Site, Area 5 Radioactive Waste Management Site

Table 4-6. Route Distance and Assumed Population Zone Densities.

Generator Site	Population Zone Designation	Total Distance (mi.)	Percent of Travel
DWCF, Barnwell, SC	Rural	1,934	78.9
	Suburban	488	19.9
	Urban	29	1.2
TOTAL		2,451	100.0
RFP, Boulder, CO	Rural	757	86.7
	Suburban	108	12.4
	Urban	8	0.9
TOTAL		873	100.0

Table 4-7. Radiological Source Term - Immobilized Waste. (TI-0.05)

Radionuclide	Ci/box	Ci/Shipment
Am-241	8.13×10^{-3}	1.30×10^{-1}
Pu-239	2.00×10^{-3}	3.20×10^{-2}
U-238	1.00×10^{-1}	1.60×10^{0}

Combustible Waste and Contaminated Metals - Several classified and unclassified wastes from SNLA and federal classified activities have been combined to create this waste form. Specific waste streams include weapons components, irradiated equipment, contaminated metals, depleted uranium and combustible waste (i.e., paper, Kimwipes, solvent-containing rags, cloth towels, gloves and gauze).

This waste form was selected for analysis purposes as representative of all non-RFP MW. It is assumed to contain a 50:50 ratio between combustible materials and metal waste. The combustible material is important in the compilation of a bounding waste form because of its contribution to thermal release fractions under accident conditions. The contaminated metals contribute to impact and thermal releases of both radionuclides and hazardous metals.

Table 4-8 presents the radiological source term assumed for the MW combustible/ noncombustible waste form. Where possible, generator supplied waste stream characterization data sheets were used to provide concentrations for these radionuclides. In some cases, radionuclides were identified with no concentration information. In order to assign activity levels to these radionuclides, 49 CFR Part 173.431 (activity limits for Type A packages) was used as guidance. The vast majority of the federal classified MW will be in the form of depleted uranium. The source term assigned to these wastes, however, includes concentrations of actinides and mixed fission products and is considered to bound wastes shipped from the DWCF and other DOE facilities.

Table 4-8. Radiological Source Term - Combustible Waste and Contaminated Metal.

Radionuclide	Ci/box (TI=1.0)	Ci/Shipment (TI=1.0)	Ci/box (TI=4.0)	Ci/Shipment (TI=4.0)
Am-241	8.13×10^{-3}	1.30×10^{-1}	8.13×10^{-3}	1.30×10^{-1}
Co-57	2.00×10^{-3}	3.20×10^{-2}	6.69×10^{-1}	1.07×10^{1}
Co-60	2.00×10^{-3}	3.20×10^{-2}	6.69×10^{-1}	1.07×10^{1}
Cs-137	2.00×10^{-3}	3.20×10^{-2}	6.69×10^{-1}	1.07×10^{1}
H-3	1.00×10^{-1}	1.60×10^{2}	1.00×10^{1}	1.60×10^{2}
Mn-54	2.00×10^{-3}	3.20×10^{-2}	6.69×10^{-2}	1.07×10^{0}
Pu-239	2.00×10^{-3}	3.20×10^{-2}	2.00×10^{-3}	3.20×10^{-2}
U-238	1.00×10^{-1}	1.60×10^{0}	1.00×10^{-1}	1.60×10^{0}
Zn-65	7.00×10^{-4}	1.12×10^{-2}	2.33×10^{-1}	3.73×10^{0}

Volumes - The proposed action establishes a volume cap of MW for the five-year period at 120,000 cubic meters (m^3). Existing MW inventories and projected generation rates of MW through fiscal year (FY) 1995 were compiled from applications to dispose of MW from RFP, NTS, SNLA, and federal classified activities. Table 4-9 shows the distribution of these waste volumes. A detailed discussion of these waste volumes is presented in Appendix III.

The difference between the established MW volume cap of 120,000 m^3 and the identified MW to be disposed of at NTS through FY 1996 (58,558 m^3), yields a contingency waste volume of 61,442 m^3. This contingency waste volume represents disposal capacity for future planned activities such as environmental restoration work at NTS, as well as for additional MW from federal classified activities, and DOE defense sites with a history of LLW shipments to NTS. This EA assesses the transportation risk of this contingency waste volume by disregarding any wastes generated and transported entirely within the NTS and assuming the longest transportation route (DWCF to NTS) as a bounding source term. Additionally, the transportation analysis was performed for a total waste volume of 150,000 m^3, a 25 percent increase over the proposed action. This establishes a conservative assessment of transportation risks for the contingency waste volume, regardless of the point of origin and specific waste characteristics, provided that the MW shipments meet the NTS Waste Acceptance Criteria (NVO-325).

For the purpose of this transportation analysis, it was assumed that all MW would be packaged in Type A 2 ft. x 4 ft. x 7 ft. (half) waste boxes. Each box would contain 1.6 m^3 (56 ft^3) of waste weighing 1,590 kg (3,500 lbs). An average shipment would consist of 16 half waste boxes and would contain 25.6 m^3 (896 ft^3) of waste.

Table 4-9. Mixed Waste Volumes per Generator Site (m^3).

	RFP	NTS	SNLA	Classified	DOD	Contingency[1]	Total
Existing Inventories	12,070	5,664	14	7,138	51	-	24,937
Newly Generated	13,880	289	161	19,047	244	-	33,621
Future	-	-	-	-	-	91,442	91,442
TOTAL	25,950	5,953	175	26,185	295	91,442	150,000

[1] Disposal capacity for yet unidentified DOE, federal classified and other MW.

The average shipment volume of 25.6 m^3 results in approximated 5618 shipments of MW to NTS for the total waste volume of 150,000 m^3 used to estimate the upper bound of the transportation impact.

4.10.3 Incident-free Radiological Risk

The total population along the route is a sum of the products of the population density for rural, suburban, and urban zones, the length of the transportation route, and the fraction of travel through each of these zones. The population at risk to external exposures for routine shipments is assumed to be that which resides within about 3.0 miles on either side of the transportation route. These and other input parameters for the RADTRAN model are summarized in Appendix VII. The population exposures for incident-free transportation for the proposed action are presented in Appendix VII Table AVII-10. As shown in the table, the annual occupational and non-occupational exposures for RFP MW shipments to NTS are 0.719 person-rems and 0.408 person-rems, respectively. The estimated exposures from transporting MW with a Transportation Index (TI) of 1.00 from the DWCF to NTS are 201 person-rems and 104 person-rems for occupational and non-occupational populations, respectively. The estimated exposures from transporting DWCF waste with a TI of 4.00 are 8.80 and 4.56 person-rems for occupational and nonoccupational populations, respectively.

4.10.4 Transportation Accident Radiological Risk

This EA includes estimates of the impacts of MW waste transportation accidents on the public using the RADTRAN IV computer code. Population at risk is modeled as the population in about a 1,000 km^2 area downwind from the accident. RADTRAN estimates cumulative, probability-weighted exposures to the population along the routes from generator to the Area 5 disposal facility at NTS. As discussed in Appendix VII, RADTRAN does not incorporate specific accident scenarios. Instead, potential accidents are divided into eight severity classes, each of which has an associated probability of occurrence and release fraction. Release fractions are different for accidents involving damage due to fire versus impact. It is assumed that two percent of potential accidents result in fire (Appendix VII). The probability of a given exposure to the population along the route is the product of accident frequency per mile, probability of occurrence of a given severity class accident, and the probability that the event will result in an impact or a fire. These probabilities, when combined with estimates of the radiologic consequences of each accident, are summed over all severity classes to estimate the total transportation risk.

Appendix VII Table AVII-11 presents an estimation of the annual exposure in the event of a highly unlikely transportation accident. The estimated exposure would range from 202 person rems to 1.80 person rems for DWCF to NTS case (TI=1) and RFP to NTS case (TI=0.05), respectively.

4.10.5 Transportation Accidents and Pollution

Transporting the waste to NTS could involve traffic accidents that would not be associated with the MW cargo. The accidents would be typical of any cargo transportation. Department of Transportation accident statistics for 1988 (DOT, 1988) indicate that truck accidents occur every 1.6×10^6 miles travelled. Extrapolation of the data for travel in various populations results in an estimate for all MW shipments that 2.9 injuries and 0.22 fatalities could occur on an annual basis. Table 4-10 presents DOE and carrier statistics which show a much better safety record than that compiled nationally for DOT. These consequences are summarized in Appendix VII, Table AVII-13.

Table 4-10. Comparison of Radioactive Material Shipments by Truck.

	Total Mileage (millions)	No. of Shipments	Accidents/[a] Incidents	Injuries	Fatalities
MWDU[(b)]	15	5,630	NR[(e)]	15	1
Chem-Nuclear[(c)]	26	NR	2	0	0
Spectra Research[(d)]	NR	2,000,000	828	NR	NR
DOE/Albuquerque	30.8	NR	3	0	0[(f)]

(a) No releases were reported.
(b) As estimated in Section 4.10 of this EA.
(c) As reported by Chem-Nuclear; reporting period 1987-1988.
(d) As reported by Spectra Research for Sandia National Laboratories. Includes all DOE radioactive waste shipments for the period 1971-1988.
(e) NR = Not Reported
(f) Fatalities have occurred but were not associated with transportation.

It is estimated that pollution generated from truck traffic in urban zones would contribute 4.5×10^{-3} Latent Cancer Fatalities (LCFs) each year for MW shipments from DWCF-NTS and 2.7×10^{-4} LCFs annually for RFP to NTS shipments.

4.10.6 Hazardous Chemical Risk

No adverse human health effects are expected to result from exposure to the hazardous chemical constituents of MW waste released during a transportation accident in which all shipment containers are breached. The two primary reasons for the lack of adverse impacts are the low initial concentrations of chemicals within the waste containers and the physical form of the waste, which limits the concentrations available for release. Estimated air concentrations of volatile organic chemicals would be below the occupational exposure levels listed by the American Conference of Government and Industrial Hygienists. Cadmium exposures may exceed the permissible exposure limits in the National nstitute of Occupational Safety and Health Guide for continuous workplace exposure, but any exposure esulting from a transportation accident would occur outdoors and last only a short time, as opposed to continuous workplace exposure. Additionally, such an exposure is highly unlikely because the EA stimates for metallic species are conservative, overstating potential exposure by at least ten times (see ection 5.0 in Appendix VII).

.11 CUMULATIVE IMPACTS

Cumulative impacts from the proposed action must be considered in context with ongoing perations at the RWMS and past use of locations near the site of the proposed action.

Radioactive waste disposal is an ongoing operation at the RWMS. The additional amount of roposed MW is small in comparison to the total volume of radioactive waste presently disposed. The ncremental increase is minor and would not appreciably contribute to overall RWMS environmental onsequences. For example, through 1988, more than 9 million curies had been disposed at the NTS LW disposal facility. The volume of waste analyzed for the proposed action would add slightly over 50,000 curies to the waste disposed, or approximately an 8% increase in curie inventory.

NTS Area 5 has also been used for both surface and subsurface testing of nuclear weapons. Six nderground nuclear explosions have occurred within a 5 km (3 mi) radius of the RWMS, and the renchman Lake playa, located approximately 10 km (6 mi) from RWMS, was the site of several early tmospheric tests. The playa area is currently used to conduct spill tests of hazardous substances.

Construction activities associated with the proposed action are small when compared to overall NTS activities. Additionally, construction activities would be confined to a very small area. Dust ontrol will mitigate the most visible impact.

Personnel operating the RWMS would potentially receive a small increase in exposure to adiation. This potential increased risk when added to the present risk would not approach the exposure imits in effect at NTS. It should be noted that to date there have been no recorded exposures to ersonnel from any waste operation activities at NTS.

For MW transportation, no significant releases from accidents have been identified. The stimated radiation that would be received by a member of the public, driver, or worker is less than from atural background radiation. The number of estimated injuries or fatalities associated with transport re also minimal. Table 4-10 summarizes data on radioactive material shipments. The data was ompiled from actual shipping records. The records were supplied by private sector radioactive waste ransporters and the Department of Energy/Albuquerque Operations. As shown, the industry and DOE ave compiled an excellent safety record.

The proposed action would increase the number of shipments arriving at NTS by approximately 5 trucks per working day. This represents less than a 20% increase in truck traffic entering and leaving he NTS. During peak period of shipping activity, there may be minor delays at the receiving and nspection points at NTS. These are not expected to be significant and additional personnel would be ssigned as necessary to expedite the process. In addition, NVO-325 requires all shippers to notify NTS raffic control prior to shipping and if necessary, shipments can be delayed to alleviate any peak work oads.

Individuals would potentially receive small exposures from normal transportation. For example, it is estimated that a member of the public exposed to all of the shipments during the five year campaign would receive an exposure of 1.02×10^{-4} rems. During the same five year period, the same individual would receive approximately 1.1 rems from natural background radiation.

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6.0 PERSONS, GROUPS, AND AGENCIES CONSULTED

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Preservation & Archaeology
Capitol Complex
Carson City, NV 89710

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APPENDIX I

LOW-LEVEL WASTE AND MIXED WASTE REGULATORY REQUIREMENTS

APPENDIX I

LOW-LEVEL WASTE AND MIXED WASTE REGULATORY REQUIREMENTS

Radioactive materials, and chemically or biologically hazardous/toxic materials are subject to a broad range of federal environmental laws and regulations. Specific actions may also be subject to state and local laws and regulations.

Radioactive wastes when combined with chemically hazardous wastes are referred to as "mixed waste" (MW). Public laws potentially relevant to the disposal of MW at the Nevada Test Site (NTS) include the Atomic Energy Act (AEA); Clean Air Act; Safe Drinking Water Act; Resource Conservation and Recovery Act (RCRA); Endangered Species Act; and National Historic Preservation Act. The Federal Facilities Compliance Act of 1992 (P.L. 102-386) imposes requirements for inventorying and planning for treatment of mixed waste and providing public reports on these actions.

Regulations promulgated by the cognizant agencies to implement these various acts are designed to prevent or minimize adverse public health or environmental effects associated with waste management activities such as handling, storage and disposal of MW. The primary U.S. Department of Energy (DOE) standards for the protection of members of the public are contained in DOE Order 5400.5. This order includes standards derived from the EPA in Title 40 of the U.S. Code of Federal Regulations (CFR) Part 61, "National Emission Standards for Radionuclide Emissions from Department of Energy (DOE) Facilities", 40 CFR Part 141, "National Interim Primary Drinking Water Regulations (Safe Drinking Water Act)", and in 40 CFR Part 191, "Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Wastes". The State of Nevada regulations (NAC 444.842 through 444.9335) are designed to protect public health and the environment from potential effects associated with hazardous wastes.

DOE Order 5820.2A, "Radioactive Waste Management", contains policies and guidelines applicable to the management of DOE low-level waste (LLW). This Order contains general policy statements regarding protection of the public health and safety, as well as specific performance objectives for DOE LLW operations. The Order also requires a site-specific performance assessment to demonstrate compliance with the objectives.

Standards for the operation of hazardous waste treatment, storage and disposal facilities pursuant to a permit or interim status are contained in 40 CFR Parts 264 and 265 (Resource Conservation and Recovery Act). Historically, there has been uncertainty over the applicability of RCRA to DOE mixed waste. This uncertainty was ended on May 1, 1987, when DOE published a rulemaking (10 CFR Part 962) that subjects defense MW to joint RCRA and AEA regulation.

In addition to the various laws, rules and regulations related to storage and disposal of defense wastes and MW, there are laws, rules and regulations governing the transportation of such wastes. There are two aspects of transportation regulations: 1) selection of routes, driver and equipment criteria, and actual transport; and 2) packaging of materials for transport. Packaging criteria also affect disposal operations and management and thus packaging is regulated from that perspective as well.

Regulations and implementing documents pertinent to transportation issues include:

- Title 49 CFR Parts 171-178, DOT hazardous materials regulations.
- Title 40 CFR Parts 260-268, EPA hazardous waste management regulations.
- Title 10 CFR Part 71, "Packaging of Radioactive Material for Transport."
- DOE Order 1540.1, "Materials Transportation and Traffic Management."
- DOE Order 1540.2, "Hazardous Material Packaging for Transport - Administrative Procedures."
- DOE Order 5480.11, "Radiation Protection for Occupational Workers."
- DOE Order 5480.3, "Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes."
- DOE Order 5820.2A, "Radioactive Waste Management."
- NVO-325, "Nevada Test Site Defense Waste Acceptance Criteria, Certification and Transfer Requirements."

Shipments of defense LLW and MW must comply with the rules, regulations and orders promulgated by the DOE, the Nuclear Regulatory Commission (NRC), the Interstate Commerce Commission (ICC), and the DOT. The major responsibilities and regulations, by governing entity, are summarized below.

- DOE. The DOE governs the protection of the public health and safety during transport of radioactive materials by requiring compliance with applicable DOT and NRC regulations. In particular, the following DOE Orders and regulations assure such compliance:

    DOE Order 1540.1. This Order governs materials transportation and traffic management and defers to the DOT and NRC regulations; the Interstate Commerce Act (49 U.S.C.); and the Hazardous Materials Transportation Act (49 U.S.C. 1801 et. seq.).

    DOE Order 5820.2. This Order establishes policies, guidelines, and minimum requirements by which the DOE manages its radioactive and mixed waste and contaminated facilities, including the transportation of waste; shipment of low-level waste defers to Order 1540.1.

    DOE Order 5481.1B. This Order establishes a system for preparation of documentation and review of safety hazards, and their elimination or control.

    DOE Order 6430.1A. This Order establishes general design criteria for DOE facilities. It defers to standards that are considered good engineering practices such as those from the American National Standards Institute and the National Fire Protection Association.

NVO-325. This documents establishes criteria for waste acceptance at NTS, including waste characteristics, waste packaging and arrangements for shipping.

- NRC. For the transport of nuclear materials, the NRC regulations apply primarily to shippers and, in particular, to the packaging of materials. 10 CFR Part 71 (Packaging and Transportation of Radioactive Material) sets packaging standards for radioactive materials and defers to DOT regulations at 49 CFR Part 177 for regulating the transport of these materials on public highways.

- ICC. The Interstate Commerce Commission has jurisdiction over the economic (cost) aspects of shipping radioactive material, such as regulating carrier rates. ICC regulations do not consider environment, health, and safety issues.

- DOT. The DOT has the primary responsibility for regulating the transportation of radioactive materials. The DOT responsibilities related to truck transportation of defense LLW and MW are defined primarily in 49 CFR Parts 171 and 177, which are summarized as follows:

  49 CFR 171.8 defines a "state-designated route" as a preferred route selected in accordance with the DOT "Guidelines for Selecting Preferred Highway Routes for Highway Route Controlled Quantities of Radioactive Materials" or an equivalent routing analysis which adequately considers overall risk to the public. Designation must have been preceded by substantive consultation with affected local jurisdictions and with any other affected States to ensure consideration of impacts and continuity of designated routes.

  "State routing agency" means an entity (including a common agency of more than one State such as one established by Interstate compact) which is authorized to use a State legal process pursuant to 49 CFR Part 177.825 to impose routing requirements, enforceable by State agencies, on carriers of radioactive materials without regard to intrastate jurisdictional boundaries. This term also includes Indian tribal authorities which have policy power to regulate and enforce highway routing requirement within their lands.

  49 CFR Part 177.825 provides: "Routing and training requirements for radioactive materials", which is excerpted as follows:

  "(a) The carrier shall ensure that any motor vehicle which contains a radioactive material for which placarding is required is operated on routes that minimize radiological risk. The carrier shall consider available information on accident rates, transit time, population density and activities, time of day, and day of week during which transportation will occur. In performance of this requirement, the carrier shall tell the driver that the motor vehicle contains radioactive materials and shall indicate the general route to be taken. This requirement does not apply when:

1) There is only one practicable highway route available, considering operating necessity and safety, or

2) The motor vehicle is operating on a preferred highway under conditions described in paragraph (b) of this section.

(b) Unless otherwise permitted by this section, a carrier and any person who operates a motor vehicle containing a package of highway route controlled quantity radioactive materials as defined in 49 CFR Part 173.403(1) of this subchapter shall ensure that the vehicle operates over preferred routes selected to reduce time in transit, except that an Interstate System bypass or beltway around a city shall be used when available.

1) A preferred route consists of:

(i) An Interstate System highway for which an alternative route is not designated by a State routing agency as provided in this section; and

(ii) A State-designated route selected by a State routing agency (see Part 171.8 of this subchapter) in accordance with the DOT "Guidelines for Selecting Preferred Highway Routes for Shipments of Large Quantity Radioactive Materials".

2) When a deviation from a preferred route is necessary (including emergency deviation, to the extent time permits), routes shall be selected in accordance with paragraph (a) of this section. A motor vehicle may deviate from a preferred route under any of the following circumstances.

(i) Emergency conditions that would make continued use of the preferred route unsafe.

(ii) To make necessary rest, fuel, and vehicle repair stops.

(iii) To the extent necessary to pick up, deliver, or transfer a highway route controlled quantity package of radioactive materials.

(c) A carrier (or his agent) operates a motor vehicle which contains a package of highway route controlled quantity radioactive materials as defined in 49 CFR Section 173.403(l) of this subchapter shall prepare a written route plan and supply a copy before departure to the motor vehicle driver and a copy to the shipper (before departure for exclusive use shipments, or otherwise within fifteen working days following departure). Any variation between the route plan and routes actually used, and the reason for it, shall be reported in an amendment to the route plan delivered to the shipper as soon as practicable but within 30 days following the deviation."

Traditionally, the choice of the highway routes used for the transportation of hazardous materials has been the prerogative of the carrier. The choice was determined by the routes authorized in the carrier's ICC Certificate or subsequent carrier's certificates. However, due to the perceived risks associated with the transport of radioactive materials, various local governmental units began to ban or limit the movements of radioactive materials through their jurisdictions. In response to local actions, the DOT published an Advance Notice of Proposed Rule Making on August 17, 1978. The final rule, published on January 19, 1981, can be summarized as follows:

1. The primary safety mechanism imposed on the transport of radioactive materials is the highly regulated packaging requirements (NRC: 10 CFR 71). Properly packaged radioactive materials can be transported with the same degree of safety as other hazardous materials.

2. Recognizing the increased safety features inherent in the Federal Interstate Highway System, movement of radioactive materials should be routed on Interstate Highways, including Interstate bypasses around population centers.

3. If a different route choice provides a demonstrated added degree of safety, an individual state may make that determination and enforce the use of the designated preferred route. The DOT has chosen the State government for this role over county and local government because it results in a reasonably small number of government units (there are approximately 23,000 county and local government units), and because the State is sufficiently large to achieve an overall approach to routing determinations.

4. However, the DOT recognizes that highway safety considerations can be, and are, highly local concerns. Therefore, the DOT specifically requires that the process of designating preferred routes be designed to involve participation by local government representatives and members of the general public.

5. Finally, reflecting the position expressed in Item 1, State and local governments must not interfere with the movements of radioactive materials shipments from points of origin along direct access to Interstate Highways, or from the Interstates to specific destinations. Similarly, normal use of non-Interstate roads for purposes of refueling, rest stops, repairs, etc., may not be denied.

APPENDIX II

FLOOD PROTECTION SYSTEM DESIGN SUMMARY

Note to Appendix II

Flood protection system design included in Appendix II was based on an initial MWDU design concept incorporating 96 disposal cells. That design would have placed the north flood protection dike near the northern boundary of the Area 5 RWMS. The currently proposed MWDU would incorporate only 10 disposal cells as shown in Figures AII.1 and AII.2 of this EA. The dike cross-section design has remained the same. However, the east and west dikes would be considerably shorter and the mean channel slopes are less. These changes were reviewed and found not to adversely effect the design considerations in Appendix II. However, that review suggests that the existing LLWMU east and west dikes may need to be improved.

APPENDIX II

FLOOD PROTECTION SYSTEM DESIGN SUMMARY

1.0 DESIGN PROCESS

The Area 5 Radioactive Waste Management Site (RWMS) is below and to the south of Massachusetts Mountain and north of Frenchman Lake. This area is believed to have been subjected to alluvial deposition during the Pleistocene and Holocene periods (French and Lombardo, 1984; Case et al., 1984). The area has also been flooded by flash floods repeatedly in the historic past, and the existing drainage pattern suggests that the area will be subjected to flooding in the future.

The alluvial fans on which the Area 5 RWMS is located are aggrading at the average rate of 2.8 inches per 1,000 years (French and Lombardo, 1984). However, the low average rate of growth of alluvial fans on a geologic time scale can be very misleading. In many documented cases, significant modification of an alluvial fan has been the direct result of a single extreme flow event (see, for example, French, 1987). Flood flows on active alluvial fans have the characteristic of being initially confined in an identifiable channel with sudden relocation of the flow to any other part of the fan during a single flow event. The danger of flooding on alluvial fans is related more to the suddenness and ferocity of the event than to the absolute magnitude of the event.

The peak flood flow rates for this EA study were derived from the results presented in Case et al., (1984). The return period of these peak flows is 140 years which substantially exceeds the design life of the Area 5 RWMS. This approach given the known inaccuracy of Miller et al., (1973) in Southern Nevada and the lack of precipitation intensity-duration-frequency data for the Nevada Test Site (NTS) is an appropriate if somewhat unconventional approach to the problem. The primary disadvantage to this approach is that a flood hydrograph for flow and sediment routing is not available.

The Case et al., (1984) study was utilized for this EA instead of the more recent Schmeltzer et al., (1993) study because the Case data were more extensive. Case is consistent with the more recent limited study by Schmeltzer.

The design concept was to use a dike with "natural" slope channels with armoring being provided on the dike side of the channel. The terminology natural slope channel refers to the fact that between two points along the dike there is a natural difference in elevation. Thus, the channel will maintain this elevational relationship and minimize the amount of construction required.

The equations developed in PRC-Toups (1980) were used to estimate the width of an unlined channel carrying a flood flow on an alluvial fan and the depth of flow in this channel. In performing these calculations, the flows from Watersheds 1 and 2 were combined to obtain the flow rate to both northeastern and northwestern channels; the flows from Watersheds 1, 2, and 3 for the east channel; and the flows from Watersheds 1, 2, and 5 for the west channel. The flows from Watersheds 1 and 2 must be combined because the resolution of the available topographic information is not sufficient to determine if there is a definite topographic boundary between these fans at the Area 5 RWMS; and thus a conservative design assumption is required. The inclusion of Watershed 5 is a conservative assumption because of its relationship to the Area 5 RWMS and the overall layout of this facility.

Finally, all flows will be critical or supercritical; and therefore, the possibility of a hydraulic jump occurring in the channels must be taken into account. The sequent depths were calculated using the standard sequent depth equation, except in cases where the value of the Froude number was such that an undular hydraulic jump might occur (French, 1985). In the case of a potential undular jump, the sequent depth equations provided by Corps of Engineers (1970) were used.

All erosion and deposition calculations for this investigation were performed using a proprietary computer program developed by R.H. French of Desert Research Institute. This program is based on the Meyer-Peter, Muller bed load transport equation (Bureau of Reclamation, 1987; Smart, 1984). The equation has been used to perform erosion/deposition calculations in Clark County, Nevada for drainage studies submitted to Federal Emergency Management Agency (FEMA). FEMA, while not endorsing the results produced by this computer code, has accepted the results (FEMA, 1983). In performing all sediment transport calculations Manning's n was taken as 0.016, the d90 sediment size as 15mm, and the median sediment size as 0.67 mm. These values resulted from an analysis of the sediment size data in French and Lombardo (1984). The fan slopes were estimated from USGS 7.5 minute topographic maps.

In evaluating the stability of a channel from the viewpoint of erosion and deposition, a hydrograph is usually provided since the flow is unsteady and the duration of a specified rate flow determines the quantity of material that may be eroded or deposited. In this case, hydrographs were not available; and it was therefore necessary to make an assumption regarding the duration of the peak flows. For the purposes of this study, it was assumed that the duration of the peak flow was 0.25 hours. This assumption is believed to result in a conservative design.

The height of the dikes is controlled by assuming that an initially supercritical flow becomes subcritical and that all of the watersheds considered contribute flow to the site. In contrast, the depth of the cutoff wall is controlled by assuming that the flow remains supercritical and that not all of the watersheds considered contribute flow to the site. The reason for this last observation is that the NE and NW channels always act in a depositional regime because of the rather small channel slopes. Thus, if sediment is not added to the E and W channels by Watersheds 3 and 4 respectively, erosion will occur in these channels that exceeds that which would occur when Watersheds 3 and 4 contribute.

2.0 FLOOD PROTECTION SYSTEM DESIGN CRITERIA

The flood protection system for the MWDU was designed on the basis of a 140-year return period storm which substantially exceeds the expected operational period. A schematic of the MWDU is shown in Figure AII-1. For design purposes, it was assumed that Watershed 4, because of its relationship to the MWDU, would not be a problem. It was further assumed that:

1. Watersheds 1 and 2 contribute to the north dikes;
2. Watersheds 1, 2, and 3 contribute to the east dike; and
3. Watersheds 1, 2, and 5 contribute to the west dike.

Inclusion of Watershed 5 is a conservative assumption because of its relationship to the MWDU and the overall site layout.

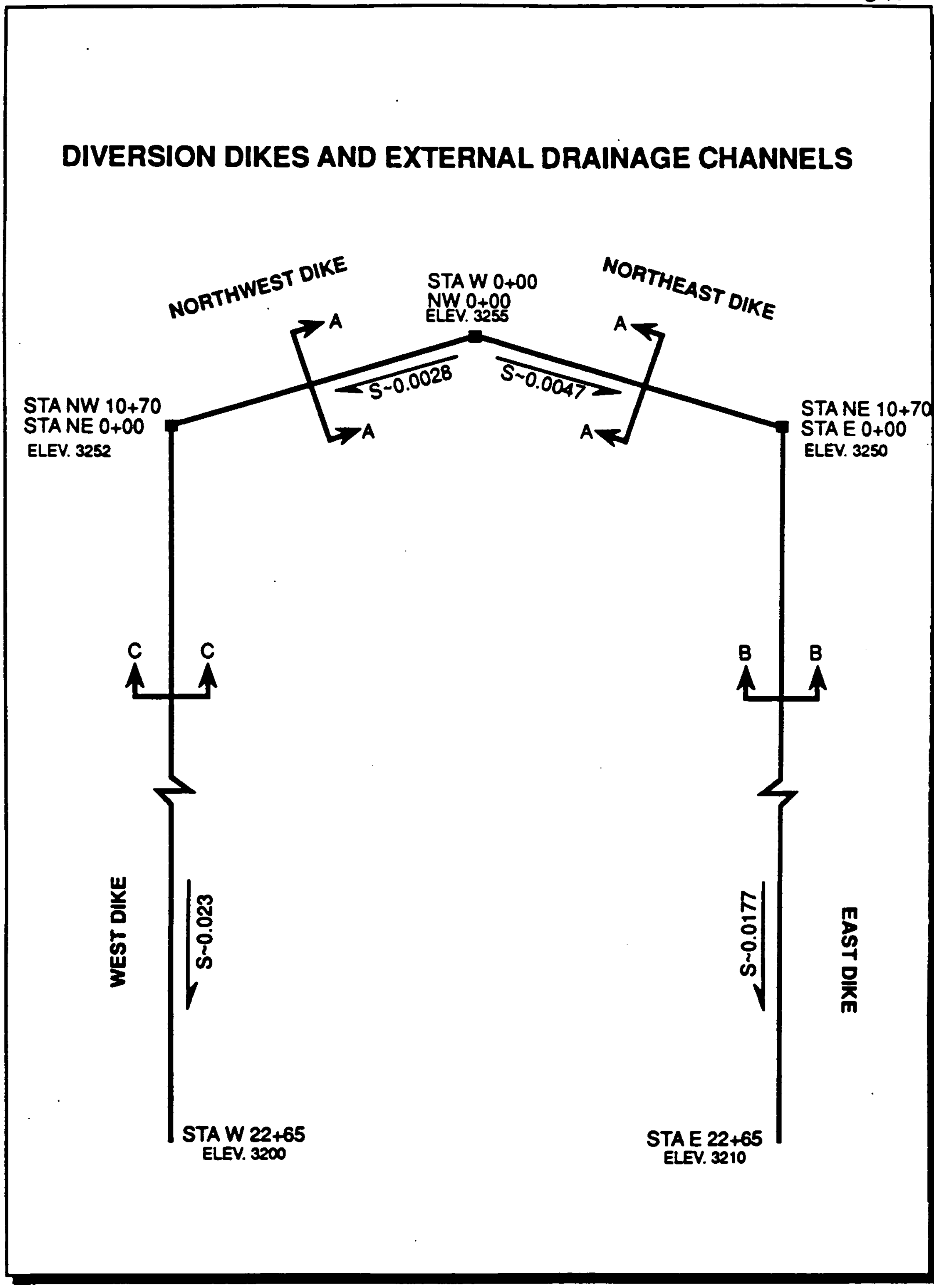

Figure AII-1. Schematic Layout for the Mixed Waste Disposal Unit Flood Protection System

Other design assumptions included:

1. soils are such that Manning's $0.016 \leq n \leq 0.021$;
2. sediment $d_{90} \approx 15$ mm and $d_m \approx 0.67$ mm;
3. sediment specific gravity = 2.65; density = 165 #/ft^3;
4. peak events occur over 1/4 hour;
5. sediment deposition occurs over 100 ft length of channel; and
6. sediment scour occurs over a 50 ft length of channel.

The basic design concept is a dike system with all natural slope channels. Typical system cross-section is presented in Figure AII-2. Watershed and flood protection system design parameters are summarized in Tables AII-1 and AII-2. Controlling design factors are summarized in Table AII-3.

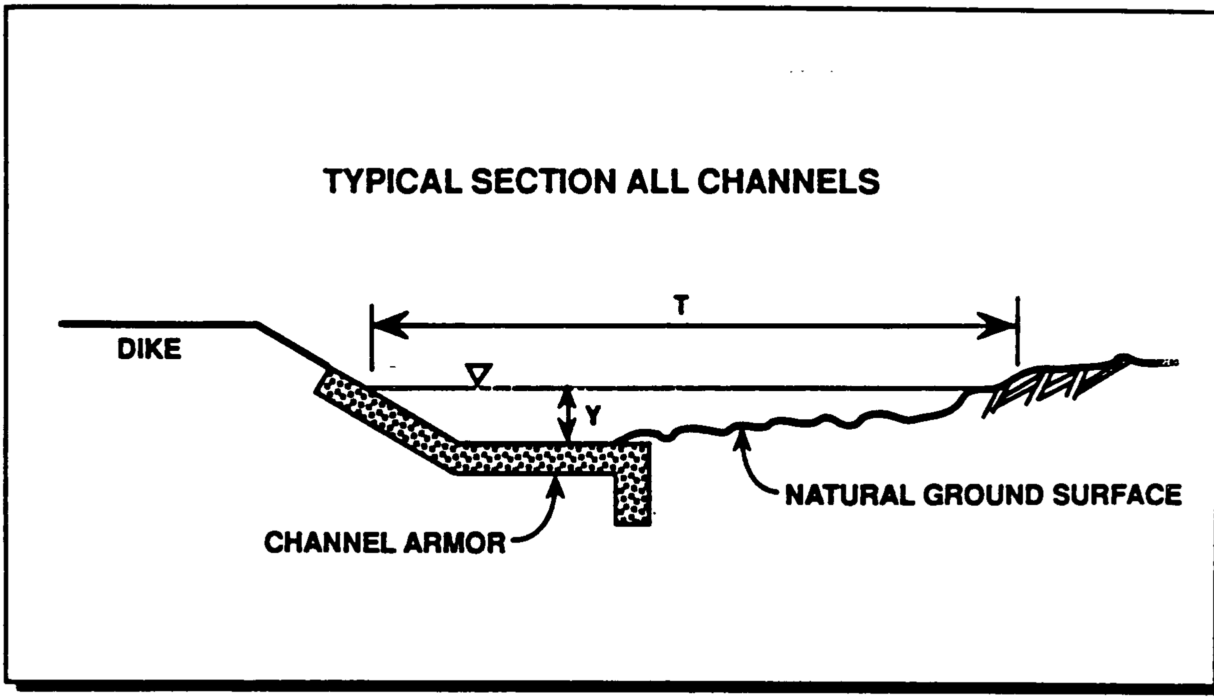

Figure AII-2. Typical Dike System Cross-Section

3.0 GENERAL CONCLUSIONS

3.1 Northeast (NE) Dike and Channel

1. The height of the armored berm is controlled by the: a) expected depth at critical flow with the potential of an undular jump, and b) expected deposition.

2. Allowing for an undular jump y = 2.6 ft.

Table AII-1. Watershed Flood Flow Analysis, Tr = 140 Years.

Watershed	Watershed Slope Near MWDU	Flood Flow (ft^3/sec)	Channel Width (ft)	Flow Depth (ft)	Cross-Sectional Area (ft^2)	Flow Velocity (ft/sec)	Sediment Production (T/hr)
1	0.411	1,270	97	0.8	77	16.4	6,800
2	0.0354	2,150	121	1.0	121	17.8	9,600
3	0.0209	6,960	208	1.7	354	20.0	16,523
5	0.0185	706	90	0.75	68	10.0	1,729

Table AII-2. Flood Channel Design Dimensions and Parameters.

Channel	Contributing Watersheds	Flood Flow (ft^3/sec)	Channel Width, T (ft)	Flow Depth, y (ft)	Cross-Sectional Area (ft^2)	Flow Velocity (ft/sec)	Froude No.	Sequent Depth, y_2 (ft)	Sedimentation		
									Capacity (tons/hr)	Load (tons/hr)	Regime
NE	1,2	3,420	210	1.8	378	9.0	1.2	2.6	1,901	16,400	deposition
NW	1,2	3,420	230	1.9	440	7.8	1.0	possible	1.024	16,400	deposition
E	1,2,3	10,380	250	2.1	525	19.8	2.4	6.2	21,241	18,400	scour
W	1,2,5	4,126	170	1.4	238	17.3	2.6	4.5	11,642	2,700	scour

Table AII-3. Controlling Design Factors for Dikes and Channels.

Channel	Dike/Armor Height Source of Flow	Dike/Armor Height Flow Class	Dike/Armor Height Sedimentation Regime	Cutoff Wall Depth Source of Flow	Cutoff Wall Depth Flow Class	Cutoff Wall Depth Sedimentation Regime
NE	1,2	Sub	Deposition	1,2	Super	Deposition
NW	1,2	Crit	Deposition	1,2	Crit	Deposition
E	1,2,3	Sub	Erosion	1,2	Super	Erosion
W	1,2,5	Sub	Erosion	1,2	Super	Erosion

3. Worst case deposition occurs with Watersheds 1 and 2 providing sediment. Although it is unlikely Watershed 2 will contribute to this channel, it is a possibility that cannot be ignored.

4. The depth of potential deposition ranges, under the assumptions made, from 0.20 ft to 2.1 ft. The estimate of deposition depth depends on the length of time over which deposition takes place and the length of channel over which deposition takes place. Deposition will most likely take place where the flow impinges on the berm - that is an unknown location. Assume approximately 100 ft.

Recommend:

Armor Height

Flow depth2.6
Deposition2.1 (over 100 ft)
Freeboard2.5 USACE EM-1110-2-1601
7.2 ft
Earthbank1.0
8.2 ~ 8.5 ft

Cutoff wall depth -1.0 ft min.

See typical section in Figure AII-3.

3.2 Northwest (NW) Dike and Channel

1. Height of armored berm is controlled by critical flow depth and expected deposition.

2. Deposition assumed to occur over 100 ft.

Recommend:

Flow depth	1.9	
Deposition	2.0	(over 100 ft)
Freeboard	2.5	
	6.4 ft	
Earthbank	1.0	
	7.4	

Allow design for Northeast to control. See typical section in Figure AII-3.

3.3 East (E) Dike and Channel

1. Height of armored berm is controlled by subcritical flow depth.
2. Depth of cutoff wall controlled by scour created by flows only from Watersheds 1 and 2.

Recommend:

Dike		Cutoff	
Flow depth	6.2	Expected Scour	2.1 ~ 2.5 ft.
Freeboard	2.5	Fac. Safety	2.0
	8.7 ~ 9.0 ft		4.5 ft
Earthbank	1.0		
	9.7 ~ 10 ft		

See typical section in Figure AII-4.

3.4 West (W) Dike and Channel

1. Height of armored berm is controlled by subcritical flow depth.
2. Depth of cutoff wall controlled by scour from Northwest and Watershed 5 flow.

Recommend:

Dike		Cutoff	
Flow depth	4.5	Expected Scour	3.3+
Freeboard	2.5	Fac. Safety	2.5
	7.0		5.8 ft ~ 6 ft
Earthbank	1.0		
	8.0		

See typical section in Figure AII-5.

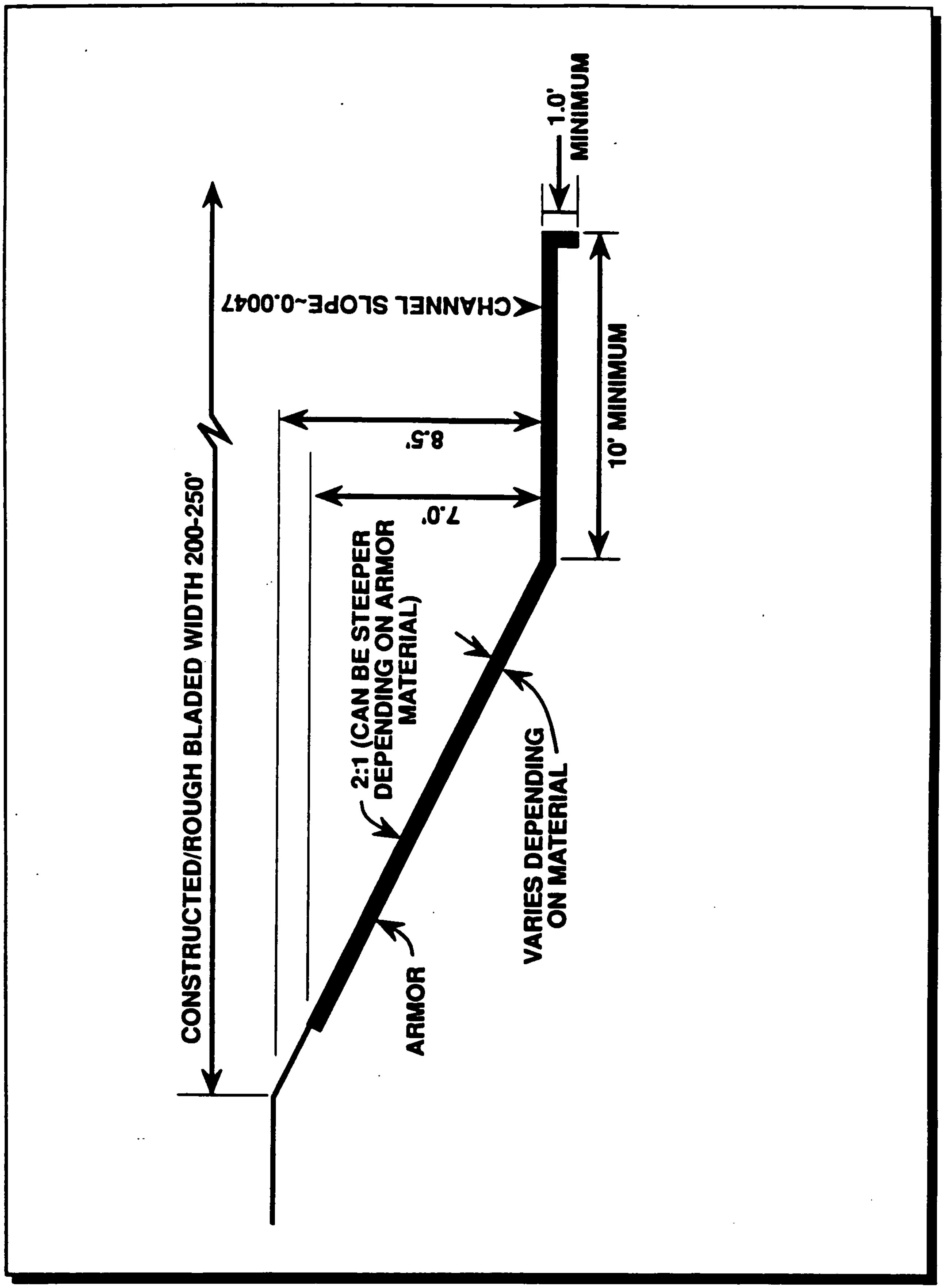

Figure AII-3. Typical Cross-Section for Northeast and Northwest Flood Protection Dikes and Storm Channels.

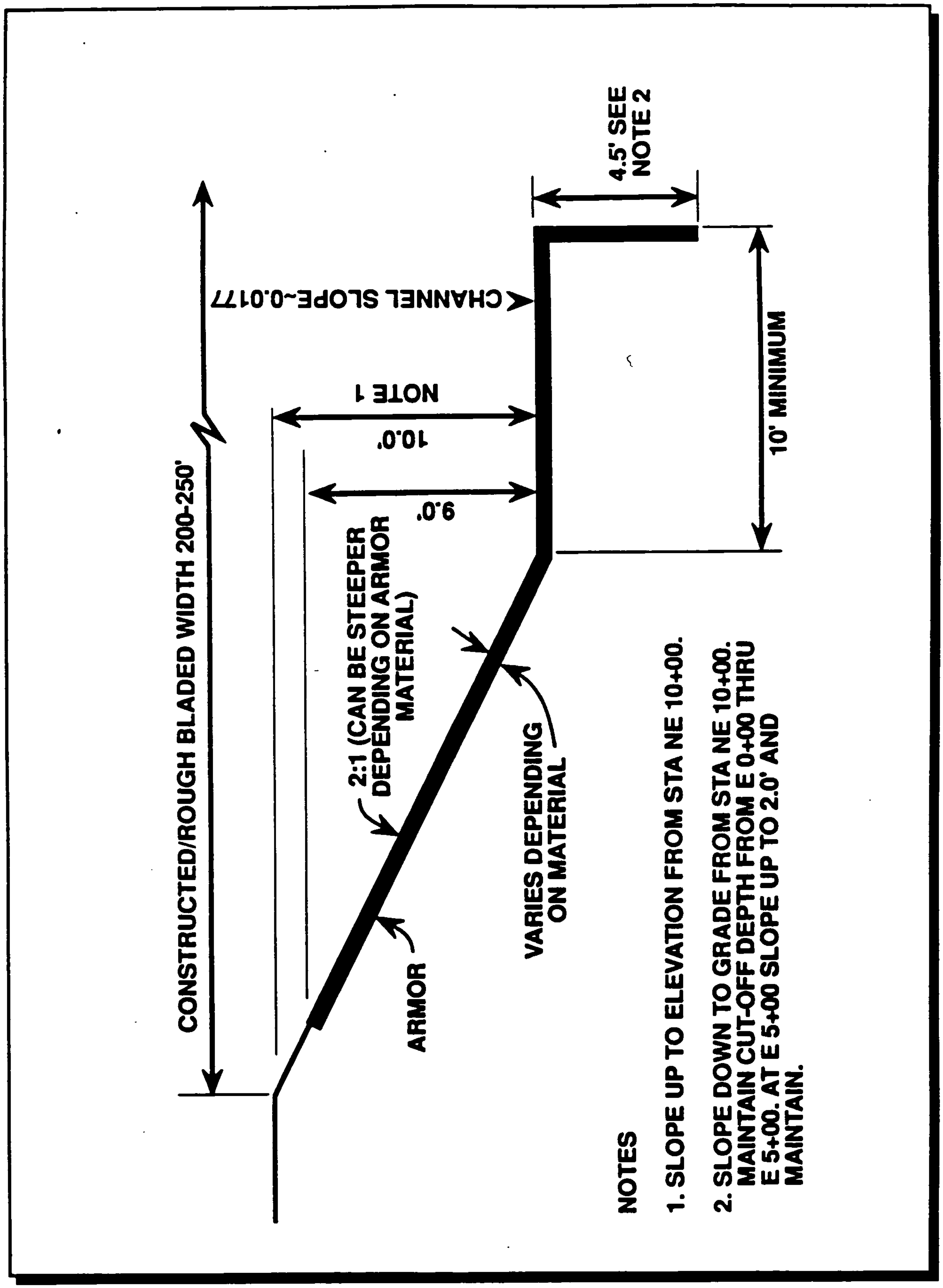

Figure AII-4. Typical Cross-Section for the East Flood Protection Dike and Storm Channel.

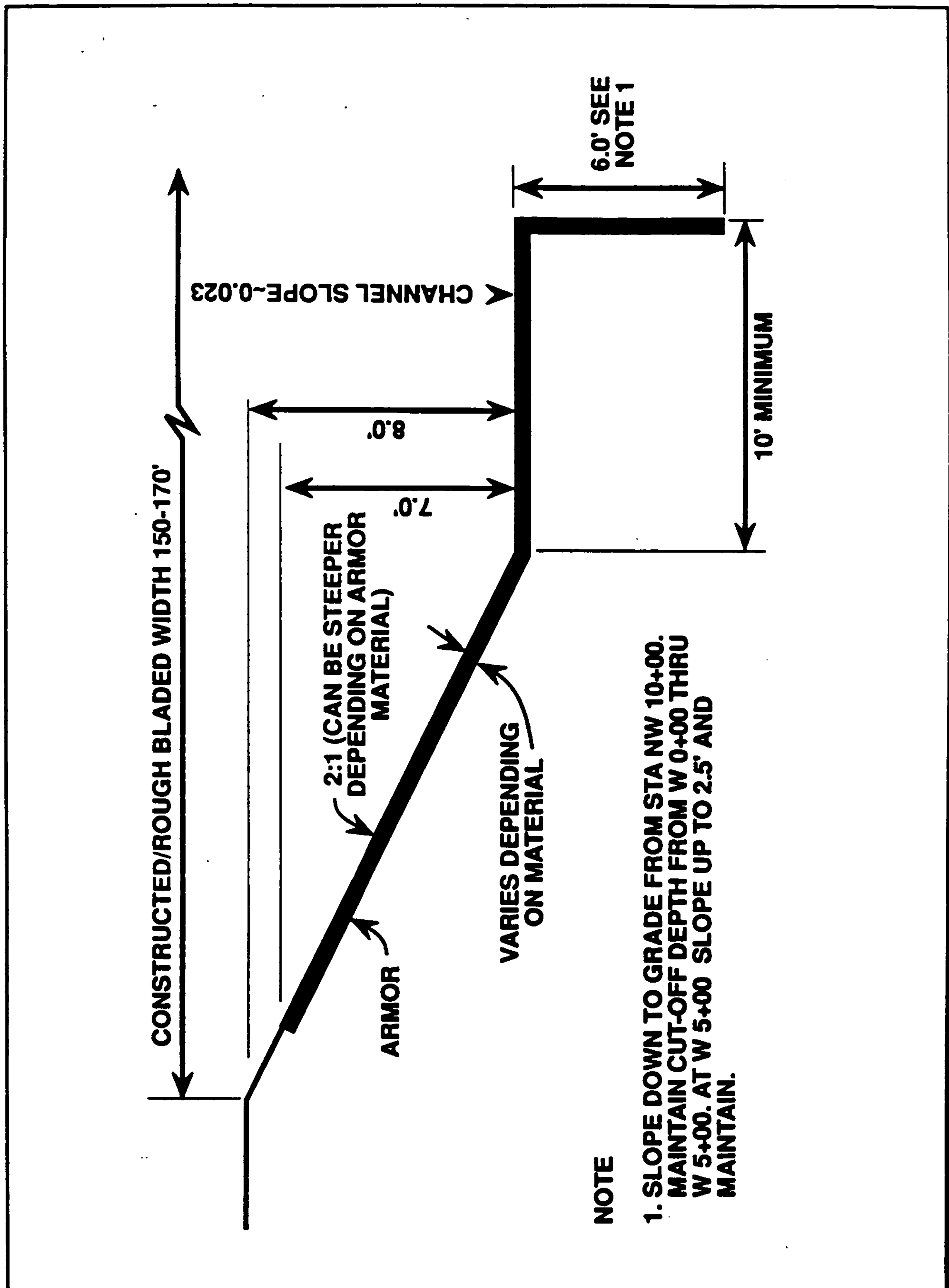

Figure AII-5. Typical Cross-Section for the West Flood Protection Dike and Storm Channel.

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APPENDIX III

WASTE SOURCE TERMS AND TRANSPORTATION ASSUMPTIONS

APPENDIX III

WASTE SOURCE TERM AND TRANSPORTATION ASSUMPTIONS

1.0 INTRODUCTION

The Department of Energy (DOE) is proposing to expand the Mixed Waste Disposal Unit (MWDU) at the Nevada Test Site (NTS). In order to estimate the transportation and disposal operation risks associated with this facility, the analyses presented in this Environmental Assessment are based on a series of assumptions: (1) selection of the waste generators to be analyzed; (2) the waste volumes; (3) the waste characteristics and radiological source term used for the transportation risks analysis; (4) the number of waste shipments and the origin of the waste shipments; and (5) the hazardous chemical source terms. These assumptions were used to estimate the risks of transportation by developing an "idealized" waste package to estimate the "upper bounds" for risks. The assumptions and the rationale for the above items used to estimate transportation and disposal operation risks are presented in the following sections.

2.0 WASTE GENERATORS

The waste generators selected for the transportation risk analysis are the Rocky Flats Plant (RFP), Sandia National Laboratory, Albuquerque (SNLA), NTS and DOE/Federal Classified Waste. Additionally, MW from Lawrence Livermore National Laboratory (LLNL) was evaluated for its particular waste characteristics. The rationale for selecting the Mixed Waste (MW) generators is as follows:

- Each of these MW generators has no other facility at which to dispose of their waste;
- Each of these MW generators has historically disposed of their waste at NTS;
- The RFP was chosen because it is representative of a large DOE production facility;
- SNLA was chosen because it is representative of a large DOE research facility;
- DOE and Federal MW was selected because NTS is the only disposal facility for classified MW; and
- As an example of other DOE facilities' waste streams, LLNL MW characteristics were evaluated because wastes are representative of a facility that is both a small research and small production facility.

3.0 WASTE VOLUMES

A Department of Energy Memorandum of June 12, 1990, states that the proposed Mixed Waste Disposal Facility at the Nevada Test Site would have a volume cap of 120,000 m^3. Additionally, the Memorandum stated that only a five year operating time period would be evaluated. These numbers were used in this analysis to establish an upper bound on the potential transportation impact. The actual disposal cap will be established by the RCRA permit. A total waste volume of 58,558 m^3 of MW is currently in storage or will be generated by NTS, RFP, SNLA, and federal classified activities during the next five years. The difference between the two volumes (91,442 m^3) is to be reserved as a "contingency waste volume capacity" for disposing of MW from planned activities such as environmental restoration at NTS. Previous experience in restoration activities at NTS indicates that waste volumes could range from 20,000 to 80,000 m^3. Mixed waste generated at other DOE facilities may also be transported to NTS for disposal.

Table AIII-1 presents the projected waste volumes for NTS, SNL, RFP, Federal classified waste, and the Department of Defense. The volumes are a total of the amount that is presently in storage and the volume that will be generated in the next five years. Table AIII-2 shows the scaled-up volume for disposal at NTS, including the 91,442 m^3 contingency volume. These estimated waste volumes were used to establish reasonable upper bounds on waste inventories for this study. Actual waste volumes may be less.

In order to bound the environmental effects of transporting and disposing of the MW, the estimation of the risks is based on disposing of 120,000 m^3 in five years. Since no more than a maximum of 120,000 m^3 can be disposed and the facility will accept waste for only five years, this is the upper bounding case. Additional conservatism in the transportation analysis was obtained by disregarding the volume of MW expected to be generated at NTS by environmental restoration and other activities, and assuming that all unidentified waste volumes would be transported to the NTS from off-site generators.

4.0 WASTE CHARACTERISTICS AND RADIOLOGICAL SOURCE TERMS

Waste stream characterization data has been supplied to DOE/NVO for MW seeking approval for shipment to NTS Area 5 RWMS. Thirty-three separate waste streams were evaluated. These wastes are considered to be representative of DOE defense production facilities (RFP), defense research operations (SNLA) and federal classified activities.

Waste forms from the representative generators are summarized below:

> Production facilities such as RFP typically produce sludges that are the products of liquid waste treatment facilities. These wastes are evaporated and the residue is immobilized by the addition of cement. These wastes are contaminated with low levels of americium, plutonium, and uranium. They are also contaminated with halogenated and non-halogenated solvents.
>
> Combustible waste consisting of materials such as paper, Kimwipes, Texwipes, solvent-containing rags, cling-free cloths, general cleaning material, wood, plastic chips, plastic (i.e., polyethylene and polyvinyl chloride), supplied air suits, bath towels, gloves, and gauze is also produced at production facilities. The materials are contaminated with low levels of americium, plutonium, and uranium. They are also contaminated with halogenated and non-halogenated solvents, some used in the degreasing operations in the manufacturing process. Depending on the operations which generate combustibles, the waste stream composition is varied.

Table AIII-1. Summary of Presently Identified MW for Disposal at NTS (m^3).

	RFP	SNLA	NTS[1]	Classified	DOD	TOTAL
Existing Inventory	12,070	14	5,664	7,138	51	24,937
Remaining 1990	3,034	11	44	3,055	3	6,147
FY 1991	6,006	30	49	3,233	14	9,332
FY 1992	1,210	30	49	3,229	28	4,546
FY 1993	1,210	30	49	3,210	57	4,556
FY 1994	1,210	30	49	3,160	57	4,506
FY 1995	1,210	30	49	3,160	85	4,534
TOTAL	25,950	175	5,953	26,185	295	58,558

[1] Includes 5,663 m^3 of MW retrievably stored at NTS.

Table AIII-2. Waste Volumes for Disposal at NTS over Next Five Years.

Site	Waste Volume (m^3) as Supplied by Site	Scaled Up Volume
NTS[1]	5,953	5,953
SNL	175	175
RFP	25,950	25,950
Classified Waste	26,480	26,480
Unidentified Contingency Waste	0	91,442[2]
Total	58,558	150,000

[1] Includes MW presently retrievably stored at NTS

[2] This waste volume could come from DOE/NV environmental restoration and other activities, and from other Federal facilities that have no alternatives to NTS disposal.

Production facilities produce metal waste consisting primarily of lead shielding and leaded glass used in routine operations in the plutonium analytical laboratories, plutonium development and recovery operations, manufacturing, assembly, and product support areas. Gloves used in glove-box operations are not included in this waste stream. This material is contaminated with low levels of plutonium or uranium.

Research facilities generate metal wastes which include depleted uranium wastes generated from weapons programs component testing at research facilities such as SNLA. Wastes are solid and include weapon pieces, contaminated soil, and decontaminated debris. Waste generation is variable and project-specific. Waste is generated from various weapons tests including drop tests, compaction studies, heat stress studies, and explosive tests.

Also included are activated wastes from weapons-related accelerator programs. Wastes are generated by activation of metals from accelerators and in the future will include tritium contaminated wastes.

Other metal wastes are radiation and miscellaneous sources and debris from the irradiation facilities. This waste includes Cs^{137} and Co^{60} radiation sources and miscellaneous calibration standards, or check standards. Debris such as lead-shielded transport containers is associated with these wastes. Generated waste forms include dry solids, filters, resins, and waste waters; however, wastes in their final form will be stabilized solids.

Classified metal wastes are generated by federal facilities and consist primarily of depleted uranium from weapons component testing. Wastes are solids and include weapon pieces and contaminated debris. Other metals include lead and beryllium.

This waste characterization data was consolidated into two idealized waste forms for purposes of performing a bounding transportation analysis for this EA. These two waste forms, immobilized sludges and combustible waste and contaminated metals, are representative of all MW from federal classified operations and DOE defense sites with a history of LLW shipments to NTS.

When possible, bounding source terms were assigned to each of these wastes based on an examination of specific waste stream characterization data sheets. When insufficient concentration data existed for individual radionuclides, values were assigned from CFR 49 173.431 (Activity Limits for Type A Packages).

Based on waste characterization data sheets for immobilized waste from RFP (TI = 0.05), the following radionuclides were identified. Concentrations were assumed based on A_2 limits for Am^{241} and Pu^{239} and a reasonable concentration was assumed for U^{238}.

Radionuclide	Concentration (Ci/shipment)
Am^{241}	1.30×10^{-1}
Pu^{239}	3.20×10^{-2}
U^{238}	1.60×10^{0}

Individual waste streams within the representative combustible and contaminated metals waste form are quite variable. In many cases, individual radiological contaminants were identified, but no specific concentrations were presented. As an example, Am^{241} and Pu^{239} are reported to be at activity levels less than 100 nCi/gm. To assign specific values for these activities in this transportation analysis, A_2 values for normal form radioactive materials were taken from CFR 49 173.435.

Mixed fission products (Co^{60} and Cs^{137}) were also identified with no specific concentrations. Due to the gamma contribution of Co^{60} and Cs^{137}, it is important to include these radionuclides in a bounding source term. A_2 values for these mixed fission products were again taken from CFR 49 173.435. For wastes representative of major defense production facilities, a value of $(A_2)(.3)$ was used for these mixed fission products. The (.3) multiplier was required to assure that the surface dose of the Type A container did not exceed 200 mrem/hr. For federal classified waste, no mixed fission products were identified. However, for a bounding analysis, a value of $(A_2)(.01)$ was used. Bounding source terms for combustible waste and contaminated metals are as follows:

DWCF with a TI = 4

Radionuclide	Average Concentration (Ci/shipment)	
Am^{241}	1.30×10^{-1}	(A_2)
Co^{57}	1.07×10^{1}	$(.3)(A_2)$
Co^{60}	1.07×10^{1}	$(.3)(A_2)$
Cs^{137}	1.07×10^{1}	$(.3)(A_2)$
H^3 (wtr)	1.60×10^{2}	(waste stream)
Mn^{54}	1.07×10^{0}	$(.3)(A_2)$
Pu^{239}	3.20×10^{-2}	(A_2)
U^{238}	1.60×10^{0}	(waste stream)
Zn^{65}	3.73×10^{0}	$(.3)(A_2)$

DWCF with a TI=1

Radionuclide	Average Concentration (Ci/shipment)	
Am^{241}	1.30×10^{-1}	(A_2)
Co^{57}	3.20×10^{-2}	$(.01)(A_2)$
Co^{60}	3.20×10^{-2}	$(.01)(A_2)$
Cs^{137}	3.20×10^{-2}	$(.01)(A_2)$
H^3 (wtr)	1.60×10^{2}	(waste stream)
Mn^{54}	3.20×10^{-3}	$(.01)(A_2)$
Pu^{239}	3.20×10^{-2}	(A_2)
U^{238}	1.60×10^{0}	(waste stream)
Zn^{65}	1.12×10^{-2}	$(.01)(A_2)$

5.0 HAZARDOUS CHEMICAL RELEASES

A listing of hazardous chemical constituents in MW intended for disposal of NTS in the next five years is presented in Appendix VII, Table AVII-8. This list is based on the Waste Characterization Data Sheets supplied by RFP, NTS and SNLA.

The volatile organic compounds, (VOC), in the form of spent solvents, and degreasers, and the heavy metals associated with the MW designated for NTS are similar in nature and concentration to the hazardous constituents contained in transuranic (TRU) waste. This is understandable since many of the same processes that produced mixed TRU waste at DOE defense sites also create low level MW: For this reason, this EA uses the same methodology for assessing the consequences of hazardous chemical exposures as was used in the Waste Isolation Pilot Plant (WIPP) SEIS (DOE, 1989).

The VOCs examined in this assessment are methylene chloride; 1,1,1-trichloroethane, 1,1,2-trichloro-1,2,2-trifluoroethane (Freon-113); and trichloroethylene. In wastes, these chemicals are the EPA-regulated hazardous components that may potentially comprise greater than one percent by weight of the waste transported to NTS and are considered hazardous by the EPA (40 CFR Part 261, Subparts C and D). All others are estimated to comprise less than one percent each by weight of the waste, and most exist only in trace quantities. Initial concentrations of VOCs in the MW are derived from data on the headspace gas concentrations of TRU waste.

The NTS acceptance criteria specify that wastes defined for disposal at the MWDU must meet the applicable land disposal requirements (LDRs) of 40 CFR Part 268. These LDRs specify concentrations of VOCs significantly less than those shown in Tables AVII-8 and AVII-9. This impact analysis utilized the higher values in Tables AVII-8 and AVII-9 as representative of the untreated waste in order to assess an upper bound of potential impacts.

Metals examined in the transportation risk analysis include lead, cadmium, mercury, and beryllium. Lead is the most abundant metal found in the waste by both weight and volume because the waste includes both lead particulates and pieces of metals (shield bricks, lined gloves, aprons). Some of the MW to be shipped to NTS for disposal from a DOE production or research facility could have as much as 550 kg of lead per box.

6.0 NUMBER AND ORIGIN-DESTINATION OF WASTE SHIPMENTS

As previously indicated, only representative MW generators have been presently identified as those who will dispose of their waste at the MWDU. Historically seventeen off-site DOE, and Federal low-level waste generators have disposed of waste at the NTS. It can be assumed that over the next five years any one or all of these generators might ship MW for disposal. The necessity for these generators to ship is dependent on many factors. Some of these might include changes in federal regulations, DOE Orders, limited or one time generation of MW, or the development of local or state situations that might require the immediate transportation and disposal of waste. Since none of these factors can be anticipated, the transportation risks will be bounded based on the following assumptions:

- 144,337 m^3 of waste will be transported and 120,000 m^3 of waste will be disposed;
- All waste will be shipped in 2' x 4' x 7' half boxes (1.6 m^3 per box) and 16 half boxes will constitute a waste shipment;
- 25.6 m^3 of waste will be transported per waste shipment;
- Of the estimated 5,953 m^3 of MW presently identified for disposal at NTS, 5,663 m^3 is in retrievable storage at RWMS. Therefore, approximately 290 m^3 or 10 shipments will be transported to the RWMS requiring no off-site transportation.
- 144,047 m^3 from off-site MW generators will require approximately 5628 shipments;

- In order to conservatively bound the transportation risks, all waste shipments will originate from RFP or the Defense Waste Consolidation Facility located at Barnwell, South Carolina;

- 1,014 of the off-site waste shipments will originate from the RFP;

- 4,614 of the off-site waste shipments will originate from the Defense Waste Consolidation Facility (DWCF) in South Carolina.

Utilization of the above assumptions will present a conservative and bounding estimate of the radiological and nonradiological transportation risks. Risks will be bounded because:

- Remedial actions planned at NTS will generate an unknown volume of MW which would not require transportation off-site prior to disposal. Transportation risks associated with these shipments would be significantly lower than those associated with transporting MW from off-site generators.

- The Rocky Flats Plant is presently the single largest known generator of MW shipping to NTS and the 1,013 shipments represent the largest known number of shipments from an identified facility;

- The utilization of the DWCF as the origin of the remaining 4,614 shipments. This results in an analyses of risks over a long distance shipping route (2,451 miles) with approximately 1.2% of the travel through an urban population zone. At a future time, any of the unidentified sites could make shipments over a longer distance route with a greater percentage of urban travel, but the number of shipments would be much less than the postulated 4,614 shipment from the DWCF. Thus the analysis presented in this EA bounds their risks.

- The transportation appendix presents an evaluation of shipments annually from the DWCF of a small number of an "idealized" high curie loading waste with a high surface dose rate. This evaluation was included to present the bounding risks of a representative number of high curie shipments such as one might expect from a facility such as SNLA.

Consistent with the health-protective approach to risk assessment, potential exposures to releases of hazardous chemicals resulting from routine operations are estimated for hypothetical workers located at the points of maximum on-site concentrations.

The potential exposed individual was assumed in each case modeled to weigh 70 kg (about 154 lbs.). Adults are used as the model residential receptor since no actual individual exists at the site boundary. In fact, the actual resident nearest to the facility is more than 3 miles from the boundary. The increased sensitivity of the elderly or very young individual from considerations such as body weight is mitigated by the additional dilution of the already very low predicted concentrations at the site boundary (see Section 5.0).

The daily respiratory volume was assumed to be 20 cubic meters (m^3) for a 24-hour period (residential exposures) (EPA, 1986) and 12 m^3 for an 8-hour period (occupational exposures) (EPA, 1985c). Due to a lack of chemical-specific data for volatile organics, a transfer coefficient of 1.00 was used to model uptake and absorption via the lungs for these chemicals.

The rate of lead deposition in the lungs was assumed to range from approximately 30 to 50 percent of particulates inhaled, while up to 70 percent of deposited lead was assumed to be absorbed within 10 hours of exposure (ATSDR, 1988a). To maintain a health-protective approach, a transfer coefficient of 0.35 (i.e., 70% x 50%) was used to represent deposition and absorption in the exposure estimates for lead.

Estimates of intake per exposure were compared with reference levels derived form appropriate, short-term occupational standards instead of AICs. These standards include the time-weighted average Threshold Limit Values (TLVs) (ACGIH, 1986) and immediately Dangerous to Life and Health (IDLH) criteria (CHEMTOX, 1988).

The TLV-based, or IDLH-based estimated intakes (I_{ai}) for the accident scenarios are estimated by the following formula:

$$I_{ai} = (C_i)(V)(A_i)(E)(f_a)$$

where:

I_{ai}	=	TLV- or IDLH-based estimated intake (mg/exposure)
C_i	=	concentration of constituent in air at the receptor location (mg/m^3)
V	=	respiratory volume (m^3/day)
A_i	=	transfer coefficient for i^{th} chemical
E	=	seconds or minutes per exposure
f_a	=	conversion factor (1440 minutes/day)

The respiratory volume of 20 m^3/day and transfer coefficients of 0.35 for lead and 1.0 for all volatile organic compounds are used in the transportation accident to estimate intake of a hypothetical exposed individual located 50 meters from the accident.

The estimated intakes for the accident scenarios postulated to occur during operations at NTS are also calculated using the above equation. Because the exposure to a worker is estimated, a respiratory volume of 12 m^3/workday is used in the calculation of intake. The transfer coefficients of 0.35 for lead and 1.0 for volatile organic compounds were utilized as above. Each exposure period in minutes was then converted, using the factors of 1 hour per 60 minutes and 1 workday per 8 hours. For the defined time period of each accident, the concentration of chemicals in air at the location of the worker is assumed to be constant.

Accident events as defined in the EA are short-term events with respect to potential exposures and associated risks. Because the risks to workers associated with the release of hazardous chemicals from accidents at NTS are well below health-based levels, risks to the public are not estimated. Short-term exposures to the public from these events will be less than those to workers because of the restricted access to the facility, operational protocols for accident control and cleanup, and the decreased concentrations of chemicals from dilution and diffusion in air.

The TLV-based acceptable intake is derived by the following equation:

$$IDLH\text{-}AI_i = (IDLH_i)(V)(EF)(A_i)$$

where:

$IDLH\text{-}AI_i$	=	Immediately Dangerous to Life and Health-based acceptance intake (mg/exposure)
IDLH	=	IDLH for the i^{th} chemical (mg/m^3) (CHEMTOX Database, 1988)
V	=	respiratory volume for a worker during a 8-hour workday (12 m^3/day)
EF	=	exposure period and conversion factors (30 minutes per exposure, one hour per 60 minutes and one workday per 8 hours)
A_i	=	transfer coefficient (1.0 or 100 percent absorption for all volatile organics)

The IDLH is based on a 30-minute exposure. However, the respiratory rate is the volume breathed during an 8-hour day. The exposure period and conversion factors are used to determine the amount that can be taken into the body (i.e., acceptable intake) during a 30-minute exposure period.

APPENDIX IV

AGENCY CONSULTATION LETTERS

- **State Department of Conservation and Natural Resources, Division of Historic Preservation and Archaeology**

ILLER
rnor

STATE OF NEVADA

ROLAND D. WESTERGARD
State Historic Preservation Officer

6291

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

DIVISION OF HISTORIC PRESERVATION AND ARCHEOLOGY
Capitol Complex
Carson City, Nevada 89710
(702) 687-5138

May 2, 1990

Robert E. Freidrichs, Acting Director
Environmental Protection Division
Department of Energy
Nevada Operations Office
P.O. Box 98518
Las Vegas, Nevada 89193-8518

Dear Mr. Freidrichs:

The Division has reviewed the following cultural resource report submitted by your agency:

DRI Short Report 111287-1 Frenchman Flat Radioactive Waste Site Expansion

The report was prepared following an intensive archeological/historic survey of the project area. The report indicates that significant historic or archeological resources were not discovered. Your agency has satisfied its obligations to identify historic properties as per 36 CFR 800.4.

The report will be incorporated into the statewide inventory. No further steps need be taken in the Section 106 process.

Sincerely,

Alice M. Baldrica, Deputy
State Historic Preservation Officer

AMB:emt

EPD FILE # 5477 B

6291

bcc:
EPD (R)
EPD RF
MGR's RF

EPD
MONROE
04/23/90

EPD
FRIEDRICHS
04/23/90

EPD
NORA
04/27/90

Alice M. Baldrica
State of Nevada
Division of Historic Preservation
and Archaeology
201 S. Fall Street
Carson City, NV 89710

SECTION 106 REVIEW

The U.S. Department of Energy (DOE) has operated the Radiation Waste Management Site (RWMS) on Frenchman Flat in Area 5 of the Nevada Test Site since 1967. DOE proposes to construct and operate the Mixed Waste Management Unit (MWMU) and continue the operations of the existing Low Level Waste Management Unit (LLWMU).

Site preparation activities for the MWMU include an access road from Road 5-01, construction of flood diversion dikes and ditches, access roads to the cells, excavate the cells and stock pile the excavated materials, and installation of a security fence around the perimeter.

Operations of the LLWMU are done entirely within the existing compound and includes (but is not limited to) earth moving, dike construction, cell excavation, road construction, and fencing. Several new structures are being planned for the facility. Most construction is located within the fenced compound on previously disturbed areas. No new surface disturbance activities are planned for the LLWMU.

Additional consultation will be done if activities fall outside this survey area or outside the existing compound.

A Class III Cultural Resource Reconnaissance was completed for the RWMS and the findings are contained in Short Report No. SR111287-1 (enclosed). No cultural resources sites were located.

Our opinion is that the construction and operation of the MWMU and operations of the existing LLWMU will have no effect on historic properties.

If you do not concur with our findings, please respond within 30 days to Les Monroe at (702) 295-1744.

Original signed by
Robert E. Friedrichs

Robert E. Friedrichs, Acting Director
Environmental Protection Division

EPD:LAM

Enclosure:
As stated

cc w/o encl:
L. C. Pippin, DRI, Reno, NV
G. F. Cochran, DRI, Reno, NV

bcc w/o encl:
J. N. Fiore, ERWM, NV
R. C. Bivona, NTSO

5411T

6291

DESERT RESEARCH INSTITUTE
CULTURAL RESOURCES RECONNAISSANCE
SHORT REPORT

SR111287-1

PROJECT:

A Class III Cultural Resources Reconnaissance of Frenchman Flat Radio Active Waste Site Expansion.

GEOGRAPHIC AND NTS AREA:

Frenchman Flat, Area 5

MAP REFERENCES:

USGS Frenchman Flat 7.5' min. Quadrangle

AREA OF SURVEY:

179 acres

DATES OF FIELD RECONNAISSANCE:

November 12-13, 1987

Derivative Classifier Gregory H. Henton Desert Research Institute

PERSONNEL:

Ronald L. Reno and Calvin Nichols

INTRODUCTION AND EXECUTIVE SUMMARY:

DOE wishes to expand the existing low level waste facilities north of Frenchman Lake in Area 5. The expansion area surveyed for archaeological sites in the north and adjacent to existing low level waste pits involves an area of approximately 0.724 km^2 (179 acres) (Figure 1). No archaeological sites were found.

PREVIOUS CULTURAL RESOURCE STUDIES IN AREA:

In 1982 the Desert Research Institute surveyed two geophysical test lines northwest of Frenchman Lake. No archaeological sites were found on the bajada, but a small camp site was found at the base of a rock outcrop on the west side of Frenchman Flat (Reno 1982). DRI conducted reconnaissances of several backhoe trench locations in Frenchman Flat in 1984, but no cultural remains were found. That same year DRI surveyed a proposed Device Assembly Area in the northwest corner of Frenchman Flat. A small number of isolated artifacts and a small opportunistic quarry were found (Henton 1984).

RECONNAISSANCE METHODS:

On November 12-13, 1987, Ronald L. Reno and Calvin Nichols, of the Social Sciences Center, Desert Research Institute examined the project area for cultural resources. Project area boundaries were pointed out by J.R. Roberts of REECo. The northwest corner (N771,280 E706,925 Central Zone, Nevada Foot Coordinate System) and northeast corner (N771,280 E709,500) of the project area are marked with permanent concrete monuments with brass caps. The southern boundary of the study area is marked by the dike at the northern end of the existing radioactive waste disposal site, which is at 768,300 feet North.

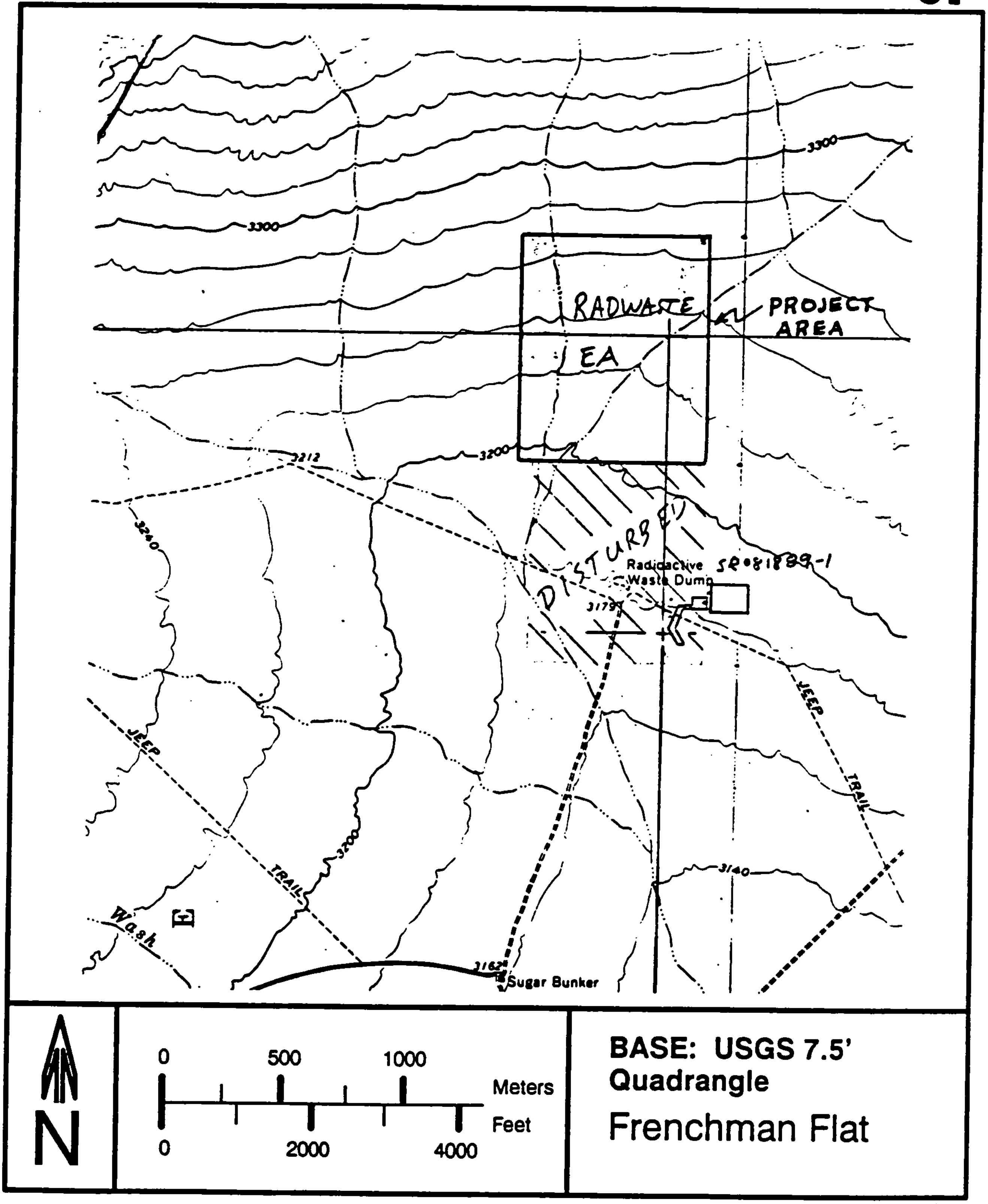

Figure 1. Project Area Map of Frenchman Flat Radio Active Waste Site Expansion.

A 100 foot interval grid system marked with laths is in place over the entire project area. Each line of laths was walked north-south by an archaeologist, resulting in parallel transects 100 feet (30.48 m) apart. Large disturbed areas were mapped and an attempt was made to locate any cultural remains from non-governmental use of the area.

RECONNAISSANCE RESULTS:

No cultural resources pre-dating government use of the area were found. This scarcity of cultural remains is consistent with results from seismic line surveys in Frenchman Flat (Reno 1982) and with mid-bajada areas on Yucca Flat (Reno and Pippin 1985:144).

RECOMMENDED PROCEDURES FOR THE PROTECTION OF CULTURAL RESOURCES:

The area surveyed for this project contains no cultural resources, but should land disturbing activities extend outside of these boundaries such areas must be surveyed for cultural resources.

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1985 *An Archaeological Reconnaissance of Yucca Flat, Nye County, Nevada*. Desert Research Institute Social Sciences Center Technical Report No. 35.

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APPENDIX V

DETAILED ASSESSMENT OF CONSTRUCTION ATMOSPHERIC EMISSIONS

APPENDIX V

DETAILED ASSESSMENT OF ATMOSPHERIC EMISSIONS

1.0 NATURE OF SURFACE DISTURBANCES

1.1 Total Emissions During Construction

Total particulate emissions resulting from construction activities were based on approximate emission factor

$$E_{TOT} = 1.2 \text{ t./acre/month of activity} \qquad (1)$$

where E_{TOT} represents total particulate emissions. This value is based on (1) medium-level activities; (2) moderate silt content (approximately 30 percent); and 3) semi-arid climate. The relationship is, thus, conservative for the present application with surface soil of low silt content. The relationship applies to particles less than approximately 30 μm in aerodynamic diameter, the total suspended particulates (TSP) measurement used for assessment of ambient concentration with respect to the TSP standard. During construction, dust levels will be minimized with frequent watering, a control method with an estimated efficiency of approximately 50 percent. Thus, estimates from equation (1) were halved for estimates of construction related particulate emissions.

Total annual emission resulting from wind erosion of exposed surfaces were based on the relationship

$$E_{TOT} = 1.7 \left(\frac{s}{1.5}\right)\left(\frac{365-p}{235}\right)\left(\frac{f}{15}\right) \text{ lb/day/acre}$$

where s is the silt content (percent), p is the number of days per year with precipitation ≥0.25 mm (0.01 in.), and f is the percentage of time that the unobstructed wind speed is greater than 5.4 m/s (12.1 mph). The relationship of equation (2) is based on empirical studies of wind erosion of active storage piles at western surface mines. For long-term (annual) emissions, s was assumed to be 5 percent, p was given a value of 30 based on 10 years of meteorological data from Yucca Flat, and f was given a value of 30 percent, estimated from 5 years of wind data from Yucca Flat. It was further assumed that soil compaction constitutes a control factor with 50 percent efficiency, so that estimates from equation (2) were halved for wind erosion from compacted surfaces.

It was further assumed that local traffic, not related to activities at the Area 5 Radioactive Waste Management Site (RWMS), would be slight and would not contribute significantly to dust levels. It is noted that dust from construction vehicles is implicitly included in the relationship for total particulate emissions for construction activities.

Finally, it was assumed that the total surface area of the cell under construction, and of a nearly completed active cell, is approximately 1.2 ha (3 ac), that the total surface area of the storm-water dike during construction is approximately 7 ha (17.4 ac) (21 m wide and 3,350 m in length), and that the exposed surface area of the storm-water dike after facing with indigenous vegetation or stone gabions is approximately 1.4 ha (3.5 ac) (4.2 m wide and 3,350 m long). Table 4-1 gives estimated maximum annual particulate emissions resulting from surface disturbance in the construction and operation phases. Additional assumptions are given as footnotes to Table 4-1.

1.2 Short-term Concentrations During Construction and Operation

Maximum 24-hour TSP concentrations resulting from particulate emissions during the construction and operation phases were estimated using U.S. Environmental Protection Agency (EPA) screening methods (Valley model, short-term mode, stability F, wind speed 2.5 m/s). Short-term emission rates were based on equations (1) and (2), except that p in equation (2) was set to zero to represent worst-case dry conditions, and f in equation (2) was raised to 50 percent to represent worst-case high wind periods. Cells and the storm-water dikes were modeled through a square area source approximation (the storm-water dike was modeled as 8 square area sources around the perimeter of the mixed waste disposal unit (MWDU) expansion area). Source heights of 2 m and 5 m were used to represent emission heights for the cells and storm-water control dike, respectively.

Maximum 24-hour average TSP concentrations were estimated for construction of the storm-water control dike, for construction of one cell, and for wind erosion from the unvegetated storm-water dike plus four exposed cell areas. As a worst possible case, particulate concentrations were estimated for a combination of wind erosion from the unvegetated storm-water dike plus wind erosion from four cell areas plus construction dust from one cell.

2.0 RELEASE OF CONSTITUENTS TO THE ATMOSPHERE

All waste to be buried in the MWDU would contain hazardous waste materials listed in 40 CFR Part 261. This section discusses the possible mechanisms by which hazardous and/or radioactive substances may be released into the atmosphere.

2.1 Process Summary

All wastes to be accepted at the MWDU are packaged solids and are not flammable in the solid state. Free liquids, bulk solids, or unpackaged material would not be accepted. Material packaging would conform to the requirements of Title 49 CFR and NVO-325. To ensure that waste material deposited in the MWDU shallow land disposal (SLD) cells satisfy the above criteria, wastes are sampled before shipment and tested to certify compliance with NVO-325 waste acceptance criteria.

Sample testing is performed at the generating site before shipment, and sealed packages are not opened for receiving inspection at the Area 5 RWMS. Incoming shipments are surveyed in accordance with NVO-325. If radiological contamination is detected, it would be assumed that hazardous chemical contamination may also be present. In this case, hazardous chemical surveys would also be performed using direct-reading instruments.

As material is received and surveyed, it would be off-loaded and stacked at one end of the SLD cell, to within 1.3 m (4 ft) of existing grade. A 2 m (6 ft) thick cover of existing alluvial material would be placed over the wastes, three rows at a time, until the cell is full. Cover material would be compacted to reduce the possibility of wind erosion.

As indicated previously, wastes to be buried at the MWDU are packaged, non-flammable solids contained in leak-proof containers and ultimately buried beneath 3 m (10 ft) of compacted alluvial soil. Based upon this process summary, exposure to the atmosphere could result from the following:

- Breaching of containers and release of hazardous gas or liquid by-products of chemical reactions.

- Breaching of containers and atmospheric entrainment of solid waste as suspended particles (aerosols).

- Suspension of radioactive material from contaminated container and vehicle surfaces.

2.2 Atmospheric Exposure Resulting from Chemical Reactions

Because of the stringent waste acceptance criteria, wastes permitted to be shipped to the MWDU would not need to be segregated. None of the materials are capable of mobilization or migration in their disposed-of state. Even if the waste were to come into contact with water, the leachate from different waste streams would not be reactive. Should waste segregation become necessary, there is adequate capacity to operate several cells simultaneously. Wastes are pretreated prior to shipment to the MWDU to stabilize gases, eliminate liquid content, and prevent bacterial action in any organic material that may be present. For these reasons, plus the frequent inspections of container integrity prior to final stacking, the possibility of atmospheric exposure through chemical reaction resulting in heat generation, fire, explosion, or generation of flammable/toxic gases is negligible.

2.3 Atmospheric Entrainment of Solid Waste Material as Suspended Aerosols

Some of the MW to be buried at the MWDU is friable and soil-like. Direct exposure to the atmosphere could thus cause small particles to be entrained and transported as suspended aerosols (wind dispersal). However, it is not clear how rapidly compacted material could be entrained if it is partially or completely exposed to turbulent air motion. In general, wind dispersal is not a problem because wastes are packaged in sealed containers and transported in closed vehicles. Inside active waste cells, the depth of the cell and periodic covering further eliminate the possibility of wind dispersal. However, direct exposure could result from accidental breaching of containers during transport, receiving, and off-loading of containers. The amount of waste material likely to be released to the atmosphere from accidental breaching depends upon the nature of the breach. If containers are simply punctured, e.g., as a result of penetration by a forklift during loading or unloading, the amount exposed probably would be very small. In such cases, rapid clean-up would minimize the possibility of release to the atmosphere. If such a breach occurs inside an active cell during unloading operations, operations would terminate, clean-up procedures would be initiated immediately, and the compromised container would be enclosed in overpacking material. The effects of accidental breaching inside an active cell would also be minimized by the sheltering provided by the cell walls, reducing exposure to ambient wind.

A more serious situation would result from large breaches, or spills, involving major destruction or other loss of integrity of the container and exposure of most of its contents. In that case, the severity would also depend upon exposure to ambient air and to prevailing wind and humidity conditions. Strong winds at the site of a major truck accident (Section 4.10) involving spills of MW, for example, could cause rapid suspension of material, but would also disperse the material rapidly. Such an accident would require emergency isolation and clean-up procedures.

Within an active cell, with unburied stacked waste containers, the worst situation would be if large amounts of waste material were released through fire or explosion. Although with the required waste treatment and stabilization, the probability of such an event is extremely low, the resulting plume could carry particles from damaged or destroyed containers, and possible toxic fumes, well into the atmosphere. A resulting hot plume would ascend rapidly and, depending on atmospheric conditions, could also disperse rapidly. A slow-burning fire, on the other hand, or a ground fire with a smoke column impinging on higher terrain, could cause ground-level concentrations to be much higher. In any case, fire-fighting equipment is kept on-site and, with access roads around the perimeter of each pit, response would be rapid and burn-time would be short.

Although wastes are treated and stabilized to prevent chemical reactions that could cause fire or explosions, some of the container and cell materials are flammable, e.g., wooden crates and pallets. In addition to the strength and durability of waste containers, the possibility of fire or exposure is minimized through prohibitions on smoking and restrictions on open flames inside of the Area 5 RWMS. Additionally, active waste cells would have a fire system installed to give early warning in the event of a fire in the waste stack. This alarm system sounds at the Area 5 RWMS offices and also at NTS fire departments in Mercury and Area 6, thereby allowing detection of fires even if they occur when the Area 5 RWMS is unmanned. Although the chances are very remote, the possibility of a stack fire exists and could occur in conjunction with a natural disaster such as an earthquake. In the event of fire or explosions, the Area 5 RWMS contingency plan calls for evacuation of personnel not required for first on-scene response, to at least 1.6 km (1 mile) in all directions and at least 1.6 km (1 mile) downwind from the site. Plans also call for suppression by Area 5 RWMS personnel, prior to arrival of the fire department, by using tanker trucks to spray water on the burning waste containers and by using earth-moving equipment to push dirt over the stack, if possible. Effects would be mitigated by the absence of resident human population and evacuation of workers.

As previously stated, contingency plans call for evacuation in the event of a fire or other accident. However, personnel in the immediate vicinity could still be exposed for a short period of time before evacuation plans could be implemented. A model analysis was performed to estimate concentrations of toxic and hazardous substances that could occur very near the scene of the accident. Two scenarios were considered: (1) a fire in an active burial cell that engulfs several waste packages; and (2) a crane accident resulting in the drop of a waste tritium container down a borehole. Details of the analyses are contained in Appendix VI. The analyses indicated that, in the case of fire, there could be possible hazardous concentrations of beryllium, lithium hydride, or radioactive isotopes at very close distances. Most of the danger would be from inhalation of fine particles. (There is no clear evidence that short-term exposure to beryllium dust is hazardous, although long-term exposure can lead to a lung disease called berylliosis.) The danger of an accidental fire is mitigated by the fact that it is unlikely that any individual at the accident site would remain in the smoke plume, unprotected, for very long. In any case, personnel should be cautioned to stay upwind from any accidental fire unless they are protected. For the accidental borehole drop, radioactivity very close to the source could exceed tolerable background concentrations by as much as three orders of magnitude. The danger in this case would also be from inhalation of β particles, and, as with the fire, personnel should be cautioned to stay upwind from the scene of a borehole accident unless they are suitably protected.

3.0 ACCIDENTAL ATMOSPHERIC RELEASES

Two accident scenarios were considered for evaluation of worst-cast accidental releases to the atmosphere. These scenarios were patterned after accident scenarios described by Hunter et al., 1982. That assessment included six accident scenarios involving ruptured waste containers and/or fire caused by internal or external sources. The two accident scenarios selected are: (1) a fire originating in one DOT-7A plywood box and spreading to adjacent boxes (Accident 1 in Hunter et al., 1982); and (2) crane failure that results in rupture of a tritium container dropped down a borehole (Accident 5 in Hunter et al., 1982). The first scenario involves the largest potential release of hazardous substances. The second scenario results in the largest release of radioactive material.

3.1 Method

The EPA dispersion model ISCST was used to estimate ground level concentrations of material accidentally released to the atmosphere. ISCST is a Gaussian plume model with an estimated accuracy, under ideal conditions, of a factor of two. For the present case, ISCST should provide order-of-magnitude estimates. A variety of assumptions is used in Gaussian models, including ISCST, that tend to yield conservative results in an application such as this.

ISCST was run in the flat terrain mode, with simulated receptors at distance increments of 25 m, out to 1 km, downwind from the source. A screening meteorological data set was used that consisted of 48 combinations of wind speed and atmospheric stability categories. For the accidental fire scenario, the fire was modeled as a small area source, and for the accidental fire scenario, the fire was modeled as a small area source, and for the accidental borehole drop scenario, the source was modeled as a point source. In both cases, emissions were assumed to originate at ground level. Model results provide estimates of ambient concentrations to which a person on the ground and at the center of the time-averaged plume could be exposed. Model listings are included at the end of this Appendix.

3.2 Fire in or Near Waste Container

In this scenario, a fire originates in or near a DOT-7A plywood box (4 x 4 x 7 ft). This could occur, for example, if a small puddle of diesel oil, spilled under a box or stack of boxes, ignites. The fire is assumed to originate in 1 box and ignites 4 boxes adjacent to the sides of the original box, 5 boxes on top of these boxes, plus 25 percent of each of the 4 boxes adjacent to the corner of the original box, for a total of 11 boxes. It is further assumed that the fire is extinguished in 1 hour.

APPENDIX VI

GROUNDWATER FLOW IN THE UNSATURATED ZONE

APPENDIX VI

GROUNDWATER FLOW IN THE UNSATURATED ZONE

Flow in the unsaturated zone obeys Darcy's Law for flow through porous media, which for one-dimensional flow is:

$$q_z = K_z \frac{dh}{dz}$$

where
q_z = specific discharge in the z direction
K_z = hydraulic conductivity in the z direction
h = total hydraulic head = $z + \psi$
ψ = pressure head
z = dimension in the vertical direction

However, the flow equation is complicated by the fact that both the hydraulic conductivity, K, and the moisture content, θ, are functions of ψ such that:

$$q_z = -K(\psi)\frac{\partial(z + \psi)}{\partial_z}$$

This is a highly non-linear function which has no simple analytical solutions. L.A. Richards in 1931 developed a solution to the unsaturated flow equation which is now known as the "Richards equation" (Freeze and Cherry, 1979):

$$\frac{\partial}{\partial\psi}\left[K(\psi)\frac{\partial\psi}{\partial x}\right] + \frac{\partial}{\partial y}\left[K(\psi)\frac{\partial\psi}{\partial y}\right] + \frac{\partial}{\partial z}\left[K(\psi)\left(\frac{\partial\psi}{\partial z} + 1\right)\right] = -S(\psi)\frac{\partial\psi}{\partial t}$$

where S(ψ) is the specific moisture capacity. Solution of this equation requires knowledge of soil moisture characteristic curves K(ψ) and S(ψ) or θ(ψ).

Even with the soil moisture characteristic curves, solution of the Richards equation is complex. Approximate solutions to the equation are available, such as that presented by Battelle (1986) or the equation can be solved with numerical methods using a computer (computer model). The Battelle approximation was developed as a screening model to identify vulnerable hydrologic conditions for hazardous waste.

APPENDIX VII

TRANSPORTATION

APPENDIX VII

TRANSPORTATION

1.0 INTRODUCTION

Mixed wastes generated at the NTS as a result of environmental restoration activities will be transported directly to the RWMS and will not require off-site transportation. In order to bound the transportation impact analysis, however, these wastes were not considered and it was assumed that all wastes not presently identified would be transported to the NTS from off-site generators. This appendix presents the methodology used to estimate the consequences of transporting mixed waste (MW) to the Nevada Test Site (NTS). The results of the risk assessments are also presented. Additionally, this section presents a discussion of the waste generator's and NTS's responsibilities for transporting and receiving MW, respectively. Appendix III presents the assumptions followed to estimate the environmental consequences of transportation.

2.0 RISK ASSESSMENT METHODOLOGY

2.1 Incident-Free

Incident-free input parameters for RADTRAN IV were developed with due regard for the characteristics of the MW Type A waste containers, and the specific anticipated transport conditions of the shipments. The penetrating radiation from the mixed waste contained in the waste package at levels allowed by the NTS Waste Acceptance Criteria (NVO-325) and Department of Transportation (DOT) regulations constitute a maximum source term for assessing incident-fee transportation impacts. In this case, no radioactive material is released but exposure to penetrating radiation from the waste package can occur to several population groups (transport crew, inspectors, people at stops where the waste shipment is located, people travelling along the highways at the same time as the waste shipment and people living along the transport route). Specific key data used by RADTRAN IV to assess incident-free transport risks are listed in Table AVII-1. The average curies per shipment used to develop the source term is presented in Table AVII-2.

In addition, maximum individual doses were determined using supplemental calculations to account for individual exposure due to inspections, refueling, food stops, and traffic congestion. The exposure categories and analysis follow the approach taken in the Waste Isolation Pilot Plant (WIPP), Final Supplemental Environmental Impact Statement (SEIS); however, selected exposure parameters were adjusted to account for specific circumstances for the mixed waste shipments. Individual dose estimates were calculated using line source (1/r) approximations with no credit for attenuation of radiation by the air or any intervening structures. Assumptions used to estimate the exposure received by the maximally exposed individuals are presented in Table AVII-3.

Table AVII-1. RADTRAN IV Incident-Free Data.

Transport Mode:	Truck over Public Highways
Route Distance[1]:	1,405 km (RFP/NTS) and 3,943 km (DWCF/NTS)
Route Population Fractions[1]:	route specific (see Table AVII-5)
Truck Speeds:	104.6 km/hr in rural zones 40.3 km/hr in suburban zones 24.2 km/hr in urban zones
Number of Crew:	2
Half Boxes Per Shipment:	16
Distance from Half Boxes (crew member in transit)	3.05 m
Stop Time:	0.011 hrs/km travelled
Number of Shipments:	Generator specific (see Table AVII-5)
Persons Exposed While Shipment is Stopped:	50
Average Exposure Distance While Stopped:	20 m
Transport Index for Each Shipment[2]:	Generator specific[3]

[1] Based on Transnet INTERSTAT run.
[2] Represents an exposure dose rate of 1/mrem/hr at a distance of 1 m from the package surface).
[3] TI Values
RFP Immobilized MW TI = 0.05.
DWCF Combustible/contaminated MW TI = 1.0.
DWCF Combustible/contaminated MW TI = 4.0.

Table AVII-2. Average Curies per Shipment.

Facility	Isotopes	Curies
RFP (TI = 0.05)		
Immobilized waste	Pu^{239}	3.20×10^{-2}
	Am^{241}	1.30×10^{-1}
	U^{238}	1.60×10^{0}
DWCF (TI = 1)		
	Mn^{54}	3.20×10^{-3}
	Co^{60}	3.20×10^{-2}
	Zn^{65}	1.12×10^{-2}
	Cs^{137}	3.20×10^{-2}
	Co^{57}	3.20×10^{-2}
	H^{3}(wtr)	1.60×10^{2}
	Pu^{239}	3.20×10^{-2}
	Am^{241}	1.30×10^{-1}
	U^{238}	1.60×10^{0}
DWCF (TI = 4.00)		
	Mn^{54}	1.07×10^{0}
	Co^{60}	1.07×10^{1}
	Zn^{65}	3.73×10^{0}
	Cs^{137}	1.07×10^{1}
	Co^{57}	1.07×10^{1}
	H^{3}(wtr)	1.60×10^{2}
	U^{238}	1.60×10^{0}
	Pu^{239}	3.20×10^{-2}
	Am^{241}	1.30×10^{-1}

Table AVII-3. Maximum Individual Exposure Assumptions.

Exposure Categories	Exposure Conditions	
Crew Member[1]	No. of Shipments:	5%
- In-Transit	Exposure Distance:	3.05 m
	Exposure Duration:	In-transit time
	Exposure Model:	RADTRAN IV
- Stops (Inspections)[2]	Exposure Distance:	1.0 m
	Exposure Duration:	.25 hours
	Exposure Model:	TI dose
- Stops (Food Stops)[3]	Exposure Distance:	20 m while dining, 10 m during surveillance
	Exposure Duration:	1 hour while dining, 1 hour during surveillance
	Exposure Model:	Line source
Departure Inspections	No. of Shipments:	100%
	Exposure Distance:	3.0 m
	Exposure Duration:	0.5 hour
	Exposure Model:	Line source
Member of Public On-Link[4]	No. of Shipments:	One Time Event
	Exposure Distance:	1.0 m
	Exposure Duration:	0.5 hour
	Exposure Model:	TI dose
Member of Public Off-Link[5]	No. of Shipments:	100%
	Exposure Distance:	30 m
	Exposure Duration:	Time for shipment to pass at 24 km/hr
	Exposure Model:	RADTRAN IV
Member of Public at Stops[6]	No. of Shipments:	50%
	Exposure Distance:	20 m
	Exposure Duration:	2 hours
	Exposure Model:	Line source

1 No refueling stops are assumed to be required.
2 Inspections are assumed every 161 km (100 miles).
3 Analysis assumes two food stops per trip.
4 Accounts for exposure to an individual in an adjacent traffic lane for an extended length of time due to traffic congestion.
5 Accounts for exposure to an individual due to all shipments which travel by his or her residence or workplace.
6 Accounts for exposure to an individual working at a truckstop.

2.2 Accidents

Highway accidents involving mixed waste shipments can potentially result in radiologic exposures to people due to release of material or nonradiologic consequences (injuries or fatalities due to accidents). The MW in the package constitutes the material at risk and potentially available for release during accidents.

The amount of radioactive or other hazardous material released in an accident depends on the severity of the accident, the characteristics of the waste, and the capabilities of the shipping container. The accident severity category scheme developed by the NRC in NUREG-0170 (Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes) was used in this analysis. The NRC defined eight accident severity categories for each transportation mode. DOT Type A packages used to ship waste to NTS can withstand a severity category I accident. Above this category, a breach in the packaging would be expected. A category VIII accident is defined as the most severe accident, with a typical fire duration of 2 hours. Other classification schemes may be utilized with additional severity categories; however, the most severe accident category would remain the same regarding level of damage and the amount of material released. Thus, for a twenty severity category classification scheme, a category 20 accident would have the same impact as a category VIII (NRC) accident. With limited data to differentiate between accident categories, there is no need to have more than eight accident categories. For the most severe accident, literature resources and conservative assumptions were used to develop best available estimates for releases. As an example, for combustible materials, it was assumed that all the material burned, with appropriate release fractions for aerosolized radioactive particulates applied to the quantity of material burned. Table AVII-4 shows the accident rates and severity category probabilities used in the analysis.

The key parameter for analyzing accidents is the estimated release fraction of radioactive material escaping to the environment. Particulates can result from impacts during accidents which fracture the radioactive material or from fires which can entrain impact-generated particulates, cause off-gassing of volatile fission products, or thermally degrade and then entrain particulates from previously intact material. For accident conditions, the parameter determines the fraction of radioactive material released to the environment and available for dispersal downwind from the accident site. Inhalation is a primary internal exposure pathway for people that results from breathing respirable (< 10μm), aerosolized particulates. As the particulates move downwind, some settle out onto the ground where they are weathered or washed away by natural processes. This pathway constitutes the "groundshine" exposure resulting from an accident. After settling, some fraction of the particles can also be resuspended into the air due to wind or other surface disturbance. These particles can then be inhaled by people as were those in the initial plume and constitute the source term for the resuspension dose pathway. Finally, particles in the air can also expose people to penetrating radiation (aside from inhalation); this pathway constitutes a "cloudshine" exposure. The sum of the exposures from these pathways constitutes the total exposure. For this analysis, the ingestion pathway (wherein particles settle on plants which are then ultimately consumed by people) was not assessed. Based on the dose conversion factors, inhalation exposures result in doses one or two orders of magnitude greater than ingestion for equal uptakes of radioactive material. In addition, any accident resulting in contamination of crops would result in interdiction of those crops (or resultant animal products) prior to consumption by the public.

Table AVII-4. Accident Rates and Severity Category Probabilities.

Population Zone	Accident Rate	Severity Category	Probability
Rural	1.370×10^{-7} acc/km	1	.4620
		2	.3020
		3	.1760
		4	.0403
		5	.0118
		6	.0065
		7	.0006
		8	.0001
Suburban	3.000×10^{-6} acc/km	1	.4350
		2	.2850
		3	.2210
		4	.0506
		5	.0066
		6	.0017
		7	.00007
		8	.000006
Urban	1.600×10^{-5} acc/km	1	.5830
		2	.3820
		3	.0278
		4	.0064
		5	.0007
		6	.0001
		7	.00001
		8	.000001

Risks from accidents that can occur regardless of cargo being transported are termed non-radiologic risks and derive simply from the fact of driving between origin and destination points.

Injuries or fatalities resulting from traffic accidents are based on national highway statistics (DOT, 1988); one-way distance travelled is the key parameter for projecting per shipment and campaign non-radiologic risks. For MW shipments, a one-way trip distance of 2,451 miles for the DWCF and 873 miles for Rocky Flats Plant to NTS was assumed with injury and fatality rates per mile of travel taken from the WIPP SEIS transportation risk assessment. For travel through urban zones, very small adverse health effects due to added pollution from vehicle exhausts, and particulates from tires and brakes are also possible. Table AVII-5 summarizes the non-radiologic risk assumptions used in the MW risk analysis.

3.0 SOURCE TERM

3.1 Introduction

This section outlines the source term analysis conducted for mixed low-level waste forms subject to transportation accident conditions. The source term calculations determine the quantity of radioactive material released in a respirable, airborne form, following an accident. Larger particle sizes (greater than 10 μm mean aerodynamic diameter) are not analyzed since they tend to be eliminated by the body and consequently are not significant in estimating health effects. The magnitude of the source term will be affected by the amount of material-at-risk in the accident, the accident conditions (e.g., intensity and duration of fire, impact energy, which are reflected in the severity category scheme used in RADTRAN), the radioactive material release mechanism, and the level of confinement provided by the waste containers.

3.2 Methodology

Calculation of radioactive release fractions for transportation accident conditions requires a knowledge or determination of three primary factors:

1. Characterization of the waste form involved in the postulated accident.

2. Identification and quantification of the response of the Type A shipping container to accident conditions.

3. Identification and quantification of the release mechanisms for the applicable accident conditions.

The release mechanism analysis utilizes representative values for parameters where published data and test results are applicable and reasonable, and conservative estimates where uncertainties exist.

Both impact and thermal release mechanisms may lead to respirable releases of radioactive material from mixed low-level waste forms under accident conditions. Potential impact release mechanisms include waste container failure, fragmentation of solid wastes, particulate formation from impact forces, and aerodynamic entrainment of particles. Thermal release mechanisms include thermally induced failures of waste containers; aerosolization of particles by combustion, gas generation, or heating or contaminated surfaces; and potential volatilization of radionuclides. Review of available information and test data in the literature has been used to identify and quantify applicable release mechanisms for waste forms, (e.g., combustible/noncombustible mixes and immobilized mixed low-level waste).

Table AVII-5. Non-Radiologic Risk Assumptions.

Population Zone	Injuries/mile	Fatalities/mile	LCF's/mile
Rural	1.33×10^{-6}	1.09×10^{-7}	0
Suburban	6.32×10^{-7}	2.69×10^{-8}	0
Urban	6.16×10^{-7}	1.54×10^{-8}	1.67×10^{-7}

One-Way Trip Distance: 2,451 miles DWCF to NTS

Travel in Population Zone: 873 miles RFP to NTS

Population Fractions[2]:

	DWCF	RFP
Rural	78.9	86.7
Suburban	19.9	12.4
Urban	1.2	0.9

Total Shipments:

NTS[1]	10
RFP	1,014
DWCF	4,614
TOTAL	5,628

[1]Assumed number of on-site shipments
[2]Percentage travel in each population zone

3.3 Suspension Factors

Fire - Releases. Transportation accidents can involve a fire which will produce a thermally driven suspension mechanism for releasing radioactive material. The extent of release will be governed by the duration of the fire and the temperatures attained within the waste matrix. For this analysis, 1.7% of all accidents are expected to result in a fire; duration is dependent on accident severity category.

The fire resulting from transportation accidents is caused by burning of fuel carried by the vehicles involved and may include fuel carried as cargo if any of the vehicles is a tanker. In this case, a more intense, longer fire would result. Flame temperatures for open burning of hydrocarbon fuels range from 1,400°F to 2,400°F, with a median temperature of approximately 1,800°F. Any transuranic isotopes within mixed low-level waste are present in an oxide form, which are highly stable at elevated temperatures. Alexander (1986) reports that volatile releases of transuranic isotopes, such as plutonium, are not of any significance until temperatures of 3,140°F are reached. Uranium oxide (e.g., UO_2 volatilization becomes measurable at approximately 2,960°F). Consequently, a volatile release of plutonium, other transuranic oxide material, or uranium oxide is not credible for the postulated accident cases. Remaining possible thermal suspension mechanisms include burning of combustible waste and heating of non-combustible or immobilized waste forms.

The Nuclear Fuel Cycle Facility Accident Analysis Handbook (Ayer, 1988) suggests a conservative suspension factor of 5.3×10^{-4} for the burning of contaminated (powder) combustible solids. This is primarily based on tests conducted by Mishima and Schwendiman (1973a) with flammable wastes, in which standard waste cartons on an elevated screen were ignited in a 710 ft^3 enclosure (9.5 ft in diameter at 10 ft tall). The average waste composition consisted to cardboard (17.5%), paper (41.1%), plastic (9.2%), rubber (2.4%), and miscellaneous material (29.3%). Exterior air was drawn into the tank enclosure through a 2-ft x 2-ft duct. While tests tend to overestimate respirable suspension values due to the idealized experimental conditions, it is judged that they are the most applicable results for combustible waste forms for the fire environments under consideration. Conservatisms include making the powder contaminant artificially more dispensable than for the actual contaminated waste and optimized fuel-air mixing.

Heating of noncombustible contaminated surfaces results in an additional thermally-drive suspension mechanism. The Nuclear Fuel Cycle Facility Accident Analysis Handbook recommends a suspension factor of 2.5×10^{-6}/second. This value is applied to both noncombustible and immobilized waste materials. The duration of the release will correspond to the extent of time the waste matrix is at an elevated temperature. They may not correspond to the fire duration and will depend on the accident thermal conditions (e.g., flame temperature, heat flux, heat source orientation to material), the attendant heat transfer mechanisms (e.g., convection, conduction, radiation), and the thermal properties of the waste matrix (e.g., thermal conductivity, heat capacity). These factors will tend to delay any rise to elevated temperature within the waste matrix as well as extend the length of time at an elevated temperature once the heat source is removed. However, for this analysis, because all 16 boxes of mixed low-level waste were assumed subjected to the thermal event (a conservative assumption), the time at temperature was assumed equal to the fire duration.

For mixed low-level combustible fractions of combustible/noncombustible mixtures, complete combustion was assumed with a respirable particulate release fraction suggested by Mishima (1973a). Identical assumptions (i.e., release from 100% combustion of the combustible fraction) applied to accidents in all accident severity categories. For noncombustible fractions, respirable release fraction were based on a particulate rate suggested by the Nuclear Fuel Cycle Facility Accident Analysis Handbook (2.5 x 10^{-6}/second) and fire durations ranging from 15 minutes for severity category I accidents to 2 hours for severity category IV-VIII accidents. All noncombustible fractions were assumed susceptible to thermal release of particulates. The total release fraction for the combustible/noncombustible mix assumed a 50/50 split between the fractions. Volatilization of fission products (Cs^{137}) was assumed to be included in the release fractions calculated for the combustible/noncombustible fractions. For immobilized waste forms, the release fractions calculated for noncombustible fractions were reduced to account for the fact that not all of the immobilized material is at risk in a fire event. This analysis assumed that the immobilized waste forms were represented by a concrete monolith in each 2 ft x 4 ft x 7 ft box. Assuming a fully engulfing fire equally exposing all surfaces of the block at a temperature of 1,800°F, an ambient concrete temperature of 100°F, a coefficient of thermal conductivity for concrete of 0.79 BTU/hr-ft-°F, and non-steady state conduction, an estimate was made of the volume of the concrete block at a temperature greater than 500° F (where particulate release from heated surfaces becomes important). This volume increased with accident severity category as longer fires were assumed.

Impact - Releases. Impact-related suspension mechanisms for releasing radioactive material occur in postulated transportation accidents in severity categories II - VIII. Impact energy can lead to fragmentation of solid waste resulting in the formation of suspended particulates or in the resuspension of contamination present on the waste matrix surface. The fraction of radioactive material aerosolized from impact stresses may be calculated using a resuspension factor approach. Substantial information exists regarding the resuspension of particulates (NUREG-75/014, Sutter, 1982). The extent of resuspension will depend on the mechanical stress applied and the firmness of the contamination fix. Resuspension factors (K) are defined as the airborne concentration/m^3 divided by the surface contamination/m^2 below the airborne measurement. Mathematically, this relationship may be expressed as:

$$K(m^{-1}) = \frac{AirborneContamination/m^3}{SurfaceContamination/m^2}$$

Sutter (1982) identifies a range of resuspension factors (4 x 10^{-2} to 1 x 10^{-10}) from various mechanical resuspension stresses.

For this analysis, a resuspension factor of 1 x 10^{-2}/m was assumed for severity category II, and a value of 4 x 10^{-2}/m for severity categories III - VIII for mixed waste boxes of combustible/noncombustible fractions. The maximum suspension factor corresponds to the highest measured value for the mechanical action of vigorous sweeping. For severity category II, the resuspension factor of 1 x 10^{-2} corresponds to the lower reported value for rigorous sweeping.

The resuspension factor may be used to estimate a release using the following approach:

$$K(m^{-1}) = \frac{AirborneContamination/m^3}{SurfaceContamination/m^2}$$

$$= \frac{(Ci/PackageVolume)_{air}}{(Ci/PackageSurfaceArea)_{waste}}$$

$$= (Ci_{air}/Ci_{waste})A/V$$

Solving for the aerosolized fraction (Ci_{air}/Ci_{waste} = RF) on an individual mixed waste box basis:

$$RF = (K)(V)/A$$

Where

K	=	Resuspension factor
V	=	Box void volume
	=	$1.11m^3$ (70% void volume)
A	=	Contamination surface area within box (conservatively taken as outer surface area)
	=	$9.29m^2$

Releases of respirable particulates from immobilized mixed low-level waste following impact events were calculated based on data developed by Jardine (1982). Release fractions of respirable particulates from concrete subjected to impact loads were estimated at 0.43%. Because it is unreasonable to assume that all 16 boxes in a shipment will be subjected to identical impact conditions at all accident severity categories, the value estimated by Jardine was reduced to account for the fraction of failed containers. This data was presented in NUREG-0170 for Type A containers. No releases are expected for severity category I accidents, 0.01 of the boxes fail in a severity category II accident, 0.10 fail at severity category II, and all boxes (100%) fail in accidents above severity category III.

<u>Entrainment - Releases</u>. Aerodynamic entrainment of particulates can act as another resuspension mechanism. For this analysis, entrainment could apply to particulate contaminants in combustibles after an impact or to contaminants in residues from previously burned combustible fractions; it does not apply to noncombustible fractions or immobilized waste because all thermally or mechanically generated respirable particles were assumed released to the environment by the previously discussed mechanisms. Parameters influencing the fraction of contaminant that may become airborne include the physical characteristics of the surface involved (e.g., porosity), windspeed, and the chemical and physical nature of the contaminant.

Sutter (1982) reports various calculated and measured resuspension rates for outdoor situations (Nevada Test Site, Hanford, Prairie Terrain, Eroding Field Conditions), with values ranging from 2.7

x 10^{-12} sec^{-1} to 3.5 x 10^{-6} sec^{-1}. The highest value corresponds to an eroding field, with an erosion rate of 310 tons/acre/month. Sutter observes that wind acting as a resuspension force will generally have a fairly low fractional removal rate of 1 x 10^{-10} sec^{-1} to 1 x 10^{-8} sec^{-1}, depending on the surface and windspeed. Mishima (1973b) have measured somewhat higher suspension rates for uranium oxide powder from various surfaces (smooth sandy soil, vegetation, stainless steel surface) in wind tunnel tests. Suspension rates ranged from 2.5 x 10^{-8} sec^{-1} to 6.7 x 10^{-6} sec^{-1} for a wind speed of 2.5 mph and 2.8 x 10^{-6} sec^{-1} to 6.8 x 10^{-5} sec^{-1} for a wind speed of 20 mph. In view of the idealized conditions for the above tests (highly dispensable powder, relatively smooth surfaces) and the other reported data, a resuspension rate of 4.6 x 10^{-10} sec^{-1} was selected for this analysis and applied to all radioactive material remaining in the combustible waste fraction after an impact (e.g., particulates generated by impact were released by the impact). Table AVII-6 summarizes the release fraction components determined for the various mixed low-level waste forms. Table AVII-7 summarizes total release fractions.

4.0 HAZARDOUS CHEMICAL RISK

Table AVII-8 shows the chemical constituents of MW. Chemicals of interest in MW are metals and Volatile Organic Compounds (VOCs) in the form of degreasers and spent solvents. These historical data were used to estimate an upper bound of potential chemical impacts. Actual impacts will be significantly lower because all wastes shipped to the Area 5 MWDU are required to meet LDR standards.

The EPA Health Effects Assessment Summary Tables were utilized to identify chemical species having either carcinogenic or noncarcinogenic effects. Of the chemical constituents identified, several are not listed or unit risk values have not been determined for the inhalation pathway (2-Butane, Ethylbenzene, Trichlorofluoroethane, 1,2-Dichloropropane). Cadmium is classified as a probable human carcinogen, with limited evidence of carcinogenicity in humans. Chloroform is also classified as a probable human carcinogen; however, while there is sufficient evidence of carcinogenicity in animals, there is a lack of evidence in humans. Methylene chloride is also of interest because it is considered a potential carcinogen by the EPA. 1,1,1-Trichlorethane and Freon-113 might produce adverse health effects. Lead is one of the most abundant metals found in the waste by both weight and volume. In sufficient concentrations, exposure to lead has been found to cause damage to the central nervous system and loss of kidney function.

During incident-free transportation of MW to NTS, the hazardous chemical constituents of this waste will present no exposure risk. This is due to the fact that 1) the waste is contained in Type A containers which are constructed so that they will not leak during normal transportation and handling conditions; 2) the initial concentration of these waste are low; and 3) the physical form of the waste further limits the concentration available for release.

In transportation accidents, the nature of hazardous chemical exposures is due to the accident release mechanisms. For this analysis a transportation accident scenario was postulated to determine the potential releases of VOCs and metals. The scenario assumes that a shipment of 16 half boxes of combustible/non-combustible waste is involved in an impact and subsequent fire. All 16 boxes are involved in the fire with the result that the total amount of VOCs calculated to be in the box are released.

Table AVII-6. Release Fraction Components.

Release Mechanism	Combustible		Noncombustible		Immobilized	
Impact:	RF = (K)(V)/(A)		RF = (K)(V)/(A)		RF = (MAR)(.43%)	
Sev. Cat.	K	RF	K	RF	MAR	RF
I	0	0	0	0	0	0
II	1×10^{-2}	1.19×10^{-3}	1×10^{-2}	1.19×10^{-3}	.01	4.3×10^{-5}
III	4×10^{-2}	4.78×10^{-3}	4×10^{-2}	4.78×10^{-3}	.10	4.3×10^{-4}
IV	4×10^{-2}	4.78×10^{-3}	4×10^{-2}	4.78×10^{-3}	1.00	4.3×10^{-3}
V	4×10^{-2}	4.78×10^{-3}	4×10^{-2}	4.78×10^{-3}	1.00	4.3×10^{-3}
VI	4×10^{-2}	4.78×10^{-3}	4×10^{-2}	4.78×10^{-3}	1.00	4.3×10^{-3}
VII	4×10^{-2}	4.78×10^{-3}	4×10^{-2}	4.78×10^{-3}	1.00	4.3×10^{-3}
VIII	4×10^{-2}	4.78×10^{-3}	4×10^{-2}	4.78×10^{-3}	1.00	4.3×10^{-3}
Thermal:	RF = (5×10^{-4})(FAT)		RF = $(2.5 \times 10^{-6}$/sec)(FD)(FAT)		RF = (2.5×10^{-6}) (FD)(FAT)(MAR)	
Sev. Cat.	RF	K	RF	FD	MAR	RF
I	8.5×10^{-6}	.25/hr	3.8×10^{-5}	.25/hr	.029	1.1×10^{-6}
II	8.5×10^{-6}	1 /hr	1.5×10^{-4}	1 /hr	.055	4.7×10^{-6}
III	8.5×10^{-6}	1.5 /hr	2.3×10^{-4}	1.5 /hr	.068	1.6×10^{-5}
IV	8.5×10^{-6}	2 /hr	3.1×10^{-4}	2 /hr	.079	2.4×10^{-5}
V	8.5×10^{-6}	2 /hr	3.1×10^{-4}	2 /hr	.079	2.4×10^{-5}
VI	8.5×10^{-6}	2 /hr	3.1×10^{-4}	2 /hr	.079	2.4×10^{-5}
VII	8.5×10^{-6}	2 /hr	3.1×10^{-4}	2 /hr	.079	2.4×10^{-5}
VIII	8.5×10^{-6}	2 /hr	3.1×10^{-4}	2 /hr	.079	2.4×10^{-5}
Wind Entrainment:	RF = $(4.6 \times 10^{-10}$/sec) (duration)(1-impact)					
Sev. Cat.	Duration	RF				
I	4 hrs	6.6×10^{-6}	Included in Thermal Above		N/A	
II	8	1.3×10^{-5}				
III	12	2.0×10^{-5}				
IV - VIII	24	4.0×10^{-5}				

MAR - Material at Risk
K - Resuspension Factor (m^{-1})
FAT - Fraction of truck accidents involving fire = 1.7%
FD - Fire duration
V/A - Volume/Area of 1/2 size box (assuming 70% void volume)

Table AVII-7. Total Release Fractions.

Severity Category	50/50 Combustible/Noncombustible	Immobilized
I	2.65×10^{-5}	1.10×10^{-6}
II	1.27×10^{-3}	4.77×10^{-5}
III	4.91×10^{-3}	4.46×10^{-4}
IV	4.96×10^{-3}	4.32×10^{-3}
V	4.96×10^{-3}	4.32×10^{-3}
VI	4.96×10^{-3}	4.32×10^{-3}
VII	4.96×10^{-3}	4.32×10^{-3}
VIII	4.96×10^{-3}	4.32×10^{-3}

Table AVII-8. Hazardous Constituents in Mixed Waste Shipments to the NTS.

Constituent	Range of Concentrations (µg/L)	Average Concentration (µg/L)
Volatile Organics:		
Acetone	130 - 6,800	2,000
2-Butanone	130 - 7,300	3,715
Chloroform	29 - 620	297
1,1-Dichloroethane	N/A	53
1,2-Dichloropropane	N/A	73
Ethylbenzene	N/A	410
Methylene Chloride	120 - 2,400	883
Toluene	32 - 750	286
1,1,1-Trichloroethane	N/A	3,700
Trichlorofluoroethane	N/A	61
Trichlorofluoromethane	N/A	340
1,1,2-Trichloro-1,2,2-Trifluroethane	130 - 3,800	2,043
Xylenes (Total)	15 - 18,000	3,937
Metals:		
Beryllium (particulate)		10 ppm
Cadmium		390 ppm
Lead (particulate)		200 ppm
Lead (metal)		344 kg/m^3
Mercury		50 ppm
Arsenic		Trace
Lithium		Trace

N/A - not applicable

The initial concentrations of VOCs of concern, and the estimated quantities released to the atmosphere during the accident, are presented in Table AVII-9. These quantities were used to estimate release rates and potential receptor concentrations (50 m from the accident site) assuming stable meteorologic conditions. The estimated releases in Table AVII-9 are an upper bound of potential releases because the VOC concentrations in the waste used in the calculations are higher than the LDR standards specified in the waste acceptance criteria for wastes to be disposed of at the MWDU.

Table AVII-9. Primary Volatile Organic Compound Concentrations of Mixed Waste

Hazardous Constituent	Average Headspace Gas Concentration (g/m^3)	Release (g)[2]
Methylene chloride	0.5	12.9
1,1,1-trichloroethane	13.2	334.9
Trichloroethylene	0.7	17.8
1,1,2-trichloro-1,2,2-trifluoroethane	1.2	30.4

[1] Based on TRU drum measurements at INEL

[2] Assumes headspace gas concentration applied to 16 boxes of combustible/noncombustible waste

With regard to hazardous metals, it was assumed that particulates of lead, cadmium, beryllium and mercury and chunks of lead (shielding, bricks, gloves, aprons) and beryllium may be present in the noncombustible fraction of the mixed waste. For the transportation accident analysis, a shipment of 16 half boxes of 50/50 combustible/noncombustible waste was assumed to be impacted and burned in a 1 hour fire. While the open burning of hydrocarbon fuels creates a flame temperature of approximately 1800°F, the thermal inertia of 16 boxes, convection mitigating mechanisms, air starvation due to accident debris and fumes, and likely evaporation of fuel and the debris before it burns all contribute to lower the average temperature of the event; for this analysis, a temperature of 1000°F was assumed. Releases of respirable particulates in this accident scenario can occur by the following mechanisms: 1) impact release of particulate fractions, 2) thermal entrainment of particulate fractions not released by impact, 3) thermal release of vapors from particulate fractions or metal chunks. Respirable particulates constitute 1% of the particulate fractions (per NVO-325 Waste Acceptance Criteria) and it was assumed that 1% of thermally released particles would be of respirable size. Impact releases and thermal entrainment of metallic particles were analyzed using the release fractions for radioactive particulates from noncombustible fractions of mixed waste.

To calculate vapor releases, partial pressures of metallic vapors at 1000°F over unlimited metal sources were determined. These partial pressures were used to calculate vapor concentrations and resulting source terms assuming the vapors were released from an area source (top surfaces of 16 burning boxes) with a wind speed of 2 m/sec for 1 hour.

The source term for each species (or the total grams available in the waste if this quantity was limiting) was used to estimate a respirable emission rate and resulting air concentration at a location near the accident.

5.0 RISK ASSESSMENT RESULTS

Results of the MW transportation risk assessment are presented in Tables AVII-10, AVII-11, and AVII-12 for incident-free, accident, and nonradiologic categories, respectively. Incident-free exposures to occupational and nonoccupational population groups for the annual shipping campaign are 211 person-rem and 109 person-rem, respectively. Using a health effect conversion factor of 4 x 10^{-4} latent cancer fatalities (LCF) per person-rem for workers and 5×10^{-4} LCF per person-rem for members of the general public (NRC, 1991), it is estimated that these exposures would result in much less than one additional LCF in the exposed populations (occupational health effects are 0.08 LCFs; nonoccupational health effects are 0.06 LCFs). Maximum individual exposures due to the shipping campaign to various population groups range from 0.0001 rem for a person living along the transportation route, and exposed to every shipment, to 2.26 rems for a truck driver who transports 5% of the shipments. Table AVII-10 presents the exposures that might be received by the various maximally exposed individuals.

Exposures to the public from radioactive material released in an accident range from 1.80 person-rems to 202 person-rems (0.0009 LCFs to 0.1 LCFs) if no credit is taken for the waste container in further reducing release fractions.

Nonradiologic consequences of the annual shipping campaign are also quite small. Less than one fatality (0.2) is estimated due to traffic accidents. Injuries due to transportation accidents is also quite low (2.9) for the annual shipping campaign. Much less than one additional LCF (0.0048) would be caused in urban areas by the pollution generated from the shipments. Total estimated fatalities and injuries for the five year shipping campaign are 1 and 15, respectively.

Table AVII-13 presents the risks of an accident exposure to VOC's. As presented in the table, potential exposure to volatile organic compounds resulting from the most severe credible transportation accident analyzed would be below the occupational exposure levels listed by the American Conference of Government and Industrial Hygienists. The estimated releases in Table AVII-13 are an upper bound of potential releases because the VOC concentrations in the waste used in the calculations are higher than the LDR standards specified in the waste acceptance criteria for wastes to be disposed of at the MWDU. The results of the analysis for metallic releases in a transportation accident are shown in Table AVII-14. Cadmium exposures may exceed the permissible exposure limits in the National Institute of Occupational Safety and Health Guide for continuous workplace exposure, but any exposure resulting from a transportation accident would occur outdoors and last only a short time, as opposed to a continuous workplace exposure. Additionally, such an exposure is highly unlikely because the EA estimates for metallic species are conservative, overstating potential exposure by at least ten times.

Table AVII-10. Annual Incident-Free Exposures.

Immobilized Sludges - RFP/NTS[1]

Population Group	Per Shipment[2]	Annual No. of Shipments	Annual Exposure
Occupational (person-rem)	3.54×10^{-3}	203	7.19×10^{-1}
Nonoccupational (person-rem)	2.01×10^{-3}		4.08×10^{-1}
Max Individuals (rem):			
Crew	4.04×10^{-4}		8.20×10^{-2}
Departure Inspections	8.33×10^{-6}		1.69×10^{-3}
Public (On-Link) (one time)	N/A		2.50×10^{-5}
Public (Off-Link)	1.06×10^{-9}		2.15×10^{-7}
Public (Stops)	5.00×10^{-6}		1.02×10^{-3}

Combustible Waste and Contaminated Metals - DWCF/NTS[3]

Population Group	Per Shipment[2]	Annual No. of Shipments	Annual Exposure
Occupational (person-rem)	8.80×10^{-1}	10	8.80×10^{0}
Nonoccupational (person-rem)	4.56×10^{-1}		4.56×10^{0}
Max Individuals (rem):			
Crew	9.88×10^{-2}		9.88×10^{-1}
Departure Inspections	6.68×10^{-4}		6.68×10^{-3}
Public (On-Link) (one time)	N/A		8.00×10^{-3}
Public (Off-Link)	8.44×10^{-8}		8.44×10^{-7}
Public (Stops)	4.00×10^{-4}		4.00×10^{-3}

Table AVII-10. Annual Incident-Free Exposures (continued).

Combustible Waste and Contaminated Metals - DWCF/NTS[4]

Population Group	Per Shipment[2]	Annual No. of Shipments	Annual Exposure
Occupational (person-rem)	2.20×10^{-1}	913	2.01×10^{2}
Nonoccupational (person-rem)	1.14×10^{-1}		1.04×10^{2}
Max Individuals (rem):			
Crew	2.47×10^{-3}		2.26×10^{0}
Departure Inspections	1.67×10^{-4}		1.52×10^{-1}
Public (On-Link) (one time)	N/A		5.00×10^{-4}
Public (Off-Link)	2.11×10^{-8}		1.93×10^{-5}
Public (Stops)	1.00×10^{-4}		9.13×10^{-2}

[1]Assumes TI = 0.05
[2]Per shipment is in rems per shipment.
[3]Assumes TI = 4.00
[4]Assumes TI = 1.00

Table AVII-11. Annual Accident Exposures.

Origin/Waste type	Per Shipment (person-rem)	Annual No.[1] of Shipments	Annual Campaign (person-rem)
RFP			
immobilized	8.85×10^{-3}	203	1.80×10^{0}
DWCF			
combustible/contaminated metals (TI = 1 Source)	2.21×10^{-1}	913	2.02×10^{2}
DWCF Combustible/contaminated[4] metals (TI = 4 Source)	2.58×10^{-1}	10	2.58×10^{-0}

[1]Due to rounding, the annual number (x5) is slightly greater than 5,628.

6.0 MIXED WASTE TRANSPORTATION PLANNING AND RESPONSIBILITIES

The MW truck transportation system will consist of the shippers (the site), the carrier (the trucking contractors), and the receiver (NTS). With respect to transportation, the defense facilities will be responsible for implementing the following transportation activities.

First, the generator must secure written approval from the DOE/NV Manager to send defense MW to the NTS Area 5 RWMS. After securing written approval, the generators must contact Reynolds Electrical & Engineering Co., Inc. (REECo) Defense Waste Management Department (DWMD) to arrange for transfer of the waste and all accompanying records. To expedite waste receipt and handling at NTS, offsite waste generators must comply with the following procedure:

1. Before a waste shipment leaves its point of origin, the generator must contact the REECo Traffic Section or, for classified and special nuclear material shipments, contact the DOE/NV Safeguards and NTS Security Branch and provide the following information:

    a. time of departure from shipping point and estimated arrival time at NTS;
    b. carrier and trailer numbers, and seal numbers, where applicable;
    c. description of load (number of pieces, volume, and weight);
    d. waste type; and

Table AVII-12. Annual Nonradiologic Consequences.

Population Zone	Per Shipment Injuries	Per Shipment Fatalities	Per Shipment LCF's	No. of Shipments	Annual Injuries	Annual Fatalities	Annual LCF's
DWCF Rural	2.57×10^{-3}	2.11×10^{-4}	0	923	2.4×10^{0}	1.9×10^{-1}	0
Suburban	3.08×10^{-4}	1.31×10^{-5}	0		2.8×10^{-1}	1.2×10^{-2}	0
Urban	1.79×10^{-5}	4.47×10^{-7}	4.84×10^{-6}		1.7×10^{-2}	4.1×10^{-4}	4.5×10^{-3}
TOTAL					2.7×10^{0}	2.0×10^{-1}	4.5×10^{-3}
RFP Rural	1.01×10^{-3}	8.25×10^{-5}	0	203	2.1×10^{-1}	1.7×10^{-2}	0
Suburban	6.83×10^{-5}	2.91×10^{-6}	0		1.4×10^{-2}	5.9×10^{-4}	0
Urban	4.93×10^{-6}	1.23×10^{-7}	1.34×10^{-6}		1.0×10^{-3}	2.5×10^{-5}	2.7×10^{-4}
TOTAL					2.3×10^{-1}	1.8×10^{-2}	2.7×10^{-4}

Table AVII-13. Estimated exposures to volatile organic compounds and associated risks from a transportation accident involving truck shipments.

Chemical	Receptor concentration (mg/m^3)	TLV-TWA[1] (mg/m^3)
Methylene chloride	1.3×10^0	175
1,1,1-trichloroethane	3.4×10^1	1900
Trichloroethylene	1.8×10^0	270
1,1,2-trichloro-1,2,2-trifluoroethane	3.1×10^0	7600

[1] ACGIH, 1986.

e. any additional information deemed necessary (e.g., special handling requirements).

2. If shipments are delayed in transit for any reason, the generator must contact REECo Traffic Section at the earliest opportunity and provide the new estimated time of arrival with pertinent information regarding the delay.

3. The hours for receiving are 0800 to 1430, Monday through Friday, except holidays. If a shipment arrives too late to off-load, the REECo Duty Office will instruct the driver to park the load at the front gate until it can be inspected by REECo Radioactive Materials Control and be approved to proceed to the Area 5 RWMS. The trailer(s) may be left at the holding area outside the front gate while driver(s) attend to personal needs.

The waste generator also should contact REECo DWMD for determination of records requirements and to coordinate funding transfers. At a minimum, the following records are required:

1. When accountable source and special nuclear materials from other than NTS sources are involved, a "Nuclear Material Transaction Report" (DOE/NRC Form 741) must be completed and forwarded to the DOE/NV Safeguards and NTS Security Branch prior to shipment.

Table AVII-14. Hazardous Metal Release in a Transportation Accident.

Element	Conc[1]. (microgram/m³)	Metal Chunks	Material Released(gms) IRF[2]	TERF[3]	Vapor[4]	Total	Release Rate (g/sec)	Receptor Conc.[5] (microgram/m³)	Exposure Limit [6]
Lead	200ppm	Yes	.24	.48	9.60	10.3	$2.9x10^{-3}$	14.5	50-100[7]
Cadmium	390ppm	No	.46	.80	97.60	98.9	$2.7x10^{-2}$	135.0	100-300[8,9]
Beryllium	10ppm	Yes	.13	.02	None	.2	$5.5x10^{-5}$	0.3	2-5[8]
Mercury	50ppm	No	.06	.11	12.6	12.8	$3.5x10^{-3}$	17.5	50[10]

[1] Total Mass of Noncombustible Fraction of 1 box = 1573 kg

[2] Impact Release Fraction: $(4.78x10^{-3})(.01)$

[3] Thermal Entrainment Release Fraction: (2.5 x 10-6/sec)(3600 sec)(.01)

[4] Vapor Partial Pressure Fraction: PP_{frac} = {Antilog (-.05223a/T +b)}/760 (from CRC Handbook): Vapor Conc.(VC)=(PP_{frac})(Mole.Wt.)(N/Vgm-moles/m³,15.03)

Pb: VC = $(6.4x10^{-8})(207.2)(15.03) = 1.99x10^{-4}$ g/m³

Cd: VC = $(5x10^{-2})(112.4)(15.03) = 8.45x10^{1}$ g/m³

Be: No Vapor, 1000°F, Melt Temperature (2347°F)

Hg: VC = $(1.2x10^{1})(200.6)(15.03) = 3.7X10^{4}$ g/m³

Vapor Source Term = (VC)(Area, 41.6^2)(Wind Speed, 2 m/sec) (Time, 3600 sec)(.01) = $(3.0x10^{3})$(VC)

Per Box

Pb: VST = 0.6 gms

Cd: VST = $2.5x10^{5}$ gms > gms available

Hg: VST = $1.1x10^{8}$ gms > gms available

[5] Assumes X/Q = $5x10^{-3}$ sec/m³ (D stability, class, 2m/sec wind speed)(Slade, 1968)

[6] Exposure limits are from the National Institute for Occupational Safety and Health (NIOSH) Pocket Guide to Chemical Hazards (US Department of Health and Human Services, June 1990)

[7] Concentration range based on OSHA permissible exposure limits for an 8-hour work shift of a 40-hour work week and NIOSH recommended exposure limits (REL) for up to a 10-hour workday during a 40-hour work week.

[8] Concentration range based on OSHA permissible exposure limits (PEL) for an 8-hour work shift of a 40-hour work week and OSHA ceiling values.

[9] Limits for cadmium fume.

[10]NIOSH REL/OSHA PEL concentration value.

2. Properly completed shipping papers as required by 49 CFR 172 Subpart C, "Shipping Papers," must accompany each shipment from offsite. For MW, a "Uniform Hazardous Waste Manifest" (EPA Forms 8700-22 and 8700-22A), or equivalent state be used for both on- and off-site shipments. If the MW is regulated under 40 CFR 268, the manifest must also be accompanied by the appropriate notice required by 40 CFR 268.7.

3. The original and one copy of completed "Radioactive Waste Management - Storage and Disposal;" forms (RE-167/0166), or equivalent, must accompany each shipment. The information required on these forms includes identities, quantities, and concentrations of radionuclides and hazardous species in waste material by package. Each package in a shipment must be identified by a package identification number and a waste stream identification number. In addition, a subset of this printed information must be electronically transferred to REECo DWMD.

Upon arrival at NTS, shipments may be subject to off-loading delays at any time due to NTS operational schedules. At Mercury, the NTS base camp, each waste shipment will be inspected by REECo Radioactive Materials Control and Traffic personnel. Upon receipt of waste at NTS Area 5 RWMS, REECo DWMD personnel will perform the following:

1. Receive the shipping papers, waste generator's records, and obtain other pertinent data. Verify that a signed certification statement accompanied the shipment and that all required information is supplied and is correct.

2. Inspect the shipping vehicle and individual packages for integrity, external radiation levels, radioactive contamination and, for MW, hazardous material contamination.

3. Verify that waste packages, including marking and labeling, meet all applicable requirements of NVO-325.

4. Process compactible waste from on-site prior to disposal.

5. Assign waste to appropriate area of Area 5 RWMS for storage or disposal.

6. Record all actions taken regarding receipt and disposition of the received waste. Report any noncompliance to DOE/NV.

7. Enter waste data into the NTS defense waste data base and verify and file records.

8. Return a copy of the uniform Hazardous Waste Manifest for MW shipments to the generator.

7.0 APPENDIX VII REFERENCES

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