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**YUCCA MOUNTAIN TRANSPORTATION ROUTES:
PRELIMINARY CHARACTERIZATION AND RISK ANALYSIS**

VOLUME I: RESEARCH REPORT

by

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University of Nevada, Las Vegas**

May 31, 1991

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Nevada Agency for Nuclear Projects, Nuclear Waste Project Office

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The Nevada Agency for Nuclear Projects/Nuclear Waste Project Office (NWPO) was created by the Nevada Legislature to oversee federal high-level nuclear waste activities in the State. Since 1985, it has dealt largely with the U.S. Department of Energy's (DOE) siting of a high-level nuclear waste repository at Yucca Mountain in southern Nevada. As part of its oversight role, NWPO has contracted for studies designed to assess the transportation impacts of a repository.

This study was funded by DOE grant number DE-FG08-85-NV10461.

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Department of Energy.

Abstract

In this study, rail and highway routes which may be used for shipments of high-level nuclear waste to a proposed repository at Yucca Mountain, Nevada are characterized. This characterization facilitates three types of impact analysis: comparative study, limited worst-case assessment, and more sophisticated probabilistic risk assessment techniques.

Data for relative and absolute impact measures are provided to support comparisons of routes based on selected characteristics. A worst-case scenario assessment is included to determine potentially critical and most likely places for accidents or incidents to occur. The assessment facilitated by the data in this study is limited because impact measures are restricted to the identification of potential areas or persons affected. No attempt is made to quantify the magnitude of these impacts. Most likely locations for accidents to occur are determined relative to other locations within the scope of this study. Independent factors and historical trends used to identify these likely locations are only proxies for accident probability.

Probabilistic risk assessment (PRA), is one possible extension of the analysis presented in this study. PRA incorporates data for likelihoods (probabilities) and consequences of events (e.g. accidents). While PRA is the most analytical of the three techniques, it is also most data intensive and, due to assumptions which must be made, most controversial. Therefore, while a demonstration of PRA was included in an earlier draft of this report, it has been excluded in this version, but is currently the focus of additional research being performed by the UNLV Transportation Research Center (TRC) for the Nevada Agency for Nuclear Projects.

Consideration of all three forms of analysis mentioned above is warranted due to the controversial nature of both the issue (nuclear waste transportation impacts) and application of the available analytical techniques (especially PRA). The goal of this research is to provide the basis for a system to be used for analyzing impacts of nuclear waste transportation, as no single tool is available at the present time for adequately addressing all concerns. When complete, such a system (located at the TRC) will be comprised of trained analysts, computer hardware and software, a geographic database, and a set of procedures for using these elements to study transportation of high-level radioactive waste and other hazardous materials.

Foreword and Acknowledgements

With the passage of the Nuclear Waste Policy Act of 1982, the State of Nevada established the Nuclear Waste Project Office (NWPO), now organized as the Nevada Agency for Nuclear Projects. NWPO is responsible for monitoring of the U.S. Department of Energy (DOE) program in all aspects of site selection, including investigation of transportation safety, risk and impacts. NWPO is developing a comprehensive program which will provide an assessment of safety and radiological risks of the use of specified Nevada highway and rail routes to Yucca Mountain and the determination of the potential safety, cost, socioeconomic, infrastructure and environmental impacts resulting from their use.

As a transportation contractor to NWPO since 1988, the UNLV Transportation Research Center (TRC) has provided significant support in the development and implementation of the transportation program. TRC staff and contractors have (1) prepared background reports and commentary on DOE transportation technical and institutional initiatives, (2) provided assistance in analyzing federal and state policies, legislation and regulations which may affect nuclear waste transportation, and, (3) with the present study, characterized and conducted preliminary risk and impact studies on Nevada highway and rail access routes which may be used, should a repository be licensed for operation at Yucca Mountain.

This work effort provides the first step in the continuing investigation of significant transportation issues related to the proposed repository. The data and information collected and the analytical models used and developed during this project are valuable assets in assuring that these issues be addressed in a rigorous fashion.

The study team wishes to express its appreciation to a number of individuals within and outside the University who supported the study team in the completion of the project. At UNLV, these individuals include Professors James Cardle and Moses Karakouzian for their assistance in developing the scope of the project and identifying analytical processes which were used. Martin Joseph and Walter Anderson provided assistance in data collection and technical presentation. Bobbie Reding, the TRC management assistant, was instrumental in integrating the report and in providing editorial assistance.

The comments of several reviewers of a draft of this document were relevant and important to the study. These comments were addressed, where possible. Most of those that were not addressed are to be considered during ongoing work at the TRC. We gratefully acknowledge these reviewers: Mr. Mike L. Baughman, Intertech Consultants (for Lincoln County), Mr. Bruce Turner, Regional Transportation Commission (Clark County), Mr. Brad Mettum (Esmeralda County), and Dr. Allen V. Kneese,

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YUCCA MOUNTAIN TRANSPORTATION ROUTES: PRELIMINARY CHARACTERIZATION AND RISK ANALYSIS

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**YUCCA MOUNTAIN TRANSPORTATION ROUTES:
PRELIMINARY CHARACTERIZATION AND RISK ANALYSIS
May 1991**

UNLV Transportation Research Center (TRC)

Executive Summary

I. Introduction

The goal of this research effort is to provide the basis for a TRC system to analyze risks and impacts of nuclear waste transportation. When complete, this system will be comprised of trained analysts, computer hardware and software, a geographic database and a set of procedures to study transportation of high-level radioactive materials. At present, no single tool is available for adequately addressing all concerns.

The specific purpose of the present study was to characterize three rail access routes and four highway routes which may be used for shipments of high-level nuclear waste to a proposed repository at Yucca Mountain. In meeting these purposes, the (1) utility of new or existing methodologies for data capture and integration, and, (2) development of inputs for later risk and impact analyses were demonstrated.

The characterization of these highways and rail access corridors will facilitate at least three approaches to impact analysis. These include (1) comparative studies, (2) limited worst-case assessments, and, (3) probabilistic risk assessment techniques. Consideration of all three forms of analysis is warranted due to the sometimes controversial nature of impact assessment and application of available analytical techniques, especially probabilistic risk assessment (PRA).

The approaches identified in the previous paragraph are but three of a number of possible strategies that may be pursued. The first two are relatively straightforward and provide decision makers with an readily usable and effective tool for addressing nuclear waste transportation issues. These two methods are capable of representing specific concerns of state and local authorities. Once study parameters have been agreed upon, there is little room for misinterpretation of the results.

For example, using comparative analysis, the data presented in this report provide the capability to express the number of persons residing within 5 miles of one route as opposed to another. In limited worst-case analysis, the greatest number of persons within a 10 mile radius of any point along the routes could be used as a proxy for population exposure. Finally, PRA is based on incorporating measures of consequence, such as exposure of human populations, with associated (derived) measures of probability of occurrence.

The present research was developed in a natural progression from data collection and analyses needed for general comparisons to the more specific and detailed inputs needed for PRA. For example, the data required for characterization and comparative analysis form the core of the data needed to perform a worst-case study. Similarly, these data, when refined, are part of those required for probabilistic risk assessment.

Relative and absolute data are provided to support future comparisons of highway and rail routes. Comparisons of highway routes may be based on the five probability data categories and eight consequence data categories developed for this study. The rail access corridors may be compared using three probability data categories and eight consequence data categories.

Data for limited worst-case assessment include the most critical and most likely places for accidents or incidents to occur. Most likely locations for accidents are determined relative to other locations on a particular route. Independent factors and historical trends used to identify these likely locations are proxies for accident probability.

The authors recognize that any risk or impact assessments facilitated by this study are restricted since this effort is a preliminary characterization and a demonstration of techniques. Not all identified probability and consequence measures were used. No attempt was made to include all attainable data, prioritize impact assessment variables or to quantify the magnitude of these impacts.

II. Characterized Routes

Four highway routes to a proposed high-level radioactive waste repository at Yucca Mountain were specified and characterized. Two routes entered Nevada from Utah at Wendover. One route entered from Arizona at Mesquite, and one from southern California at Stateline. These routes have been identified by the U.S. Department of Energy or the State of Nevada as potential paths for nuclear waste shipments.

In addition, three rail access corridors under study by the U.S. Department of Energy were investigated. These access routes include spurs which would connect the repository with the Union Pacific Railroad. Connections to the mainline would be made near Jean, Caliente or Carlin.

III. Characterization Measures

Characterization measures were divided into two categories, including probability and consequence measures. All of the data elements identified for a full characterization study were not assimilated due to resource limitations. The most important or readily obtainable data were collected and measures derived for each of several segments of the analyzed routes.

In the following listings, those measures used in the present study are numbered. Those measures not used are marked by an asterisk (*).

Measures required to support all three types of analysis were identified. These include:

1. **measures of consequence probability**

Note that the general phrase "consequence probability" is used rather than accident or incident probability, as there may be consequences of routine operations. The probabilities associated with non-routine operations are very small and the probability associated with routine operations is one minus this small number. Therefore, the probability of routine operational consequences can be taken as 1.0, for all practical purposes.

a. probability of occurrence and severity of radiological accidents measured by:

- 1) accident location;
- 2) probability of accident;
- * type, severity of accident;
- * probability of release/ dispersion/ magnitude;
- * areal coverage, speed, timing;
- * probability of exposure;
- * probability of exposure effects.

b. probability of occurrence and severity of non-radiological accidents measured by:

- 1) accident location;
- 2) probability of accident;
- * type, severity of accident.

Probability data used for highway analysis:

- 1) distance
- 2) accident history and rates
- 3) infrastructure characteristics
- 4) hazardous materials shipments and inventories
- 5) road conditions (environmental)

¹Consequences of routine transportation of hazardous material include, but are not necessarily limited to costs and other impacts of: transportation infrastructure construction and maintenance, increased traffic volume, emergency preparedness, and noise/air pollution.

Probability data used for rail access analysis:

- 1) distance
- 2) anticipated accident rates
- 3) hazardous materials inventories

2. measures of consequence/severity of consequence

a. radiological, accident conditions:

- 1) health effects;
- 2) economic effects;
- 3) environmental impacts;
- * institutional impacts;
- * social impacts due to perception of risks/human factors.

b. non-radiological (no release), accident conditions:

Same as above.

c. radiological, non-accident conditions:

- 1) health effects;
- 2) economic impacts;
- * institutional impacts;
- * social impact due to perceived risk/human factors.

d. non-radiological, non-accident conditions:

- 1) economic impacts;
- 2) environmental impacts;
- * institutional impacts.

Consequence data used for highway analysis:

- 1) resident population
- 2) non-resident population
- 3) ecologically sensitive areas
- 4) land use
- 5) property value
- 6) difficult/dangerous to evacuate areas
- 7) meteorological conditions
- 8) traffic volume

Consequence data used for rail access analysis:

- 1) resident population
- 2) non-resident population
- 3) ecologically sensitive areas
- 4) land use

* not used in present study.

Consequence data used for rail access analysis
(continued):

- 5) property value
- 6) difficult/dangerous to evacuate areas
- 7) meteorological conditions
- 8) infrastructure characteristics

IV. Methods

Four Nevada highway routes leading to the site of the proposed high-level radioactive waste repository were selected for specification and characterization. Selected routes are those which would be used under present federal regulation or those which may be designated by the State of Nevada as alternatives. Two routes enter Nevada on Interstate 15 from Arizona and California and continue to the site on U.S. 95. Two routes enter the state on U.S. 93 at Wendover and continue to the site on portions of state and U.S. highways. Total length of the routes ranges from 105 to 435 miles.

Three rail access routes recommended by DOE for preliminary engineering and characterization studies were analyzed in this study. These spurs would be connected to one of two mainline railroads presently operating in Nevada. The access routes include spurs beginning at Jean, Caliente and Carlin. Total length of the routes ranges from 121 to 406 miles.

Probability measures regarding the likelihood of radiological and non-radiological accidents were developed. They were then integrated into a computerized relational database developed at the UNLV Transportation Research Center. This database allows for comprehensive or detailed accident and infrastructure analyses, as appropriate. Five elements were included in the probability data set for highway analysis and three elements for rail analysis.

Consequence measures regarding health effects, economic effects and environmental impacts under accident and non-accident conditions were developed using a geographic information system (GIS) designed by TRC staff. Eight elements were included in the consequence data set for both highway and rail analysis.

Analyses were completed for most variables for corridors of 0.5, 1, 2, 6, 10 and 20 miles along the routes. Time and resource constraints made it impossible to derive some measures for each corridor width. However, current GIS applications at TRC will allow rapid extension of data collection and analytic capabilities within a short time.

V. Preliminary Findings and Discussion

In the comparative analysis for highways, tables are presented at the end of Chapter 2 which compare average or absolute values within various corridors for each data variable.

No attempt was made to assign weights or level of importance for decision making. This would fall within the province of state, local government and tribal officials who would use the results in such deliberations. Comparative data for potentially critical accident locations (end of Chapter 3) and likely accident locations (end of Chapter 4) may be used in the same fashion. In future investigations, measures developed in these comparative studies, as well as data not complete or yet collected, may be used in probability risk assessments for selected routes.

In the comparative analysis for rail, tables are also presented (ends of Chapter 5 and 6) to show average or absolute values for each variable. These route-specific data should be most helpful in assisting the state in monitoring DOE work on rail access routes and in conducting independent studies of selected routes. An important use of the data would be in the development of an inventory of the facilities. This inventory could then be used in the estimation of costs and analysis of safety of operations on the route. It would also provide critical information for conducting probabilistic risk assessment for a route.

Data on design standards and specifications would provide the basis for design and construction of the rail spur along the corridor. This would be helpful in identifying some of the constraints or restrictions of use of the proposed corridor.

At present, the existing data do not provide sufficient detail to be used for any engineering purposes or for a comprehensive evaluation of the route. Precise information on the alignment of the proposed spur is unavailable. This information is critical for development of the engineering design and cost estimates, as well as for a comprehensive assessment of the route.

TRC research efforts in the near and long terms will enhance the utility of the study results by modifying several of the databases developed for this project. In addition, 1991 work under the NWPO contract will include the study of certain institutional factors not addressed in the present investigation. Several improved methodologies for data collection, estimation and presentation also will be incorporated in the 1991 work.

1 Introduction

1.1 Background and Motivation for the Study

The Nuclear Waste Policy Act of 1982 (NWPA), as amended, directed the U.S. Department of Energy (DOE) to study Yucca Mountain, Nevada, for suitability as the nation's first deep geologic repository for spent nuclear fuel and high-level radioactive waste. The transportation of these wastes from nuclear reactors and defense facilities to a repository is a most visible and important consideration in determining the feasibility of such an undertaking.

Of great concern to persons in Nevada and throughout the country are the potential risks and impacts which would result from the cross-country transportation of large amounts of such hazardous cargo. Working with the Nevada State/Local Government Planning Group (SLGPG), the Nevada Agency for Nuclear Projects (NWPO) has identified major areas of concern within the state. These are (1) policy, cost and legal implications for states and local governments, (2) safety and health risks to the human population and (3) risks of disturbing and/or contaminating the environment. Major transportation issues and a framework for ongoing investigation have been identified through a transportation needs assessment (1989) commissioned by NWPO through the UNLV Transportation Research Center (TRC). Since 1985, NWPO contractors have engaged in investigations in the areas of socioeconomic and cost impact, risk assessment, potential degradation and maintenance of highway infrastructure, system safety, system development, and institutional interactions. With the guidance of the SLGPG and the transportation needs assessment, this study provides three methodologies and supporting data for a preliminary risk and impact analysis of nuclear waste transportation in Nevada. It is anticipated that later TRC work will integrate appropriate findings of the ongoing NWPO socioeconomic study.

1.2 Methodology

The goal of this research is to provide the basis for a system for analyzing impacts of nuclear waste transportation, as no single tool is presently available for adequately addressing all concerns. In this study, potential rail and highway access routes within Nevada are characterized. This characterization facilitates three types of analyses (from among a number of possible strategies that can be taken):

- 1) **comparative study**, which uses relative and absolute data to support comparisons on selected characteristics.

¹This study was performed by the UNLV Transportation Research Center (TRC) for the Nevada Agency for Nuclear Projects, Nuclear Waste Projects Office (NWPO).

2) **worst-case assessment**, which includes the determination of the potentially critical and potentially likely places for accidents or incidents to occur. The assessment facilitated by the data is restricted because impact measures are limited to the identification of potential areas or persons affected. No attempt is made to quantify the magnitude of these impacts, and in the case of likely locations for accidents, only proxy measures (e.g., independent factors, historical trends) are used in determining accident probability.

3) **probabilistic risk assessment (PRA)**, which demonstrates the incorporation of data for likelihoods (probabilities) and consequences of impacts. PRA differs from worst case assessment in that all segments of a proposed route contribute to the total "risk". In worst-case assessment, only the worst places (in terms of potential consequences) and likely places (in terms of probability) for an accident to occur are identified. Those locations not determined to be critical are not singled out for analysis.

In PRA, the probability of an incident occurring at any point (segment) along the route is multiplied by its quantitative consequences to derive a measure of risk. The measures for each segment are then summed to represent the risk for the entire route. PRA is the most analytical of the three techniques, the most data intensive, and, due to assumptions which must be made, most controversial. While the data and methodologies presented in this study support the application of PRA, this method of analysis is currently being demonstrated under separate study².

The first two approaches identified in the previous paragraphs (comparative study and worst case assessment) are relatively straightforward, but provide decision makers with an effective yet transparent tool for addressing nuclear waste transportation issues. These two methods are capable of representing specific concerns of state and local authorities, say, what populations are within potentially affected areas. Once the parameters to be included in such studies are agreed upon, there is little room for misinterpretation of the results. For example, using comparative analysis, the data presented in this report provide the capability to express the number of persons residing within 5 miles of one route as opposed to another or the extent of ecologically sensitive areas within a 20 mile corridor surrounding one or more routes. In limited worst-case analysis, the greatest number of persons within a 10 mile radius of any point along the routes could be determined.

Finally PRA is based on incorporating measures of consequence, such as exposure of human populations, with associated (derived) measures of probability of occurrence.

² University of Nevada, Las Vegas, Transportation Research Center (TRC) fiscal year 1991 work sponsored by the Nevada Agency for Nuclear Projects, Nuclear Waste Projects Office (NWPO).

The research reported here was developed in a natural progression from data collection and analysis needed for general comparisons to the more specific and detailed needed for PRA. For example, the data required for characterization and comparative analysis form the core of the data needed to perform a worst-case study. Similarly, these data, when refined, are part of those required for probabilistic risk assessment.

A discussion of data requirements for route-specific probability risk assessment using models such as RADTRAN 4.0 is presented in Section 1.3. In that section, several matrices are presented that assist in identifying the types of measures and data required to establish estimates of potential consequences of transporting high-level spent nuclear fuel and the associated probabilities of occurrence for these consequences. In Section 1.4, the measures and data used in this study are defined. Section 1.5 addresses some of the major concerns regarding availability and quality of data for route-specific probabilistic risk assessment.

PRA requires determination or estimation of consequences and their associated probability of occurrence. One methodology proposed for PRA includes developing measures of spent fuel transportation consequences, establishing the probabilities of each of these consequences, and multiplying these together to obtain measures of total impact. The following diagram displays the overall concept outlined in this methodology.

1.3 General Data Requirements

This section presents a discussion of the general data required to support all three types of analysis defined in section 1.2.1. While the diagram in the preceding section demonstrates the PRA concept, the measures and data to be

included in matrices A through D can be used for all three analytical methodologies.

Matrix A (Table 1-1) presents measures of consequence probability identified in this study. The general phrase "consequence probability" is used rather than accident or incident probability, as there may be consequences of routine operations. Because the probabilities associated with non-routine operations are very small, and the probability associated with routine operations is one minus this small number, the probability of routine operational consequences can be taken as 1.0, for all practical purposes.

The consequences of spent fuel transportation may be classified according to Matrix C (Table 1-2).

Matrix B (Table 1-3) presents the data required to establish probabilities of various levels of radiological and non-radiological accidents (the probability of non-accident operations is 1.0 minus the probability of accident operations - see note above under the description of Table 1-1).

The data needed to support quantification of these measures are presented in Matrix D (Table 1-4).

Table 1-1

Matrix A: Measures of Probability

	Radiological	Non-Radiological
Accident	Probability of occurrence and severity of radio-logical accidents measured by: Probability of Accident: Type, Severity Probability of Release/Dispersion: Magnitude, Areal Coverage, Speed, Timing Probability of Exposure Probability of Exposure Effects	Probability of occurrence and severity of non-radiological accidents measured by: Probability of Accident: Type, Severity
Non-Accident	Probability ≈ 1	Probability ≈ 1

³Consequences of routine transportation of hazardous material include, but are not necessarily limited to costs and other impacts of: transportation infrastructure construction and maintenance, increased traffic volume, emergency preparedness, and noise/air pollution.

1.4 Scope and Limitations of the Study

The previous sections have identified the overall framework for the impact analyses used in this study. This section discusses the major components of this framework: the measures and data used to quantify impacts. Probability and consequence data which were within the scope of this research are first listed. Some important measures which were beyond the scope of this study are then described.

This chapter delineates both the measures studied and not studied in the present effort. This is appropriate in providing the reader with a framework with which to review and interpret the findings. However, the reader must keep in mind that the absolute values of each of the measures may be of limited use to decision makers given the rapid growth of the southern Nevada region. This growth will have major effects on such factors as population numbers and distribution; land use; traffic and commodity flows on rail and highway; and, infrastructure, among others. In turn, these changes will have significant effects upon risk and impact analysis which must be done should the repository becomes closer to reality. This issue was not addressed in this descriptive study. A well-defined effort must be made within the next two years to deal with problems of projection of relationships between rapidly changing situations and reasonable impact analyses.

Given this, the reader may be well advised to focus upon methodologies and measure definition rather than the absolute values of the measures to ascertain whether the present approach is likely to be of utility in the future.

1.4.1 Measures Within Scope of Study

Characterization measures included in the study were divided into two categories: probability measures and consequence measures. Due to resource limitations, all of the data elements identified in the matrices of the preceding section were not assimilated. Key data and other readily obtainable data were collected and measures were derived for each of several segments of the analyzed routes. This format is compatible with the requirements of existing PRA models such as RADTRAN. Example route-specific PRA's (RADTRAN runs) using some of these data (along with default values provided by RADTRAN) will be presented in future work.

Table 1-2

Matrix C: Measures of Consequence/Severity of Consequence

	Radiological	Non-Radiological
Accident	<p>1) Health Effects</p> <p>Acute or latent effects of radiation exposure</p> <p>Number of persons exposed and distribution of exposure levels</p> <ul style="list-style-type: none"> - general population - crew and handlers - drivers and passengers of other vehicles - pedestrians - emergency responders <p>2) Economic Effects</p> <ul style="list-style-type: none"> - cleanup - business disruption (present and future) - loss of tax base - loss of land rents - loss of access to transportation facilities - emergency response - medical and lost wages - perceptual amplification - other <p>3) Environmental Impacts on:</p> <ul style="list-style-type: none"> - Wildlife species - Water supplies - recreational lands - other <p>4) Institutional Impacts</p> <ul style="list-style-type: none"> - loss of tax revenues - organizational/regulatory impacts <p>5) Social Impact due to perception of risks</p>	<p>1) Health Effects</p> <p>Injury/death to:</p> <ul style="list-style-type: none"> - crew - drivers and passengers of other vehicles - pedestrians - general population <p>2) Economic Effects</p> <ul style="list-style-type: none"> - property damage - medical and lost wages <p>3) Institutional Impacts</p> <ul style="list-style-type: none"> - organizational/regulatory impacts - loss of revenues due to perceived impacts - other <p>4) Social Impact</p> <ul style="list-style-type: none"> - due to perceived risk - other

Table 1-2 (cont.)

Matrix C: Measures of Consequence/Severity of Consequence (cont.)

	Radiological	Non-Radiological
Non-Accident	<p>1) Health Effects</p> <p>Latent effects of radiation exposure</p> <p>number of persons exposed and distribution of exposure levels</p> <ul style="list-style-type: none"> - general population - crew - drivers and passengers of other vehicles - pedestrians <p>2) Economic Impact</p> <ul style="list-style-type: none"> - health effects - perceived impacts <p>3) Institutional Impacts</p> <ul style="list-style-type: none"> - organizational/regulatory impacts - loss of revenues due to perceived impacts - other <p>4) Social Impact</p> <ul style="list-style-type: none"> - due to perceived risk - other 	<p>1) Economic Impacts</p> <ul style="list-style-type: none"> - operating costs - infrastructure maintenance - infrastructure reconstruction - infrastructure development - traffic congestion - changes in property values due to infrastructure changes - other <p>2) Environmental Impacts</p> <ul style="list-style-type: none"> - due to infrastructure improvement or development - due to increased traffic levels - other <p>3) Institutional Impacts</p> <ul style="list-style-type: none"> - organizational/regulatory - other

Table 1-3

Matrix B: Probability Data

	Radiological	Non-radiological
Accident	<ol style="list-style-type: none"> 1) Driver <ul style="list-style-type: none"> - Shipment/Vehicle/Driver Characteristics 2) Shipment <ul style="list-style-type: none"> - Shipment/Vehicle/Driver Characteristics 3) Vehicle <ul style="list-style-type: none"> - Shipment/Vehicle/Driver Characteristics 4) Road <ul style="list-style-type: none"> - Highway Distance/ Specification - Highway Infrastructure - Highway Traffic - Highway Accident History - Railroad Infrastructure - Rail Corridor Specification/ Distance - Railroad Traffic - Rail Accident History 5) Environmental <ul style="list-style-type: none"> - Hazardous Shipments/ Inventories - Meteorological/ Environmental 6) Institutional <ul style="list-style-type: none"> - Legislation, Policies, Regulations: Current and Proposed 	Same as Radiological without radiological characteristics of the shipment
Non-Accident	Probability $\approx$ 1.0	Probability $\approx$ 1.0

Table 1-4

Matrix D: Consequence Data

	Radiological	Non-radiological
Accident	<ul style="list-style-type: none"> - Population - Land Use - Property Values - Tourism, business location and operation, retirement migration statistics and projections - Difficult/dangerous to evacuate locations - Ecologically Sensitive Areas - Highway Distance/ Specification - Highway Traffic - Rail Corridor Specification/Distance - Hazardous Shipments/ Inventories - Shipment/Vehicle/Driver Characteristics - Legislation, Policies, Regulations: Current and Proposed - Emergency Response Data - Exposure pathways 	<ul style="list-style-type: none"> - Highway Traffic - Hazardous Shipments/ Inventories - Shipment/Vehicle/ Driver Characteristics - Legislation, Policies, Regulations: Current and Proposed - Emergency Response Data
Non-accident	<ul style="list-style-type: none"> - Population - Land Use - Property Values - Tourism, business location and operation, retirement migration: statistics and projections - Highway Distance/ Specification - Highway Traffic - Rail Corridor Specification/Distance - Shipment/Vehicle/Driver Characteristics - Legislation, Policies, Regulations: Current and Proposed - Emergency Response Data 	<ul style="list-style-type: none"> - Land Use - Property Values - Ecologically Sensitive Areas - Highway Distance/ Specification - Highway Infrastructure - Highway Traffic - Railroad Infrastructure - Rail Corridor Specification /Distance - Shipment/Vehicle/ Driver Characteristics - Legislation, Policies, Regulations: Current and Proposed

Data used in developing the probability and consequence measures are listed below. Detailed sources, values, and uses of the measures in identifying potentially critical and likely places for accidents to occur are presented in Chapters 2 through 6 of this report.

Probability Data Used for Highway Analysis

1. Distance
2. Accident history and rates
3. Infrastructure characteristics
4. Hazardous materials shipments and inventories
5. Road conditions (environmental)

Consequence Data Used for Highway Analysis

1. Resident population
2. Non-resident population
3. Ecologically sensitive areas
4. Land use
5. Property value
6. Difficult/dangerous to evacuate locations
7. Meteorological conditions
8. Traffic volume

Probability Data Used for Rail Access Analysis

1. Distance
2. Anticipated accident rates
3. Hazardous materials inventories

Consequence Data Used for Rail Access Analysis

1. Resident population
2. Non-resident population
3. Ecologically sensitive areas
4. Land use
5. Property value
6. Difficult/dangerous to evacuate locations
7. Meteorological conditions
8. Infrastructure characteristics

Some of the route-specific data collected for this report are presented in terms of density within corridors of various widths along the routes. It is important to note that, while it would be desirable to know the magnitude of these measures for any given corridor width, time and resource limitations made that impossible within the current scope. Therefore, some measures are derived for more corridor widths than others. For example, due to the labor intensive process used to calculate property values, this measure is presented only for a 2 mile corridor. Non-resident populations, however, were calculated using an automated geographic information system (GIS) which facilitated estimations for 0.5, 1, 2, 6, 10, and 20 mile corridor widths. Currently, GIS application is facilitating calculation of most

parameters for all corridor widths, but is beyond the scope of the current study.

1.4.2 Important Measures Not Studied

Interpretation of the findings of this study is limited since data were not collected for the following six characterization measures which may influence results of a transportation impact assessment. Such data were not collected because of time constraints, the qualitative nature of the data or present unavailability of information.

1) Emergency Response Capability and Safe Havens

Information on emergency response capability and safe havens would be necessary for determining institutional control and cost impacts due to accidents or incidents along the analyzed routes. Information on emergency facilities and capabilities and identification of possible safe havens for either highway or rail routes is not presently available and should be included in future research.

2) Measures of Impact on Tourism, Business and Migration

Measures of impact on tourism, business and migration would provide a basis for the assessment of off-network impacts due to transportation of radioactive waste. Socioeconomic impact studies for NWPO have included preliminary information on tourism, business and migration. However, they were not route-specific, and, in some cases, incomplete for routes included in the present analysis. Data requirements for use in transportation studies need to be identified, and such data collected and included in more comprehensive impact analyses. Data compatibility issues which arise as a result of the qualitative nature of some of this information need to be resolved in the development of a complete and integrated impact assessment program.

3) Shipment/Vehicle/Driver Characteristics

Information on shipment, vehicle and driver characteristics affect the probable safety risks, health effect and accident likelihood and severity. A complete risk assessment must include these elements. However, at present, complete information is not available for modal mix, cask and vehicle characteristics, operational plans and driver qualifications and training. The Department of Energy is in the process of developing cask designs and has yet to provide plans for modal mix, system configuration and operations and driver qualifications and training. This information is expected to be published during Federal Fiscal Year 1991 as part of the DOE Transportation Plan. As such information becomes available, it will be included in the ongoing State transportation risk and impact assessments.

4) Legislation/Policies/Regulation

Qualitative information on legislation, policies and regulations is valuable in determining the available state network for the potential transportation of nuclear waste to a repository. It is also important in determining possible institutional control of risks and impacts accruing from such shipments. The State of Nevada is presently considering the designation of routes for highway-route-controlled quantities of nuclear materials (including nuclear waste) and federal law establishes specified procedures for state route designation. However, the State designation process is not complete and the U.S. Congress has only recently re-authorized the Hazardous Materials Transportation Act (HMTA) as the Hazardous Materials Transportation Uniform Safety Act (HMTUSA). This act clarifies the roles of federal and state governments in regulating hazmat shipments. HMTUSA calls for cooperative studies in mode and route selection and use of dedicated trains in shipping hazardous materials. It also requires the U.S. Department of Transportation to engage in rulemaking regarding shipment container standards, personnel training and emergency preparedness. In view of recency of this federal action and delays in implementation, it is not yet possible to intelligently assess its potential impact.

5) Perceived Risk/Dread Amplification

It is known from a series of studies done on behalf of the State of Nevada (i.e., Slovic, Kasperson, Kunreuther) that the general public perceives the risk of high-level waste transportation to be significantly greater than do investigators in the field. Added to this is the public "dread" surrounding nuclear issues. At this point, no mature approach has been developed to address inflated public perceptions of consequences and probability in calculating such impacts as cost of public opposition and stigmatization effects of transportation accidents. In certain cases, perceived risk may have significant effects on governmental policy or regulatory action which may influence impact levels. The findings of investigations which address these issues should be integrated into a comprehensive impact analysis.

6) Delineation of Alternative Routes

The analyses in this study do not consider the availability of alternative routes. "In the event of an accident, highways within rural Nevada may be closed for inordinately long periods of time. This would be particularly true in the event that a cleanup were required. In difference to urban areas, rural areas frequently do not have alternative transportation routes. The potential impact due to circuitous routing may be important, and

is not considered in this report."⁴ As characterization proceeds, it may be necessary to consider other routes not included here. Should this be the case, methodologies developed in the present study will be transferrable to the analyses of other routes.

1.5 Data Collection and Reduction Methodologies

Due to the structure of this report, presentation of data collection and reduction methodologies in each section characterizing the routes would be repetitive. To avoid this, a general description of these methodologies is given here. Where applicable, unique considerations are presented in the body of this report.

1.5.1 Probability Measures

► Accident History and Rates

Highway accident history data were collected for a five year period, from 1984 through 1988. Accident records were obtained from the Safety Engineering Division of the Nevada Department of Transportation (NDOT) on magnetic tape. The accident records include about 90 items of information for each reported accident. The exact location, date, and vehicle type were used in determining accident rates for all vehicles and trucks only. Truck accident data were broken down into: single unit trucks, trucks with one trailer, and trucks with two trailers. Data were aggregated by segments defined to represent homogeneous roadway elements. Segments were defined as large as possible to provide statistical significance.

A public domain relational data base (RIM) was used to manage the disaggregated accident data. Location, date, and vehicle type involved in the accidents were extracted from data stored on magnetic tape.

Segment distances and vehicle traffic used for calculating accident rates were obtained from the NDOT Annual Traffic Reports. Calculations appear in Appendices 2-B, 2-H, 2-N, and 2-T. Included in these appendices are segment lengths, roadway functional classification and class, traffic volume, vehicle and truck miles traveled, vehicle and truck kilometers traveled, number of accidents, accidents per mile, accidents per kilometer, accidents per million vehicle and truck miles traveled, and the

⁴review comments from Mike Baughman, Intertech Consultants. (Consultant to Lincoln County - in a letter to Mr. Robert Halstead of NWPO, dated January 30, 1991.)

five year averages and standard deviations⁵ for accidents per million vehicle and truck miles traveled.

► Infrastructure

This report adopts the functional highway classification scheme used by the Nevada Department of Transportation. These classifications include: Interstate Rural, Interstate Urban, Principal Arterial Rural, Principal Arterial Urban, Minor Arterial Rural, Minor Arterial Urban, Major Collector Rural, Minor Collector Rural, Collector Urban, Local Rural, Local Urban, and Principal Arterial Freeway/Expressway Urban.

Highway facilities outside urban areas make up the rural road system. Interstate highways are characterized by fully controlled access and grade-separated interchanges. Principal arterials consist mainly of the highest traffic volume corridors. Minor arterials are streets and highways that service (intersect) principal arterials. Collectors funnel traffic from local streets to the arterial system. Local streets are low-volume access roads.

Road width includes traveled lanes and available shoulder. While highway traffic lanes should generally be at least 12 feet wide, shoulder areas provide space for emergency stops, space for drivers to recover safely if there is loss of vehicle control, and structural support of the traffic-bearing pavement.

Pavement type is divided into two categories: rigid and flexible. Rigid pavements are constructed with Portland cement concrete. Flexible pavements consist of bituminous materials. The Nevada Department of Transportation uses the following notation for pavement types: I indicating bituminous concrete, J indicating portland cement concrete, and G indicating mixed bituminous pavement.

Currently only about 20 percent of roadway characteristics data exist in computerized form at NDOT. As most of this information still resides in written or map format, it was beyond the scope of this study to collect complete data for roadway geometrics and infrastructure. However, these additional infrastructure data are likely to have an important effect on impact assessments, and should be collected for future studies.

The following parameters were collected to represent the difference in infrastructure between the routes.

⁵Standard deviation is a measure of variation given in the same units as samples (in this study, accident rates for various years). It reflects the variation of a set of samples around the true average value for the underlying distribution. In this study, a normal distribution is assumed for accident rates. High standard deviations relative to the average can indicate high variances but may also reflect an insufficient sample size.

- Functional classification
- Number of lanes
- Road width
- Pavement type
- Bridges and culverts
- Railroad crossings, overpasses and underpasses
- Speed limits and travel times
- Rest areas
- Truck length and weight limits

► **Hazardous Shipments/Inventories**

Hazardous shipments and inventories were included in the data collected for this study. In the event of a collision with or other incident involving the release of hazardous materials, nuclear waste shipments and crew members may come in contact with flammable gases, poisonous gases, etiologic and other hazardous materials. In addition to potentially increasing the probability of a release of radioactivity, these materials may complicate emergency response activities and cleanup operations. A further application of these data would be to help assess a baseline risk of non-radiological hazardous materials to the public. This would facilitate comparative risk assessment (between high-level waste and other hazardous material shipments).

Six parameters were included in the hazardous shipments/inventories data:

1. Number of trucks per day along routes.
2. Number of trucks per day crossing routes.
3. Number of tons per day along routes.
4. Number of tons per day crossing routes.
5. Miles of high pressure natural gas pipelines within route corridors.
6. High pressure natural gas pipelines crossing routes.

Items 1 through 4 were determined from NDOT's 1988 Commodity Report. Truck shipments and tons of hazardous material shipped include nine categories of hazardous materials:

- explosives, including those with mass explosion hazard, projection hazard, fire hazard, and very insensitive explosives.
- gases, including flammable, nonflammable, and poisonous.
- flammable liquids with a flash-point from below -18 degrees Celsius up to 61 degrees Celsius.
- flammable solids, spontaneously combustible material, and materials that are dangerous when wet.
- oxidizers and organic peroxides.
- poisonous and etiologic (infectious) materials.

- radioactive materials.
- corrosives.
- miscellaneous hazardous materials.

Data were collected for total number of trucks carrying hazardous materials and tons of hazardous material that would cross or come close to potential nuclear waste transportation routes.

Miles of high pressure natural gas pipelines lying within each corridor were taken from maps provided by the Nevada Public Service Commission's Hazardous Materials Pipelines Locating Atlas. Where two or more pipelines were located within the same corridor of a particular route, the total mileage reflects a summation.

The number of high pressure pipelines crossings for each of the rail and highway routes was also obtained. In some instances, the same pipeline crossed a route several times.

Data limitations for hazardous shipments/inventories included the lack of detailed information about hazardous material shipments. The NDOT commodity report showed a listing of the number of shipments and the tonnage but no information was included about the frequency or consequences of accidents. The hazardous materials pipeline atlas showed the physical location of pipelines in Nevada but listed no details about the amount of being shipped through each pipeline. Note: Only high pressure natural gas pipelines are included in this study. Data for pipelines carrying other hazardous materials, such as chlorine and gasoline are not presented in this study.

Data for high pressure natural gas pipelines are specified primarily as a probability factor. The effects of a rupture and subsequent explosion of such a facility on a nuclear waste shipment are not clear. However, the location of these pipelines must also be considered from the non-nuclear perspective in construction issues. In particular, the effect of new or increased rail traffic above or near buried pipelines is also the subject of recent inquiry (e.g. Southern California Rail/Gas Pipeline incident, 1989).

► Road Conditions (Environmental)

Data on environmental factors which affect road conditions (e.g. ice, rainfall, snowfall, dust, flood, mud slides, and rock slides) were extracted from Environmental Factors Affecting Nevada Highways (UNR, 1987).

1.5.2 Consequence Measures

► Resident Population

In this study, information is provided for resident and non-resident population. Resident population refers to the

permanent, year-round population, and may under-represent a potentially significant number of persons who reside in Nevada for only portions of the year.

Population density within the proposed study area is a key variable in risk assessment. Resident populations are expressed in terms of density per square mile per mile along proposed routes as well as in terms of absolute numbers of residents within various route corridors.

Data for resident population were obtained from various sources including the Nevada Department of Taxation, Rand McNally Commercial Atlas and Marketing Guide, Clark County Department of Comprehensive Planning, UNR Bureau of Business and Economics Research and CACI Marketing Systems. Population estimates for the same cities or areas from each of these sources varied. Sources sufficient for highway corridor estimation were often lacking for the rail corridors. Estimates were also taken for different base years (ranging from 1985 to 1990), which may tend to introduce small errors in total population estimation for rural areas. The most recent estimates were used when available. Only the more recent sources were used for rapidly growing Southern Nevada. Although not available in time for this study, 1990 Census data will be used in future studies.

The process of resident population estimation presented several difficulties. These included difficulty in obtaining population statistics for rural Nevada (especially for areas outside Clark County), population statistics representing each township, range and section, updates for new residential dwellings and population growth rates, and the absence of a postal zip code boundary cartographic maps for rural Nevada.

In areas where recent population figures were lacking or unavailable (e.g. the vicinity of Craig Road, North Las Vegas) they were estimated by multiplying the number of dwelling units by a factor of 3.25 persons per household. This factor was used as representative for the City of North Las Vegas.

Initially, an attempt was made to estimate rural resident population using the population in each zip coded area obtained from the CACI Sourcebook of Zip Code Demographics. While annual populations and growth rates are readily available, no definitive information on zip code boundaries could be obtained. This delayed accurate population distribution estimation.

The absence of population distribution patterns in rural areas required the following assumptions to compute population density along the proposed highway route:

- a) Any population in rural areas (outside of places, towns and cities) is assumed to be distributed within a 1/2

mile corridor along the centerline of improved county roads.

- b) The population outside major city limits is uniformly distributed along all improved county roads.

(Recently, a compilation of 1990 Las Vegas aerial photos were obtained from Landiscor Aerial Photo, Inc. of Nevada. In these photos it was noted that the housing distribution follows a pattern which weakens the assumption of uniform distribution in the preliminary analysis, precluding the assumption's use for urban and suburban area calculations.)

The density of population (total population divided by area) for populated places within route corridors is estimated by the following process: In "places" where population is concentrated (e.g. unincorporated townships), population density is estimated as the product of the "place's" total population and the ratio of its area within the corridor to its total area.

In both methods, area calculation was greatly facilitated by use of the GIS system.

► Non-Resident Population

In 1989, the total number of visitors to the Las Vegas Valley was estimated to be 18,129,684 (LVCVA, 1990). This number is large compared to any other potential source of non-residents along any of the highway or rail routes in this study. And while numbers of non-residents may be significant relative to resident populations outside of the Las Vegas Valley, calculations of non-resident population for the corridors around the routes is limited to Las Vegas Valley visitors in this study.

The primary source of annual data on the volume of tourist arrivals and visitors attending conventions, trade shows and tournaments is the Las Vegas Convention and Visitors Authority. Supplementary data were obtained from Microcosm 1989, Dun's Marketing Services, the Las Vegas Marketing Bulletin 1988 and 1989 (Annual Summary) and Great Basin National Park Visitor Statistics by the White Pine Chamber of Commerce. In areas where incomplete data exist (e.g., average daily occupancy and number of hotel/motel rooms), information was gathered by the study team through telephone surveys.

Visitor volumes are affected by season, dates and nature of events, scenic spots, recreational areas, etc. This makes it difficult to get a volume of non-resident population that would be accurate at all times. In addition, the lack of information

⁶In the rural counties of Nevada, significant portions of the county may be federal lands. Resident population estimates for the rural areas of these counties could be improved by distributing populations only along privately held lands.

in the rural areas of Nevada introduced some error in the analysis.

The methodology used in this study to estimate the number of non-residents within route corridors was:

- 1) Digitize the location of all hotels and motels in Clark County (Las Vegas). Digitize the route alignments and use a GIS system to buffer the routes and define corridor limits (0.5, 1, 2, 6, 10, and 20-mile corridors).
- 2) Assume all visitors stay in motels or hotels.
- 3) Assume all hotels and motels have the same occupancy ratios.
- 4) Calculate the number of hotel/motel rooms within the corridor in question by overlaying a map of the corridor limits with a map of hotel locations.
- 5) Divide the number of hotel/motel rooms in the corridor (R_c) by the total number of hotel/motel rooms in Clark County (R_T) to get the ratio of all rooms within the corridor (P).

$$P = R_c / R_T$$

- 6) Multiply the total number of visitors (TV) by the average length of stay (AS) to get the total number of visitor-days in Clark County (TD).

$$TD = TV * AS$$

- 7) Divide the total number of visitor-days (TD) by 365 to get the average number of visitors per day in Clark County (DV).

$$DV = TD / 365$$

- 8) To obtain the number of non-residents (visitors) within the corridor (V_c), multiply the ratio of all rooms within the corridor by the average number of visitors per day in Clark County.

$$(V_c) = P * DV$$

► **Ecologically Sensitive Areas (ESAs)**

In this study, ecologically sensitive areas are divided into three categories:

- 1) National Forests/Wildlife Refuges
- 2) Desert Tortoise Habitats (as an example of endangered wildlife areas)
- 3) Selected Ecologically Sensitive Areas (includes 1) and 2) plus: surface water bodies, wildlife habitats (all species), and wildlife conservation areas and refuges)

Agencies contacted as potential sources of information to identify various ecologically sensitive area were the U.S. Bureau of Land Management, U.S. Soil Conservation Service, U.S. Army Corps of Engineers, Division of Anthropological Studies, UNLV Environmental Research Center, Nevada Department of Wildlife, Nevada Department of Forestry, Nevada Water Planning Division, Las Vegas Water District, and Nevada Natural Heritage Program. Of the agencies contacted, only Nevada Natural Heritage Program and Nevada Department of Wildlife had readily accessible or comprehensive data. To supplement information from various agencies, maps published by the United States Geologic Survey (USGS) were also used.

A Geographic Information System (GIS) was used to digitize ESAs for the entire study area and identify ESAs within buffered zones (corridors) of the proposed routes. For this study, ESAs within 20 mile corridors along the routes were identified.

Use of the GIS presented various technical problems. These included large amounts of hardcopy data needed to support analyses, time required for digitizing, maps with varying reference systems, and maps of varying scale and accuracy.

The method used to delineate ecologically sensitive areas consisted of drawing the boundaries of ecologically sensitive areas on a Nevada base map. Areas such as national forests were referenced in the USGS maps. The locations and areas of various refuges for wildlife and endangered species were provided by the Nevada Department of Wildlife. Other areas were sketched on maps by experts with local information. In the latter case, perimeters were defined by noting some significant changes in topography, contour or geologic setting between two adjoining areas. While approximate, data obtained from this procedure were deemed sufficient for preliminary evaluation purposes.

GIS application required creating separate coverages (maps and corresponding data) for each ESA category. For example, a total of eight files were created for wilderness areas and endangered species refuges: desert tortoise, bighorn sheep, mule deer, antelope, peregrine falcon, water fowl, fish and chipmunk.

The coverages created can later be overlaid on base maps containing proposed route corridors.

► **Land Use**

Land within the corridors analyzed in this study was categorized according to eight types of use. These eight land uses are:

1. Government/vacant lands. These are lands which are owned by the government (for which no specific land use is available) or are private lands (that are either vacant or whose land use is unknown).
2. Unspecified urban lands are those which lay within the boundaries of a city along a particular route. More specific land use specifications were unavailable. The lands could include any of the other land use types.
3. Residential land may include private homes, apartment complexes, mobile home estates, condominiums, town-homes, duplexes, triplexes, or fourplexes (and any common area used in conjunction with residential areas such as club houses, pools, laundry rooms, or other facilities developed for the exclusive use of property owners/residents).
4. Industrial land is used for the storage or manufacture of products.
5. Commercial land use indicates wholesale or retail sales or repair of products, or services. This includes hotels, motels, casinos, general services, professional and business services, financial services, entertainment facilities, recreational areas not including parks or museums, shopping centers, retail stores, restaurants and bars, automotive services, RV parks, etc.
6. Non-profit community facilities are used as cultural, religious, educational, or community recreational facilities such as parks. Also included are facilities such as animal control, civil defense, judicial or legislative facilities, postal facilities, fire and police protection, public roads and highway departments.
7. Transportation, communication, and utilities land use include radio and television stations, aircraft, rail, or truck terminals and depots, water, gas, and power plants, rubbish disposal and dump sites, and sewage facilities and treatment plants.

8. Minor improvement lands have improvements such as fences, barns, sheds, or other structures of modest value.

This study includes land use classifications for two mile corridors along highway and rail routes. For areas along all routes lying outside of Clark County one of two methods was used to establish land use. First, any area of the corridor which fell within the boundaries of a city was labeled as unspecified urban land use. Second, all area within the two mile corridor outside the limits of a city was labeled as government/vacant.

All land with a two mile corridor along highway Route B⁷, Spur 8 and connector, and Spur 7 and connector was classified in this manner. Parts of highway Route A and Spur 3 and its mainline connector from Utah lying outside Clark County were also categorized in this manner. These methods were utilized due to lack of detailed information about land outside of Clark County.

For areas within a two mile corridor of routes within Clark County but outside the boundaries of Las Vegas a different methodology was used. Each "range and township" (convention used to define a geographic grid) with part of a specified route passing through its boundaries was identified. The land use code and total area for each parcel within that "range and township" was identified on Clark County tax assessor maps. The total area for each land use type within a "range and township" was summed (a) and then divided by the total area of the "township and range" (A). The total area of each "range and township" falling within the two mile corridor for each route (AC) was calculated and then multiplied by the percentage for each land use type using the following equation:

$$\text{Total area for each land use category} = AC \times (a \div A)$$

This method was used for parts of highway route A, I-15 from Arizona, I-15 from California, part of rail spur 3 and all of rail Spur 3's mainline connector from California.

Land use codes within Clark County falling within the boundaries of Las Vegas were determined by a different methodology:

A two mile corridor along each route was drawn on a Las Vegas City map. Sample points were established at 1/2 mile intervals along both sides of the route along the midpoint of the corridor, ie. 1/2 mile from the route. These sample points were identified on Clark County tax assessor maps and a land use for each data point was established. This particular land use was then assumed to represent all land within each 1/2 mile interval

⁷Please refer to Chapter 2 for specification of Highway Routes A, B, I-15 to US 95 from Arizona, and I-15 to US 95 from California. Rail spurs and access routes are defined in Chapter 5.

along the route. Each data point represents 1/2 square miles (1/2 mile interval x 1 mile buffer on each side). Parts of highway routes A, I-15 to US 95 from Arizona, and I-15 to US 95 from California falling within Las Vegas city limits were assigned land use designations according to this method.

One limitation to this method is that the size of the sample areas (0.5 square miles) often made it difficult to establish a single land use code. One city block could contain offices, retail outlets, a bank, a casino, and several residences. In any case, the sensitivity of the analysis to land use data element size has not been established.

The land use data from this study may prove useful for other studies concerned with recovery and restructuring/restoring functions, services, and infrastructure following other types of civil and military emergencies.

► Property Value

Property value includes the value of the actual real estate and the value of any existing improvements, usually buildings, located on a parcel of land.

Property values were established for two mile corridors along highway and rail routes. For areas outside Clark County one of two methods was utilized. First, all land with the corridor not falling within the boundaries of a city was assigned the value of \$183,499 per square mile. This figure represents an average for government/vacant lands within Clark County. It was also used for areas outside of Clark County because of the difficulty in obtaining data for the areas. Second, property values for areas within the boundaries of a city were calculated using the following equation:

$$\text{Total property value} = A \times (\$ \$ \div A')$$

A = area of city within two mile corridor

\$ \$ = total assessed value of city according to
tax assessor records

A' = total area of city

The property value for all of Highway Route B, Caliente Rail Spur 7 and mainline connector, Carlin Rail Spur 8 and mainline connector, and parts of Highway Route A and Jean Rail Spur 3 were calculated according to these methods.

For areas within the two mile corridor of routes within Clark County but outside the boundaries of Las Vegas a different methodology was used. Each "range and township" (convention used to define a geographic grid) with part of a specified nuclear waste route passing through its boundaries was identified and the property value and total area for each parcel within that "range and township" was identified on Clark County tax assessor maps. The property values for all parcels within the "range and

township" were summed (PV) and then divided by the total area of the "township and range" (A). The total area of each "range and township" (AC) falling within the two mile corridor for each route was calculated and the property value was determined using the following equation:

$$\text{Total Property Value} = AC \times (PV \div A)$$

This method was used for parts of Highway Route A, I-15 to US 95 from Arizona, I-15 to US 95 from California, part of Rail Spur 3 and all of its mainline connector from California.

Property values for parcels in Clark County falling within the boundaries of Las Vegas were determined by a different methodology:

A two mile corridor along each route was drawn on a Las Vegas city map. Sample points were established at 1/2 mile intervals along both sides of the route along the midpoint of the corridor, ie. 1/2 mile from the route. These sample points were identified on Clark County tax assessor maps and a property value for each sample point was established. This value was assumed to represent all land within each 1/2 mile interval along the route. Each sample point represents 1/2 square miles (1/2 mile interval x 1 mile buffer distance), using the following equation:

$$\text{Total Property Value for Interval} = 0.5 \times (PV \div A)$$

PV = property value for individual parcel
A = area of parcel
0.5 = size of interval

Parts of Highway Route A, the route along I-15 to US 95 from Arizona, and the route along I-15 to US 95 from California, within Las Vegas city limits were assigned property values according to this method.

► Difficult/Dangerous to Evacuate Locations

Difficult to evacuate locations are those with occupants who would be difficult to safely evacuate in the event of a nuclear waste transportation accident. This category includes schools, hospitals, and prisons. Other areas such as pre-schools, rest or retirement homes, homeless shelters, etc. are also difficult to evacuate but were not included in the scope of this study due to time constraints.

Dangerous to evacuate locations are establishments that would be dangerous to evacuate or leave unattended in the event of an emergency. Prisons or detention facilities are examples of dangerous to evacuate location and were included for this study. Banks, chemical factories, or commercial or industrial establishments with costly inventories would be also be dangerous places to leave unattended in the event of an emergency. Due to

time constraints, however, these types of facilities were not included.

A list of Nevada public schools with enrollment figures for the 1987-88 school year and a list of private schools with enrollment figures for 1988 was used. Each school was geographically located with respect to corridors along each transportation routes. The total school enrollment for each corridor reflects the number of students attending schools falling within that corridor.

The available list of schools did not identify whether a school was attended nine months or year-round. In the Clark County School District, there is severe overcrowding and several schools have instituted double sessions. Therefore, the school enrollment figures may not provide accurate information on the number of students present in the schools at any one time. Such information would be necessary to determine the temporal distribution of the school population.

A similar procedure was followed for hospitals in Nevada. The total for each corridor reflects the number of hospitals beds located within the corridor, not the actual number of patients.

The number of inmates in prisons and detention homes within each corridor was determined by the same method as for school enrollment. The occupancy rates were taken from a list of the actual number of inmates as of August 21, 1990 made by the director's office at the Nevada Department of Prisons.

► Meteorological Conditions

Data for meteorological conditions along the proposed transportation routes may be used to assess potential dispersion characteristics of potential releases. Meteorological data presented in this report include the amount of rainfall and snowfall along routes. Wind and dust may also have a significant impact, but are beyond the current scope.

Other, important factors which might effect airborne dispersion of radionuclides include barometric pressure and relative humidity. Further, rainfall may tend to accumulate radionuclides in soils and/or in storm runoff water.

► Traffic Volume

Highway traffic volumes used in this study included the average annual daily traffic (AADT) and average daily traffic (ADT). AADT counts were obtained for all vehicles and for trucks for 1984 through 1988. ADT counts were obtained for all vehicles for the same time period. AADT break-downs for all vehicles and trucks only are presented for all highway routes and follow the segmentation used by NDOT's 1988 Annual Traffic Report. Where segmentation does not follow the Annual Traffic Report, the reasoning is documented. ADT's were calculated for maximum month

and volume, minimum month and volume, and absolute and relative differences between the two.

1.6 Data Availability and Quality

1.6.1 Highway

During the course of this study, many sources for the data required for route-specific PRA (presented in Section 1.3 above) were identified. Particularly useful and high quality data were obtained for highway infrastructure and accident histories from the Nevada Department of Transportation. This information exists on a mainframe computer and was integrated into a Transportation Research Center-developed minicomputer relational database. This database allows for comprehensive or very detailed accident and infrastructure analyses at a level conducive to route-specific PRA.

Information on property values and land use was obtained from comprehensive and recent County Tax Assessor records. Enough information exists at each of the State's County Assessor's offices to provide some of the required data for route-specific PRA. However, obtaining and reducing this disaggregated data is beyond the scope of the current work. For example, the county with the most advanced computerized system of record keeping is probably Clark County. Even for Clark County (office located such that the study team could have daily access), identification of information (property value and land use) for one parcel requires looking up the parcel in one of several thousand hard-copy parcel maps, recording the parcel number, then accessing a computer record to obtain the needed information. This process would have required excessive resource commitments if repeated for the approximately 20,000 parcels within the half-mile corridors alone. Analyses performed for other counties (farther away and less computerized) would be potentially more difficult. These constraints motivated the sampling techniques presented in Chapters 2 and 5.

Data for other measures were developed by the Transportation Research Center using a specially designed Geographic Information System (GIS). These measures included non-resident population estimation, identification and quantification of ecologically sensitive areas, and interpolation of resident populations - all within various corridors along proposed routes. It is expected

⁸Parcel mapping will be facilitated by a computerized address-matching capability for 1991 FY TRC/NWPO work. It is also noted that in some of the smaller counties, even though the assessor records may not be computerized, the relative difficulty of obtaining these data may be mitigated by the fact that in these counties, private lands and the subsequent number of parcels is far fewer than in the larger counties. These parcels are also, generally larger, therefore facilitating rapid identification and assessment.

that the information derived from original sources and reduced with GIS exist nowhere else. Further, this capability can be expanded to include other measures, provide more detailed analyses, or be applied to other research projects (nuclear waste or non-nuclear waste related).

1.6.2 Rail

Models used for rail route-specific probabilistic risk assessment require detailed information related to shipment, vehicle, guide-way and the human and natural environment characteristics. Among these data, some are related to infrastructure and include characteristics of the alignment such as gradients, curvatures, embankments, bridges, and tunnels. At the current time, such information is not completely available. Further, prior to precise definition of the proposed alignment, acquisition of these data is not appropriate.

The data available currently for the three rail spurs and mainline connectors under consideration are not precise and cannot be used for a comprehensive and accurate PRA. Conducting such a PRA would require the development of a more comprehensive, detailed and more accurate database than is available currently. However, a demonstration PRA using RADTRAN 4 is currently being performed as part of fiscal year 1991 work for NWPO using the databases developed at the TRC.

During the course of this study, many sources for the data required for route-specific PRA were identified. Information on property values and land-use may be obtained from County Tax Assessor records. Collection of assessor parcel information for the proposed rail spurs is less cumbersome than that for highway route analysis, as the spurs pass mainly through unpopulated areas. These unpopulated areas have large parcels (there are not many parcel records to locate) and property values and land use does not vary across large regions.

As with highway route-specific information, data for other measures were developed using a specially designed Geographic Information System (GIS). These measures included identification and quantification of ecologically sensitive areas and interpolation of resident populations - all within various corridors along proposed routes.

1.7 Summary

The present study provides the basis for a preliminary, yet comprehensive evaluation of the risk and impacts of highway and existing/planned rail routes which may be used for the shipments of high-level radioactive waste to the proposed Yucca Mountain repository.

Highway routes under consideration by the State of Nevada for designation as preferred routes were characterized using distance, accident history and rates, infrastructure, hazardous

materials shipments and inventories and road conditions. Further measures were developed for resident and non-resident population along the routes, ecologically sensitive areas, land use, property values, difficult or dangerous to evacuate areas, meteorological conditions and traffic volumes. Potentially likely and critical places for truck accidents were identified. Population, cost, environmental and accident severity impacts were determined for potentially critical locations.

This study also includes a preliminary characterization of seven rail access routes (three rail spur routes and 4 mainline connectors) under consideration by DOE for providing access to Yucca Mountain. These routes are characterized using the same measures as those for highway with the exception of environmental road conditions and likely places for accidents since historical data do not exist for proposed spurs.

In this study, rail and highway routes are characterized to facilitate three forms of analysis: comparative study, worst-case assessment, and probabilistic risk assessment techniques. Four highway routes are characterized to support comparisons of routes on selected characteristics in Chapter 2. Limited worst-case assessment (determining potentially critical and potentially likely places for highway accidents or incidents to occur) is presented in Chapters 3 and 4, respectively. Chapter 5 characterizes three rail access routes. These rail routes are compared for potentially critical locations for accidents to occur in Chapter 6. As mentioned previously, no analysis of likely places for rail accidents is provided due to lack of data. Finally, Chapter 7 provides a discussion of some methodological extensions of this work, currently being pursued by the UNLV Transportation Research Center for the NWPO.

2 Preliminary Highway Route Characterization

Due to large amount of data required to support characterization of statewide routes, and because of the limited resources available for assimilating these data, many analytical approaches were developed and applied in this study (sampling procedures, prioritizing mechanisms, quality assurance measures, and so forth). This chapter presents the specification and characterization of four highway routes from three entry points to Nevada - Wendover (2 routes), Mesquite (near Arizona border), and Stateline (near California border) - to the Nevada Test Site, the proposed location of a high-level radioactive waste repository (Yucca Mountain). These routes are characterized according to the probability and consequence measures identified in Chapter 1. A summary comparison of the four routes using these measures is also presented.

One of the responsibilities of the Nevada Department of Transportation (NDOT) is to designate routes for shipment of highway route-controlled quantities of radioactive materials. In a 1989 report (UNR, 1989) a study is presented that proposes such routes. It is this report that specifies two of the four routes characterized in this chapter. These routes are referred to as Route A (Wendover to Yucca Mountain via Las Vegas) and Route B (Wendover to Yucca Mountain via Tonopah).

The other two routes characterized in this chapter are two of those currently designated for highway route-controlled quantities of radioactive materials. They are: Interstate 15 (I-15) south from the Arizona border to US Highway 95 (US 95) north to Yucca Mountain (referred to as I-15 to US 95 from Arizona), and Interstate 15 (I-15) north from the California border to US Highway 95 (US 95) north to Yucca Mountain (referred to as I-15 to US 95 from California).

The chapter is divided into five sections. The first four sections specify and characterize the four highway routes under study. The final section compares the four routes in a summary fashion (Tables 2-3 through 2-9).

2.1 Route: A (From Wendover via Las Vegas)

Highway Route A enters Nevada from Utah at Wendover. The route consists of sections of US 93 Alt, US 93 (northern section), US 6, SR 318, US 93 (southern section), I-15, Craig Road (North Las Vegas), Rancho Road (Las Vegas), and US 95.

2.1.1 Route Specification and Distance

Route A was broken down by sections and segments. This breakdown was established to provide homogeneous segments for risk modeling and impact assessment. Sections were broken down by highway classification. Sections were segmented according to a methodology used in the NDOT 1988 Annual Traffic Report and by population boundaries (where population densities changed

significantly). Appendix 2-A lists the location, and distance of each segment. For example, a segment listed as 2.3 represents section 2, segment 3. Route A was divided into 47 segments. Distances were obtained from the NDOT 1988 Annual Traffic Report. The total distance for route A is 415.7 miles. Figure 2-1 shows the alignment of the route.

2.1.2 Probability Measures

This section provides operational definitions and sources of information for five probability measures used in characterizing Highway Route A. Data for each of the measures include: distance, accident history and rates, infrastructure characteristics, hazardous materials shipments and inventories, and environmental conditions along the road.

2.1.2.1 Accident History and Rates

Accident rates were calculated from historical Nevada-specific accident data. For 1984 to 1988, the five year average accident rate for all vehicles on Route A was 307 accidents per million vehicle miles traveled (MVMT). The five year average accident rate for trucks was 113 accidents per million truck miles traveled (MTMT). The five year average was determined by first calculating the average for each year for the specified route segment, then averaging over 5 years. Accident data by route segment are presented in Appendix 2-B.

For 1987, the accident rate for all vehicles for the state of Nevada was 389 accidents per MVMT. This rate was obtained from the NDOT Safety Engineering Division. The 1987 accident rate for all vehicles on Route A was 207 accidents per MVMT and 106 accidents per MTMT for trucks.

Accident rates were calculated from traffic volumes and number of accidents. For route A, the NDOT Annual Traffic Reports did not provide a breakdown of vehicle traffic for segments 4.1 through segment 4.6 (State Route 318). (Table 2-1 presents an example of the format of NDOT accident records.)

Vehicle traffic data for SR 318 were only available in the form of portable traffic recorder stations which only provide spot counts (Table 2-2).

As defined in this study, accident rates are determined for a particular segment of highway over a given period of time by dividing the number of accidents by traffic volume. Both the number of accidents and traffic volume can vary at many points along a route. Additionally, more than one accident per time period may occur at a single location. A systematic method of defining route segments is therefore needed. Calculation of a single accident rate for a route is perhaps most straightforward. This rate could then be used to compare routes based on total probability of accident. However, inclusion of a measure of accident consequence requires more specific spatial information

Table 2-1: NDOT Annual Traffic Report Data Format

U.S. ROUTE NO. 93

FROM THE ARIZONA STATE LINE ON HOOVER DAM WESTERLY TO FAP 095 (RAILROAD PASS INT) AND FROM FAP ROUTE 015 AT U.S. 93 INT NORTHERLY V'A CALIENTE AND PIOCNE TO FAP ROUTE 050 (U.S. 50) AT MAJOR'S JUNCTION AND FROM FAP ROUTE 050 (U.S. 50) IN ELY NORTHERLY VIA WELLS TO THE IDAHO STATE LINE NORTH OF JACKPOT

	1988 TRAFFIC PASSENGER VEHICLES								PREVIOUS YEARS TRAFFIC		
	CUM.	SEG	TOTAL		NEVADA		OTHER-STATE		TRUCKS	1987	1986
	MILES	MILES	VEH	%	VEH	%	VEH	%	VEH		
ARIZONA-NEVADA LINE	4.047	4.047	9,975	40	3,990	50	4,987	10	998	9,710	8,815
FAS 166	5.661	1.614	11,555	47	5,431	44	5,084	9	1,040	11,000	10,500
NCL-NUL BOULDER CITY	6.569	0.908	11,555	47	5,431	44	5,084	9	1,040	11,000	10,500
.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.

Source: NDOT 1988 Annual Traffic Report

**Table 2-2
Average Daily Traffic At Portable Traffic Recorder Stations**

COUNTY WHITE PINE										
STATION	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
33 0064 SR 318 (SUNNYSIDE RD), 100 FT E OF US 6, N OF PRESTON	215	305	410	450	475	600	680	640	655	695
33 0066 SR 318 (SUNNYSIDE RD), 0.2 MI S OF SAR 895, S OF PRESTON	295	310	405	455	485	500	570	615	665	785
33 0067 SR 318 (SUNNYSIDE RD) IN LUND, 200 FT S OF CENTER ST	650	640	720	790	860	950	1,050	1,000	930	1,015
.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.

Source: NDOT 1988 Annual Traffic Report

than simply that the accident may occur at some point along the route. Accidents at different locations would have different consequences. Therefore, calculation of accident rates for every point along the route may be considered. However, because historical data are limited, this would result in calculation of accident rates of zero for many points. Further, those points where accidents have occurred would be attributed unreasonably

high accident rates. The methodology followed in this study compromises between calculating accident rates for an entire route and calculating accident rates at every point along the route. Segments for accident rate calculation were defined to facilitate both probability and consequence measurement. Number of accidents is greatly dependent on traffic levels, so segments were first broken down to reflect changes in traffic volumes. (NDOT calculation of accident rates is dependent on this breakdown. Traffic volumes are known only for specific count locations, so assumptions are made regarding the traffic volumes between count stations.) As mentioned, the consequences of a given accident are also dependent on location. To account for this, the segmentation is also dependent on changes in population density (Figure 2-2).

Average Annual Daily Traffic (AADT) for the established segments were determined from spot traffic counts. However, the spot counts did not provide information on the composition of truck traffic. As a result, the truck AADT had to be estimated for the segments on SR 318. Because the fraction of truck traffic was fairly constant on segments of US 95 which have similar characteristics, it was assumed that the fraction of truck traffic on SR 318 would be the same as that observed on US 95 near Mina, Beatty and Goldfield. On these segments truck traffic made up 25 percent of total traffic. In Nevada, however, the fraction of trucks is smaller within urbanized areas than in rural areas (intercity segments). Therefore, assuming a 25 percent truck ratio would result in an overestimation of truck traffic on urbanized areas of SR 318. To avoid this overestimation, the estimates of truck traffic within urbanized areas of SR 318 were based on the fraction of truck traffic in the urbanized areas of Mina, Beatty and Goldfield on US 95 where truck traffic made up only 15 percent of the total. This estimation procedure is illustrated in Figures 2-3, 2-4 and 2-5. In these graphs, truck and total vehicle volumes from three count stations (one in the rural area upstream of a town, one within the town, and the third in the rural area downstream of the town) are shown.

Information provided by NDOT for Rancho Road and Craig Road in Las Vegas was not broken down into segments nor did it contain data for truck AADTs. The methodology used to define the route segments on Rancho Road and Craig Road followed a segmentation reflecting boundaries of areas with different population densities. Total vehicle AADTs were determined from spot counts. Truck AADTs were determined by examining adjacent and similar roads for determining the fraction of truck traffic. In this case, the fraction of AADT made up by truck traffic was estimated to be 0.06 based on the fraction of truck traffic recorded on Smoke Ranch Road, an arterial with similar characteristics.

A discrepancy concerning the accuracy of data from a previous collection effort was noted in a letter from the City of North Las Vegas to Mr. Denny Barry, N.D.O.T., Carson City, dated March 27, 1990. Re: Radioactive Materials Transportation Plan,

Phase II. Topics of concern addressed were the high number of accidents at the intersection of Jones Boulevard and Craig Road, and the low ADT (Average Daily Traffic) for Craig Road.

1. The total number of accidents were reported as tabulated by NDOT. The number of total accidents for the years 1984-1988 for Craig Road is over 200. The letter stated 31 accidents occurred at the intersection in 1988, and 20 in 1989. The segments for tabulation are not broken down by intersections, but figures are noted for accidents at all intersections.
2. The AADTs used for tabulation in this report were obtained from the 1984 through 1988 NDOT Annual Traffic Reports. The above referenced letter also stated that the ADT for Craig Road (4390) was low. Also, the year for this figure was not given. In 1988, an AADT of 4019 was used for Craig Road in the analysis. Annual increases in ADT of 12 to 15 percent per year for Craig Road were also noted. Using a 12 percent growth rate, the AADT for 1989 would have been 4501, 5041 for 1990.

2.1.2.2 Infrastructure

Infrastructural characteristics begin with functional classification. Information obtained from the NDOT Traffic Accident History, 1984 to 1988, indicates the following classification for Route A. Interstate urban constitutes 3.8 percent of the total route. Principal arterial urban constitutes 0.4 percent of the total route. Principal arterial rural constitutes 14.2 percent of the total route. Minor arterial rural constitutes 55.1 percent of the total route. And, Major collector rural constitutes 26.5 percent of the total route.

Two lane roadway constitutes 82.2 percent of the total route. Four lane undivided roadway constitutes 0.2 percent of the total route. The remaining 17.0 percent of the route is four-lane divided highway. The distance-weighted average for the total route was 2.34 lanes. This information was obtained from 1987 NDOT Research Division, Log of the Federal-Aid System.

The roadway width for the route varied from 20 to 48 feet. The following describes the roadway width distribution of Route A: roadway of 20 feet width constituted 6.6 percent of the total route, 22 feet - 4.5 percent, 24 feet - 70.6 percent, and 48 feet - 17.4 percent. Various road tapers constituted the remaining 0.9 percent of the total route. This information was obtained from the Log of the Federal-Aid System (1987 NDOT Research Division).

The roadway along Route A includes both flexible and rigid pavement types. Mixed bituminous penetration (G) comprises 49.0 percent, bituminous concrete (I) 50.4 percent and portland cement concrete (J) 0.6 percent of the total route (NDOT Traffic Accident History 1984-1988).

The following infrastructure data were extracted from the 1989 NDOT Cumulative Mileage Milepost Listing. There are 6 bridges, 26 culverts, and 1 interchange (bridge) for the entire route. There are 3 at-grade railroad crossings, 5 overpasses where the roadway passes over the railroad, and 1 underpass (road under railroad).

The ideal travel time was calculated to be 7.62 hours. This was determined by dividing the distance by the posted speed limit. This does not include delays. The speed limits within the towns and cities are: Wendover - 35 miles per hour; McGill - 35 miles per hour; Ely - 25/35 miles per hour; Craig Road - 35/45 miles per hour; Rancho Road - 45/55 miles per hour; Indian Springs - 35 miles per hour. The speed limits of the highways are: US 93 Alt - 55 miles per hour; US 6 - 55 miles per hour; SR 318 - 55 miles per hour; US 93 - 55 miles per hour; I-15 - 55/65 miles per hour; US 95 - 55/65 miles per hour. This information was obtained from the 1984-1988 NDOT Highway Traffic Accident History.

There is one rest area along Route A (NDOT Highway Rest Area Inventory).

Trucks over 70 feet require special permits from NDOT. The maximum weight limit set by NRS 484.745 on one axle is equal to 20,000 lbs, on any tandem axle is equal to 34,000 lbs.

A detailed listing of bridges, culverts, railroad intersections, and highway speeds for this route is presented in Appendix 2-C.

2.1.2.3 Hazardous Shipments/Inventories

There were 17 truck shipments crossing Route A carrying a total of 311.9 tons of hazardous materials. An average of 252 trucks per day carry a total of 5,916 tons of hazardous cargo over all or part of this route daily. Detailed data are presented in Appendix 2-D.

High-pressure natural gas pipelines cross the route at 4 places. As indicated in the following, these pipelines also run along the route within various distances:

Corridor Width	Miles of Pipeline
0.5 miles	2.9
1.0 miles	12.1
2.0 miles	17.6
6.0 miles	23.5
10.0 miles	24.4
20.0 miles	26.4

2.1.2.4 Road Conditions (Environmental)

1987 data indicate that there were more than 16 inches of annual rainfall for 16 miles of Route A, eight to sixteen inches for 157 miles, and four to eight inches for 241 miles of the route.

There were more than 40 inches of snowfall annually for 36 miles of the route, twenty to forty inches for 66 miles, ten to twenty inches for 130 miles, two to ten inches for 64 miles, and zero to two inches for 75 miles of the route (Environmental Factors Affecting Nevada Highways, UNR, 1987).

2.1.3 Consequence Measures

This section provides operational definitions and sources of information for eight consequence measures used in characterizing Highway Route A. Data for these measures include: resident population, non-resident population, ecologically sensitive areas, land use, property value, difficult/dangerous to evacuate areas, meteorological conditions and traffic volume.

2.1.3.1 Resident Population

Appendix 2-E shows the within-city/town population densities of individual segments along the proposed route and the population densities outside towns or cities using population data from the Clark County Department of Comprehensive Planning and the Nevada Department of Taxation. The appendix includes densities for a 0.5 mile-wide corridor only. Population density along transportation routes is a key input to probabilistic risk assessment.

Total population within the 0.5, 2, and 20 mile corridors for the route were established using a GIS overlay of the corridors on population distributions by section, traffic zone, city limit or zip code. Illustrations of this technique for the cities of Las Vegas and Ely are presented in Figures 2-7 and 2-8, respectively. The populations within three corridors along Route A are:

Corridor Width Resident Population

0.5 miles	12,831
2.0 miles	28,832
20.0 miles	577,966

2.1.3.2 Non-Resident Population

Non-resident populations within 0.5, 1, 2, 6, 10 and 20 mile corridors along Route A were established using a GIS overlay of the corridors on hotel/motel locations. An illustration of this technique is presented in Figure 2-8. The non-resident populations determined for these corridors are:

Corridor Width Non-Resident Population

0.5 miles	0
1.0 miles	0
2.0 miles	0
6.0 miles	694
10.0 miles	22,590
20.0 miles	148,385

Appendix 2-F provides detailed information on non-resident population estimation.

2.1.3.3 Ecologically Sensitive Areas

Much of the land area along proposed Route A is comprised of national forests, air force lands and wildlife refuges. In its northern sections, Route A passes through Humboldt National Forest. About 71 miles of this route lies within Clark or Nye Counties (Segments 5.40 - 9.90) in the vicinity of the Nellis Air Force Base Bombing and Gunnery Range and the Desert National Wildlife Range.

Three categories of ESAs were characterized within 10 miles of route A (20 mile corridor): national forests/wildlife refuges, desert tortoise habitats, and a combination of selected ESAs (Figures 2-9, 2-10, and 2-11). The total areas for these three categories for the 20 mile corridor along Route A are:

Type of ESA	Area
National Forests/Wildlife Refuges	1,375 square miles
Desert Tortoise Habitats	1,966 square miles
All ESAs	4,925 square miles
Total area of corridor	8,630 square miles*

* (20 miles x length of route) + buffers at ends of route

2.1.3.4 Land Use

All parcels within a 2 mile corridor along segments 5.3 through 6.2, segments 9.4 through 9.6, and segments 9.8 and 9.9 of Route A were identified as having a government/vacant code according to Clark County Tax Assessor records. Part of the land along segments 9.6 through 9.8 fell within the boundaries of Indian Springs. No information was obtained to further identify the parcels within Indian Springs, so the percent of area within the 0.5 mile corridor that was located in Indian Springs was labeled as unspecified urban area.

Land in segments 1.1 through 5.2 that fell within the boundaries of West Wendover, McGill, Ely, Lund, and Alamo was assigned an unspecified urban code and all other lands were assigned the government/vacant code.

Several small places: Lage's Junction, Sunnyside, Hiko, Ash Springs, Cactus Springs, and Mercury also lay along the route. Their land uses were listed as government/vacant lands since they could not be located on any available maps and data defining their geographic extent was presently unavailable.

All segments of Highway Route A that do not fall within any town or city were assumed to be government/vacant lands. In many instances this may not be an accurate portrayal of the value or sensitivity of the functions and uses to which this land is being or may be put. It may be useful to develop a sensitivity or value index to better reflect the true value of a function that utilizes a given area of land (one that does not conflict with national security interests).

The unspecified urban land use category for all areas which fall within the boundaries of West Wendover, Ely, McGill, Lund, Alamo, and Indian Springs is a broad classification which simply indicates that the land in these areas lies within a city, township, or populated place. No additional information was available for this preliminary phase of the characterization.

The land-use within a 2 mile corridor along Route A may be characterized as follows: (Appendix 2-G contains more detailed information.)

Land Use Type	Area
Residential	4.9 square miles
Industrial	0.3 square miles
Commercial	0.9 square miles
Non-profit	0.0 square miles
Trans./Comm.	0.0 square miles *
Minor Improvements	1.0 square miles
Government	805.2 square miles
Unspecified Urban	17.8 square miles

* Because of the statistical sampling technique applied in this preliminary study, the amount of land representing roadway right-of-way was not represented. This is not representative of the large amount of land actually used within the 2 mile corridor for roadway. Other uses should be adjusted accordingly and should be viewed relatively due to the omission of lands used for transportation and communications.

2.1.3.5 Property Value

For this report, property values include the value of the land plus the value of any existing improvements, usually buildings, that are found on the land.

Sampling techniques were similar to those used for identifying land uses. In the absence of more complete information on the area, government/vacant property values were used for the towns of Sunnyside, Hiko, Lage's Junction, Ash

Springs, Cactus Springs and Mercury, which also lay along Route A. Property values for the towns of West Wendover, Ely, McGill, Lund and Alamo were obtained from tax assessor information and reflect the average assessed value for the entire city and may not replicate the exact value of all the land parcels and improvements within the city. Also, the tax assessor files assigned a property value for the entire city but did not specify an exact area. The area used for Ely was the townsite boundary determined from a Nevada Department of Transportation Highway map. As no specific townsite boundaries were available for West Wendover, Lund, Alamo, Preston and McGill, the boundaries for these towns were estimated the extent of local streets shown on highway maps.

Property values for the cities of Indian Springs and Preston were not known. However an area for the cities was known, so average property values for city of Goodsprings was used. The Goodsprings average was used because actual property values for parcels within the township could be gathered from Clark County Tax Assessor records. It was assumed that Goodsprings was representative of other small towns in the study area.

Several small towns (places) along Highway Route A were not included due to lack of information about those towns. The towns of Lage's Junction, Cactus Springs, Sunnyside, Hiko, Ash Springs and Mercury lay along the highway and rail routes but no information on property value or town boundaries could be located. This made it impossible to gather adequate information about the towns to include them in the determination of the property value along the routes. Although not included, the cities could represent significant property values potentially affected by an accident.

The total property value calculated for Route A within a 2 mile-wide corridor is approximately \$763 million. More detailed information is presented in Appendix 2-H.

2.1.3.6 Difficult/Dangerous to Evacuate Locations

Three types of difficult to evacuate locations were identified to represent this category. They are: number of enrolled school children, number of hospital beds, and number of prison inmates within the corridors along Route A. Appendix 2-I provides more detailed information. The following summarizes the totals:

Corridor Width	School Children	Hospital Beds	Prison Inmates
0.5 miles	0	74	0
1.0 miles	956	74	0
2.0 miles	2144	74	1,491
6.0 miles	16,143	282	1,549
10.0 miles	41,911	429	2,187
20.0 miles	84,822	2,055	2,187

2.1.3.7 Meteorological Conditions

Data for meteorological conditions along the proposed transportation routes may be used to assess potential dispersion characteristics of potential releases. Meteorological data consist of information such as the amount of rain, snow, wind, and dust that impacts the proposed route. Due to time limitations, data for the parameters of wind, dust, and flood were not collected.

The Statewide Radioactive Materials Transportation Plan, Phase II, prepared for the Nevada Department of Transportation by the College of Engineering at the University of Nevada-Reno, noted that Route A had sections with average annual snowfall above 40 inches and annual rainfall between 8 and 16 inches.

2.1.3.8 Traffic Volume

Average Daily Traffic for Route A was established from data collected at four counting stations over 5 years by NDOT. While seasonal variations should be taken into account for routing analysis, existing data are not sufficient to calculate these variations accurately for all locations along the routes. The highest monthly variation in a given year was observed to be 82.4 percent between the lowest (January) and highest (August) monthly ADTs. The lowest overall monthly variation occurred one year with a 26.0 percent difference between February and August.

The distance-weighted average daily traffic for Route A was calculated as 1,557 vehicles per day. Weighted average truck ADT was calculated as 319 trucks per day. (Appendix 2-B provides more detailed traffic data.)

2.2 Route: B (From Wendover via Tonopah)

Highway Route B enters Nevada from Utah at Wendover. The route consists of sections of US 93 Alt, US 93 (northern section), US 6, and US 95.

2.2.1 Route Specification and Distance

Specification and distances for sections and segments of Route B are listed in Appendix 2-J. Route B is divided into 42 segments. Distances were obtained from the NDOT 1988 Annual Traffic Report. The total distance for route B is 434.9 miles. The alignment of this Route is presented in Figure 2-12.

2.2.2 Probability Measures

Data for each of the probability measures used in characterizing Highway Route B include: distance, accident history and rates, infrastructure characteristics, hazardous materials shipments and inventories, and environmental conditions along the road.

2.2.2.1 Accident History and Rates

Accident rates were calculated from historical Nevada-specific accident data. For 1984 to 1988, the five year average accident rate for all vehicles on Route B was 346 accidents per million vehicle miles traveled (MVMT). The five year average accident rate for trucks was 275 accidents per million truck miles traveled (MTMT). The five year average was determined by first calculating the average for each year for the specified route segment, then averaging over 5 years. Accident data by route segment is shown in Appendix 2-K.

For 1987, the accident rate for all vehicles for the state of Nevada was 389 accidents per MVMT. This rate was obtained from the NDOT Safety Engineering Division. The accident rate for all vehicles in 1987 along Route B was 253 accidents per MVMT and 247 accidents per MTMT for trucks.

2.2.2.2 Infrastructure

Infrastructure characteristics begin with functional classification. Information obtained from the NDOT Traffic Accident History 1984-1988 indicates the following classification of Route B. Nearly 34 percent of the total route is classified as principal arterial rural, while 66 percent is considered minor arterial rural.

Two lane roadway constitutes 99.1 percent of the total route. Four lane undivided roadway constitutes 0.5 percent of the total route. The remaining 0.4 percent of the route is four-lane divided highway.

The roadway width for the route varied from 20 to 48 feet. The following describes the roadway width distribution of Route B: 20 feet width for 6.2 percent of the route, of 22 feet width for 8.8 percent, 24 feet width for 81.0 percent, and 26 feet width for 2.5 percent. Various road tapers constituted the remaining 1.5 percent of the total route. This information was obtained from the Log of the Federal-Aid System (1987 NDOT Research Division).

The roadway along Route B includes both flexible and rigid pavement types. Mixed bituminous penetration (G) comprises 51.0 percent, and bituminous concrete (I) 49.0 percent of the total route (NDOT Traffic Accident History 1984-1988).

There are 5 bridges and 16 culverts along route B. There are 2 at-grade railroad crossings, and 2 overpasses where the roadway passes over the railroad (1989 NDOT Cumulative Mileage Milepost Listing).

The ideal travel time was calculated to be 8.08 hours. This was determined by dividing the distance by the posted speed limit. This does not include delays. The speed limits within the towns and cities are: Wendover - 35 miles per hour; McGill -

35 miles per hour; Ely - 25/35 miles per hour; Tonopah - 25/35/45 miles per hour; Goldfield - 25 miles per hour; Beatty - 25 miles per hour. The speed limits of the highways are: US 93 Alt - 55 miles per hour; US 6 - 55 miles per hour; US 95 - 55 miles per hour. This information was obtained from the 1984-1988 NDOT Highway Traffic Accident History.

There are four rest areas along Route B (NDOT Highway Rest Area Inventory).

Trucks over 70 feet require special permits from NDOT. The maximum weight limit set by NRS 484.745 on one axle is equal to 20,000 lbs, on any tandem axle is equal to 34,000 lbs.

A detailed listing of bridges, culverts, railroad intersections, and highway speeds for this route is presented in Appendix 2-L.

2.2.2.3 Hazardous Shipments/Inventories

There were 17 truck shipments crossing Route B carrying a total of 311.9 tons of hazardous materials. An average of 165 trucks per day carry a total of 3,682 tons of hazardous cargo over all or part of this route daily. Detailed data are included in Appendix 2-D.

High-pressure natural gas pipelines do not cross Route B, nor do any of these pipelines lie within 10 miles (a 20 mile corridor) of the route.

2.2.2.4 Road Conditions (Environmental)

1987 data indicate that there were more than 16 inches of annual rainfall for 40 miles of Route B, eight to sixteen inches for 131 miles, four to eight inches for 258 miles, and less than four inches over the remaining 7 miles of the route.

There were more than 40 inches of snowfall annually for 41 miles of the route, twenty to forty inches for 96 miles, ten to twenty inches for 134 miles of the route, two to ten inches for 147 miles of the route, and zero to two inches for 16 miles of the route.

2.2.3 Consequence Measures

Data for each of the consequence measures used in characterizing Highway Route B include: resident population, non-resident population, ecologically sensitive areas, land use, property value, difficult/dangerous to evacuate areas, and meteorological conditions and traffic volume.

2.2.3.1 Resident Population

The data sources and the approach used to collect and process population data along proposed Route B are similar to

that of Route A. Appendix 2-M shows the population density of individual segments along the proposed route within a 0.5 mile-wide corridor.

Total populations within 0.5, 2, and 20 mile corridors along Route B were established using a GIS overlay of the corridors on population distributions by section, traffic zone, city limit or zip code. Figure 2-13 illustrates this technique.

The populations within these corridors is:

Corridor Width	Resident Population
0.5 miles	10,279
2.0 miles	16,976
20.0 miles	16,976

2.2.3.2 Non-Resident Population

Since Route B is located away from the major resort areas of Nevada, the volume of non-resident tourists is small compared to that of the more heavily populated areas of Nevada (Reno, Las Vegas). However, the volume of visitors to the rural areas of Nevada along Route B may be significant relative to resident populations in these areas. When comparing Route B to the other three potential waste routes, the non-resident population is listed as "few" at the end of this chapter. It is not intended to neglect the relative importance of visitors to rural areas along Route B.

2.2.3.3 Ecologically Sensitive Areas

Ecologically sensitive areas within a 20 mile corridor along proposed Route B include desert tortoise habitats at Amargosa Desert, antelope and mule deer refuges at Monitor Range and Humboldt National Forest, and others.

Three categories of ESAs were characterized within 10 miles of route B (20 mile corridor): national forests/wildlife refuges, desert tortoise habitats, and a combination of selected ESAs (Figures 2-14, 2-15, and 2-16). The total areas for these three categories for the 20 mile corridor along Route B are:

Type of ESA	Area
National Forests/Wildlife Refuges	876 square miles
Desert Tortoise Habitats	1,480 square miles
All ESAs	3,786 square miles
Total area of corridor	9,012 square miles*

* (20 miles x length of route) + buffers at ends of route

2.2.3.4 Land Use

Land in segments 1.1 through 5.2 of Route B that fell within the boundaries of West Wendover, McGill, Ely, Lund, and Tonopah, Goldfield, and Beatty was assigned an unspecified urban code and all other lands were assigned the government/vacant code.

Small places known as Lage's Junction, Currant, Warm Springs, Scotty's Junction, and Amargosa Valley (Lathrop Wells) also lay along the route. They were listed as government/vacant in lieu of detailed information.

The unspecified urban land use category for all areas which fall within the boundaries of West Wendover, Ely, McGill, Tonopah, Goldfield, and Beatty is a broad classification which simply indicates that the land in these areas lies within a city or town but does not reflect the actual land use.

The land-use within a 2 mile corridor along Route B may be characterized as follows: (Appendix 2-N presents more detailed information.)

Land Use Type	Area
Trans./Comm.	0.0 square miles *
Government	858.7 square miles
Unspecified Urban	9.8 square miles

* Because of the statistical sampling technique applied in this preliminary study, the amount of land representing roadway right-of-way was not represented. This is not representative of the large amount of land actually used within the 2 mile corridor for roadway. Other uses should be adjusted accordingly and should be viewed relatively due to the omission of transportation and communications lands.

2.2.3.5 Property Value

In the absence of more detailed information, government/vacant property values were assigned to land within Lage's Junction, Currant, Warm Springs, Scotty's Junction, and Amargosa Valley (also known as Lathrop Wells), which also lay along Route B.

The property values for the cities of West Wendover, Ely, McGill, Tonopah, Goldfield, and Beatty, were obtained from tax assessor information and reflect the average assessed value for the city and may not replicate exact value of all the land parcels and improvements within the city. The tax assessor information provided a property value for the entire city but did not specify an exact geographic area for this value. The area used for Ely, Tonopah, and Beatty were townsite boundaries from Nevada Department of Transportation Highway maps. No townsite boundaries were identified for West Wendover, Goldfield, and

McGill. The boundaries for these cities were estimated from the extent of streets shown on highway maps.

The total property value calculated for Route B within a 2 mile-wide corridor is approximately \$298 million. Appendix 2-0 presents more detailed information.

2.2.3.6 Difficult/Dangerous to Evacuate Locations

Three types of difficult to evacuate locations were identified to represent this category. They are: number of enrolled school children, number of hospital beds, and number of prison inmates within the corridors along Route B. Appendix 2-I presents more detailed information. The following summarizes the totals for Route B:

Corridor Width	School Children	Hospital Beds	Prison Inmates
0.5 miles	275	85	0
1.0 miles	1,534	85	0
2.0 miles	2,820	85	0
6.0 miles	3,074	85	0
10.0 miles	3,077	85	638
20.0 miles	3,077	85	638

2.2.3.7 Meteorological Conditions

Annual snowfall on parts of Route B exceed 40 inches on average. Rainfall averages between 8 and 16 inches annually.

2.2.3.8 Traffic Volume

Average Daily Traffic for Route B was established from data collected at four counting stations over 5 years by NDOT. While seasonal variations should be taken into account for routing analysis, existing data are not sufficient to calculate these variations accurately for all locations along the routes. The highest monthly variation in a given year was observed to be 82.4 percent between the lowest (January) and highest (August) monthly ADTs. The lowest overall monthly variation occurred one year with a 51.2 percent difference between January and August.

The distance-weighted average daily traffic for Route B was calculated as 940 vehicles per day. Weighted average truck ADT was calculated as 191 trucks per day. (Appendix 2-K presents more detailed traffic data.)

2.3 Route: I-15 to US 95 from Arizona

This highway route consists of sections of I-15 and US 95 from Mesquite at the border of Arizona and Nevada to Yucca Mountain.

2.3.1 Route Specification and Distance

Specification and distances for sections and segments of the highway route from Arizona are listed in Appendix 2-P. This route was divided into 44 segments. Distances were obtained from the NDOT 1988 Annual Traffic Report. The total distance for this route is 143.3 miles. Figure 2-17 illustrates the alignment of this Route.

2.3.2 Probability Measures

This section provides operational definitions and sources of information for five probability measures used in characterizing the highway route from Arizona. Data for each of the measures include: distance, accident history and rates, infrastructure characteristics, hazardous materials shipments and inventories, and environmental conditions along the road.

2.3.2.1 Accident History and Rates

Accident rates were calculated from historical Nevada-specific accident data. For 1984 to 1988, the five year average accident rate for all vehicles on the highway route from Arizona was 176 accidents per million vehicle miles traveled (MVMT). The five year average accident rate for trucks was 78 accidents per million truck miles traveled (MTMT). The five year average was determined by first calculating the average for each year for the specified route segment, then averaging over 5 years. Appendix 2-Q details accident data by route segment.

For 1987, the accident rate for all vehicles for the state of Nevada was 389 accidents per MVMT. This rate was obtained from the NDOT Safety Engineering Division. The 1987 accident rate for all vehicles for the route from Arizona was 198 accidents per MVMT and 44 accidents per MTMT for trucks.

2.3.2.2 Infrastructure

Infrastructure characteristics begin with functional classification. Information obtained from the NDOT Traffic Accident History 1984-1988 indicates the following classification of the highway route from Arizona. Nearly 46 percent of the total route is classified as interstate rural, 11 percent as interstate urban, 12 percent principal arterial urban, and 32 percent is considered principal arterial rural (NDOT Traffic Accident History 1984-1988).

Four lane divided roadway constitutes 98.8 percent of the total route. Six lane divided roadway constitutes 1.2 percent of the total route. The distance-weighted average for the entire route is 4.02 lanes (1987 NDOT Research Division, Log of the Federal-Aid System).

The roadway width for the route varied from 48 to 72 feet. The following describes the roadway width distribution of the

route: roadway of 48 feet width constituted 94 percent of the route and roadway of 72 feet width constituted 4 percent of the total route. Various road tapers constituted the remaining 2 percent of the total route. This information was obtained from the Log of the Federal-Aid System (1987 NDOT Research Division).

The roadway along Route I-15 to US 95 from Arizona includes both flexible and rigid pavement types. Mixed bituminous penetration (G), and bituminous concrete (I), and portland cement concrete (J) (NDOT Traffic Accident History 1984-1988).

There are 32 bridges and 22 culverts along route I-15 to US 95 from Arizona (1989 NDOT Cumulative Mileage Milepost Listing).

The ideal travel time was calculated to be 2.35 hours. This was determined by dividing the distance by the posted speed limit. This does not include delays. The speed limits within the towns and cities are: Las Vegas - 55 miles per hour; Indian Springs - 35 miles per hour. The speed limits of the highways are: I-15 - 55/65 miles per hour; US 95 - 55/65 miles per hour. This information was obtained from the 1984-1988 NDOT Highway Traffic Accident History.

There are no rest areas along the route from Arizona (NDOT Highway Rest Area Inventory).

Trucks over 70 feet require special permits from NDOT. The maximum weight limit set by NRS 484.745 on one axle is equal to 20,000 lbs, on any tandem axle is equal to 34,000 lbs.

Appendix 2-R presents a detailed listing of bridges, culverts, railroad intersections, and highway speeds for this route.

2.3.2.3 Hazardous Shipments/Inventories

There were 72 truck shipments crossing the Highway route from Arizona carrying a total of 272.4 tons of hazardous materials. An average of 100 trucks per day carry a total of 2,291 tons of hazardous cargo over all or part of this route daily. Detailed data are presented in Appendix 2-D.

A high-pressure natural gas pipeline crosses the route at one place. Pipelines also run along the route within various distances as indicated in the following:

Corridor Width	Miles of Pipeline
0.5 miles	6.1
1.0 miles	6.2
2.0 miles	10.8
6.0 miles	14.9
10.0 miles	19.1
20.0 miles	29.3

2.3.2.4 Road Conditions (Environmental)

1987 data indicate that there were four to eight inches of rainfall and less than two inches of snowfall annually for the entire route from Arizona.

2.3.3 Consequence Measures

This section provides operational definitions and sources of information for eight consequence measures used in characterizing the highway route from Arizona. Data include: resident population, non-resident population, ecologically sensitive areas, land use, property value, difficult/dangerous to evacuate areas, meteorological conditions and traffic volume.

2.3.3.1 Resident Population

The data sources and the approach used to collect and process population data along the proposed highway route from Arizona are similar to that used for Routes A and B. Appendix 2-S shows the population density of individual segments within a 0.5 mile-wide corridor along the proposed route.

Total population within 0.5, 2, and 20 mile corridors for the route were established using a GIS overlay of the corridors on population distributions by section, traffic zone, city limit or zip code. Figure 2-18 illustrates this technique.

The populations within these corridors along the route from Arizona are:

Corridor Width	Resident Population
0.5 miles	29,554
2.0 miles	120,037
20.0 miles	636,356

2.3.3.2 Non-Resident Population

Non-resident populations within 0.5, 1, 2, 6, 10 and 20 mile corridors for the route from Arizona were established using a GIS overlay of the corridors on hotel/motel locations within Las Vegas. Figure 2-19 illustrates this technique. The non-resident populations determined for these corridors along the route from Arizona are:

Corridor Width	Non-Resident Population
0.5 miles	245
1.0 miles	6,053
2.0 miles	24,035
6.0 miles	62,607
10.0 miles	127,348
20.0 miles	154,585

Appendix 2-T provides detailed information on non-resident population estimation.

2.3.3.3 Ecologically Sensitive Areas

Three categories of ESAs were characterized within 10 miles of the highway route from Arizona (20 mile corridor): national forests/wildlife refuges, desert tortoise habitats, and a combination of selected ESAs (Figures 2-20, 2-21, and 2-22). The total areas for these three categories within a 20 mile corridor along the route are:

Type of ESA	Area
National Forests/Wildlife Refuges	514 square miles
Desert Tortoise Habitats	2,323 square miles
All ESAs	3,005 square miles
Total area of corridor	3,180 square miles*

* (20 miles x length of route) + buffers at ends of route

2.3.3.4 Land Use

The land uses within a 2 mile corridor along the highway route from Arizona may be characterized as follows: (Appendix 2-U presents more detailed information.)

Land Use Type	Area
Residential	13.6 square miles
Industrial	0.4 square miles
Commercial	4.3 square miles
Non-profit	3.5 square miles
Trans./Comm.	0.5 square miles *
Minor Improvements	1.7 square miles
Government	265.1 square miles
Unspecified Urban	1.7 square miles

* Because of the statistical sampling technique applied in this preliminary study, the amount of land representing roadway right-of-way was not represented. This is not representative of the large amount of land actually used within the 2 mile corridor for roadway. Other uses should be adjusted accordingly and should be viewed relatively due to the omission of transportation and communications lands.

2.3.3.5 Property Value

The total property value calculated for the highway route from Arizona within a 2 mile-wide corridor is approximately \$8.76 billion. More detailed information is presented in Appendix 2-V.

2.3.3.6 Difficult/Dangerous to Evacuate Locations

Three types of difficult to evacuate locations were identified to represent this category. They are: number of enrolled school children, number of hospital beds, and number of prison inmates within the corridors along the highway route from Arizona. Appendix 2-I presents more detailed information. The following summarizes the totals for the route from Arizona:

Corridor Width	School Children	Hospital Beds	Prison Inmates
0.5 miles	5,626	0	0
1.0 miles	12,128	0	0
2.0 miles	22,224	473	1,491
6.0 miles	53,774	1,074	1,491
10.0 miles	71,066	1,994	1,491
20.0 miles	89,966	2,184	1,491

2.3.3.7 Meteorological Conditions

Annual snowfall on the highway route from Arizona averages less than two inches. Rainfall averages between 4 and 8 inches per year.

2.3.3.8 Traffic Volume

The distance-weighted average daily traffic for the highway route from Arizona was calculated as 9,578 vehicles per day. Weighted average truck ADT was calculated as 1,420 trucks per day. (Appendix 2-Q presents more detailed traffic data.)

2.4 Route: I-15 to US 95 from California

This highway route consists of sections of I-15 and US 95 from Stateline at the border of California and Nevada to Yucca Mountain.

2.4.1 Route Specification and Distance

Specification and distances for sections and segments of the highway route from California are listed in Appendix 2-W. This route was divided into 36 segments. Distances were obtained from the NDOT 1988 Annual Traffic Report. The total distance for this route is 105.3 miles, the shortest of the four highway routes. Figure 2-23 illustrates the alignment of this Route.

2.4.2 Probability Measures

This section provides operational definitions and sources of information for five probability measures used in characterizing the highway route from California. Data for each of the measures include: distance, accident history and rates, infrastructure characteristics, hazardous materials shipments and inventories, and environmental conditions along the road.

2.4.2.1 Accident History and Rates

Accident rates were calculated from historical Nevada-specific accident data. For 1984 to 1988, the five year average accident rate for all vehicles on the highway route from California was 274 accidents per million vehicle miles traveled (MVMT). The five year average accident rate for trucks was 132 accidents per million truck miles traveled (MTMT). The five year average was determined by first calculating the average for each year for the specified route segment, then averaging over 5 years. Appendix 2-X details accident data by route segment.

For 1987, the accident rate for all vehicles for the state of Nevada was 389 accidents per MVMT. This rate was obtained from the NDOT Safety Engineering Division. The accident rate for all vehicles in 1987 for the route from California was 316 accidents per MVMT and 79 accidents per MTMT for trucks.

2.4.2.2 Infrastructure

Infrastructure characteristics begin with functional classification. Information obtained from the NDOT Traffic Accident History 1984-1988 indicates the following classification of the highway route from California. Nearly 40 percent of the total route is classified as interstate, 60 percent as principal arterial (NDOT Traffic Accident History 1984-1988).

Four lane divided roadway constitutes 96.2 percent of the total route. Six lane divided roadway constitutes 3.8 percent of the total route. The distance-weighted average for the entire route is 4.08 lanes (1987 NDOT Research Division, Log of the Federal-Aid System).

The roadway width for the route varied from 48 to 72 feet. The following describes the roadway width distribution of the route: roadway of 48 feet width constituted 95 percent of the total route and roadway of 72 feet width constituted 4 percent of the total route. Various road tapers constituted the remaining 1 percent of the total route. This information was obtained from the Log of the Federal-Aid System (1987 NDOT Research Division).

The roadway along Route I-15 to US 95 from California includes both flexible and rigid pavement types. Mixed bituminous penetration (G), and bituminous concrete (I), and portland cement concrete (J) (NDOT Traffic Accident History 1984-1988).

There are 24 bridges and 10 culverts along route I-15 to US 95 from California (1989 NDOT Cumulative Mileage Milepost Listing).

The ideal travel time was calculated to be 1.82 hours. This was determined by dividing the distance by the posted speed limit. This does not include delays. The speed limits within the towns and cities are: Las Vegas - 55 miles per hour; Indian

Springs - 35 miles per hour. This information was obtained from the 1984-1988 NDOT Highway Traffic Accident History.

There is one rest areas along the route from California (NDOT Highway Rest Area Inventory).

Trucks over 70 feet require special permits from NDOT. The maximum weight limit set by NRS 484.745 on one axle is equal to 20,000 lbs, on any tandem axle is equal to 34,000 lbs.

Appendix 2-Y contains a detailed listing of bridges, culverts, railroad intersections, and highway speeds for this route.

2.4.2.3 Hazardous Shipments/Inventories

There were 122 truck shipments crossing the highway route from California carrying a total of 1,166.4 tons of hazardous materials. An average of 141 trucks per day carry a total of 2,291 tons of hazardous cargo over all or part of this route daily. Detailed data are presented in Appendix 2-D.

High-pressure natural gas pipelines cross the route at 3 places. These pipelines also run within various distances of the route from California as indicated in the following:

Corridor Width	Miles of Pipeline
0.5 miles	4.7
1.0 miles	11.9
2.0 miles	33.2
6.0 miles	54.8
10.0 miles	58.9
20.0 miles	72.7

2.4.2.4 Road Conditions (Environmental)

1987 data indicate that there were four to eight inches of annual rainfall and less than two inches of snowfall for the entire route from California.

2.4.3 Consequence Measures

This section provides operational definitions and sources of information for eight consequence measures used in characterizing the highway route from California. Data for these measures include: resident population, non-resident population, ecologically sensitive areas, land use, property value, difficult/dangerous to evacuate areas, meteorological conditions and traffic volume.

2.4.3.1 Resident Population

The data sources and the approach used to collect and process population data along the proposed highway route from

California are similar to that used for the other highway routes. Appendix 2-2 shows the population density of individual segments within a 0.5 mile-wide corridor along the proposed route.

Total population within 0.5, 2, and 20 mile corridors for the route from California were established using a GIS overlay of the corridors on population distributions by section, traffic zone, city limit or zip code. Figure 2-24 illustrates this technique.

The populations within these corridors is:

Corridor Width	Resident Population
0.5 miles	38,411
2.0 miles	147,935
20.0 miles	625,494

2.4.3.2 Non-Resident Population

Non-resident populations within 0.5, 1, 2, 6, 10 and 20 mile corridors for the route were established using a GIS overlay of the corridors on hotel/motel locations. Figure 2-25 illustrates this technique. The non-resident populations determined for these corridors along the route from California are:

Corridor Width	Non-Resident Population
0.5 miles	5,626
1.0 miles	48,853
2.0 miles	128,733
6.0 miles	153,505
10.0 miles	154,283
20.0 miles	157,009

Appendix 2-AA provides detailed information on non-resident population estimation.

2.4.3.3 Ecologically Sensitive Areas

Three categories of ESAs were characterized within 10 miles of the highway route from California (20 mile corridor): national forests/wildlife refuges, desert tortoise habitats, and a combination of selected ESAs (Figures 2-26, 2-27, and 2-28). The total areas for these three categories for the 20 mile corridor along the route are:

Type of ESA**Area**

National Forests/Wildlife Refuges	378 square miles
Desert Tortoise Habitats	1,520 square miles
All ESAs	2,075 square miles
Total area of corridor	2,420 square miles*

* (20 miles x length of route) + buffers at ends of route

2.4.3.4 Land Use

The land uses within a 2 mile corridor along the highway route from California may be characterized as follows: (Appendix 2-BB presents more detailed information.)

Land Use Type	Area
Residential	14.8 square miles
Industrial	0.6 square miles
Commercial	9.8 square miles
Non-profit	2.8 square miles
Trans./Comm.	1.1 square miles *
Minor Improvements	1.3 square miles
Government	178.5 square miles
Unspecified Urban	1.7 square miles

* Because of the statistical sampling technique applied in this preliminary study, the amount of land representing roadway right-of-way was not represented. This is not representative of the large amount of land actually used within the 2 mile corridor for roadway. Other uses should be adjusted accordingly and should be viewed relatively due to the omission of transportation and communications lands.

2.4.3.5 Property Value

The total property value calculated for the highway route from California within a 2 mile-wide corridor is approximately \$20.56 billion, the highest of the four highway routes. More detailed information are presented in Appendix 2-CC.

2.4.3.6 Difficult/Dangerous to Evacuate Locations

Three types of difficult to evacuate locations were identified to represent this category. They are: number of enrolled school children, number of hospital beds, and number of prison inmates within the corridors along the highway route from California. Appendix 2-I contains more detailed information. The following summarizes the totals:

Corridor Width	School Children	Hospital Beds	Prison Inmates
0.5 miles	4,165	0	0
1.0 miles	9,779	746	0
2.0 miles	16,748	746	1,491
6.0 miles	46,764	1,799	1,491
10.0 miles	79,998	2,069	1,491
20.0 miles	88,289	2,144	2,069

2.4.3.7 Meteorological Conditions

Annual snowfall on the highway route from California averages less than two inches. Rainfall averages between 4 and 8 inches per year.

2.4.3.8 Traffic Volume

The distance-weighted average daily traffic for the highway route from California was calculated as 16,855 vehicles per day, the highest of the four highway routes. Weighted average truck ADT was calculated as 2,120 trucks per day (also the highest). (Appendix 2-X presents more detailed traffic data.)

2.5 Summary Comparison of Highway Routes

This section provides a tabular comparison by corridor for the characteristics of the four highway routes.

Table 2-3

Summary Highway Link Characteristics

ROUTE	A	B	1-15 to US 95 FROM Arizona	1-15 to US 95 FROM CALIFORNIA
TOTAL DISTANCE (MILES)	415.8	434.9	143.3	105.3
TOTAL ACCIDENT RATES 5 YEAR AVERAGE (ACC/MVMT)	307	346	187	274
TRUCK ACCIDENT RATES 5 YEAR AVERAGE (ACC/MTMT)	113	293	81	132
AVERAGE NUMBER OF LANES	2.34	2.02	4.02	4.08
AVERAGE ROAD WIDTH (FEET)	27.6	23.3	49.4***	50.4***
AVERAGE TRAVEL TIME (HOURS)	7.62	8.08	2.35	1.82
NUMBER OF RAILROAD CROSSINGS	3	2	0	0
NUMBER OF BRIDGES	6	5	32	24
NUMBER OF CULVERTS	26	16	22	10
NUMBER OF REST AREAS	1	4	0	1
MAXIMUM RAINFALL (INCHES) DISTANCE (MILES)	>16 16	>16 40	4-8 143.3	4-8 105.3
MAXIMUM SNOWFALL (INCHES) DISTANCE (MILES)	>40 36	>40 41	<2 143.3	<2 105.3
FUNCTIONAL CLASS(ES) *	I,P,M,C	P,M	I,P	I,P
SURFACE TYPE(S) **	G,I,J	G,I	G,I,J	G,I,J
TRAFFIC VOLUME (AVG VEHICLES PER DAY)	1,557	940	9,578	16,855
TRAFFIC VOLUME (AVG TRUCKS PER DAY)	319	191	1,420	2,120
VEHICLE MILES TRAVELED (MILLIONS, ANNUAL)	236	149	502	648
TRUCK MILES TRAVELED (MILLIONS, ANNUAL)	48	30	52	82
HAZMAT TRUCKS/DAY (CROSSING ROUTE)	17	17	72	122
HAZMAT TRUCKS/DAY (ALONG ROUTE)	252	165	100	141
HAZMAT TONS/DAY (CROSSING ROUTE)	311.9	311.9	274.2	1166.4
HAZMAT TONS/DAY (ALONG ROUTE)	5,916	3,682	2,291	2,291
NUMBER OF GAS PIPELINE CROSSINGS	4	0	1	3

* I: Interstate, P: Principal Arterial, M: Minor Arterial, C: Major Collector

** G: Mixed Bituminous Penetration, I: Bituminous Concrete, J: Portland Cement Concrete

*** This is the average road width excluding the median for divided highway

Table 2-4

**Summary Highway Route Comparisons
0.5 Mile-wide Corridor**

ROUTE	A	B	I-15 to US 95 FROM Arizona	I-15 to US 95 FROM CALIFORNIA
RESIDENT POPULATION	12,831	10,279	29,554	38,411
NON-RESIDENT POPULATION	few	few	245	5,626
NUMBER OF SCHOOL STUDENTS	0	275	5,626	4,165
NUMBER OF HOSPITAL BEDS	74	85	0	0
PRISON POPULATION	0	0	0	0
MILES OF GAS PIPELINE (ALONG ROUTE)	2.9	0.0	6.1	4.7

Table 2-5

**Summary Highway Route Comparisons
1 Mile-wide Corridor**

ROUTE	A	B	I-15 to US 95 FROM Arizona	I-15 to US 95 FROM CALIFORNIA
NON-RESIDENT POPULATION	few	few	6,053	48,853
NUMBER OF SCHOOL STUDENTS	956	1,534	12,178	9,779
NUMBER OF HOSPITAL BEDS	74	85	0	746
PRISON POPULATION	0	0	0	0
MILES OF GAS PIPELINE (ALONG ROUTE)	12.1	0.0	6.2	11.9

Table 2-6

**Summary Highway Route Comparisons
2 Mile-wide Corridor**

ROUTE	A	B	I-15 to US 95 FROM Arizona	I-15 to US 95 FROM CALIFORNIA
RESIDENT POPULATION	28,832	16,976	120,037	147,935
NON-RESIDENT POPULATION	few	few	24,035	128,733
PROPERTY VALUE (\$ MILLION)	763	298	8,756	20,564
LAND USE AREA: RESIDENTIAL (SQUARE MILES)	4.9	0.0	13.6	14.8
LAND USE AREA: INDUSTRIAL(SQUARE MILES)	0.3	0.0	0.4	0.6
LAND USE AREA: COMMERCIAL (SQUARE MILES)	0.9	0.0	4.3	9.8
LAND USE AREA: NON-PROFIT COMMUNITY FACILITIES (SQUARE MILES)	0.0	0.0	3.5	2.8
LAND USE AREA: TRANSPORT, COMMUNICATIONS OR UTILITIES (SQUARE MILES)	0.0	0.0	0.5	1.1
LAND USE AREA: MINOR IMPROVEMENTS (SQUARE MILES)	1.0	0.0	1.7	1.3
LAND USE AREA: GOVERNMENT OR VACANT (SQUARE MILES)	805.2	858.7	261.1	178.5
LAND USE AREA: UNSPECIFIED URBAN (SQUARE MILES)	17.8	9.8	1.7	1.7
NUMBER OF SCHOOL STUDENTS	2,144	2,820	22,224	16,748
NUMBER OF HOSPITAL BEDS	74	85	473	746
PRISON POPULATION	1,491	0	1,491	1,491
MILES OF GAS PIPELINE (ALONG ROUTE)	17.6	0.0	10.8	33.2

Table 2-7

**Summary Highway Route Comparisons
6 Mile-wide Corridor**

ROUTE	A	B	I-15 to US 95 FROM Arizona	I-15 to US 95 FROM CALIFORNIA
NON-RESIDENT POPULATION	694	few	62,607	153,505
NUMBER OF SCHOOL STUDENTS	16,143	3,074	53,774	46,764
NUMBER OF HOSPITAL BEDS	282	85	1,074	1,799
PRISON POPULATION	1,549	0	1,491	1,491
MILES OF GAS PIPELINE (ALONG ROUTE)	23.5	0.0	14.9	54.8

Table 2-8

**Summary Highway Route Comparisons
10 Mile-wide Corridor**

ROUTE	A	B	I-15 to US 95 FROM Arizona	I-15 to US 95 FROM CALIFORNIA
NON-RESIDENT POPULATION	22,950	few	127,348	154,283
NUMBER OF SCHOOL STUDENTS	41,911	3,077	71,066	70,998
NUMBER OF HOSPITAL BEDS	429	85	1,994	2,069
PRISON POPULATION	2,187	638	1,491	1,491
MILES OF GAS PIPELINE (ALONG ROUTE)	24.4	0.0	19.1	58.9

Table 2-9**Summary Highway Route Comparisons
20 Mile-wide Corridor**

ROUTE	A	B	I-15 to US 95 FROM Arizona	I-15 to US 95 FROM CALIFORNIA
RESIDENT POPULATION	577,966	16,976	636,356	625,494
NON-RESIDENT POPULATION	148,385	few	154,585	157,009
NUMBER OF SCHOOL STUDENTS	84,822	3,077	89,966	88,289
NUMBER OF HOSPITAL BEDS	2,055	85	2,184	2,114
PRISON POPULATION	2,187	638	1,491	2,069
MILES OF GAS PIPELINE (ALONG ROUTE)	26.4	0.0	29.3	72.7
ESA: ALL SELECTED (SQUARE MILES)	4,925	3,786	3,005	2,075
ESA: NATIONAL FORESTS/WILDLIFE REFUGES (SQUARE MILES)	1,375	876	514	378
ESA: DESERT TORTOISE HABITAT (SQUARE MILES)	1,966	1,480	2,323	1,520

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3 Identification of Potentially Critical Locations for Highway Accidents

In the introductory chapter of this report, three forms of transportation impact analysis using route characterization measures were discussed. The first of these, comparative evaluation, was demonstrated at the conclusion of Chapter 2 after the four highway routes were characterized. The second form of impact analysis, "worst case" analysis, is presented in this and the next chapter (potentially critical locations, and potentially likely locations for accidents, respectively). The third form of analysis, probability risk assessment, is to be demonstrated in future work.

This chapter identifies some potentially critical locations for truck accidents on Highway Routes A, B, I-15 to US 95 from Arizona, and I-15 to US 95 from California, for the general categories of potential population impacts, cost and difficulty of accident cleanup, environmental impacts, and impact on accident severity. Included in the "population impacts" category are numbers of residents and non-residents within specified corridors along the routes. The "cost and difficulty of accident cleanup" category is addressed using measures of property value, land use, difficulty to evacuate locations, and traffic volume. "Environmental impact" is analyzed according to the nature and area of several ecologically sensitive areas. "Accident severity" is reflected in measures of meteorological conditions, infrastructure, and hazardous materials shipments and inventories. Finally, a comparison of the highway routes on critical accident locations, based upon the four categories, is presented.

In this chapter, references to potentially critical locations are made in two ways: by segment number (Appendices 2-A, 2-J, 2-P, and 2-W provide segment specification), and by geographic description (e.g. 2 miles north of Tonopah on US 6).

3.1 Route: A (From Wendover via Las Vegas)

3.1.1 Potential Population Impacts

Potential population impacts are divided into two categories, resident and non-resident populations.

3.1.1.1 Resident Population

Observation of data for a 0.5 mile corridor shows that the areas with highest population densities along Route A are comprised of Segments 2.8 through 3.2 and Segments 7.3 through 8.1 (Ely in White Pine County and Craig Road in Clark County). Figure 3-1 shows population density distributions for each segment within a 2 mile corridor along Route A. This figure may be compared with similar graphs for each of the other three routes (Figures 3-2, 3-3, and 3-4).

3.1.1.2 Non-Resident Population

There are many potentially critical locations for non-resident populations along route A in the Las Vegas metropolitan area where tourist populations are high. While within a 6 mile corridor there are few resorts, hotels, or motels, nearly all hotel rooms within the Las Vegas area are within a 20 mile corridor. Only 5 percent of all hotel rooms in the Las Vegas Valley are beyond the 20 mile corridor along this route. Further, non-resident populations in other areas along the route, while small in comparison to those of Las Vegas, may be significant relative to resident populations and important to local economies.

Segment 7.3 has the highest non-resident population for Highway Route A for both the 0.5 and 2 mile corridors. The segment with highest non-resident population for the 20 mile corridor is Segment 7.2.

3.1.2 Cost and Difficulty of Accident Cleanup

To approach the issue of cost and difficulty of accident cleanup, data were analyzed for each of the following categories: property values, land uses, difficult to evacuate locations, and traffic volumes. Property values and land uses are included as measures of the utility of land and property which may be temporarily or permanently lost due to an accident. Difficult to evacuate locations are included as emergency response procedures would be more involved, hence expensive, for such locations. Traffic volume is included as a measure of the potentially affected population¹ as well as a measure of the potential impacts of temporarily closing a roadway.

3.1.2.1 Property Value

Potentially critical locations within a two mile corridor were established for property values according to two criteria, 1) the single worst place for an accident and 2) the worst segments for an accident to occur.

The worst location for an accident was determined by the following method:

- 1) Sample parcels of property were identified at a distance of 1/2 mile either side of the route every 1/2 mile along the route within the Las Vegas area, as explained in Chapter 1.

- 2) Property values and areas of sample parcels were determined using Clark County tax assessor maps. The property value was divided by the area to give property value per square mile.

¹The term "on-link" populations is used by some PRA models.

3) This value was assumed to represent the entire interval area (0.5 square miles on each side of the route).

4) The average property value for each side of the route was determined.

5) The average represents the property value for a 1/2 mile segment of the route.

6) This procedure was followed for all pairs of data points along the route that were within the Las Vegas area.

7) A potentially critical location along the route was determined to be the 1/2 mile interval with the highest property value per square mile.

Potentially critical segments for accidents were determined by:

1) dividing the total property value of each sample parcel along both sides of the route within each segment by it's area, producing a unit value in dollars per square mile for each sample representing 1/2 square mile intervals along the routes,

2) adding the unit values for all samples within each segment and dividing by the number of sample points within the segment, producing an average value per square mile for the entire segment, and

3) determining potentially critical segments to be those with the highest property value per square mile.

A potentially critical location for an accident along Route A is a 1/2 mile section located within Segment 9.1, from the junction of US 95 and Rancho Road to a point 1/2 mile north of the junction. The property value at this location is \$309 million per square mile.

Potentially critical segments include Segment 9.1 with an average value of \$53 million per square mile, and Segments 6.5 and 8.1 with values of \$65 million and \$44 million per square mile, respectively. (Appendix 2-H provides detailed information on property values.)

3.1.2.2 Land Use

To identify potentially critical locations for accidents based on land use, a criterion was established: areas with highest concentration of urban land use would be considered potentially critical. Of course, other types of land use may also be identified for this purpose. For Highway Route A, the segments with highest urban use are 1.1, 1.4, 2.5, 2.6, 2.8, 3.2, 5.4, 6.1, 7.1, and 8.1. Each of these segments has at least 0.75 square miles of urban land use.

3.1.2.3 Difficult/Dangerous to Evacuate Locations

► School Enrollment

Potentially critical locations for school enrollment are those segments with the highest number of school children attending schools within that corridor of the segment. The enrollment includes both public and private schools from pre-kindergarten to the twelfth grade. Pre-schools, day care centers, and post high-school education facilities, such as colleges, were not included due to time constraints.

The 1/2 mile corridor allows for no specification of a critical location for an accident, because no schools are located within a quarter mile of the route. The worst place for an accident based on the 1 mile corridor is Segment 2.8, which has a total enrollment of 555. For the 2 mile corridor, a potentially critical place is Segment 3.1 with an enrollment of 596. Segment 6.5 has the highest enrollment for the 6 mile corridor at 3,818. In the 10 mile corridor, Segment 7.1 has an enrollment of 11,577 students. Finally, for the 20 mile corridor, with an enrollment of 23,015, Segment 6.5 is a potentially critical place for an accident.

► Prison Occupancy

No prison or correctional facilities lie within a 1 mile corridor of Route A. Segment 9.8 has a prisoner count of 1,491 within a 2 mile corridor, and is a potentially critical place for an accident.

► Hospital Bed Count

Segment 3.2, with a bed count of 40, is a potentially critical location for an accident for the 0.5, 1, and 2 mile corridors. Segment 7.1 has a bed count of 163 for the highest count within the 6 mile corridor. Segment 7.2, with a bed count of 310, is a potentially critical segment for the 10 mile corridor, and Segment 7.1, with a bed count of 903, is the potentially critical segment for the 20 mile corridor.

Detailed information regarding difficult/dangerous to evacuate locations is provided in Appendix 2-I.

3.1.2.4 Traffic Volume

Traffic volume is the flow of vehicles per unit time for a given highway segment. While a high volume may not necessarily indicate a high accident rate, it subjects a greater volume of vehicles to accident risk. A potentially critical location (highest traffic volume) is located on I-15 near the junction of US 93. In 1988, the volume in this area was 3,774,100 vehicles (per year).

Traffic volumes experience seasonal variation. The data show an increase in traffic from winter to summer ranging from 26.0 percent to 82.4 percent over the last five years of data for the 4 collection stations used by the Nevada Department of Transportation (NDOT). The summer months (July and August) have the highest traffic volumes and the winter months (November through February) have the lowest traffic volumes. One exception is a station on State Route 318 (SR 318), which has high traffic volumes in October for the years 1985 through 1987. With only four stations used to obtain traffic counts, the accuracy in determination of potentially critical locations for traffic accidents may be limited.

3.1.3 Environmental Impacts

3.1.3.1 Ecologically Sensitive Areas

The total area within each ecologically sensitive area (ESA) category was calculated within a 20 mile corridor using a geographic information system (GIS).

The total coverage of ESAs within the 20 mile corridor along Route A is 4,925 square miles. Wildlife refuges cover the largest area, representing 70.4 percent of the total. They are followed by national forests which account for 27.3 percent.

No systematic method was devised to identify potentially critical accident locations for ecologically sensitive areas. One such method might be to tabulate the ESA percentage of corridor width at set intervals along the route, then identify locations with highest percentages as critical. In lieu of such a procedure, by observing the plots of ESA/corridor overlap presented in Chapter 2, one may identify areas of potential concern. For example, a potentially critical location for highway accidents may be identified as between Segments 5.4 and 9.6 (about 50 miles, total). This section lies within Clark and Nye Counties and consists of a large area of desert tortoise habitat. Another potentially critical location is made up of Segments 1.4 - 2.2 (Humboldt National Forest and White River Valley) - a refuge for antelopes, mule deer and elk. This section is approximately 70 miles long.

However, the method described above may not be responsive to the prevalence of natural resources. For example, key watershed areas have not been addressed in the scope of this study. The Pahrangat National Wildlife Refuge is directly traversed by U.S. 93, is within desert tortoise range, is partially within the Desert Sheep Range, and has extensive surface waters associated with it. Yet, in application of the methodology above, the area does not stand out as a potentially critical accident location.

3.1.4 Impact on Accident Severity

Measures used to quantify impact on accident severity include meteorological conditions, which affect release dispersion rates and directions, infrastructure characteristics, which affect vehicular accident severity, and hazardous materials shipments and inventories, such as explosives which may impact waste shipments.

3.1.4.1 Meteorological Conditions

Meteorological conditions affect radiation release dispersions. Wind, rain, and snow change dispersion characteristics. Collection of wind data was beyond the scope of the current research effort. Data for annual rainfall and snowfall were collected. These data were used to compute an average for the route as a whole. Consequently, the lack of variation in the rainfall and snowfall for the route prohibits identification of a potentially critical location for accidents. Further, it would be difficult to specify critical accident locations using this measure due to the spatial and temporal dynamics of meteorological conditions. With some real probability, any location along the route could have equally severe meteorological conditions.

3.1.4.2 Infrastructure

Railroad crossings or bridges are potentially critical locations for truck accidents. Even if an accident occurring near a railroad crossing did not involve collision with a train, the rail line may be temporarily unusable, possibly for an extended period of time. An accident involving a cask falling off a bridge would require appropriate emergency equipment and response capabilities.

Due to time constraints, data for the height of bridges were not collected. Data showing the location of railroad crossings were summarized in Chapter 2. There is no measure for a potentially critical railroad crossing. If external factors are taken into consideration such as whether the track is on a main line or the crossing's proximity to an urban area, the railroad crossing located on Craig Road, Segment 7.1, may be considered to be a potentially critical accident location. Future study may produce a methodology for developing severity measures incorporating the probability of a collision with a train.

3.1.4.3 Hazardous Material Shipments/Inventories

► High-Pressure Natural Gas Pipelines

For the 0.5 mile corridor around Highway Route A, a potentially critical accident location is along Segment 6.5, where 0.91 miles of high-pressure natural gas pipeline are located within 1/4 mile of the route. For the 1 mile corridor, a

potentially critical location is Segment 7.1 which has 2.80 miles within 1/2 mile of a pipeline. A potentially critical segment for the 2 mile corridor is 6.2, with 3.38 miles of pipeline. For the 6, 10, and 20 mile corridors, a potentially critical location is also Segment 6.2 (7.04 miles).

Segments 6.2, 6.5, 7.1, and 8.1 are crossed at some point by a gas pipeline.

► Hazardous Material Shipments

Potentially critical locations along Highway Route A are Segments 1.1, with 62 truck shipments of hazardous materials per day, and 6.2 through 6.5, with 76 daily shipments (NDOT Commodities Report).

Detailed information regarding hazardous material shipments/inventories is provided in Appendix 2-D.

3.2 Route: B (From Wendover via Tonopah)

3.2.1 Potential Population Impacts

3.2.1.1 Resident Population

Figure 3-2 shows population density distributions for each segment within a 2 mile corridor along Route B. From the plot, the areas of high population concentration can be delineated. These include Segments 2.7 through 3.2, located at Ely in White Pine County. These segments comprise 5.676 miles (1.17 percent) of Route B. Estimated density within the 0.5 mile corridor is about 1,800 persons per square mile. These segments are identified as potentially critical areas.

While the remaining distance of Highway Route B (430 miles) has an average population density of less than one person per square mile, some segments do run through more populous areas (e.g. Goldfield and Tonopah). All population along the route has been included in this study as practicable.

3.2.1.2 Non-Resident Population

No data regarding non-resident population are presented for Highway Route B. The non-resident population along this route is small compared to that along the other highway routes. Identification of critical accident locations with respect to this parameter is not included in the current scope of work. However, while this population is small when compared to that of Las Vegas, the relative impacts on non-resident population along Route B should not be ignored. Future studies should lead to an assessment of this potential impact.

3.2.2 Cost and Difficulty of Accident Cleanup

3.2.2.1 Property Value

Potentially critical places for accidents along Highway Route B are Segments 3.14 and 4.10. These segments have the highest property value per route mile and would possibly incur the greatest economic consequences in the event of an accident. Segment 3.14 has a value of \$29 million per square mile. Segment 4.10 has a value of \$37 million per square mile (Appendix 2-0 has detailed property value data). These segments were identified by the same methodology used for Route A in section 3.1.2.1.

3.2.2.2 Land Use

In terms of land use, potentially critical accident locations along Highway Route B are Segments 1.1, 1.4, 2.5, 2.6, 2.8, and 3.2. Each of these segments has at least 0.75 square miles of urban land use. This assumes that urban land is potentially severely affected by accidents. Identification of other critical areas is possible given different decision criteria. (Refer to Appendix 2-N for breakdowns of land use percentages for all routes.)

3.2.2.3 Difficult/Dangerous to Evacuate Locations

► School Enrollment

Segment 4.10 is a potentially critical location for an accident based on the 0.5 mile corridor, with 204 children enrolled in schools that are located within a quarter mile of the segment. Segment 4.1 has an enrollment of 704 and is a potentially critical place for accidents for the 1, 2, 6, 10, and 20 mile corridors.

► Prison Occupancy

In terms of prison population, Segment 2.7 is the only potentially critical place for an accident to occur along Highway Route B. The total number of prison and correctional institution inmates within a 10 mile corridor along Segment 2.7 is 638.

► Hospital Bed Count

Based on hospital bed count, a potentially critical location for an accident to occur for Highway Route B would be along Segment 4.1. Hospital(s) with a total of 45 beds lie within all corridors for this segment.

Detailed information regarding difficult/dangerous to evacuate locations is provided in Appendix 2-I.

3.2.2.4 Traffic Volume

A potentially critical location for Route B (highest traffic volume) is located in Wendover in Elko County at the junction of Old US 40 and US 93A. This location had a traffic volume 2,458,275 in 1988.

The increase in traffic from winter to summer ranges from 51.2 percent to 82.4 percent over the last five years of data for the one collection station used by NDOT. The summer months (August) have the higher traffic volumes and the winter months (January) have the lower traffic volumes. Only one station has been used to count traffic. Therefore, use of traffic volume in the determination of a potentially critical accident location along Highway Route B may be inappropriate.

3.2.3 Environmental Impacts

3.2.3.1 Ecologically Sensitive Areas

Route B has a concentration of ecologically sensitive areas in its northern section and mainly covers Humboldt National Forests. This potentially critical area is traversed by Segments 5.4 to 9.6 (about 70 miles).

The national forests account for an area of 715.7 square miles or 93.5 percent of the total area of ESAs for Route B.

3.2.4 Impact on Accident Severity

3.2.4.1 Meteorological Conditions

No potentially critical locations for Route B were identified based on meteorological data.

3.2.4.2 Infrastructure

Section 3.1.4.2 provided a general description of infrastructural considerations. Data indicating the location of railroad crossings are presented in Appendix 2-L. If proximity to population centers is a criterion, the railroad crossing located just north of Ely may be considered a critical location. Another possible critical location exists in Goldfield, along a critical curve. More study is required to quantify the impacts of such infrastructural characteristics on likelihood of accident.

3.2.4.3 Hazardous Shipments/Inventories

► High-Pressure Natural Gas Pipelines

Highway Route B is not close to any high-pressure natural gas pipelines (within 10 miles).

► Hazardous Material Shipments

Segment 1.1 has the highest number of hazardous materials shipments along Route B. Daily truck shipments along the route total 62 for all types of hazardous materials. Segments 1.3 and 1.4 are also potentially critical locations with 36 truck shipments each day. Route B is crossed by shipments of hazardous materials at only one location. Segment 4.1 is crossed by a daily average of 18 trucks carrying 366 tons of hazardous materials.

Detailed information regarding hazardous material shipments/inventories is provided in Appendix 2-D.

3.3 Route: I-15 to US 95 from Arizona

3.3.1 Potential Population Impacts

3.3.1.1 Resident Population

Figure 3-3 shows population density distributions for each segment within a 2 mile corridor along the highway route from Arizona. Segments 2.3 through 2.6 are the locations along the route with the highest population densities and are identified as potentially critical locations.

3.3.1.2 Non-Resident Population

There are many potentially critical locations for non-resident populations along the highway route from Arizona in the Las Vegas metropolitan area where tourist populations are high. Nearly all hotel rooms within the Las Vegas area are within a 20 mile corridor along this route. A potentially critical location for the 0.5 mile corridor is Segment 1.22. For the 2 mile corridor, Segments 1.21, 1.22, 2.1, and 2.2 have the highest non-resident populations. Highest non-resident population densities for the 20 mile corridor are for Segments 1.21 to 2.4.

3.3.2 Cost and Difficulty of Accident Cleanup

3.3.2.1 Property Value

A potentially critical location for an accident within the two mile corridor based on property values is a 1/2 mile portion of I-15 beginning at the interchange of Washington/"D" Street and ending at a point 0.5 miles south of the interchange. This location has a property value of \$1.9 billion per square mile.

Potentially critical segments are Segment 1.22, with a property value of \$1.9 billion per square mile and Segment 2.12 with a value of \$338 million per square mile.

Potentially critical locations and segments were determined by the same methodology used for Route A (Section 3.1.2.1).

3.3.2.2 Land Use

Potentially critical sections within a two mile corridor for land use are Segments 1.14, 1.20, 1.21, 2.2, 2.5, 2.6, 2.8, 2.9, and 2.10. Each of these segments has at least 0.75 square miles of urban or residential land use.

3.3.2.3 Difficult/Dangerous to Evacuate Locations

► School Enrollment

The segment with the highest number of school children enrolled within the 1/2 mile band width is Segment 2.4 with an enrollment of 3,303. Segment 2.4 is also a potentially critical location for the 1 and 2 mile corridors with a total enrollment of 4,845. Segment 2.4 is a potentially critical location for the 6 mile corridor (8,575). Segment 1.21 is a potentially critical location based on the 10 mile corridor (10,427), and Segment 2.1, with an enrollment of 15,839, is potentially critical based on the 20 mile corridor.

► Prison Occupancy

No prisons are located within a 1 mile corridor of the route from Arizona. Segment 2.21 is potentially critical with a total of 1,491 prisoners within a 2 mile corridor.

► Hospital Bed Count

No hospitals are located within the 1/2 and 1 mile corridors of the route from Arizona. Segment 2.2 has the most hospital beds for the 2 and 6 mile corridors (310, and 746, respectively). A potentially critical location for the 10 and 20 mile corridors is Segment 2.1, which has a total of 760 and 950 beds, respectively.

Detailed information regarding difficult/dangerous to evacuate locations is provided in Appendix 2-I.

3.3.2.4 Traffic Volume

A potentially critical location for Route I-15 to US 95 from Arizona (highest traffic volume) is located on US 95 near the junction of I-15. In 1988, the volume at this location was 42,489,650 vehicles (per year).

Traffic volumes experience seasonal variation. Average daily traffic (ADT) data for the route along I-15 and US 95 from Arizona include total vehicles counts from two stations (specific locations). The existing data show a maximum difference of 72.6 percent (an absolute difference of 4,673 for a maximum ADT of 11,111 in July to a minimum ADT of 6,438 in January). The minimum difference is 25.4 percent (an absolute difference of 1,356 for a maximum ADT of 6,686 in August to a minimum ADT of 5,330 in February). The determination of potentially critical

locations for traffic accidents based on only two stations may be inappropriate.

3.3.3 Environmental Impacts

3.3.3.1 Ecologically Sensitive Areas

The total area within each ecologically sensitive area (ESA) category was calculated within a 20 mile corridor along the route from Arizona using a GIS.

The total coverage of ESAs within the 20 mile corridor is 3,005 square miles. Desert tortoise habitat cover the largest area, representing 77.3 percent of the total. Recreation lands such as parks and forests are the next largest accounting for 17.1 percent.

3.3.4 Impact on Accident Severity

3.3.4.1 Meteorological Conditions

No potentially critical locations for the highway route from Arizona were identified based on meteorological data.

3.3.4.2 Infrastructure

Due to time constraints, data to support identification of critical locations based on infrastructure characteristics were not collected.

3.3.4.3 Hazardous Shipments/Inventories

► High-Pressure Natural Gas Pipelines

A potentially critical location for the 1/2 mile corridor is Segment 1.19, with 2.0 miles of proximate pipeline. An additional potentially critical location for the 6 mile corridor is Segment 2.8 with 2.0 miles of high pressure natural gas pipelines. Segment 2.6 has 2.3 miles of pipeline, the highest for the 10 mile corridor. Segment 1.19, with 4.0 miles of pipeline, is a potentially critical location for the 20 mile corridor.

The route is crossed four times by a high-pressure natural gas pipeline. It is crossed within Segments 1.15, 1.21, 1.17, and 2.15.

► Hazardous Material Shipments

Segments 1.1 through 1.22, with a daily average of 76 trucks carrying 1,926 tons of hazardous materials being shipped along the route, are potentially critical locations based on hazardous material truck shipments along the route from Arizona.

Segment 2.1 is the only place the route is crossed by hazardous shipments. A daily average of 72 trucks carrying 366 tons of hazardous materials cross the route at that segment.

Detailed information regarding hazardous material shipments/inventories is provided in Appendix 2-D.

3.4 Route: I-15 to US 95 from California

3.4.1 Potential Population Impacts

3.4.1.1 Resident Population

Figure 3-4 shows population density distributions for each segment within a 2 mile corridor along the highway route from California.

A potentially critical location for the 0.5 mile corridor is Segment 1.22. Figure 3-4 shows Segments 1.8, 1.10 through 1.13, and 2.3 through 2.6 to be the locations with the highest population densities within a 2 mile corridor. Critical locations for the 20 mile corridor include Segments 1.9 through 1.12.

3.4.1.2 Non-Resident Population

There are many potentially critical locations for non-resident populations along the highway route from California in the Las Vegas metropolitan area where tourist populations are high. Nearly all hotel rooms within the Las Vegas area are within a 20 mile corridor along this route. Short sections of the route traversing Jean and Stateline also have relatively high non-resident population densities.

3.4.2 Cost and Difficulty of Accident Cleanup

3.4.2.1 Property Value

A potentially critical location for an accident in terms of property value along Route I-15 from California is a portion beginning 1 mile south of the Tropicana interchange on I-15 and ending at a point 1/2 mile south of Tropicana. The property value per square mile for this 1 square mile area within the 2 mile corridor is \$2.3 billion.

Potentially critical segments are 1.10 with a value of \$2.2 billion per square mile and 1.14 with \$1.5 billion per square mile.

These locations were determined by using the same method used for Route A (Section 3.1.2.1).

3.4.2.2 Land Use

Potentially critical segments for land use are 1.5, 1.7, 1.14, 2.2, 2.5, 2.6, 2.8, 2.9, and 2.10. Each of these segments has at least 0.75 square miles of urban or residential land use. Determination of these segments as potentially critical is based on the assumption that urban or residential land use is potentially most sensitive.

3.4.2.3 Difficult/Dangerous to Evacuate Locations

► School Enrollment

A potentially critical location for school occupancy for each corridor was determined to be the segment with the highest number of school children attending schools within each particular corridor. Segment 2.4 is the potentially critical location for the 1/2, 1, 2, 6, and 10 mile corridors. A total of 3,303 children attend schools with the 1/2 mile corridor, 4,845 are enrolled with the 1 and 2 mile corridors, 8,575 are enrolled within the 6, and 9,226 are enrolled within the 10 mile corridor. For the 20 mile corridor, Segment 2.1 is the critical location with an enrollment of 15,839.

► Prison Occupancy

The only place along Highway Route I-15 from California with a prison is Segment 2.21. A total of 1,491 inmates are located within a 2 mile corridor.

► Hospital Bed Count

No hospitals are located with the 1/2 mile corridor along the highway route from California. Segment 1.14 is a potentially critical location for the 1, 2, and 6 mile corridors with a hospital bed count of 746. For the 10 and 20 mile corridors, Segment 2.1 is a potentially critical location with a bed count of 760 and 950 for the 10 and 20 mile corridors, respectively.

Detailed information regarding difficult/dangerous to evacuate locations is provided in Appendix 2-I.

3.4.2.4 Traffic Volume

A potentially critical location (highest traffic volume) is located on I-15 near the junction of US 95. In 1988, the volume in this area was 45,844,000 vehicles (per year).

Traffic volumes experience seasonal variations. Average daily traffic data for the route along I-15 and US 95 from California include total vehicles from two stations (specific locations). The existing data show a maximum percent difference of 53.8 percent (absolute difference 7,168 for a maximum ADT of 20493 in August to a minimum ADT of 13,325 in January). The minimum percent difference is 26.0 percent (absolute difference

of 1,598 for a maximum ADT of 7,743 in August to a minimum ADT of 6,145 in February). With only two stations representing the seasonal variations, the determination of potentially critical locations for traffic accidents may be problematic.

3.4.3 Environmental Impacts

3.4.3.1 Ecologically Sensitive Areas

The total area within each ecologically sensitive area (ESA) category was calculated within a 20 mile corridor using a GIS system.

The total extent of ESAs within the 20 mile corridor is 2,075 square miles. Desert tortoise habitat cover the largest area, representing 73.3 percent of the total. Recreational lands such as parks and forests make up 18.2 percent.

3.4.4 Impact on Accident Severity

3.4.4.1 Meteorological Conditions

No potentially critical locations were identified for the highway route from California based on meteorological data.

3.4.4.2 Infrastructure

Due to time constraints, data to support identification of critical locations based on infrastructure characteristics were not collected.

3.4.4.3 Hazardous Shipments/Inventories

► High-Pressure Natural Gas Pipelines

A total of 1.176 miles of high pressure natural gas pipelines lie within the 1/2 mile corridor of Segment 1.14, making it a potentially critical location for that corridor. Segment 1.3 is a potentially critical spot for the 1, 2, 6, 10, and 20 mile corridors. A total of 4.64 miles lie within the 1 mile corridor, 6.56 miles lie within the 2, and 12.90 miles lie within the 6, 10, and 20 mile corridors.

Pipelines cross the route a total of four times. The segments crossed are 1.5, 1.8, and 1.10, and 2.15.

► Hazardous Material Shipments

Segments 1.1 through 1.14, with a daily average of 117 trucks carrying 1,926 tons of hazardous materials, are potentially critical accident locations in terms of hazardous shipments along the route from California.

A potentially critical location for shipments crossing the routes is Segment 2.1, which has a daily average of 72 trucks carrying 366 tons.

Detailed information regarding hazardous material shipments/inventories is provided in Appendix 2-D.

3.5 Summary Comparison of Highway Routes on Potentially Critical Locations for Truck Accidents

The tables in this section (3-1 to 3-7) provide comparisons between the four highway routes on critical accident locations.

Table 3-1

Summary of Potentially Critical Highway Accident Locations Based on Highway Link Characteristics

ROUTE	A	B	I-15 to US 95 from Arizona	I-15 to US 95 from California
Trucks per day of hazardous materials along route	115 from junction US 93 north of Las Vegas to Craig Road exit (76)	180 from Utah border to West Wendover Interchange (62)	I-15 from Arizona border to junction US95 in Las Vegas (76)	I-15 from California border to junction US95 in Las Vegas (117)
Tons per day of hazardous materials along route	115 from junction US 93 north of Las Vegas to Craig Road exit (1,926)	180 from Utah border to West Wendover Interchange (1,385)	I-15 from Arizona border to junction US95 in Las Vegas (1,926)	I-15 from California border to junction US95 in Las Vegas (1,926)
Trucks per day of hazardous materials crossing route	none	Junction of US 6 and US 95 in Tonopah (18)	Junction of I-15 and US 95 in Las Vegas (72)	Junction of I-15 and US 95 in Las Vegas (72)
Tons per day of hazardous materials crossing route	US93 junction with US 50 in Ely (312)	Junction of US 6 and US 93 in Ely (366)	Junction of I-15 and US 95 in Las Vegas (366)	Junction of I-15 and US 95 in Las Vegas (366)
Pipelines crossing route	I-15, about 3/4 mile south of Apex Interchange	none	I-15, about 3/4 mile south of Apex Interchange	I-15, about 5 miles south of Sloan exit
	Craig Road, 1/2 mile west of junction with I-15		I-15, between Lake Mead and D St./ Washington Exit	I-15, 2 miles south of Tropicana
	Tonopah Hwy., 1/2 mile north of junction of Craig Road		US 95, 1/2 mile south of junction of Rancho Road	US 95, 1/2 mile south of junction of Rancho Road
	I-15, 3/4 miles north of Craig Road Exit		I-15, 3/4 miles north of Craig Road Exit	I-15, 1/4 miles north of Henderson Exit

Table 3-2

**Summary of Potentially Critical Highway Accident Locations
Based on Characteristics of a 0.5 Mile-wide Corridor**

ROUTE	A	B	I-15 to US 95 from Arizona	I-15 to US 95 from California
Resident Population	Segments 2.8, 2.9, 3.1, 3.2	Segments 3.1, 3.2	Segment 2.4	Segment 1.9
Non-resident Population	Segment 7.3	N/A	Segment 1.22	Segment 1.8
School Enrollment	none (0)	US 95, junction of SR 374 to South Beatty (204)	US 95, Valley View Exit to Decatur Blvd (3,303)	US 95, Valley View Exit to Decatur Blvd (3,303)
Hospital Beds	US 6, East City Limit of Ely to Murry St., Ely (40)	US 6, junction of US 95 in Tonopah to South City Limit (45)	none (0)	none (0)
Prison Inmates	none (0)	none (0)	none (0)	none (0)
Miles of High-pressure Natural Gas Pipeline	I-15, Apex Interchange to junction of Elkhorn Road (1.0)	none (0)	I-15, junction of Craig Road to Cheyenne Exit (2.0)	I-15, Charleston Exit to junction of us 95 (1.2)

Table 3-3

**Summary of Potentially Critical Highway Accident Locations
Based on Characteristics of a 1 Mile-wide Corridor**

ROUTE	A	B	I-15 to US 95 from Arizona	I-15 to US 95 from California
School Enrollment	East Ely to Ely (555)	US 95, junction of US 6 to South Tonopah City Limit (704)	US 95, Valley View Exit to Decatur Blvd (4,845)	US 95, Valley View Exit to Decatur Blvd (4,845)
Hospital Beds	US 6, East City Limit of Ely to Murry St., Ely (40)	US 6, junction of US 95 in Tonopah to South City Limit (45)	none (0)	I-15, Charleston Exit to junction of US 95 (746)
Prison Inmates	none (0)	none (0)	none (0)	none (0)
Miles of High-pressure Natural Gas Pipeline	Craig Road, from junction of I-15, west 2.3 miles (2.8)	none (0)	I-15, junction of Craig Road to Cheyenne Exit (2.0)	I-15, Jean Exit to Sloan Exit (4.6)

Table 3-4

**Summary of Potentially Critical Highway Accident Locations
Based on Characteristics of a 2 Mile-wide Corridor**

ROUTE	A	B	I-15 to US 95 from Arizona	I-15 to US 95 from California
Resident Population	Segments 8.1, 8.2	Segment 2.8	Segment 2.6	Segments 1.8 to 1.14
Non-resident Population	Segment 7.3	N/A	Segments 1.21, 1.22, 2.1, 2.2	Segments 1.9 to 1.14
Property Value	US 95, junction of Ranch Road, north 1/2 mile (\$309 mil.)	US 95, East City Limit of Beatty, south 1/2 mile (\$37 million)	I-15, D St./ Washington Interchange, south 1/2 mile (\$1.9 bil.)	I-15, 1/2 mile south of Tropicana Interchange, south 1/2 mile (\$2.3 bil.)
School Enrollment	US 95, junction of US 6 to South Tonopah City Limit (596)	US 95, junction of US 6 to South Tonopah City Limit (704)	US 95, Valley View Exit to Decatur Blvd (4,845)	US 95, Valley View Exit to Decatur Blvd (4,845)
Hospital Beds	US 6, East City Limit of Ely to Murry St., Ely (40)	US 6, junction of US 95 in Tonopah to South City Limit (45)	US 95, Highland Drive Exit to Valley View Exit (310)	I-15, Charleston Exit to junction of US 95 (746)
Prison Inmates	I-15, Indian Springs Air Base Road to west Indian Springs city limit (1,491)	none (0)	I-15, Indian Springs Air Base Road to west Indian Springs city limit (1,491)	I-15, Indian Springs Air Base Road to west Indian Springs city limit (1,491)
Miles of High-pressure Natural Gas Pipeline	Craig Road, from junction of I-15, west 2.3 miles (3.4)	none (0)	I-15, junction of Craig Road to Cheyenne Exit (2.0)	I-15, Jean Exit to Sloan Exit (6.6)

Table 3-5

**Summary of Potentially Critical Highway Accident Locations
Based on Characteristics of a 6 Mile-wide Corridor**

ROUTE	A	B	I-15 to US 95 from Arizona	I-15 to US 95 from California
School Enrollment	I-15, North Las Vegas City Limit to Craig Road Interchange (3,818)	US 95, junction of US 6 to South Tonopah City Limit (704)	US 95, Valley View Exit to Decatur Blvd (8,575)	US 95, Valley View Exit to Decatur Blvd (8,575)
Hospital Beds	Craig Road, I-15 Interchange, west 2.3 miles (163)	US 6, junction of US 95 in Tonopah to South City Limit (45)	US 95, Highland Drive Exit to Valley View Exit (746)	I-15, Charleston Exit to junction of US 95 (746)
Prison Inmates	I-15, Indian Springs Air Base Road to west Indian Springs city limit (1,491)	none (0)	I-15, Indian Springs Air Base Road to west Indian Springs city limit (1,491)	I-15, Indian Springs Air Base Road to west Indian Springs city limit (1,491)
Miles of High-pressure Natural Gas Pipeline	Craig Road, from junction of I-15, west 2.3 miles (7.03)	none (0)	I-15, junction of Craig Road to Cheyenne Exit (2.0)	I-15, Jean Exit to Sloan Exit (12.8)

Table 3-6

**Summary of Potentially Critical Highway Accident Locations
Based on Characteristics of a 10 Mile-wide Corridor**

ROUTE	A	B	I-15 to US 95 from Arizona	I-15 to US 95 from California
School Enrollment	Craig Road, 2.3 miles west of junction of I-15, west 4 miles (11,577)	US 95, junction of US 6 to South Tonopah City Limit (704)	I-15, Lake Mead Exit to D St./ Washington Exit (10,427)	US 95, Valley View Exit to Decatur Blvd (9,226)
Hospital Beds	Craig Road, 2.3 miles west of junction of I-15, west 4 miles (310)	US 6, junction of US 95 in Tonopah to South City Limit (45)	US 95, junction of I-15 to Highland Drive Exit (760)	US 95, junction of I-15 to Highland Drive Exit (760)
Prison Inmates	I-15, Indian Springs Air Base Road to west Indian Springs city limit (1,491)	US 93, Ely Airport to East Ely (638)	I-15, Indian Springs Air Base Road to west Indian Springs city limit (1,491)	I-15, Indian Springs Air Base Road to west Indian Springs city limit (1,491)
Miles of High-pressure Natural Gas Pipeline	Craig Road, from junction of I-15, west 2.3 miles (7.03)	none (0)	US 95, Jones Exit to Rainbow Exit (2.4)	I-15, Jean Exit to Sloan Exit (12.8)

Table 3-7

**Summary of Potentially Critical Highway Accident Locations
Based on Characteristics of a 20 Mile-wide Corridor**

ROUTE	A	B	I-15 to US 95 from Arizona	I-15 to US 95 from California
Resident Population	Segments 7.2, 7.3, 8.1, 8.2	Segments 2.8, 2.9	Segments 1.9, 1.10, 1.11, 1.12	Segments 1.9 to 1.12
Non-resident Population	Segment 7.2	N/A	Segments 1.21 to 2.4	Segments 1.8 to 1.14
School Enrollment	I-15, North Las Vegas City Limit to Craig Road Interchange (23,015)	US 95, junction of US 6 to South Tonopah City Limit (704)	US 95, junction of I-15 to Highland Drive Exit (15,839)	US 95, junction of I-15 to Highland Drive Exit (15,839)
Hospital Beds	Craig Road, junction I-15, west 2.3 miles (903)	US 6, junction of US 95 in Tonopah to South City Limit (45)	US 95, junction of I-15 to Highland Drive Exit (950)	US 95, junction of I-15 to Highland Drive Exit (950)
Prison Inmates	I-15, Indian Springs Air Base Road to west Indian Springs city limit (1,491)	US 93, Ely Airport to East Ely (638)	I-15, Indian Springs Air Base Road to west Indian Springs city limit (1,491)	I-15, Indian Springs Air Base Road to west Indian Springs city limit (1,491)
Miles of High-pressure Natural Gas Pipeline	Craig Road, from junction of I-15, west 2.3 miles (7.0)	none (0)	I-15, Craig Road Exit to Cheyenne Ave. Exit (4.0)	I-15, Jean Exit to Sloan Exit (12.8)

4 Identification of Likely Locations for Truck Accidents on Highway Routes

This chapter identifies likely locations for truck accidents on the four highways routes based upon accident history and rates, infrastructure characteristics and environmental conditions along each route. A comparison of the routes on likely accident locations is presented.

4.1 Route: A (From Wendover via Las Vegas)

4.1.1 Accident History and Rates

In this study, relative accident rates between segment are assumed to remain unchanged in the future. The highest truck accident rate along route A is 1830 accidents per million truck miles traveled (MTMT). This rate (1984-1988 5 year average) occurs on segment 8.2 which is along Rancho Road, Las Vegas.

4.1.2 Infrastructure

A critical grade with no passing lane presents a potentially likely location for an accident to occur. The American Association of State Highway and Transportation Officials (AASHTO) defines a hazardous condition on a roadway segment by specifying a combination of grade and road length without a passing lane as follows:

7 %	Greater than 500 feet
5 %	Greater than 750 feet
4 %	Greater than 1100 feet

According to this definition, there exist 14 critical grades over 4%, eight critical grades over 5%, and no critical grades over 7% on Route A. These may present likely places for accidents. The identification of these areas represents only an example of identification of likely accident locations given infrastructure characteristics. This simplistic treatment should be followed by more robust analyses.

4.1.3 Road Conditions (Environmental)

Poor road conditions caused by rainfall, snowfall, dust, flash floods, mud slides, rock slides and especially the presence of ice increase the likelihood of accidents. Likely locations for truck accidents, due to environmentally affected road conditions, are difficult to determine, as weather conditions change with time. Average conditions therefore must be used. Due to time constraints, only data for rainfall and snowfall were used in determination of likely locations in this preliminary analysis. On route A there are about 16 miles of road with rainfall greater than 16 inches annually. This length of road is located on US 93 north of Ely. There are about 36 miles of road with snowfall of greater than 40 inches annually. This portion of road is located on US 93 north of Ely.

4.2 Route: B (From Wendover via Tonopah)

4.2.1 Accident History and Rates

The highest accident rate along route B is 3733 accidents per MTMT. This rate (1984-1988 5 year average) occurs on segment 4.10 which is near Beatty. The rate for this segment, however, has a high standard deviation. This is due to its very short length (0.17 miles) and the fact that in some years one or two accidents were reported, and in others, none.

4.2.2 Infrastructure

On Route B, there exist 28 critical grades over 4%, twenty-five critical grades over 5%, and no critical grades over 7%. These may represent likely places for accidents.

4.2.3 Road Conditions (Environmental)

On Route B there are approximately 16 miles of road with a rainfall greater than 16 inches annually. This portion of road is located on US 93 north of Ely. There are about 36 miles of road with snowfall of greater than 40 inches annually. This section of road is located on US 93 north of Ely.

4.3 Route: I-15 to US 95 from Arizona

4.3.1 Accident History and Rates

The highest truck accident rate along route I-15 to US 95 from Arizona is 381 accidents per MTMT. This rate (a 5 year average, 1984-1988) occurs on segment 2.6 which is on I-15 between Jones Blvd and Valley View Drive in Las Vegas.

4.3.2 Infrastructure

The route from Arizona has at least four lanes along all segments and is grade separated. Specifying a likely location for an accident due to the presence of a critical grade without a passing lane is not possible, as no such condition exists.

4.3.3 Road Conditions (Environmental)

The route from Arizona has an average annual rainfall of four to eight inches. The annual snowfall for the entire is two inches or less. These road conditions should not factor heavily into increasing the likelihood of accident.

4.4 Route: I-15 to US 95 from California

4.4.1 Accident History and Rates

The highest truck accident rate along the route from California is 838 accidents per MTMT. This rate (a 5 year average for 1984-1988) occurs on segment 1.9 which is located on

I-15 between the Tropicana and Dunes-Flamingo interchanges in Las Vegas.

4.4.2 Infrastructure

The highway route from California has at least four lanes along all segments and is grade separated. Specifying a likely location for an accident based on minimum grades without passing lanes is not possible, as no such condition exists.

4.4.3 Road Conditions (Environmental)

The route from California an average annual rainfall of four to eight inches. The annual snowfall for the entire route is two inches or less. As in the case of the highway route from Arizona, road conditions should not weigh heavily in the determination of likely accident locations (within the state of Nevada).

4.5 Summary Comparison of Highway Routes on Likely Accident Locations

This section compares the four highway routes on selected potentially likely accident locations (Table 4-1). These comparisons are made using respective accident history and rates, infrastructure characteristics and environmental conditions along the road.

Table 4-1

Comparison of Highway Routes on
Likely Locations for Accident

ROUTE	A	B	I-15 to US 95 FROM ARIZONA	I-15 to US 95 FROM CALIFORNIA
ACCIDENT HISTORY	Segment 8.2 1830 Acc/MTMT on Rancho Road, Las Vegas	Segment 4.10 3733 Acc/MTMT near Beatty	Segment 2.6 381 Acc/MTMT US 95 between Jones and Valley View, Las Vegas	Segment 1.9 838 Acc/MTMT I-15 between Tropicana and Flamingo, Las Vegas
INFRA- STRUCTURE	Dependent upon grade length without passing lane, 14 loc. @ 4% grade 8 loc. @ 5% grade 0 loc. @ 7% grade	Dependent upon grade length without passing lane, 28 loc. @ 4% grade 25 loc. @ 5% grade 0 loc. @ 7% grade	Gradient criterion not applicable - whole route is 4 lanes or greater	Gradient criterion not applicable - whole route is 4 lanes or greater
ROAD CONDI- TIONS	North of Ely, 16 miles of road with >16" of rainfall and >40" of snowfall	North of Ely, 16 miles of road with >16" of rainfall and >40" of snowfall	All sections, 4-8" of rainfall, <2" of snowfall	All sections, 4-8" of rainfall, <2" of snowfall

5 Preliminary Rail Access Route Characterization

The DOE had considered 10 alternative spurs (corridors) to provide rail access to the potential repository at Yucca Mountain from existing main lines currently being used by regional rail carriers. In January 1990, DOE recommended three of these alternative rail spurs for preliminary engineering and characterization studies (US DOE, 1990). Since there is no rail link in existence to connect Yucca Mountain to any of the main lines currently used by rail carriers, it will be necessary to construct one or more of these rail spurs. The three spurs identified are to be connected to the Union Pacific Railroad mainline near Jean, Caliente and Carlin respectively.

This chapter presents the specification and characterization of the three rail spurs and access routes (spurs plus mainline connectors): Jean, Caliente, and Carlin. The characterization is based upon probability and consequence measures. The probability measures include Anticipated Accident Rates and Hazardous Shipments/Inventories. The consequence measures include resident and non-resident population, ecologically sensitive areas, land use, property value, difficult/dangerous to evacuate locations, meteorological conditions, and infrastructure characteristics. A summary comparison of the routes using these measures is also presented.

5.1 Rail Route: Spur 3: (Jean)

The Jean spur was option 3 of the initial 10 options considered by the DOE. It is the first of the three alternatives addressed in this study.

5.1.1 Route Specification and Distance

The route specification for the Jean spur is divided into two parts: the existing mainline connectors and the proposed spur.

Mainline Connector from California

The mainline connector for the Jean spur from southern California would be the southern section of the Union Pacific railroad (UP) mainline track in Nevada. This section extends from the California-Nevada border to a point near Jean. The total length of this section of the UP mainline is approximately 13 miles (milepost 287.95 at the state border to about milepost 301 near Jean).

Mainline Connector from Utah

The mainline connector for the Jean spur from southern Utah would be the southern section of the Union Pacific railroad (UP) mainline track in Nevada. This section extends from the Utah-Nevada border to a point near Jean. The total length of this

section of the UP mainline is approximately 199 miles (milepost 500.53 near the state border to about milepost 301 near Jean).

New Rail Spur

The proposed rail spur begins about 0.7 miles east of Jean, along the Union Pacific mainline, approximately 20 miles to the southwest of Arden Siding. After crossing US Interstate 15, the route follows a northerly course along State Highway 161, passing 1 mile to the south of Goodsprings. North of Goodsprings, route 3 zigzags through Goodsprings Valley and the Springs Mountain. The route, then runs northwest parallel to the Nevada-California border, passing southwest of Pahrump. The route continues along the Nevada California border to a point about a mile east of State Highway 373, where the route turns north and runs parallel to Highway 373. Route 3 crosses US 95 half a mile east of Lathrop Wells (Amargosa Valley). It proceeds north joining with proposed rail route 7, 1.855 miles from the site. The union of routes 3 and 7 head north, ending at the proposed Yucca Mountain Site. The route passes through Clark and Nye Counties.

The Jean rail spur was broken down into four segments. This segmentation was done primarily to facilitate of data collection. Descriptions of the segments are:

Segment 3.1	Rail spur 3 from the Yucca Mountain Site heading south to the split into spurs 3 and 7.
Segment 3.2	Rail spur 3 from the split of spur 3 and 7 heading southeast to the 116 degree longitude line.
Segment 3.3	Rail spur 3 from the 116 degree longitude line heading south to the 36 degree latitude line.
Segment 3.4	Rail spur 3 from the 36 degree latitude line heading south to the intersection with the Union Pacific spur east of Jean.

Spur 3 (Jean) is projected to have a total length of about 121 track miles. The lengths of the individual segments on this spur are:

Segment 3.1	1.85 miles
Segment 3.2	62.78 miles
Segment 3.3	15.00 miles
Segment 3.4	41.35 miles

5.1.2 Probability Measures

This section provides operational definitions and sources of information for probability measures used in characterizing the Jean rail corridor. Data for each of the measures are presented. The measures include, for the entire route and each link, anticipated accident rates, and hazardous shipments and inventories.

5.1.2.1 Anticipated Accident Rates

The Jean rail spur has only been proposed and does not currently exist. Thus, there are no historical data available for the number of accidents, traffic volumes, and accident rates for the Jean rail spur. Therefore, proxy measures will have to be used to determine the anticipated accident rates and related safety indicators for this route.

The best proxy measures of safety indicators would be based on routes with similar characteristics. It would be difficult to find two routes with exactly similar characteristics. However, as a first approximation, indicators from the rail network in the state of Nevada would provide some proxy measures. Data at the national level would have to be used for proxy measures when Nevada specific information are not available. The primary limitations of using such measures is that such data are aggregate, and that the actual characteristics of the proposed may be different from those of the rail network from which these data have been obtained.

Rail accidents can be classified based on the type of accident. The categories of accidents commonly found in the literature are: 1) those involving fatalities, 2) those that result in injuries and no fatality, and 3) those resulting in property damage only. Another method of classifying rail accidents would include the categories of collisions and derailments. The former classification has been used in the discussions presented in this section.

There are a total of 348 at-grade public crossings and 284 private crossings in Nevada. Information on accidents at at-grade crossings in the state of Nevada is recorded by the State Department of Transportation. This information for the years from 1980 to 1986 can be found in the Nevada Rail Plan: 1988 Update. Most accidents occurred between midnight and 8:00 AM. Table 5-1 summarizes accidents in Nevada at at-grade rail crossings.

Table 5-1 shows only the number of accidents at at-grade rail crossings. Information on other types of accidents in rail transportation, or the rate of accidents in Nevada was not gathered for this study.

In order for comparisons of the relative safety of various routes to be meaningful, the comparisons should be based on accident rates and not on the total number of accidents alone. Accident rates can be obtained by normalizing the number of accidents based on appropriate measures of exposure. Appropriate measures of exposure that could be used to determine accident rates include train miles of travel, ton-miles of train travel, number of train operations, and so on.

Table 5-1

Nevada Railroad Grade Crossing Accidents

Description	1980-86	1987
Fatal Accidents	2	0
Persons Killed	6	0
Injury Accidents	19	0
Persons Injured	15	0
Property Damage Accidents	38	8
Total Accidents	67	8

Source: Nevada Department of Transportation, Nevada Rail Plan: 1988 Update.

Table 5-2 provides an indication of the total number of accidents, the total train miles of travel and the accident rate per million train miles for the whole nation. The total number of accidents includes collisions and derailments. In 1986, there were 6 rail accidents that were collisions which resulted in fatalities. In the same year, there were 6 rail derailments which resulted in fatalities. Also, about 75% (701) of the accidents resulting in injuries were derailments, and 21.8% (204) of the accidents resulting in injuries were collisions.

It is to be noted that the proposed rail spur alignments call for grade separated crossings with major roads and at-grade crossings with minor roads. The provision of grade separated intersections would eliminate the potential for accidents at at-grade intersections. The possibility of at-grade accidents would then be only at the intersections of the rail spur with minor roads.

The accident history for the portion of this access route made up by the UP mainline connector could be obtained since this section has been in operation from around the turn of the century. However, this accounts for only about 10% of the length of the entire route. Accident rates for this section were not obtained for this study, but could be included in future work on a detailed analysis of the rail access route.

Table 5-2**U.S. Railroad Accidents, Train Miles and Accident Rates**

Year	Total Accidents	Total Train Miles (Millions)	Accident Rate per Million Train Miles
1976	10,227	774.8	13.2
1977	10,362	750.0	13.8
1978	11,277	752.0	15.0
1979		763.4	12.8
1980	8,451	717.6	11.8
1981	5,781	676.2	8.8
1982		573.4	8.0
1983		558.2	7.0
1984	3,900	592.6	6.6
1985	3,275	570.9	6.0
1986	2,620	567.1	4.6

Source: Nevada Department of Transportation, Nevada Rail Plan: 1988 Update.

5.1.2.2 Hazardous Shipments/Inventories

Hazardous shipments are shipments of dangerous materials that are explosive, flammable, spontaneously combustible, poisonous, radioactive, corrosive, or are oxidizers. Facilities that store these materials are designated sites for hazardous inventories. The shipment of these commodities by road would cross the rail access corridors to Yucca Mountain. These crossing points are potential points of conflict for the two modes of transportation. Some of the cross over points of the two modes could be grade separated, thereby eliminating any direct conflict in the movement of trains and road vehicles. The number of such shipments and the quantity of these shipments therefore warrant consideration in the analysis of safety of rail operations. Data on the average number and quantity of hazardous materials (hazmat) shipments crossing the rail access routes were obtained from the Nevada Commodity Report (NDOT, 1988). These are summarized as follows for the Jean spur and the Jean rail access routes from California and Utah.

Number of Hazmat Trucks and Tons of Hazmat Crossing Jean Routes

Description	Spur	Access Route from CA	Access Route from Utah
Number of Hazmat Trucks per day	131	131	273
Tons of Hazmat/day	2,291	2,291	2,306

The rail-route corridors, within which pipelines used to transport hazardous materials are located, were identified and tabulated. Information on the location of high pressure natural gas pipelines was obtained from Hazardous Materials Pipelines Locating Atlas. The location of segments with hazardous shipments could be used to identify potentially critical locations along the rail access routes.

The presence and location of hazardous shipments/inventories could be considered both as a probability measure and as a consequence measure when characterizing the route. This is illustrated in the following discussion.

The presence and location of the high pressure natural gas pipelines could impact the shipment of high level nuclear waste. An accident involving a pipeline, such as a rupture or explosion, in the vicinity of the transport link would affect the nuclear waste shipment in a number of ways. These include the possibility of causing an accident to the vehicle transporting the nuclear waste, closure of the transport link that would have been used for the nuclear waste shipment, or the possibility of rerouting the shipment.

On the other hand, the construction of a rail spur near the pipeline could also increase the possibility of the occurrence of an accident to the pipeline. For example, a derailment involving the train transporting the nuclear waste could increase the overburden pressure on the pipeline and cause it to rupture. This would not have occurred had the spur not been constructed.

The lengths of high pressure natural gas pipelines within 0.5, 1, 2, 6, 10 and 20 mile-wide corridors around the Jean rail spur and the entire Jean access route were determined to be as follows:

Corridor Width (miles)	<u>Length of Pipeline (miles)</u>		
	Spur	Access Route from CA	Access Route from Utah
0.5	0.3	3.2	28.6
1	0.5	6.9	31.2
2	0.5	22.7	37.2
6	0.5	22.7	60.4
10	0.5	22.7	65.0
20	0.5	22.7	71.4

A significant limitation was the lack of more detailed data on hazardous material shipments. The commodity report provided a listing of the average number of shipments and the tonnage. However, it did not provide any information on the frequency or consequences of accidents. The Hazardous Materials Pipeline Atlas showed the physical location of pipelines in Nevada but provided no details on the amounts of hazardous material being shipped through each pipeline, accidents, or the consequences of accidents involving shipments through the pipelines. There were 4 pipelines crossing the access route from Utah while there was only 1 pipeline crossing the Jean spur and the access route from California.

5.1.3 Consequence Measures

This section provides a discussion of eight consequence measures used in characterizing the Jean rail spur and access route and the sources of information. These measures include resident population, non-resident population, ecologically sensitive areas, land use, property value, difficult/dangerous to evacuate areas, meteorological conditions, and infrastructure characteristics.

5.1.3.1 Resident Population

Short portions of the proposed Rail Spur 3 will be aligned close to four town sites, Jean, Pahrump, Sandy Valley, and Goodsprings. A longer portion of the spur will traverse the Amargosa valley and a portion of Nevada Test site. The populations for these places were obtained from Clark County Department of Comprehensive Planning and the Nye County Profile and are summarized as follows:

Jean (1990):	664 (mainly prisoners)
Goodsprings (1990):	132
Sandy Valley (1990):	436
Pahrump (1985):	5346

This data may not accurately reflect the actual population but in the absence of more accurate data, such as from the 1990 Decennial Census, they serve as an approximate measure of the population.

Data on resident population within a specified distances from the transport link were collected for the spur and the access route. 0.5 mile-wide, 2 mile-wide, and 20 mile-wide corridors around the rail links were identified and the resident population within each of these corridors were determined. An illustration of the method used to estimate population in the Las Vegas Valley around the rail link using zip-code population data is presented in Figure 5-1. The segment shown in the figure is a part of the access route from Utah.

It was determined that the population within the route corridors were 664 (0.5 mile-wide corridor), 796 (2 mile corridor), and 1232 (20 mile corridor) for the proposed Jean rail spur. The resident population estimates for the same corridors for the entire Jean access route (rail spur plus Union Pacific connector) from California were also 664, 796, and 1232 respectively. The same estimates for the access route from Utah were 23803, 97589, and 658600 respectively.

5.1.3.2 Non-Resident Population

The non-resident population estimates for various corridors along the Jean access route from Utah (rail spur plus Union Pacific connector) are:

14,372	(0.5 mile wide corridor)
54,486	(1.0 " " " ")
127,076	(2.0 " " " ")
154,163	(6.0 " " " ")
155,211	(10. " " " ")
156,614	(20. " " " ")

The same estimates for the Jean Access Route from California are:

0	(0.5 mile wide corridor)
663	(1.0 " " " ")
1,326	(2.0 " " " ")
2,559	(6.0 " " " ")
2,559	(10. " " " ")
2,559	(20. " " " ")

For the Jean Spur alone, the estimated number of non-residents, on average is:

0	(0.5 mile wide corridor)
663	(1.0 " " " ")
1,326	(2.0 " " " ")
1,326	(6.0 " " " ")
1,326	(10. " " " ")
1,326	(20. " " " ")

Figure 5-2 illustrates the GIS algorithm used to estimate non-resident population whereby hotel-casinos and motels were identified within various corridors along the route alignment.

The Jean access route from Utah traverses through the Las Vegas metropolitan area where the non-resident population within a 2 mile corridor exceeds the resident population. The portion of the corridor within the Las Vegas metropolitan area comprises one of the busiest tourist markets and largest concentration of hotel rooms in the world. The occupancy rates in these hotels is consistently greater than 80% (over 90% for hotel rooms and 72% for motel rooms). While it is not surprising that the non-resident population is greater than the resident population, no previous study has quantified this phenomenon.

5.1.3.3 Ecologically Sensitive Areas

The approach used to identify ecologically sensitive areas (ESAs) along the proposed Rail Spur 3 is similar to that used for the proposed highway routes. This involves overlaying the proposed route on a map of Nevada with identified sensitive areas, buffering the route by a corridor 20 miles wide, and estimating the extent of ecologically sensitive areas falling within this corridor.

The three proposed rail access routes with entry points from Jean, Caliente, and Carlin will traverse through ecologically sensitive areas.

Areas considered to be potentially ecologically sensitive include: wildlife refuges, habitats of endangered species such as desert tortoise, bald eagle and peregrine falcon, national forests, reservoirs and water reserves, wild horses, bighorn sheep, mule deer and elk sanctuaries.

The proposed rail spur 3 will traverse habitats for endangered species, specifically desert tortoise, and a wildlife refuge for big horn sheep, mule deer, peregrine falcon and chipmunks. These are located in the Red Rock Canyon Recreation Lands and Bird Spring Mountain or Segment 3.4 which is about 41 miles in length.

The total extent of the ESAs within a 20 mile-wide corridor around the Jean rail spur includes about 32 square miles of national forests/wildlife refuges, about 1564 square miles of, Desert Tortoise habitat, and a total for a combination of selected ESAs of about 1842 square miles. The rail access route through Jean from California has about 32 square miles of national forests/wildlife refuges, 1902 square miles of Desert Tortoise habitat, and an area of a combination of selected ESAs of about 1938 square miles within a 20 mile-wide corridor around the route. The rail access route from Utah has about 148 square miles of national forests/wildlife refuges, 3689 square miles of Desert Tortoise habitat, and a total of 4807 square miles of a combination of selected ESAs within a 20 mile-wide corridor around the route. The extent of the national forests/wildlife refuges, Desert Tortoise habitats, and a combination of selected ESAs within the 20 mile corridor of the Jean spur are shown in Figures 5-3, 5-4 and 5-5 respectively. Similar illustrations for

the access route from California and the access route from Utah are presented in Figures 5-6 to 5-8 and 5-9 to 5-11 respectively.

5.1.3.4 Land Use

Land use is the term used to refer to the manner in which a parcel of land is utilized. For this study, land use is broken down into the following categories: government/vacant, residential, commercial, industrial, lands with minor improvements, non-profit community facilities, transportation/communications/ utilities, and unspecified urban. This is primarily the same as the classification used by the Clark County assessor's office. However, areas outside of Clark County are classified either as government/vacant or unspecified urban because of a lack of more detailed information. In such areas, all lands within urban areas are classified as unspecified urban. All other lands are classified as government/vacant. Definitions of the land use categories used in this study were provided in Chapter 1, Section 1.5.2.

Land uses within a 2 mile-wide corridor around the Jean spur and the access route from California were identified. Details of the land use along the Utah access route are not included in this study. The following were the approximate extent of the various land uses within the 2 mile-wide corridor along the Jean spur and the California access route:

<u>Land Use</u> <u>Category</u>	<u>Area (square miles)</u>		
	<u>Spur 3</u>	<u>Access Route</u>	
		Calif.	Utah
residential	0	N/A	N/A
commercial	0.5	N/A	N/A
industrial	0.1	N/A	N/A
non-profit community facilities	0.3	N/A	N/A
transport/communications/utilities	0	N/A	N/A
minor improvements	0	N/A	N/A
government/vacant land	241.1	266.9	N/A
unspecified urban	0	0	N/A

5.1.3.5 Property Values

Property value is the term used to represent the net worth, in dollars, of a parcel of land. It includes both the value of the actual real estate and the value of any existing improvements, usually buildings, that are found on the parcel of land. The property values within specified corridors along the rail and highway routes can be used to estimate the potential economic impact of a nuclear accident.

The total property value of lands lying within a 2 mile-wide corridor around the rail spur from Jean was estimated to be about \$78 million. The property values for the rail access route

California was estimated to be \$112 million. Similar property values for the rail access route from Utah were not estimated. The procedure adopted to collect and reduce information on property values for the Jean Spur follows below. Similar procedures were used for the Union Pacific mainline connector links.

For segment 3.4, a 2 mile-wide corridor was identified on a Clark County map. The "ranges" and "townships" (convention used to define a geographic grid) lying within corridors along routes were identified and the total property value, PV, was determined for the entire area, A, within the range and township. The proportion of this area, a, within the 2 mile-wide corridor around the rail spur was identified. The net property value of the lands within the corridor, pv, was assumed to be proportional to the extent of the area within the corridor in the range and township. The following equation summarizes the calculation of property values within the 2 mile-wide corridor.

$$pv = (a/A) * PV$$

Property values along segments 3.1 through 3.3 were calculated using a value of \$183,499 per square mile unless any urban areas lay within the 2 mile-wide corridor. This value is an average value for government/vacant lands in Clark County. It was used as an estimate for all lands outside of Clark County that do not lie within the boundaries of a city. It was used to approximate the property values of other parcels of government/vacant land throughout the state because of the difficulty of obtaining actual values for parcels outside of Clark County. The accuracy of applying this value to areas along the route is unknown because there are no data available for comparison.

The property values for segment 3.4 of proposed rail spur 3 are based on averages for the range and townships that fall within the 2 mile-wide corridor around the route. The total property value of all the parcels within each range and township was divided by the total area within the range and township to estimate the average property value per square mile. This was then used to estimate the total property value of lands within the 2 mile-wide corridor.

One major problem with accuracy of data is that the total property value figures are based on assessed value of individual land parcels and their improvements for tax assessment purposes. The discrepancy, if any, between the tax assessor's value and the fair market value is unknown. In reality, the fair market value may be greater than the assessor's value. This would then increase the value of property along the routes.

The greatest limitation was the difficulty in collecting data for an adequate number of land parcels points to accurately reflect the actual property value of all the lands along the routes. A more detailed and comprehensive data collection effort

would be required to attain significant improvements in the accuracy of the current estimates.

Another limitation was the difficulty of obtaining information on property values for land parcels in areas outside of Clark County. Obtaining accurate data for cities and areas in other counties of Nevada would require trips to the tax assessor offices in the respective counties and physically collecting the necessary information. For small cities, such as Lage's Junction, Carrant, Warm Springs, etc., accurate information on property values was unavailable.

5.1.3.6 Difficult/Dangerous to Evacuate Locations

Establishments and areas with occupants who would be difficult to safely evacuate in the event of a nuclear waste transport accident are referred to in this study as "difficult to evacuate locations." This category would include schools, hospitals, and rest homes.

"Dangerous to evacuate locations" are places that would be difficult to evacuate or unsafe to leave unattended in the event of an emergency. Prisons or detention homes are obvious examples of dangerous to evacuate places. Banks, commercial or industrial establishments with costly inventories would be dangerous places to leave unattended.

Data were collected for hospitals, prisons, detention camps, and public and private schools for the entire state of Nevada. The data elements included location, type of facility, and occupancy count. Facilities located within specified corridors around the rail route through Jean were identified and data on their occupancy were obtained. Such information was obtained for 0.5 mile-wide, 1 mile-wide, 2 mile-wide, 6 mile-wide, 10 mile-wide and 20 mile-wide corridors along the rail spur and access route. These are summarized in Table 5-3.

Table 5-3

**Jean Access Route:
Summary of Difficult to Evacuate Locations**

Rail Spur/Route	Corridor Width (miles)	# School Students	# Hospital Beds	Prison Population
Jean Spur	0.5	0	0	0
	1	0	0	0
	2	0	0	631
	6	0	0	631
	10	0	0	631
	20	81	0	631
California Access Route	0.5	0	0	0
	1	0	0	0
	2	0	0	631
	6	0	0	631
	10	0	0	631
	20	81	0	631
Utah Access Route	0.5	1001	0	0
	1	2192	12	0
	2	9622	921	631
	6	44313	1791	631
	10	74343	2106	631
	20	88736	2140	631

There was no difference in any of the characteristics of the difficult/dangerous to evacuate locations (within a 20 mile-wide corridor) between the rail spur and the rail access route from California for the aforementioned corridors. The access route from Utah exhibits much higher levels. The number of hospital

beds within a 20 mile-wide corridor for the entire rail access route from California were zero, while the number of school students was 81. There were significant numbers of school students (1001) within a 0.5 mile-wide corridor for the Utah access route (88,736 for a 20 mile-wide corridor). Similarly, there were significant numbers of hospital beds within the various corridors for this route. The prison population affected by this route is identical for all the three routes/spur discussed above. The reason for the significantly higher numbers for the Utah access route is that it traverses through the heavily populated Las Vegas metropolitan area.

The occupancy count of each type of facility could be used to represent the number of people, at each facility, who may be affected along the route.

The list of schools did not identify twelve month or nine month schools. In the case of the Clark County School District, there is severe overcrowding and several schools have instituted double sessions and twelve month classes. Therefore, the school enrollment figures may not provide accurate information on the number of students present in the schools at any one time. Such information would be necessary to determine the temporal distribution of the school population.

5.1.3.7 Meteorological Conditions

Meteorological conditions affect the dispersion of any nuclear release into the environment. Factors such as rain, snow, and wind may dampen or spread a dispersion plume. Rain would dampen the cloud but at the same time permeate the radioactivity into the soil. Snow may blanket the ground temporarily, but it may also endanger a collecting water shed. Wind, depending upon speed and direction, could disperse radioactivity over a large area.

Rainfall and snowfall data relevant to the rail spur were collected. Wind data were not collected for this study. The following summarizes the annual snowfall and rainfall for rail spur 3 from Jean.

Rainfall		Snowfall	
12 miles	< 4 inches	97 miles	0 to 2 inches
109 miles	4 to 8 inches	24 miles	2 to 10 inches

Source: Environmental Factors Affecting Nevada Highways,
(University of Nevada-Reno, 1987)

Flash floods, mud slides, and rock slides may endanger a rail line. Since the exact alignment of the rail spur has not been specified to date, it is not possible to obtain information on specific areas likely to experience rock slides or flash flooding.

5.1.3.8 Infrastructure

Data related to railroad infrastructure are varied. They include information on the substructure (soil), the rail track structure (ballast, ties, fasteners, rail), super structure or supporting structures (culverts, bridges, tunnels), and the geometry of the track. The costs related to the infrastructure are also relevant data. These are costs associated with the construction and operation of a railroad link (mainline or spur) and include those related to the design, construction, upgrade and maintenance of the railroad infrastructure.

The route specific data related to railroad infrastructure for the proposed spurs included in this report are obtained from the Preliminary Rail Access Study by the US DOE (January, 1990). These are limited to estimates of the approximate alignment options, length, construction costs, operation and maintenance costs, and conflicts with land use plans. No additional route specific data were collected in this study on the rail infrastructure. However, additional information on national design criteria were collected and an extensive bibliography on issues related to design, construction, operation, and safety in rail transportation was developed. Infrastructure data related to the existing mainline track were obtained from the Union Pacific Railroad Western District Condensed Profile.

Route specific data have many applications. One of the primary uses of route specific data would be in the development of an inventory of the facilities. This inventory could then be used in the estimation of costs and analysis of safety of operations on the route. It would also provide critical information for conducting Probabilistic Risk Assessment for the route.

Data on design standards and specifications would provide the basis for design and construction of the rail spur along the corridor. They will also be helpful in identifying some of the constraints or restrictions of the proposed corridor.

The existing data do not provide sufficient detail to be used for any engineering purposes or for a comprehensive evaluation of the route. Precise information on the alignment of the proposed spur is unavailable. This information is critical for development of the engineering design and cost estimates, as well as for a comprehensive assessment of the route. Thus, a new data collection effort is essential for the development of accurate and detailed data.

The route specific information available for the existing UP mainline track from California and Utah to serve as a connector for the Jean spur are presented in detail in Appendix 5-B and summarized below.

UP Mainline Connector from California

Length: 13 miles (approximately): Milepost 287.95 to about Milepost 301.

Counties traversed: Clark

Major features: 17 bridges and culverts
3 sidings
average gradient = 0.20%
% length with grade greater than 1% = 46.30

Rail: A mix of two types of rail is found for this segment of the
UP connector - 133 lb/yard, 133 lb/yard CWR (Continuously
Welded Rail)

UP Mainline Connector from Utah

Length: 199 miles (approximately): Milepost 301.30 to Milepost 500.53.

Counties traversed: Clark, Lincoln

Major features: 289 bridges and culverts
38 sidings
average gradient = 0.27%
% length with grade greater than 1% = 29.58

Rail: A mix of two types of rail is found for this segment of the
UP connector - 133 lb/yard, 133 lb/yard CWR (Continuously
Welded Rail)

The route specific information available for the Jean Spur are summarized below.

Proposed Rail Spur

Length: 121 miles (new construction)

Counties traversed: Clark, Nye

Major features: 1 minor grade separated crossing
2 major grade separated crossings
1 bridge (40 mile wash)
@ cost = \$ 2 million
maximum gradient = 2.5%
maximum cross slope = 13%

The terrain is rugged near the southern end of the proposed alignment for the rail spur. A considerable amount of earth and drainage work would be required, particularly near the Spring Mountains.

Capital cost: \$ 142 million (track work, grading, drainage)

Annual O&M cost: \$ 0.74 million
(base = \$ 5,140 per track mile
or \$ 50.15 per gross ton mile)

Land Use Conflicts: none - minor contact with private land
- no significant conflicts with
current BLM land use plans

5.2 Rail Route: Spur 7 (Caliente)

The Caliente spur was option 7 of the initial 10 options considered by the DOE. It is the second of the three alternatives addressed in this study.

5.2.1 Route Specification and Distance

As in the case of the Jean spur, the route specification for the Caliente spur is divided into two parts: the existing mainline connector and the proposed spur. While mainline connections from California and Utah are in existence, this study is limited to the examination of the one from Utah.

Mainline Connector from Utah

The mainline connector for the Caliente spur from southern Utah would be the southern section of the Union Pacific railroad (UP) mainline track in Nevada. This section extends from the Utah-Nevada border to a point near Caliente. The total length of this section of the UP mainline is approximately 40 miles (milepost 500.53 at the state border to about milepost 459.95 near Caliente).

New Rail Spur

Rail spur 7 starts four miles to the east of Caliente in Lincoln County winds to the north of Caliente and then crosses US 93 about two miles to the north of Caliente. About 36.5 miles west of Caliente, spur 7 splits with option 7E. The base spur of 7 heads north parallel to Highway 318. At a point 7 miles north of Hiko, spur 7 makes a 180 degree turn, crossing Highway 318. The spur then follows a southwestern course, rejoining option 7E, 3.5 miles past the intersection of Highways 93 and 375. It then winds in a north-westerly direction along Highway 375 until the point where 375 joins US Highway 6. It heads to the west with a slightly south bearing to a point about 12 miles southeast of Tonopah where it is joined by proposed rail spur 8. The joined routes 7 and 8 pass about eight miles east of Tonopah in Nye County. The proposed rail spur 7 then heads south to about nine miles north of Goldfield in Esmeralda County where options 7A and 7B split off spur 7. The main spur heads south, passes about 7 miles to the east of Goldfield and reunites with options 7A and 7B fourteen miles south of Goldfield. The reunited routes, heading south, pass two miles west of Scotty's Junction, then

crosses US 95 about eleven miles south-east of Scotty's Junction. After crossing US 95, spur 7 runs roughly parallel to the north-west of US 95, passing two-thirds of a mile east of Beatty. Nine miles south-east of Beatty it breaks away from US 95 and heads east to a point five miles to the north and slightly to the west of Lathrop Wells (Amargosa Valley). It then follows a northerly direction until joining with proposed rail spur 3, 1.86 miles from the Yucca Mountain Site. Both joint routes then head north-west to the proposed nuclear waste storage facilities at Yucca Mountain. Spur 7 passes through Lincoln, Nye, and Esmeralda Counties. Proposed rail spur 7 is 406 miles long.

Option 7A splits off from main spur 7 nine mile north of Goldfield. Option 7A runs south-west about 5.2 miles, where it splits with option 7B. It then heads south, passing 0.8 miles west of Goldfield and then reunites with option 7B and main spur 7 fourteen miles south of Goldfield. The total additional length for this option is 34.52 miles long. Option 7A passes through Nye and Esmeralda Counties.

Option 7B splits from option 7A about 5.2 miles south east of the beginning of option 7A. It takes a long, winding, southerly course far to the west of Goldfield and then rejoins the main spur fourteen miles south of Goldfield. Option 7B is an additional 66.771 track miles long and passes through Nye and Esmeralda Counties.

Option 7C begins at the UP mainline northeast of the main part of Caliente at the junction with the now abandoned Up Pioche-Prince branch line. The option heads west to join Spur 7 near US Highway 93. The additional length of option 7C is 1.116 miles and it is located only in Lincoln County.

Option 7D takes off from the UP mainline about 0.8 mile southwest of the center of Caliente. The option follows a northwesterly course along US Highway 93 before joining base spur 7. Option 7D is 0.837 miles in additional length and is within Lincoln County.

Option 7E leaves base spur 7 approximately 36.5 miles to the west of Caliente and heads west following along US Highway 93 and Nevada Highway 375. It rejoins the base spur 3.5 miles past the intersection of Highway 93 and Highway 375. The entire additional length of 7.741 miles of Option 7E is located in Lincoln County.

The Caliente rail spur was divided into a number of small segments. The segment specifications for the various options of alignments of this spur are:

Segment 7.1: Beginning of rail spur 7 at intersection of 7 and UP spur east of Caliente to junction with options 7C and 7D.

- Segment 7.2: Junction with options 7C and 7D heading west to split with 7E.
- Segment 7.3: Rail spur 7 from split with option 7E to reunion with 7E.
- Segment 7.4: Rail spur 7 from reunion with option 7E heading west to 116 degree longitude line.
- Segment 7.5: Rail spur 7 from 116 degree longitude line heading north to 38 degree latitude line.
- Segment 7.6: Rail spur 7 from 38 degree latitude line heading west to junction with rail spur 8.
- Segment 7.7: Junction with rail spur 8 heading south to 38 degree latitude line.
- Segment 7.8: Rail spur 7 from the 38 degree latitude line heading south to split with options 7A and 7B.
- Segment 7.9: From beginning of split with options 7A and 7B heading south to reunion of 7, 7A, and 7B.
- Segment 7.10: From reunion with options 7A and 7B heading south to 37 degree latitude line.
- Segment 7.11: Rail spur 7 from 37 degree latitude line heading south to union with rail spur 3.
- Segment 7.12: Union of sections 3 and 7 from their junction heading north to Yucca Mountain Site.

Option 7A:

- Segment 7A.1: Option 7A from split with rail spur heading west to split into options 7A and 7B.
- Segment 7A.2: Option 7A from split with 7B to reunion of options 7, 7A, and 7B.

Option 7B:

- Segment 7B.1: Option 7B from split into 7A and 7B to reunion options 7, 7A, and 7B.

Option 7C:

- Segment 7C.1: Option 7C from its beginning near Caliente to the intersection of options 7 and 7C.

Option 7D:

Segment 7D.1: Option 7D from its beginning near Caliente to the intersection of options 7 and 7D.

Option 7E:

Segment 7E.1 Option 7E from the split of rail spur 7 into options 7 and 7E to the reunion of options 7 and 7E.

The total distance for Spur 7 (Caliente) is 406 miles. The additional lengths of the other options are as follows: option 7A is 34.52 miles long, option 7B is 66.77 miles long, option 7C is 1.11 miles long, option 7D is 0.84 miles long, and option 7E is 7.74 miles in length.

The lengths of the individual segments on rail route 7 and its options are:

Option 7:

Segment 7.1	8.36 miles
Segment 7.2	33.71 "
Segment 7.3	19.21 "
Segment 7.4	47.80 "
Segment 7.5	9.58 "
Segment 7.6	58.99 "
Segment 7.7	5.26 "
Segment 7.8	5.82 "
Segment 7.9	30.85 "
Segment 7.10	38.00 "
Segment 7.11	35.80 "
Segment 7.12	1.85 "

Option 7A:

Segment 7A.1	5.19 miles
Segment 7A.2	29.32 "

Option 7B:

Segment 7B.1	5.19 miles
Segment 7B.2	61.57 "

Option 7C:

Segment 7C.1	1.11 miles
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Option 7D:

Segment 7D.1	0.83 miles
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Option 7E:

Segment 7E.1 7.74 miles

The UP connector to the Caliente spur is the UP mainline from the Utah-Nevada border (Uvada) to Caliente. Its total length is about 40 miles.

5.2.2 Probability Measures

The probability measures used to characterize the Caliente rail access route are similar to those discussed for the Jean access route in Section 5.1.2. The measures include, for the entire route and each link, length of the access spur/route, anticipated accident rates, and hazardous shipments and inventories. Data on the lengths of the access route were presented in Section 5.2.1.

5.2.2.1 Anticipated Accident Rates

The rail spur from Caliente to Yucca Mountain does not exist currently and needs to be constructed. Consequently, there are no historical data available for the number of accidents, traffic volumes, and accident rates on the Caliente rail spur. Thus, proxy measures will have to be used to determine the anticipated accident rates and related safety indicators for this route.

The proxy measures for anticipated accident rates, discussed in section 5.1.2.1 for the Jean rail spur, would be applicable to the Caliente spur also.

5.2.2.2 Hazardous Shipments/Inventories

Data on the number and quantity of shipments of hazardous materials (hazmat) crossing the rail access routes were obtained from the Nevada Commodity Report (NDOT, 1988) as in the case of the Jean access routes. These were the same for the Caliente spur and the entire rail access route from Utah. The information is summarized below.

Number of Hazmat Trucks and Tons of Hazmat Crossing Caliente Route

Description	Spur	Access Route from Utah
# Hazmat Trucks/day	61	61
Tons of Hazmat/day	1,800	1,800

These shipments are fewer in number and smaller in quantity than the shipments crossing the Jean spur/access route.

The tabulation of hazardous shipments/inventories related to the Caliente rail spur were obtained using the procedure discussed in section 5.1.2.3 for the Jean spur. The discussions presented regarding data limitations for the Jean spur are applicable to the Caliente spur also. No high pressure natural gas pipelines were found within the specified corridors of the Caliente rail access route or crossing the routes.

5.2.3 Consequence Measures

This section provides information on consequence measures used in characterizing the Caliente rail spur and access route. The measures included are the same as those used for the Jean spur. These measures include resident population, non-resident population, ecologically sensitive areas, land use, property value, difficult/dangerous to evacuate areas, meteorological conditions, and infrastructure characteristics.

5.2.3.1 Resident Population

The proposed rail spur 7 and its options traverses mainly desert valleys and mountain ranges where population is concentrated primarily at two areas - Caliente and Tonopah. Two additional areas contribute to population within various corridors of the route - Goldfield and Beatty.

As in the Jean case, data on resident population within a specified distances from the transport link were collected for the Caliente spur and access route. 0.5 mile-wide, 2 mile-wide, and 20 mile-wide corridors around the rail transport segments were identified and the resident population within each of these corridors were determined. It was determined that the population within these corridors were 315, 1160, and 1160 respectively for the total length of the proposed Caliente rail spur. The resident population estimates for the same corridors for the entire Caliente access route (rail spur plus Union Pacific connector from Utah) were also 315, 1160, and 1160 respectively. An illustration of the GIS methodology used to estimate population within a 0.5 mile-wide corridor in the vicinity of Caliente is shown in Figure 5-12.

5.2.3.2 Non-Resident Population

The non-resident population within specified corridors, up to a 20 mile-wide corridor, around the Caliente spur and access route is small compared to the non-resident population in the Las Vegas Valley. No data on non-resident population were readily available. However, non-resident populations along this spur may be significant relative to resident population levels in these areas.

5.2.3.3 Ecologically Sensitive Areas

The northern portion of this proposed Caliente rail spur would pass through areas of Toiyabe National Forest, Toquima

National Forest and Monitor Range. As in rail Spur 3 (Jean), this route was buffered using a 20 mile-wide corridor around the rail link and the area of the ecologically sensitive areas falling within this corridor was calculated.

The total extent of ESAs within the 20 mile-wide corridor around the Caliente spur includes about 147 square miles of national forests/wildlife refuges, about 1246 square miles of desert tortoise habitats, and an area of a combination of selected ESAs of about 3792 square miles. These areas for the entire rail access route are 265 square miles, 1248 square miles, and 3958 square miles, respectively. Thus, the spur alone accounts for nearly all the identified ESA areas potentially impacted by the Caliente route (including the mainline connector).

The extent of the national forests/wildlife refuges, Desert Tortoise habitats, and all selected ESAs within the 20 mile corridor of the Caliente spur are shown in Figures 5-13, 5-14 and 5-15 respectively. Similar illustrations for the access route from Utah are presented in Figures 5-16, 5-17 and 5-18 respectively.

5.2.3.4 Land Use

The approach used to identify land use within a 2 mile-wide corridor along the proposed rail spur from Caliente is the same as that adopted for the Jean spur. Similarly, the limitations of this data are the same as discussed for the Jean spur.

The areas along segments 7.1 through 7.12, segment 7A.1, segment 7B.1, and segment 7E.1 were assumed to be vacant or government lands and were listed under that category. Part of the area of 7C.1 and 7D.1 included land within the boundaries of Caliente. This land was listed as unspecified urban land. The area that fell within Caliente was divided by the total area of the corridor along the segment and then was multiplied by 100 to give the percentage of unspecified urban land. This number was subtracted from 100 to give the percentage of government/vacant land.

Some of the corridor along segment 7A.2 was within the boundaries of Goldfield. This was also accounted for in a manner similar to cities along highway Routes A and B.

The land uses within a 2 mile-wide corridor around the Caliente spur and the access route were identified. The following were the approximate extent of the various land uses within the 2 mile-wide corridor along the Caliente spur and the access route:

<u>Land Use Category</u>	<u>Area (square miles)</u>	
	<u>Spur</u>	<u>Access Route</u>
government/vacant land	590.0	671.4
unspecified urban	0	0

Areas for all segments of rail spur 7 that do not fall within a city's limit were assumed to be government/vacant lands. The government/vacant distinction appears to indicate vacant or unused land. This may not be an accurate reflection of the actual land use.

The unspecified urban land use category for areas along the corridor which fall within the boundaries of Goldfield or Caliente is a broad classification which indicates that the land in these areas lies within a city. But it does not accurately reflect the actual use of lands within the city.

5.2.3.5 Property Values

The methodology used to determine the total property value within specified corridors along the Caliente spur and access route was essentially similar to that discussed in Section 5.1.3.5 for the Jean spur.

The total property value of the lands within a 2 mile-wide corridor along the Caliente Spur was estimated to be about \$17 million. The total property value for a similar corridor along the entire Caliente access route was estimated to be \$32 million.

5.2.3.6 Difficult/Dangerous to Evacuate Locations

The procedure used to obtain data on difficult/dangerous to evacuate locations along the Caliente spur is the same as that discussed in section 5.1.3.6 for the Jean rail spur. A summary of this information for the Caliente route is presented in Table 5-4.

Table 5-4

**Caliente Access Route:
Summary of Difficult to Evacuate Locations**

Rail Spur/Route	Corridor Width (miles)	# School Students	# Hospital Beds	Prison Population
Caliente Spur	0.5	0	0	0
	1	0	0	0
	2	0	0	0
	6	102	12	0
	10	177	12	0
	20	248	12	0
Caliente Access Route	0.5	0	0	0
	1	0	0	0
	2	0	0	0
	6	102	12	0
	10	177	12	0
	20	248	12	0

There was no difference in any of the characteristics of the difficult/dangerous to evacuate locations (within a 20 mile-wide corridor) between the rail spur and the rail access route for the aforementioned corridors. There was no prison population within the 20 mile-wide corridors. The number of school students and hospital beds within the 20 mile-wide corridors for the entire Caliente rail access route were 248 and 12 respectively.

5.2.3.7 Meteorological Conditions

The annual rainfall and snowfall for the Caliente rail spur (alternative 7) are summarized as follows:

Rainfall		Snowfall	
365 miles	4 to 8 inches	162 miles	2 to 10 inches
41 miles	8 to 16 inches	244 miles	10 to 20 inches

Source: Environmental Factors Affecting Nevada Highways
(University of Nevada, Reno, 1987)

5.2.3.8 Infrastructure

The basic information on the characteristics of data included in this section (on the Caliente Spur) is the same as that discussed for the Jean Spur in Section 5.1.3.8. The route specific information available for the existing UP mainline track from Utah that will serve as a connector to the Caliente spur are summarized below. Detailed information on this connector is presented in Appendix 5-C.

UP Mainline Connector from Utah

Length: 40 miles (approximately): Milepost 459.95 to Milepost 500.53.

Counties traversed: Lincoln

Major features: 66 bridges and culverts
8 tunnels
10 sidings
maximum gradient = 2.06%
average gradient = 0.59%
% length with grade greater than 1% = 41.0

Rail: A mix of three types of rail is found for this segment of the UP connector - 133 lb/yard, 133 lb/yard CWR (Continuously Welded Rail), and HS (High Strength steel).

Proposed Rail Spur

The route specific information available for the Caliente Spur are summarized below.

<u>Alternative</u>	<u>Total Length of Spur</u>	<u>Capital Cost</u> <u>\$ millions</u>	<u>Annual O&M Cost</u> <u>\$ millions</u>
7.	406 miles (new construction)	692	2.90
7A.	413 miles (new construction)	698	2.90
7B.	448 miles (new construction)	735	3.30
7C.	389 miles (new construction)	639	2.80
7D.	388 miles (new construction)	636	2.80
7E.	380 miles (new construction)	631	2.70
7CE.	367 miles (new construction)	579	2.60

Counties traversed: Lincoln, Nye, Esmeralda

Major features: Alt 7 - very rugged terrain

Alt 7A - old railroad grade is much steeper than 2.5% (DOE's limit)

Alt 7B - easier to construct

Alt 7C, D, E - avoid rugged terrain

Land Use Conflicts: Alt 7, 7A and 7B avoid private lands completely, but might affect archeological sites and deer habitat. These also have no conflict with current BLM land use plans.

Alt 7C, 7D, 7E have to cross about 2 miles of private land

5.3 Rail Route: Spur 8 (Carlin)

The Carlin spur was option 8 of the initial 10 options considered by the DOE. It is the third among the three alternatives addressed in this study.

5.3.1 Route Specification and Distance

As in the cases of the Jean and Caliente rail access routes, the route specification for the Carlin access route could also be divided into two parts: the existing mainline connector and the proposed spur. While the mainline connections from both California and Utah are in existence, this study included only the later. Even for the evaluation of connector from Utah was limited compared to the level of detail included for the connectors for the Jean and Caliente options.

Mainline Connector from Utah

The mainline connector for the Carlin spur from northern Utah would be the northern section of the Union Pacific railroad (UP) mainline track in Nevada. This section extends from the Utah-Nevada border (near Wendover) to a point near Carlin. The total length of this section of this UP mainline is approximately 141 miles (milepost 607 at the state border to about milepost 446 near Caliente).

New Rail Spur

Rail spur 8 begins about five miles to the southwest of Carlin in Elko County. It leaves the paired trackage of the SP and UP railroads at this point and heads roughly south as it runs to the west of Nevada Highway 278 to about 40 miles south of the mainline railroads. It then runs into Monitor Valley and Ralston Valley and joins rail spur 7 south of US Highway 6, about 12 miles east of Tonopah. The spur would pass through Elko, Nye, Esmeralda, Eureka, and Lander counties. The proposed rail spur 8 is 365 miles long.

Option 8A splits from spur 8 approximately 11 miles south of Carlin, 6.3 miles from the beginning of spur 8. It heads south, running parallel to the west of the base route. It rejoins the base spur and ends about 9 miles from the split. Option 8A is 9.281 miles long and is entirely in Eureka County.

The Carlin spur was divided into a number of segments to facilitate data collection. The specification of the segments for the spur and its option are:

Segment 8.1:	Beginning of rail spur 8 heading south to split into options 8 and 8A.
Segment 8.2:	Beginning of split with rail spur option 8A to end of split with 8A.
Segment 8.3:	End of split with rail spur option 8A heading south to 40 latitude line.
Segment 8.4:	Forty degree latitude line heading south to 39 degree latitude line.
Segment 8.5:	Thirty-nine degree latitude line heading south to the junction with rail spur 7 of the proposed rail route.
Segment 8.6:	Rail spur 7 from junction with spurs 7 and 8 heading south to 38 degree latitude passing to the east of Tonopah.
Segment 8.7:	Rail spur 7 from the 38 degree latitude heading south to split with 7A and 7B.
Segment 8.8:	Rail spur 7 from the beginning of split with 7A and 7B, heading south passing to the east of Goldfield, to end of split.
Segment 8.9:	Rail spur 7 from end of split with 7A and 7B heading south to 37 degree latitude line.

Segment 8.10: Rail spur from 37 degree latitude line heading south, passing Beatty, to union with rail spur 3.

Segment 8.11: Union of rail spurs 3 and 7 from their junction heading north to Yucca Mountain.

Option 8A:

Segment 8A.1: Beginning of split with rail spur 8 to end of split.

The length of the proposed rail spur 8 (Carlin spur) is 365 track miles. Option 8A would make it marginally shorter (by 0.082 miles) when segment 8.2 would be replaced by segment 8A.1. The lengths of the individual segments on the Carlin spur are:

Option 8:

Segment 8.1	6.35 miles
Segment 8.2	9.36 "
Segment 8.3	40.63 "
Segment 8.4	79.37 "
Segment 8.5	79.33 "
Segment 8.6	6.31 "
Segment 8.7	6.98 "
Segment 8.8	36.99 "
Segment 8.9	45.56 "
Segment 8.10	42.93 "
Segment 8.11	1.88 "

Option 8A:

Segment 8A.1 9.28 miles

5.3.2 Probability Measures

The probability measures used to characterize the Carlin rail access route are similar to those discussed earlier for the Jean and Caliente access routes in Sections 5.1.2 and 5.2.2. The measures include, for the entire route and each link, length of the access spur/route, anticipated accident rates, and hazardous shipments and inventories. Data on the lengths of the access spur were presented in Section 5.3.1.

5.3.2.2 Anticipated Accident Rates

The rail spur from Carlin to Yucca Mountain does not currently exist. Thus, there are no historical data available for the number of accidents, traffic volumes, and accident rates on the Carlin rail spur. Therefore, proxy measures will have to be used to determine the anticipated accident rates and related safety indicators for this route.

The proxy measures for anticipated accident rates, discussed in section 5.1.2.2 for the Jean rail spur, would be applicable to the Carlin spur also.

5.3.2.3 Hazardous Shipments/Inventories

The tabulation of hazardous shipments/inventories related to the Carlin rail spur were obtained using a procedure identical to that discussed in section 5.1.2.3 for the Jean spur. The discussions presented regarding data limitations for the Jean spur are applicable to the Carlin spur also. The Carlin spur had 67 trucks carrying about 1,897 tons of hazardous materials crossing daily. The entire access route had about 332 trucks and 6271 tons of hazardous materials crossing it daily. No high pressure natural gas pipelines were found within the specified corridors of the Carlin rail spur, but the mainline connector has high pressure gas pipelines within the 6, 10, and 20 mile-wide corridors as in the following summary:

Length of High Pressure Natural Gas Pipelines within Rail Access Route Corridors

Corridor Width (miles)	Length of Pipeline (miles)	
	Spur	Access Route from Utah
0.5	0.0	0.0
1	0.0	0.0
2	0.0	0.0
6	0.0	19.4
10	0.0	25.5
20	0.0	30.4

5.3.3 Consequence Measures

Data for each of the consequence measures used in characterizing the Carlin rail corridor are presented in this section. These measures are the same as those used for the Jean and Caliente access routes and include resident population, non-resident population, ecologically sensitive areas, land use, property value, difficult/dangerous to evacuate areas, meteorological conditions and infrastructure characteristics.

5.3.3.1 Resident Population

The only identified resident population data for the proposed rail spur 8 from Carlin are 1980 data from the University of Reno, Bureau of Business and Economic Research. This included an annual projection from 1981 to 1989 and 5 year projections from the year 1990 to 2010. The projections show a progressive population increase in Elko and a fairly level population (no growth) in Carlin. The accuracy of this estimate has not been verified.

As was done for the Jean and Caliente access routes, data on resident population within a specified distances from the transport link were collected for the Carlin spur and access route. 0.5 mile-wide, 2 mile-wide, and 20 mile-wide corridors around the rail transport segments were identified and the resident population within each of these corridors were determined. It was determined that the population within these corridors were 0, 0, and 0 respectively for the total length of the proposed Carlin rail spur. The resident population estimates for the same corridors for the entire Carlin access route (rail spur plus Union Pacific connector from Utah) were 13965, 20622, and 25675 respectively.

5.3.3.2 Non-Resident Population

The proposed Carlin rail spur will cut across national forests which may be used as camping or hunting grounds. The non-resident population in these areas would include campers, hunters, and other outdoor enthusiasts. At present, no data on the volume or frequency of campers and hunters in these areas are available. The non-resident population within specified corridors, up to a 20 mile-wide corridor, around the Carlin spur and access route is small compared to the non-resident population in the Las Vegas Valley. However, non-resident populations along this spur may be significant relative to resident population levels in these areas.

5.3.3.3 Ecologically Sensitive Areas

The approach used to identify ecologically sensitive areas along the proposed rail access route through Caliente is similar to that used for the proposed highway routes and the Jean rail access route. As for the Jean route, the ESAs within a 20 mile-wide corridor were determined.

The proposed rail Spur from Carlin affects habitats for antelope and mule deer which are mainly in the Toiyabe National Forest. The total extent of ESAs within the 20 mile-wide corridor around the Carlin spur includes about 1365 square miles of national forests/wildlife refuges, about 1085 square miles of desert tortoise habitats, and 2943 square miles of all selected ESAs. The respective extent for the entire rail access route are 1441 square miles, 1085 square miles, and 3256 square miles.

The extent of the national forests/wildlife refuges, Desert Tortoise habitats, and all selected ESAs within the 20 mile corridor of the Carlin spur are shown in Figures 5-19, 5-20 and 5-21 respectively. Similar illustrations for the access route from Utah are presented in Figures 5-22 to 5-24 respectively.

5.3.3.4 Land Use

The approach used to identify land use within a 2 mile-wide corridor along the proposed rail access route from Carlin is the

same as that described earlier in Section 5.1.3.4 for the Jean spur. The limitations of this data are the similar as well.

All land within the 2 mile-wide corridor along all segments of the Carlin rail spur 8 and option 8A were assumed to be either government/vacant or unspecified urban lands. This is because of the unavailability of a detailed breakdown of the land use as was available for lands within Clark County. There were no urban lands within this corridor. Thus all the land use was described by the government/vacant category. This may appear to indicate vacant or unused land which may not be an accurate reflection of the actual land use.

The land uses within a 2 mile-wide corridor around the Carlin spur and the Carlin access route were identified. The following were the approximate extent of the various land uses within the 2 mile-wide corridor along the Carlin spur and the entire access corridor:

<u>Land Use</u> <u>Category</u>	<u>Area (Square Miles)</u>	
	<u>Spur</u>	<u>Access Route</u>
Government/vacant land	730.0	1019.0
Unspecified urban	0.0	14.5

5.3.3.5 Property Values

The methodology used to determine the total property value within specified corridors along the Carlin spur and access route was essentially similar to that discussed in Section 5.1.3.5 for the Jean spur.

The total property value of the lands within a 2 mile-wide corridor along the Carlin Spur was estimated to be about \$130 million. The total property value for a similar corridor along the entire Carlin access route was estimated to be \$256 million.

5.3.3.6 Difficult/Dangerous to Evacuate Locations

The procedure used to obtain data on difficult/dangerous to evacuate locations along the Carlin spur is the same as that discussed in section 5.1.3.6 for the Jean rail spur. A summary of this information for the Carlin route is presented in Table 5-5.

Table 5-5

**Carlin Access Route:
summary of Difficult to Evacuate Locations**

Rail Spur/Route	Corridor Width (miles)	# School Students	# Hospital Beds	Prison Population
Carlin Spur	0.5	0	0	0
	1	0	0	0
	2	0	0	0
	6	0	0	0
	10	0	0	0
	20	482	0	150
Carlin Access Route	0.5	864	0	0
	1	1464	0	0
	2	4792	50	0
	6	4792	50	0
	10	4792	50	0
	20	4863	50	150

There were some differences in the characteristics of the difficult/dangerous to evacuate locations (within a 20 mile-wide corridor) between the rail spur and the rail access route for the aforementioned corridors. The population in prisons would be affected only in the 20 mile-wide corridor of the access route. The number of school students within a 0.5 mile-wide corridor of the access route numbered 864, and there were 50 hospital beds within a 2 mile-wide corridor for access route. The number of students within a 20 mile-wide corridor of the entire access route was 4863. Of these, 482 students were within a 20 mile-wide corridor along the proposed spur.

5.3.3.7 Meteorological Conditions

The annual rainfall and snowfall for the Carlin rail route are summarized as follows:

Rainfall

219 miles 4 to 8 inches
146 miles 8 to 16 inches

Snowfall

146 miles 2 to 10 inches
73 miles 10 to 20 inches
146 miles 20 to 40 inches

Source: Environmental Factors Affecting Nevada Highways
(University of Nevada, Reno, 1987)

5.3.3.8 Infrastructure

The basic information on the characteristics of data included in this section for the Carlin is the same as that discussed for the Jean Spur in Section 5.1.3.8. The route specific information available for the existing UP mainline track from Utah that will serve as a connector to the Carlin spur are summarized below. Detailed information on this connector is presented in Appendix 5-D.

UP Mainline Connector from Utah

Length: 161 miles (approximately): Milepost 446 to Milepost 607.

Counties traversed: Elko

Major features: 13 sidings

Rail: A mix of at least two types of rail is found for this segment of the UP connector - 133 lb/yard, 133 lb/yard CWR (Continuously Welded Rail).

Proposed Rail Spur

The basic information on the characteristics of data included in this section (on the Carlin Spur) is the same as that discussed for the Jean Spur in Section 5.1.3.8.

The route specific information available for the Carlin Spur are summarized below.

Length: Alt 8: 365 miles (new construction)
Alt 8A: 365 miles (new construction)

Counties traversed: Elko, Lander, Eureka, Esmeralda, Nye

Major features: generally rugged terrain
minimal private land holdings

Capital cost: Alt 8: \$ 661 million
Alt 8A: \$ 659 million

Annual O&M cost: Alt 8: \$ 2.90 million
Alt 8A: \$ 2.50 million

Land Use Conflicts: - minor contact with private land at the northern end of spur (about 5 miles in length)
- minimal conflict with current BLM land use plans

5.4 Summary Comparison of Jean, Caliente and Carlin Rail Corridors

This section provides a comparison of the characteristics of the Jean, Caliente and Carlin rail access routes. The summary is provided in a tabular form. First, route-link characteristics are presented. These characteristics are primarily infrastructure related. Information on shipments of hazardous materials crossing the routes and meteorological factors are also included in this table. Next, separate tables are presented for comparison data for several corridor widths (0.5, 1, 2, 6, 10, and 20 miles) along the routes.

Table 5-6

Summary Rail Link Characteristics

ROUTE	SPUR 3	SPUR 7	SPUR 8	SPUR 3 & MAINLINE FROM CA	SPUR 3 & MAINLINE FROM UTAH	SPUR 7 & MAINLINE	SPUR 8 & MAINLINE
TOTAL LENGTH (MILES)	121	406	365	133	605	405	526
NUMBER OF BRIDGES AND CULVERTS	N/A	N/A	N/A	17*	289*	66*	N/A
NUMBER OF TUNNELS	N/A	N/A	N/A	0*	7*	8*	N/A
NUMBER OF SIDINGS	N/A	N/A	N/A	3*	38*	10*	14*
WEIGHT OF RAIL (LB/YARD)	N/A	N/A	N/A	133	133	133	133
MAXIMUM RAINFALL (INCHES) DISTANCE (MILES)	4-8 109	8-16 41	8-16 146	N/A	N/A	N/A	N/A
MAXIMUM SNOWFALL (INCHES) DISTANCE (MILES)	2-10 24	10-20 244	20-40 146	N/A	N/A	N/A	N/A
HAZMAT TRUCKS/DAY (CROSSING ROUTE)	131	61	67	131	273	61	332
HAZMAT TONS/DAY (CROSSING ROUTE)	2,291	1,800	1,897	2,291	2,306	1,800	6,271
NUMBER OF GAS PIPELINE CROSSINGS	1	0	0	1	4	0	0
AVERAGE GRADE, %	N/A	N/A	N/A	0.20*	0.27*	0.59*	N/A
PERCENT WITH GRADE > 1.00%	N/A	N/A	N/A	46.30*	29.58*	41.00*	N/A

* - Note: The information presented is only for the mainline connector and does not include the spur.

N/A - not applicable or data not collected/available

Table 5-7

**Summary Rail Route Comparisons
0.5 Mile-wide Corridor**

ROUTE	SPUR 3	SPUR 7	SPUR 8	SPUR 3 & MAINLINE FROM CA	SPUR 3 & MAINLINE FROM UTAH	SPUR 7 & MAINLINE	SPUR 8 & MAINLINE
RESIDENT POPULATION	664	315	few	664	23,803	315	13,965
NON-RESIDENT POPULATION	few	few	few	few	14,372	few	few
NUMBER OF SCHOOL STUDENTS	0	0	0	0	1,001	0	864
NUMBER OF HOSPITAL BEDS	0	0	0	0	0	0	0
PRISON POPULATION	0	0	0	0	0	0	0
MILES OF GAS PIPELINE (ALONG ROUTE)	0.3	0.0	0.0	3.2	28.6	0.0	0.0

Table 5-8

**Summary Rail Route Comparisons
1 Mile-wide Corridor**

ROUTE	SPUR 3	SPUR 7	SPUR 8	SPUR 3 & MAINLINE FROM CA	SPUR 3 & MAINLINE FROM UTAH	SPUR 7 & MAINLINE	SPUR 8 & MAINLINE
NON-RESIDENT POPULATION	663	few	few	663	54,486	few	few
NUMBER OF SCHOOL STUDENTS	0	0	0	0	2,192	0	1,464
NUMBER OF HOSPITAL BEDS	0	0	0	0	12	0	0
PRISON POPULATION	0	0	0	0	0	0	0
MILES OF GAS PIPELINE (ALONG ROUTE)	0.5	0.0	0.0	6.9	31.2	0.0	0.0

Table 5-9

**Summary Rail Route Comparisons
2 Mile-wide Corridor**

ROUTE	SPUR 3	SPUR 7	SPUR 8	SPUR 3 & MAINLINE FROM CA	SPUR 3 & MAINLINE FROM UTAH	SPUR 7 & MAINLINE	SPUR 8 & MAINLINE
RESIDENT POPULATION	796	1,160	0	796	97,589	1,160	20,622
NON-RESIDENT POPULATION	1,326	few	few	1,326	127,076	few	few
PROPERTY VALUE (\$ MILLION)	78	17	130	112	N/A	32	256
LAND USE AREA: RESIDENTIAL (SQUARE MILES)	0.0	N/A	N/A	0.0	N/A	N/A	N/A
LAND USE AREA: INDUSTRIAL(SQUARE MILES)	0.1	N/A	N/A	0.1	N/A	N/A	N/A
LAND USE AREA: COMMERCIAL (SQUARE MILES)	0.5	N/A	N/A	0.8	N/A	N/A	N/A
LAND USE AREA: NON-PROFIT COMMUNITY FACILITIES (SQUARE MILES)	0.3	N/A	N/A	0.5	N/A	N/A	N/A
LAND USE AREA: TRANSPORT, COMMUNICATIONS OR UTILITIES (SQUARE MILES)	0.0	N/A	N/A	0.0	N/A	N/A	N/A
LAND USE AREA: MINOR IMPROVEMENTS (SQUARE MILES)	0.0	N/A	N/A	0.0	N/A	N/A	N/A
LAND USE AREA: GOVERNMENT OR VACANT (SQUARE MILES)	241.1	590.0	730.0	266.9	N/A	671.4	1019.0
LAND USE AREA: UNSPECIFIED URBAN (SQUARE MILES)	0.0	0.0	0.0	0.0	N/A	0.0	14.5
NUMBER OF SCHOOL STUDENTS	0	0	0	0	9,622	0	4,792
NUMBER OF HOSPITAL BEDS	0	0	0	0	921	0	50
PRISON POPULATION	631	0	0	631	631	0	0
MILES OF GAS PIPELINE (ALONG ROUTE)	0.5	0.0	0.0	22.7	37.2	0.0	0.0

Table 5-10

**Summary Rail Route Comparisons
6 Mile-wide Corridor**

ROUTE	SPUR 3	SPUR 7	SPUR 8	SPUR 3 & MAINLINE FROM CA	SPUR 3 & MAINLINE FROM UTAH	SPUR 7 & MAINLINE	SPUR 8 & MAINLINE
NON-RESIDENT POPULATION	1,326	few	few	2,559	154,163	few	few
NUMBER OF SCHOOL STUDENTS	0	102	0	0	44,313	102	4,792
NUMBER OF HOSPITAL BEDS	0	12	0	0	1,791	12	50
PRISON POPULATION	631	0	0	631	631	0	0
MILES OF GAS PIPELINE (ALONG ROUTE)	0.5	0.0	0.0	22.7	60.4	0	19.4

Table 5-11

**Summary Rail Route Comparisons
10 Mile-wide Corridor**

ROUTE	SPUR 3	SPUR 7	SPUR 8	SPUR 3 & MAINLINE FROM CA	SPUR 3 & MAINLINE FROM UTAH	SPUR 7 & MAINLINE	SPUR 8 & MAINLINE
NON-RESIDENT POPULATION	1,326	few	few	2,559	155,211	few	few
NUMBER OF SCHOOL STUDENTS	0	177	0	0	74,343	117	4,792
NUMBER OF HOSPITAL BEDS	0	12	0	0	2,106	12	50
PRISON POPULATION	631	0	0	631	631	0	0
MILES OF GAS PIPELINE (ALONG ROUTE)	0.5	0.0	2.1	22.7	65.0	0.0	25.5

Table 5-12

**Summary Rail Route Comparisons
20 Mile-wide Corridor**

ROUTE	SPUR 3	SPUR 7	SPUR 8	SPUR 3 & MAINLINE FROM CA	SPUR 3 & MAINLINE FROM UT	SPUR 7 & MAINLINE	SPUR 8 & MAINLINE
RESIDENT POPULATION	1,232	1,160	few	1,232	658,600	1,160	25,675
NON-RESIDENT POPULATION	1,326	few	few	2,559	156,614	few	few
NUMBER OF SCHOOL STUDENTS	0	248	482	0	88,655	248	4,863
NUMBER OF HOSPITAL BEDS	0	12	0	0	2,140	12	50
PRISON POPULATION	631	0	150	631	631	0	150
MILES OF GAS PIPELINE (ALONG ROUTE)	0.5	0.0	7.0	22.7	71.4	0.0	30.4
ESA: ALL SELECTED (SQUARE MILES)	1,842	3,792	3,180	1,938	4,807	3,958	3,256
ESA: NATIONAL FORESTS/WILDLIFE REFUGES (SQUARE MILES)	32	147	1,365	31	148	265	1,441
ESA: DESERT TORTOISE HABITAT (SQUARE MILES)	1,564	1,246	1,085	1,902	3,689	1,248	1,085

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6 Identification of Potentially Critical Locations for Rail Accidents

Potentially critical locations for rail accidents on the three rail spurs and four access routes (spurs plus mainline connectors): Jean (two connectors), Caliente and Carlin are identified in this chapter. For each spur or route, the analysis is based on the categories of potential population impacts, cost and difficulty of accident cleanup, environmental impacts and impact on accident severity. Measures included in the "Population Impacts" category are numbers of residents and non-residents along the routes. The "Cost and Difficulty of Accident Cleanup" category encompasses property value, land use, difficult to evacuate locations and traffic volume. "Impact on Environment" includes the number and nature of ecologically sensitive areas. The "Accident Severity" category is composed of measures of meteorological conditions and infrastructure characteristics. Finally, a comparison of the three proposed rail spurs and access routes on potentially critical accident locations, based upon measures for the four categories, is presented. The locations are identified either using the segment number (specified in Chapter 5) or by a description of the location with respect to major geographic features.

6.1 Rail Route: Spur 3 (Jean)

6.1.1 Potential Population Impacts

6.1.1.1 Resident Population

The proposed Jean Spur and its California access route will be closest to residents of Jean, Pahrump, Goodsprings, and Sandy Valley. A continuing effort to obtain more accurate and complete population data is being undertaken by the research group. These data are considered essential in forecasting population during the life-span of the project so that the severity of damage in the event of accident can be estimated. The access route from Utah to the Jean spur would be proximate to a large number of people in the Las Vegas Metropolitan area and a smaller number near Caliente.

6.1.1.2 Non-Resident Population

As discussed in Chapter 5, the most significant potential impact on non-resident population would be in the Las Vegas metropolitan area. Other areas with relatively high non-resident population densities are near Jean and Stateline. This assumes that impact would be greater for larger, absolute numbers of non-residents. However, visitors to other areas along the route represent an important element of the economy, relative to the much smaller resident populations.

6.1.2 Cos. and Difficulty of Accident Cleanup

6.1.2.1 Property Value

The highest property values within a 2 mile-wide corridor would be expected to be in the Las Vegas metropolitan area along the access route from Utah. However, property value data for this route were not collected because of time constraints. This would probably be the a potentially critical area for an accident to occur. For spur 3, Segment 3.4, which is close to Jean, has the highest property value for Spur 3 and would be a potentially critical place for an accident to occur, in terms of property value.

6.1.2.2 Land Use

There is no single critical accident location along the Jean Spur. The land use code for all segments is listed as 100% government/vacant. Since the land use for the access routes from California and Utah were not identified in this study, a single critical accident location based on land use cannot be identified for these access routes.

6.1.2.3 Difficult/Dangerous to Evacuate Locations

Difficult to evacuate locations include schools, hospitals and prisons/correctional institutions. Information on location and occupancy of these facilities is summarized for all the routes included in this study in Appendix 6-A. The identification of potentially critical locations, if any, for rail accidents on the proposed routes with respect to these facilities follows.

► School Enrollment

One school is located within a 20-mile corridor along Spur 3 and its mainline connector from California. The school enrollments were significant in the Las Vegas area for the mainline connector from Utah and this would be a potentially critical area/stretch for an accident to occur. The information on school enrollments within specified corridors for the spur and its mainline connectors is summarized in Appendix 6-A. The enrollment figures includes both public and private schools from pre-kindergarten to the twelfth grade. Pre-schools, day care centers, and post high-school education facilities, such as colleges, were not included. This information could be used to determine the potentially critical location, depending on the width of the critical corridor. The width of the critical corridor may in turn depend on a number of factors including the characteristics of the materials being transported, environmental conditions and so on.

Jean Spur 3

One school (enrollment 81 students) is located in Sandy Valley. It is within the 20-mile corridor of this route. This location is thus identified as the potentially critical location for a rail accident to occur on the Jean spur.

Jean Spur 3 with Mainline Connector from California:

One school (enrollment 81 students) is located in Sandy Valley. It is within the 20-mile corridor of this route. This location is thus identified as the potentially critical location for a rail accident to occur on the Jean spur.

Jean Spur 3 with Mainline Connector from Utah:

A number of schools are located within a 20 mile-wide corridor along the route. The school enrollment within a 0.5 mile-wide corridor is 1001 and that within a 20 mile wide corridor is 88,736 (Appendix 6-A). The identification of the potentially critical location for rail accidents depends on the width of the critical corridor.

► **Prison and Correctional Institution Occupancy**

Segment 3.4 has an occupancy of 578 within the 2 mile corridor (Appendix 6-A) and is a potentially critical location for an accident along proposed Spur 3 and both its access routes.

► **Hospital Occupancy**

No hospitals are located within a 20 mile-wide corridor along any segments of Spur 3 or its mainline connector from California (Appendix 6-A). There were 2140 hospital beds within a 20 mile-wide corridor for the mainline connector from Utah. A vast majority of these hospital beds were in the Las Vegas area and this would be a potentially critical area/stretch for a rail accident to occur.

6.1.3 Environmental Impacts

6.1.3.1 Ecologically Sensitive Areas

A 20 mile-wide corridor along the Jean Spur largely covers a habitat for the desert tortoise, an endangered species. It also includes a wildlife area for big horn sheep, mule deer and chipmunks. Transport links within these areas (figures presented in Chapter 5) would be the potentially critical locations for accidents to occur.

6.1.4 Impact on Accident Severity

6.1.4.1 Meteorological Conditions

Wind conditions influence the identification of potentially critical locations for rail accidents occur. Areas where wind conditions are most severe need to be identified for this purpose. Because wind data were not collected due to time constraints, this measure cannot be used in determining potentially critical accident locations. Data for distribution of wind speed and direction may be analyzed in future studies. Similarly with respect to rainfall and snowfall, locations with steep embankments and those with hilly terrain would be the potentially critical locations if they were subject to potential land/mud/snow slides. The level of detail of data required to analyze these may also be addressed in future studies.

6.1.4.2 Infrastructure

Locations with high embankments, high bridges, sharp curves and/or steep slopes would be areas where the occurrence of an accident could have severe consequences due to infrastructure characteristics. However, not all of this information is currently available. Similarly, locations with tunnels could also be considered potentially critical locations. There were numerous tunnels, bridges and fairly steep gradients for the access route from Utah. Available information on these characteristics were presented in Appendices to Chapter 5.

6.1.4.3 Hazardous Shipments/Inventories

Location of the inventories hazardous materials and their shipment influences the determination of potentially critical locations for rail accidents to occur during the transportation of high level radioactive waste. As stated earlier in this study, this would include the frequency of shipments of hazardous materials, and their quantities, across rail links or in the close proximity of the rail links. Also included would be the transport of natural gas through pipelines. Such information for all the routes included in this study are summarized in Appendix 6-B.

► Hazardous Material Pipelines

Segments 3.2 and 3.4 are the only segment within 10 miles of a hazardous material (high pressure gas) pipeline, with 0.25 miles of the pipeline (i.e., lying within the 0.5 mile corridor) for any of the proposed routes through Jean (Appendix 6-B). There is one location on Segment 3.4 with a pipeline crossing. Thus, these segments could be considered potentially critical locations for a rail accident to occur if high pressure gas pipelines were the only consideration.

► Hazardous Materials Shipments

For the Jean spur and the access route from California, Segments 3.2 and 3.4 respectively have 14 and 117 daily truck shipments of all classes of hazardous materials crossing them. The quantities of hazardous materials shipped across these segments are 365.8 tons and 1925.5 tons respectively. They are potentially critical locations for a rail accident to occur.

In addition to the crossings on segments 3.2 and 3.4, highways I-15, US 95, and FAS 160 also cross the proposed rail access route from Utah through Jean. Information on the quantities of hazardous materials being shipped across on these highway routes are presented in Appendix 6-B. The locations of these crossings could be considered potentially critical locations for accidents to occur.

6.2 Rail Route: Spur 7 (Caliente)

6.2.1 Potential Population Impacts

6.2.1.1 Resident Population

Potentially critical locations in terms of density of resident population along the Caliente Spur and its mainline connector from Utah are Segment 7.1 (8.0 mi), Segment 7C.1 (1.0 mi) and Segment 7D.1 (0.8 mi) for Options 1, C and D, respectively. These segments lie within the boundaries of the City of Caliente.

6.2.1.2 Non-Resident Population

While little data for non-resident population were available for the Caliente access route, the relative impact on the local areas should not be neglected. However, because of the limited scope of this study, emphasis was placed on the larger numbers of non-resident population found in the Las Vegas Valley and potentially critical locations for an accident were not identified for this route.

6.2.2 Cost and Difficulty of Accident Cleanup

6.2.2.1 Property Values

It is not possible to identify a single potentially critical place for an accident along Spur 7 and its mainline connector from Utah. Data available indicate that the region around Caliente might be a potentially critical location. This would be along segments 7C.1 and 7D.1. These segments have the highest property values per route mile and would be the worst place, in terms of property value, for an accident to occur.

6.2.2.2 Land Use

At least 85% of the area through Segments 7C.1 and 7D.1 traverse could be classified as urban land. This is the region near Caliente. Urban land is likely to be affected more than other types of lands. Therefore, Segments 7C.1 and 7C.2 could be considered more potentially critical accident locations in terms of land use along the Caliente Spur or its mainline connector from Utah.

6.2.2.3 Difficult/Dangerous to Evacuate Locations

► School Enrollment

The enrollment in schools within each corridor width along Spur 7 and its mainline access route from Utah are presented in Appendix 6-A. It is interesting to note that all of the enrollment is along a single link (segment 7.1). This is in the vicinity of Caliente which could therefore be considered to be the potentially critical location for an accident to occur.

► Prison and Correctional Institution Occupancy

No prisons or correctional institutions are located within a 20 mile-wide corridor along Spur 7 or its mainline connector from Utah (Appendix 6-A).

► Hospital Beds

The total number of beds in hospitals located within each corridor width for Spur 7 and the mainline connector from Utah are presented in Appendix 6-A. All the hospital beds are concentrated along a single link in the vicinity of Caliente (segment 7.1) which could therefore be considered to be a potentially critical location for an accident to occur.

6.2.3 Environmental Impacts

6.2.3.1 Ecologically Sensitive Areas

Figures showing the ecologically sensitive areas within a 20 mile corridor for the Caliente Spur and its access route from Utah have been presented in Chapter 5.

National forests comprise a significant portion of the total area of ESAs within the 20 mile-wide corridor. The ecologically sensitive areas within the 20 mile corridor are highly dispersed. Therefore, it is difficult to identify one particular segment along the Caliente Spur which could potentially be most severely affected in the event of a transportation accident.

The Caliente Spur would also cut across a wilderness area where an antelope habitat is located. Another area is a habitat for desert tortoises, bighorn sheep, mule deer and to a lesser

extent, water fowl. Due to time constraints, data for these are not included in the analysis.

6.2.4 Impact on Accident Severity

6.2.4.1 Meteorological Conditions

The discussions presented in section 6.1.4.1 for the Jean spur and access routes apply for the Caliente Spur and access route also.

6.2.4.2 Infrastructure

The discussions presented in section 6.1.4.2 for the Jean spur and access routes apply for the Caliente Spur and access route also.

6.2.4.3 Hazardous Shipments/Inventories

► Hazardous Material Pipelines

No segments of the Caliente Spur or its mainline connector are close to (within 10 miles of) any hazardous material pipelines (Appendix 6-B).

► Hazardous Materials Shipments

A summary of the category and quantities (tons) of hazardous materials crossing the Caliente spur and its mainline connector are presented in Appendix 6-B. This information could be used to determine the potentially critical accident locations for these routes depending on the weights given to the category of the hazardous material being shipped.

The Nevada Commodity Report, (NDOT, 1988) showed that while the daily number of shipments of hazardous materials by trucks on segment 7.1 was zero, a total of 274.2 tons of these materials were transported by trucks on the same segment. This inconsistency in the data is to be noted.

6.3 Rail Route: Spur 8 (Carlin)

6.3.1 Potential Population Impacts

6.3.1.1 Resident Population

Elko, Carlin and Tonopah are the three most heavily populated areas along the Carlin Spur. Wendover and Wells are also populated and lie along the mainline connector from Utah. Tonopah appears to most proximate to the tentative alignment. Elko, however, has the highest population. Tonopah falls within Segment 8.6 and Elko, Segment 8.1. Each segment is approximately 6.0 miles long.

6.3.1.2 Non-Resident Population

A major portion of the Carlin Spur would cut across national forests. Non-resident populations (hunters, campers) would be concentrated in those areas.

While little data for non-resident population were available for the Carlin access route, the relative impact on the local areas should not be neglected. However, because of the limited scope of this study, emphasis was placed on the larger numbers of non-resident population found in the Las Vegas Valley and potentially critical locations for an accident were not identified for this route.

6.3.2 Cost and Difficulty of Accident Cleanup

6.3.2.1 Property Values

All segments of Spur 8 have the same property value per route mile. There is, therefore, no single potentially critical place for an accident to occur is identified. All segments would be affected equally.

6.3.2.2 Land Use

The Carlin Spur has no single critical accident location since all segments have 100% government/vacant codes. It is assumed that in the event of an accident, any segment would be equally affected.

6.3.2.3 Difficult/Dangerous to Evacuate Locations

► School Enrollment

The number of children attending schools within each corridor along Spur 8 and its mainline access route from Utah are presented in Appendix 6-A. Segment 8.1 is the only segment on Spur 8 that has any school enrollment and therefore is considered a potentially critical location for a rail accident. In the case of the access route from Utah, the enrollments within the each corridor inside the city limits of Wells, Wendover and Carlin are similar. These enrollments are significantly higher than those for segment 8.1. Thus, Wells, Wendover and Carlin could all be considered potentially critical places along the access route from Utah for rail accidents.

► Prison and Correctional Institution Occupancy

Segment 8.1 is the only potentially critical location for an accident along Spur 8 and its mainline access route from Utah in terms of prisons as difficult to evacuate locations. A prison with 150 inmates lies within the 20 mile corridor (Appendix 6-A). This segment could be considered a potentially critical location for an accident to occur on these routes.

► Hospital Occupancy

There are no hospitals within a 20 mile-wide corridor along Spur 8. The mainline connector from Utah has no hospital beds within a 1 mile-wide corridor, 50 hospital beds within a 2 mile-wide corridor (Appendix 6-A). This is within the city limits of Elko which could then be considered the potentially critical location for this route in terms of difficulty of evacuating hospitals.

6.3.3 Environmental Impacts

6.3.3.1 Ecologically Sensitive Areas

Figures showing the ecologically sensitive areas within a 20 mile corridor for the Carlin Spur and its access route from Utah have been presented in Chapter 5. Ecologically sensitive areas (ESA) have been analyzed only for the main alignment of the Carlin Spur. Its option (8A) has not been addressed as yet.

Two categories of ESAs fall within the 20 mile corridor. These are national forests and lakes. The Toiyabe National Forest comprises nearly all of the total covered ESA's (1,205 square miles). Approximately 132 miles of the Carlin Spur pass through this forest starting from the middle of Segment 8.4 to Segment 8.7. This stretch appears to be potentially critical as a large area of forest reserves would be affected in the event of a radioactive material transportation-related accident.

6.3.4 Impact on Accident Severity

6.3.4.1 Meteorological Conditions

The discussions presented in section 6.1.4.1 for the Jean spur and access routes apply for the Carlin Spur and access route also.

6.3.4.2 Infrastructure

The discussions presented in section 6.1.4.2 for the Jean spur and access routes apply for the Carlin Spur and access route also.

6.3.4.3 Hazardous Shipments/Inventories

► Hazardous Material Pipelines

No high pressure gas pipelines are located within the 0.5, 1, 2, and 6 mile corridors of the Carlin spur (Appendix 6-B). A potentially critical location along the Carlin Spur for the 10 mile corridor is segment 8.1 which has 6.35 miles of high-pressure natural gas pipeline lying within the corridor. A potentially critical location for the 20 mile corridor is segment 8A.1, with 0.10 miles located within 10 miles of a gas pipeline.

The access route from Utah has pipelines within a 6 mile-wide corridor as shown in Appendix 6-B.

► **Hazardous Materials Shipments**

A summary of the category and quantities (tons) of hazardous materials crossing the Carlin spur and its mainline connector are presented in Appendix 6-B. Segments 8.5, 8.8, and 8.9 are the three segments of the Carlin spur with the greatest total quantities of hazardous materials shipped across them. All the segments of the mainline connector to the Carlin spur, except segment CRLN.4, have significant amounts of hazardous materials crossing them. Segment CRLN.5 has over 100 tons, and segments CRLN.1, CRLN.2, and CRLN.3T have over 1000 tons crossing them daily. The determination of potentially critical locations for accidents could be made using this information. It would depend on the relative weights given to the individual categories of the materials.

6.4 Summary Comparison of Rail Access Routes 3, 7, and 8

This section provides comparisons between the three rail spurs and the four alternative rail access routes (spurs plus mainline connectors) on potentially critical accident locations. The comparisons are presented in a tabular form in the following pages.

Table 6-1

Summary of Potentially Critical Rail Accident Locations
Based on Rail Link Characteristics

ROUTE	SPUR 3	SPUR 7	SPUR 8	SPUR 3 & MAINLINE FROM CALIFORNIA	SPUR 7 & MAINLINE	SPUR 8 & MAINLINE
PIPELINES CROSSING ROUTE	intersection of UP mainline and Spur 3 (east of Jean)	none identified	none identified	intersection of UP mainline and Spur 3 (east of Jean)	none identified	none identified
HAZMAT TRUCKS PER DAY CROSSING ROUTE	117 trucks cross on I-15, 0.5 miles from junction of UP mainline and Spur 3, near Jean	none identified	22 trucks cross on US-6, 13 miles east of Tonopah	117 trucks cross on I-15, 0.5 miles from junction of UP mainline and Spur 3, near Jean	none identified	58 trucks cross on I-80, in Wells
HAZMAT TRUCK-TONS PER DAY CROSSING ROUTE	1,926 tons cross on I-15, 0.5 miles from junction of UP mainline and Spur 3, near Jean	none identified	486 tons cross on US-6, 13 miles east of Tonopah	1,926 tons cross on I-15, 0.5 miles from junction of UP mainline and Spur 3, near Jean	none identified	1,385 tons cross on I-80, in Wells

Table 6-2

**Summary of Potentially Critical Rail Accident Locations
Based on Characteristics of 0.5 Mile-wide Corridor**

ROUTE	SPUR 3	SPUR 7	SPUR 8	SPUR 3 & MAINLINE FROM CALIFORNIA	SPUR 7 & MAINLINE	SPUR 8 & MAINLINE
HOSPITAL BEDS	none identified	none identified	none identified	none identified	none identified	none identified
SCHOOL ENROLLMENT	none identified	none identified	none identified	none identified	none identified	864 students near junction of UP mainline and 12th street in Elko
PRISON INMATES	none identified	none identified	none identified	none identified	none identified	none identified
MILES OF HIGH-PRESSURE NATURAL GAS PIPELINE IN CORRIDOR	0.3 miles of pipe from junction of UP mainline and Spur 3 to 0.5 miles from junction, near Jean	none identified	none identified	0.3 miles of pipe from junction of UP mainline and Spur 3 to 0.5 miles from junction, near Jean	none identified	none identified

Table 6-3

**Summary of Potentially Critical Rail Accident Locations
Based on Characteristics of 1 Mile-wide Corridor**

ROUTE	SPUR 3	SPUR 7	SPUR 8	SPUR 3 & MAINLINE FROM CALIFORNIA	SPUR 7 & MAINLINE	SPUR 8 & MAINLINE
HOSPITAL BEDS	none identified	none identified	none identified	none identified	none identified	none identified
SCHOOL ENROLLMENT	none identified	none identified	none identified	none identified	none identified	864 students near junction of UP mainline and 12th street in Elko
PRISON INMATES	none identified	none identified	none identified	none identified	none identified	none identified
MILES OF HIGH-PRESSURE NATURAL GAS PIPELINE IN CORRIDOR	0.5 miles of pipe from junction of UP mainline and Spur 3 to 0.5 miles from junction, near Jean	none identified	none identified	0.5 miles of pipe from junction of UP mainline and Spur 3 to 0.5 miles from junction, near Jean	none identified	none identified

Table 6-4

**Summary of Potentially Critical Rail Accident Locations
Based on Characteristics of 2 Mile-wide Corridor**

ROUTE	SPUR 3	SPUR 7	SPUR 8	SPUR 3 & MAINLINE FROM CALIFORNIA	SPUR 7 & MAINLINE	SPUR 8 & MAINLINE
HOSPITAL BEDS	none identified	none identified	none identified	none identified	none identified	50 beds, junction of UP mainline and 12th street in Elko
SCHOOL ENROLLMENT	none identified	none identified	none identified	none identified	none identified	3,537 students near junction of UP mainline and 12th street in Elko
PRISON INMATES	631 inmates from junction of UP mainline and Spur 3 to 0.5 miles from junction, near Jean	none identified	none identified	631 inmates from junction of UP mainline and Spur 3 to 0.5 miles west of junction, near Jean	none identified	none identified
MILES OF HIGH-PRESSURE NATURAL GAS PIPELINE IN CORRIDOR	0.5 miles of pipe from junction of UP mainline and Spur 3 to 0.5 miles from junction, near Jean	none identified	none identified	0.5 miles of pipe from junction of UP mainline and Spur 3 to 0.5 miles from junction, near Jean	none identified	none identified
PROPERTY VALUE	\$33,031,440 from junction of UP mainline and Spur 3 to 0.5 miles from junction, near Jean	none identified	none identified	\$33,031,440 from junction of UP mainline and Spur 3 to 0.5 miles from junction, near Jean	none identified	\$17,290,902 from junction of UP mainline and 12th Street in Elko to 0.5 miles south of junction

Table 6-5

**Summary of Potentially Critical Rail Accident Locations
Based on Characteristics of 6 Mile-wide Corridor**

ROUTE	SPUR 3	SPUR 7	SPUR 8	SPUR 3 & MAINLINE FROM CALIFORNIA	SPUR 7 & MAINLINE	SPUR 8 & MAINLINE
HOSPITAL BEDS	none identified	12 beds, from junction of UP mainline and Spur 7 to 1 mile west of junction, in Caliente	none identified	none identified	12 beds, from junction of UP mainline and Spur 7 to 1 mile west of junction, in Caliente	50 beds, junction of UP mainline and 12th street in Elko
SCHOOL ENROLLMENT	none identified	102 students, from junction of UP mainline and Spur 7 to 1 mile west of junction, in Caliente	none identified	none identified	102 students, from junction of UP mainline and Spur 7 to 1 mile west of junction, in Caliente	3,537 students near junction of UP mainline and 12th street in Elko
PRISON INMATES	631 inmates from junction of UP mainline and Spur 3 to 0.5 miles from junction, near Jean	none identified	none identified	631 inmates from junction of UP mainline and Spur 3 to 0.5 miles west of junction, near Jean	none identified	none identified
MILES OF HIGH-PRESSURE NATURAL GAS PIPELINE IN CORRIDOR	0.5 miles of pipe from junction of UP mainline and Spur 3 to 0.5 miles from junction, near Jean	none identified	none identified	0.5 miles of pipe from junction of UP mainline and Spur 3 to 0.5 miles from junction, near Jean	none identified	16.4 miles of pipe along UP mainline from 4 miles SW of Elko to 20.4 miles SW of Elko

Table 6-6

**Summary of Potentially Critical Rail Accident Locations
Based on Characteristics of 10 Mile-wide Corridor**

ROUTE	SPUR 3	SPUR 7	SPUR 8	SPUR 3 & MAINLINE FROM CALIFORNIA	SPUR 7 & MAINLINE	SPUR 8 & MAINLINE
HOSPITAL BEDS	none identified	12 beds, from junction of UP mainline and Spur 7 to 1 mile west of junction, in Caliente	none identified	none identified	12 beds, from junction of UP mainline and Spur 7 to 1 mile west of junction, in Caliente	50 beds, junction of UP mainline and 12th street in Elko
SCHOOL ENROLLMENT	none identified	177 students, from junction of UP mainline and Spur 7 to 1 mile west of junction, in Caliente	none identified	none identified	177 students, from junction of UP mainline and Spur 7 to 1 mile west of junction, in Caliente	3,537 students near junction of UP mainline and 12th street in Elko
PRISON INMATES	631 inmates from junction of UP mainline and Spur 3 to 0.5 miles from junction, near Jean	none identified	none identified	631 inmates from junction of UP mainline and Spur 3 to 0.5 miles west of junction, near Jean	none identified	none identified
MILES OF HIGH-PRESSURE NATURAL GAS PIPELINE IN CORRIDOR	0.5 miles of pipe from junction of UP mainline and Spur 3 to 0.5 miles from junction, near Jean	none identified	2.1 miles of pipe from junction of UP mainline and Spur 8 to 2.1 miles from junction, near Carlin	0.5 miles of pipe from junction of UP mainline and Spur 3 to 0.5 miles from junction, near Jean	none identified	16.4 miles of pipe along UP mainline from 4 miles SW of Elko to 20.4 miles SW of Elko

Table 6-7

**Summary of Potentially Critical Rail Accident Locations
Based on Characteristics of 20 Mile-wide Corridor**

ROUTE	SPUR 3	SPUR 7	SPUR 8	SPUR 3 & MAINLINE FROM CALIFORNIA	SPUR 7 & MAINLINE	SPUR 8 & MAINLINE
HOSPITAL BEDS	none identified	12 beds, from junction of UP mainline and Spur 7 to 1 mile west of junction, in Caliente	none identified	none identified	12 beds, from junction of UP mainline and Spur 7 to 1 mile west of junction, in Caliente	50 beds, junction of UP mainline and 12th street in Elko
SCHOOL ENROLLMENT	none identified	248 students, from junction of UP mainline and Spur 7 to 1 mile west of junction, in Caliente	none identified	none identified	248 students, from junction of UP mainline and Spur 7 to 1 mile west of junction, in Caliente	3,537 students near junction of UP mainline and 12th street in Elko
PRISON INMATES	631 inmates from junction of UP mainline and Spur 3 to 0.5 miles from junction, near Jean	none identified	150 inmates from junction of UP mainline and Spur 8 to 0.5 miles south of junction	631 inmates from junction of UP mainline and Spur 3 to 0.5 miles west of junction, near Jean	none identified	150 inmates, 5 miles along UP mainline near Carlin
MILES OF HIGH-PRESSURE NATURAL GAS PIPELINE IN CORRIDOR	0.5 miles of pipe from junction of UP mainline and Spur 3 to 0.5 miles from junction, near Jean	none identified	2.1 miles of pipe from junction of UP mainline and Spur 8 to 2.1 miles from junction, near Carlin	0.5 miles of pipe from junction of UP mainline and Spur 3 to 0.5 miles from junction, near Jean	none identified	16.4 miles of pipe along UP mainline from 4 miles SW of Elko to 20.4 miles SW of Elko

7 Extensions

This work has allowed TRC investigators to develop a preliminary data base for future impact studies and GIS-based data management and analytic techniques. Use of three to five probability data categories and eight consequence data categories to characterize highway routes and rail access corridors has permitted preliminary analysis of such routes. This beginning effort has provided a solid basis upon which to develop future studies in this area. Comments on the preliminary draft report from NWPO staff and other interested persons have proved valuable in enhancing the present work and in providing direction for related studies in the near and long terms.

It has been stated previously that important probability measures were not developed in this study. These include measures such as dispersion, magnitude, areal coverage, speed, and timing of release; probability of exposure; probability of exposure effects and, type and severity of accident. Further, consequence measures such as institutional and social impacts due to perception of risks/human factors were not investigated.

In addition, it was beyond the scope of this preliminary study to consider six characterization measures thought to have a potential influence on the results of the three types of analysis. These include emergency response capability and safe havens; measures of impact on tourism, business and migration; human and organizational factors such as governmental/industry control and shipment/vehicle/driver characteristics; legislation, policies and regulation, and availability of alternative routes.

It is understood by the investigators that perceived risk of nuclear waste transportation is important in the development of a comprehensive risk assessment model and must be considered by decision makers. TRC staff has begun background work in the inclusion of perceived risk in its analytic models and studies in this area are being conducted under the auspices of the State of Nevada. This will be incorporated in future TRC risk modeling efforts.

Several of the databases developed in this study need to be updated or modified per suggestions of reviewers of the draft report. Among these are the inclusion of the Ash Meadows and adjacent wetlands and the new boundaries of the Toiyabe National Forest in the Ecologically Sensitive Areas category.

Several improved methodologies for data collection, estimation, and presentation will be incorporated in the 1991 work. These are discussed briefly below.

Estimates of rural county population density may be improved by distributing population over only private lands. For purposes of this investigation, population outside of rural towns and cities was distributed evenly along all improved county roads. This resulted in a degree of error which would be unacceptable in

a final characterization study which may be used in decision making.

The "Difficult/Dangerous to Evacuate" category should be expanded to include communities with only one transportation access route. These include mining or farming populations that can only be reached by one road (air evacuation may be required in the event of an incident).

The effects of directionality on accident rates needs to be considered. Direction of accident can be obtained from the NDOT accident database. However, traffic volumes are not reported by direction, and no directional accident rates were calculated in this study. By assuming a directional distribution of traffic, a reasonable estimate of directional accident rates can be obtained in future work.

Data for population in unincorporated towns in rural counties needs to be improved. These data exist, although they may not be "computerized" as they are in Clark and Washoe counties. However, this is a manageable amount of data which could be obtained in future work.

Property value and land use estimation will be greatly improved and automated during 1991 fiscal year efforts. Two elements of this effort will be to implement computer address matching capabilities (GIS based) and to obtain site specific data for the rural counties (where tax assessor information is not computerized). The information for these counties, while not automated, should be attainable due to the far smaller number of parcels in these counties. The success of this effort will, however, depend on the cooperation and resource capabilities of rural county agencies.

Non-resident population estimation for the rural counties can be improved by obtaining park and forest visitor volumes. While small in numbers relative to Las Vegas visitor populations, these populations are important to rural economies and ways of life.

Much of the rail characterization presented in this report is general due to the lack of specific alignments. Given the exact alignments, future work could include details on construction and operating parameters such as grade, cut and fill, maintenance costs, geometrics, infrastructure characteristics and cost, etc. Precise alignments could also alter the characterization of off-system impacts (affected populations, ecologically sensitive areas, etc.) Information on current operating characteristics of existing mainline track could also be supplemented in future studies.

In addition to augmenting the body of work contained herein, TRC staff will proceed with work which will enhance the state's capability to monitor DOE's transportation initiatives and carry out independent risk and impact studies. For example,

investigation and use of the RADTRAN risk assessment model will allow the input of probability and severity measures into the present analytic framework. Further, results of the study of rail construction issues and additional rail access corridors will strengthen the developing TRC data base.

To the extent possible, 1991 work for NWPO will include the study of such institutional factors as emergency response capabilities along specified routes, human and organizational factors which may affect governmental decision-making in route selection and legislation and regulation.

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