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SUMMARY AND CONCLUSIONS OF THE NNWSI AREA-TO-LOCATION SCREENING ACTIVITY

Nevada Nuclear Waste Storage Investigations

Site Evaluation Working Group

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EXECUTIVE SUMMARY

Chapter 1: A comprehensive system study has been performed to screen the Nevada Research and Development Area (NRDA) of the Nevada Test Site (NTS) and nearby areas for relatively favorable locations of about ten square miles for the permanent disposal of radioactive waste in a mined repository. The purpose of this screening is to use available information to identify such locations. The results of this screening will allow more informed decisions as to where future repository exploration can be concentrated to optimize the chances that the locations chosen for characterization will actually qualify as a licensed repository site.

The screening was conducted in a manner compatible with the general repository siting strategy of the DOE National Waste Terminal Storage Program (NWTS). The systems analysis was performed by the Technical Overview Contractor (TOC) of Sandia National Laboratories (SNL) for the Site Evaluation Working Group (SEWG) of the Nevada Nuclear Waste Storage Investigations (NNWSI). Data for the study were provided by SNL, Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL) and the U.S. Geological Survey (USGS).

Chapter 2: The study compares the relative favorability of various locations and host rocks. This is done by assessing how well 23 geographical attributes and eight host-rock attributes satisfy 40 weighted performance objectives for ideal repository locations.

The 23 geographical attributes discriminate among various locations in the screening area independent of host-rock properties. The eight host-rock attributes discriminate among nine candidate rock types, independent of site-specific rock properties.

The 40 performance objectives form the lower-level of a three-tiered, hierarchical tree. This objectives tree relates criteria for specific repository locations to broad, national goals of safe, cost-effective, and environmentally sound management of radioactive waste. Twelve middle-level objectives logically connect the site-specific lower-level objectives to the broad national goals. The goals are represented by four separate upper-level objectives of the tree. A weight is assigned to each objective at each level of the tree to account for priorities among and within different levels.

The relative favorability of each discriminating attribute is quantified on a scale of zero to ten with respect to each pertinent lower-level objective. These relations among attributes and objectives are expressed as favorability graphs, which constitute the quantitative screening criteria.

The objectives, attributes, favorability graphs, and a base map of the screening area were digitized on an APPLICON Graphics System. Software was developed to calculate from the digital input the relative favorability, normalized to a maximum rating of 100,000, for each of 1,514 half-mile centered grid cells of the base map and for each of nine site-independent rock types.

Chapter 3: Results of the calculations are displayed as maps of location ratings and lists of host-rock ratings. The results show (1) six individual analyses based on the entire array of objectives and attributes (overall results) and (2) nineteen separate analyses of restricted subsets of either objectives or attributes. Location ratings are displayed at two significant digits on maps which show three categories of relative favorability: high; intermediate; and low. Host-rock lists show separate ratings to two significant digits for saturated and unsaturated conditions. The difference between saturated and unsaturated host-rock ratings is based on the assumption that one of the host-rock attributes, hydraulic transmissivity, is unimportant in the unsaturated zone.

Chapter 4: Fifteen alternative locations were identified based on groupings of similarly rated grid cells of the base map. These locations are ranked according to their weighted ratings with respect to separate analyses. Analogous rankings are provided for both saturated and unsaturated host rocks.

Of the 15 locations, northern Yucca Mountain ranks highest, primarily due to favorable ratings for long-term safety. Northern Yucca Mountain rates high for independent components of long-term safety including containment, isolation, avoidance of disruptive events, tectonic attributes, and human disturbance attributes. When host-rock attributes are combined with geographical attributes, northern Yucca Mountain becomes the highest rated location due to the ratings of the Calico Hills Tuff. This rock type is the third highest rated saturated rock and fourth highest unsaturated rock. Other potentially usable host rocks at this location are the unsaturated Topopah Spring Tuff, which ranks second for unsaturated rocks, and saturated Crater Flat Tuff, which ranks fourth for saturated rocks. Potential drawbacks at northern Yucca Mountain are indicated by relatively low ratings for near-term objectives including low-cost construction of surface facilities and environmental impacts of construction and operations.

Northeastern Jackass Flats rates highest of the 15 locations for host-rock independent attributes. However, this location is not underlain by any of the host rocks evaluated in this screening. As a result, relatively low ratings occur when host-rock attributes are considered. High ratings for geographical attributes at northeastern Jackass Flats are primarily a result of favorable environmental, surface terrain and hydrologic attributes. These, in turn, contribute to high ratings for isolation, natural processes which enhance containment and isolation, environmental impacts, and low-cost construction of surface facilities. However, less favorable tectonic attributes detract somewhat from ratings for long-term safety, resulting in lower ratings than northern Yucca Mountain for this set of objectives. Overall geographical ratings for northeastern Jackass Flats are generally the same as or somewhat higher than for northern Yucca Mountain. The former location is generally rated better for near-term concerns and hydrology while the latter is rated better for long-term safety and tectonics.

A third location, Calico Hills-Upper Topopah Wash, also stands out as a relatively favorable alternative. In direct contrast to northeastern Jackass Flats, this location rates low for host-rock independent attributes and high when host-rock attributes are included. Argillite and perhaps granite occur beneath the Calico Hills-Upper Topopah Wash location, though the granite, if it occurs, may be too deep to be used for a repository. These rock types are the first and second rated rock types, respectively, for both saturated and unsaturated conditions. The ratings of argillite account for the high combined ratings of geographical and host-rock attributes at this location. Hydrologic attributes at Calico Hills-Upper Topopah Wash rate very high, whereas tectonic, surface terrain, and human disturbance attributes generally rate low. These attributes are generally responsible for high ratings for isolation and natural processes but for somewhat unfavorable ratings for disruptive events, containment, and near-term concerns, including construction of both surface and underground facilities.

The remainder of the 15 locations compared in this study rate somewhat to significantly lower than the three locations discussed above. Thus, the results of this screening indicate that three locations in the screening area are most likely to qualify as licensed repository sites. These locations, in order, are: northern Yucca Mountain; northeastern Jackass Flats; and Calico Hills-Upper Topopah Wash. Because northeastern Jackass Flats has no relatively homogeneous rock type beneath it, its viability as a prime candidate location is questionable. Calico Hills-Upper Topopah Wash, though underlain by the highest rated rock type, argillite, exhibits potential obstacles to site qualification due to the potential for tectonic disturbance or inadvertent human intrusion. Therefore, northern Yucca Mountain emerges as the location within the screening area which, based on the assumptions of this screening, offers the fewest obstacles to site qualification.

Three rock types at this location rate highly enough to rule out any obviously disqualifying factors for their use as repository hosts. These rock types are the saturated or unsaturated Calico Hills Tuff, the unsaturated Topopah Spring Tuff, and the saturated Crater Flat Tuff. However, some cost penalties for construction or surface facilities may be incurred at northern Yucca Mountain due to generally rugged terrain.

The results discussed in this Executive Summary and in more detail in the body of this report provide evaluations only of the relative merits of alternative locations and host rocks. The demonstration of either suitability or unsuitability for any of the locations in the screening area is not possible at this time. Regulatory criteria for site acceptability must first be available. Then, anticipating the general tenor of these criteria, more site-specific data than now available are required to allow quantitative predictions of expected short and long-term environmental and health impacts of repository development. Therefore, based on this screening, it is not possible to determine if any, all, or none of the locations in the screening area are acceptable as repository sites.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1. INTRODUCTION

Purpose

The purpose of this report is twofold: (1) to summarize the results of the area-to-location screening activity for the Nevada Nuclear Waste Storage Investigations (NNWSI); and (2) to conclude which locations in the Nevada Test Site (NTS) screening area are rated the most favorable for further investigation of their suitability for siting a mined geologic repository to permanently dispose of radioactive waste. The conclusions are based on the results of a quantitative systems study of the relations among (1) objectives for repository performance; (2) known and inferred physical characteristics in the screening area; and (3) the relative favorability of these characteristics with respect to satisfying repository performance objectives. The results of the systems study are analytical and convey relative favorability for repository siting at various locations in the screening area.

Because the results only assess relative favorability, no definitive conclusions can be drawn from this study about whether the most favorable locations are indeed suitable for repositories. In the same manner, nothing in this study indicates that the least favorable locations are unsuitable for repositories. Such assessments of absolute suitability require performance criteria from the Nuclear Regulatory Commission (NRC) and detailed, site-specific data for a particular location, neither of which are available at this time. Therefore, the purpose of this screening is to use the limited information about natural systems at the NTS available as of the summer of 1981 to identify in a logical way those locations which have the highest potential for eventually proving suitable for a repository.

Many assumptions were quantified during this study, and the validity of the results and conclusions clearly depends on the reasonableness of these assumptions. Each assumption or set of assumptions is traceable to its effects on the results and conclusions. To help limit errors due to invalid assumptions, mathematical and interpretive variations about the assumptions were investigated in a quantitative manner. Analysis of these variations provided the basis for evaluating the sensitivity of the results and conclusions to changes in the underlying assumptions.

Definition of the NNWSI Screening Area

The area considered by the NNWSI for repository exploration on the NTS is restricted to the Nevada Research and Development Area (NRDA) to avoid potential interference with the Department of Energy's (DOE) prime mission at the NTS, namely nuclear weapons testing [1]. Accordingly, formal boundaries for the NNWSI screening area are defined as follows:

"(a) on the NTS to the NRDA, and
(b) contiguous to the NRDA (to) the areas defined by extension of the northern border of the NRDA west to the western edge of the Topopah Spring Northwest 7-1/2 minute topographic quadrangle, and south to the southwest corner of the Lathrop Wells 7-1/2 minute topographic quadrangle, then east to the point where the southward extension of the eastern boundary of the NRDA meets the southern edge of the Specter Range 7-1/2 minute topographic quadrangle [2]."

This area is shown in Figure 1. It consists of about 380 square miles on and immediately adjacent to the southwest portion of the NTS.

Relation of NNWSI Screening to National Efforts

Relation to National Waste Terminal Storage Program

The NNWSI screening activity supports the general siting strategy of DOE's National Waste Terminal Storage Program (NWTS) for selecting one or more repository sites in the conterminous United States for disposal of heat-generating radioactive waste produced by the commercial sector [3]. This siting strategy calls for focusing attention on successively smaller parcels of land as more information becomes available from continuing exploration and characterization activities. For convenience, land units of successively smaller size are classified, respectively, as regions, areas, locations, and sites. Regions are generally considered to be tens of thousands of square miles or larger; areas about 1,000 square miles; locations about 10 square miles; and sites a few square miles, or as large as required for an underground radioactive waste repository [3].

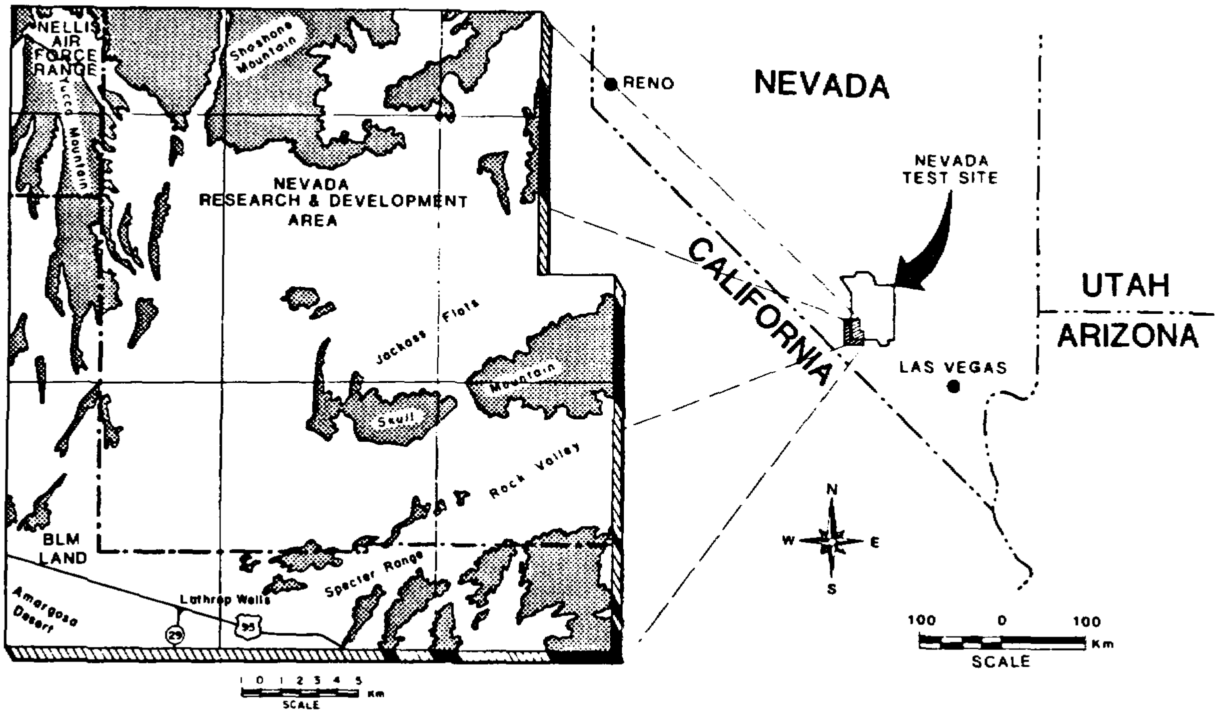

Figure 1. NNWSI Area-to-Location Screening Area

Before formal adoption of the current NWTS siting strategy, the DOE decided to evaluate the feasibility of disposing of commercial radioactive waste within the boundaries of its own land reservations. When the formal strategy was adopted, the NTS was classified as an area [3,4]. In this context, the first formal screening step at the NTS involved the identification of an area of sufficient size on and contiguous to the NTS to be designated as the NNSWI screening area. The screening area as defined in the previous section most closely approximates the size of "areas" in the NWTS siting strategy. The results of the screening activity thus represent location screening within the designated area in accordance with the requirements of the DOE stepwise approach to repository site selection.

Relation to Anticipated Regulatory Requirements

Because repository siting and development depends on receiving a license to operate a radioactive waste disposal facility from the NRC, the screening was conducted in a manner compatible with anticipated NRC requirements for repository site-selection procedures. Appropriate parts of this report will be summarized in Part A of the NNWSI Site Characterization Report [3,5] to be submitted to the NRC in 1983.

It should be noted that the screening method does not quantify predictions of radioactive releases from a repository or corresponding radiogenic health effects. It does, however, identify locations where such consequences are expected to be lower than others. In this way, the screening is compatible with attempts to find locations which will meet regulatory health standards expected from the U.S. Environmental Protection Agency (EPA).

Organization of NNWSI Screening Activity

A formal organization was established by the NNWSI in late 1979 and early 1980 for overseeing, coordination, and performing area-to-location screening at the NTS [6,7,8]. This organization is composed of a Site Evaluation Steering Committee (SESC), a Site Evaluation Working Group (SEWG), and the NNWSI Technical Overview Contractor (TOC) (Figure 2).

The Steering Committee is chaired by the NNSWI Project Manager and is composed of federal employees from DOE's Nevada Operations Office (DOE/NV) and the U.S. Geological Survey. It is responsible for recommending repository siting options at the NTS to the Manager, DOE/NV. During development of the screening method, the Steering Committee periodically reviewed progress and provided overall programmatic guidance.

The Working Group is chaired by a staff member of the NNWSI project office at DOE/NV and is composed of at least one representative from Sandia National Laboratories (SNL), Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL), and the U.S. Geological Survey (USGS). The Working Group was responsible for closely monitoring technical aspects of the screening activity and forwarding the results and conclusions of the screening to the Steering Committee.

The NNWSI Technical Overview Contractor (TOC) of SNL was charged by the Working Group with developing, coordinating, and implementing the screening method. Geotechnical data were provided to the TOC by staff members of SNL, LANL, LLNL, and the USGS. Ecological and other environmental data were provided by a cadre of contractors from Nevada, including EG&G, Reynolds Electrical and Engineering Co., Inc. (REECO), University of

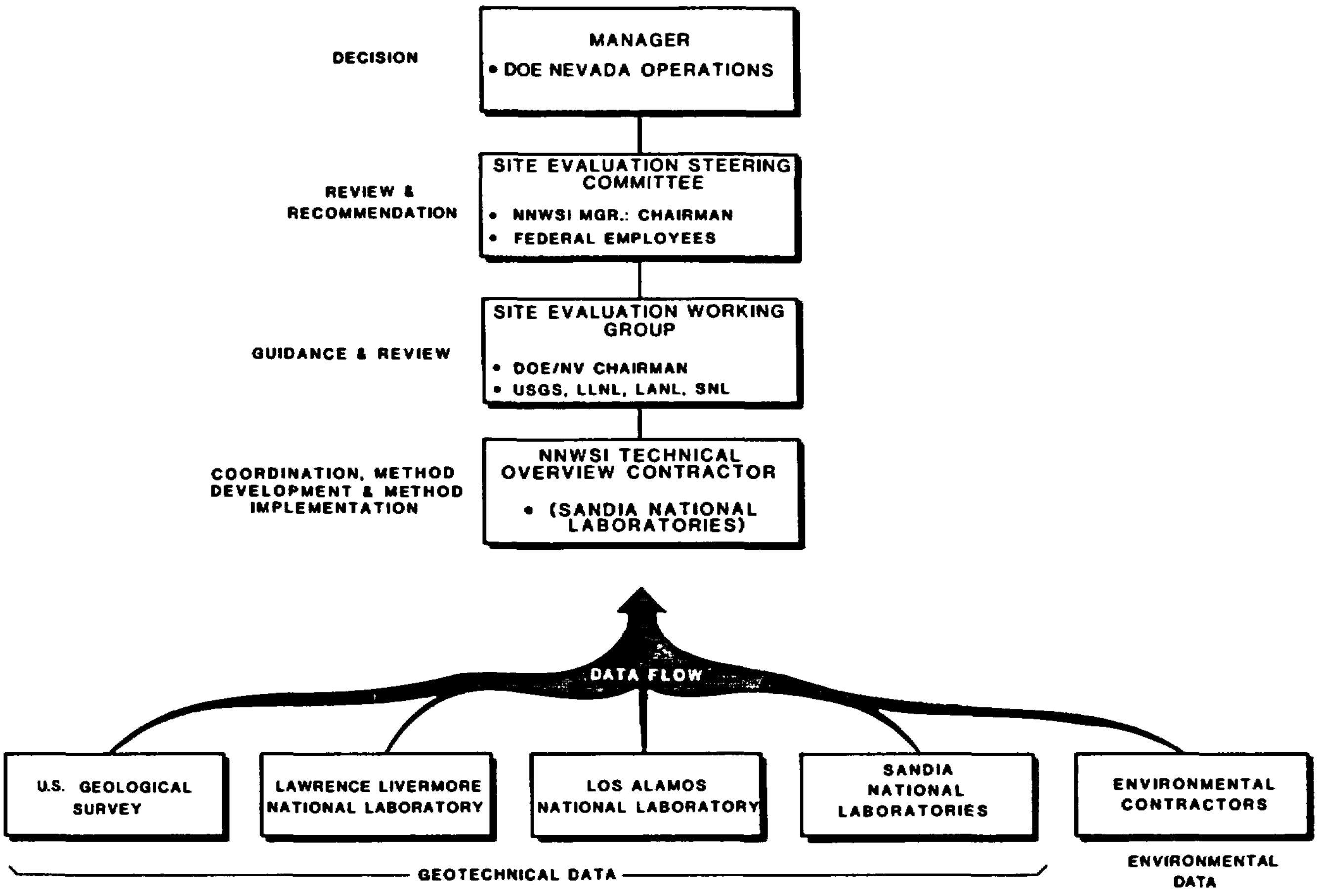

Figure 2. Organization Chart of the NNWSI Screening Activity

Nevada-Las Vegas (UNLV), Desert Research Institute (DRI), and the EPA. Consultants, primarily from Los Alamos Technical Associates (LATA), were obtained as required to augment technical input to screening and to assist the TOC in designing, implementing, and documenting the screening method. Table 1 lists representatives and their organizational affiliations for the Steering Committee, Working Group, and TOC.

SITE EVALUATION STEERING COMMITTEE

R. M. Nelson	DOE/NV, Chairman	(Late 1979 to January 1982)
M. P. Kunich	DOE/NV, Acting Chairman	(January 1982 to present)
P. J. Mudra	DOE/NV	(1979 to present)
B. W. Church	DOE/NV	(1979 to present)
J. R. Boland	DOE/NV (Represent Church)	(January 1981 to present)
J. R. Gilpin	DOE/NV	(1979 to present)
J.O. Cummings	DOE/NV	(1979 to present)
E. M. Douthett	DOE/NV	(1979 to January 1981)
C. E. Revell	DOE/NV	(January 1981 to present)
W. S. Twenhofel	USGS	(1979 to January 1981)
G. L. Dixon	USGS	(Acting, January 1981 to present)

SITE EVALUATION WORKING GROUP

H. L. Melancon	DOE/NV, Chairman	(January 1980 to present)
R. C. Carlson	LLNL	(January 1980 to present)
H. P. Stephens	SNL	(January 1980 to November 1980)
S. Sinnock	SNL	(November 1980 to present)
J. K. Johnstone	SNL	(January 1980 to November 1980)
A. R. Lappin	SNL	(November 1980 to present)
R. C. Gooley	LANL	(January 1980 to November 1980)
J. D. Purson	LANL	(November 1980 to present)
G. L. Dixon	USGS	(Acting, January 1980 to March 1980)
H. W. Smedes	USGS	(March 1980 to October 1980)
F. Maldonado	USGS	(October 1980 to present)
J. J. Lorenz	REECo, Secretary	(January 1980 to present)

TECHNICAL OVERVIEW CONTRACTOR (SNL)

Participants in NNWSI Screening

H. P. Stephens (SNL)	(January 1980 to November 1980)
S. Sinnock (SNL)	(November 1980 to present)
J. A. Fernandez (SNL)	(July 1980 to January 1982)
M. W. Sharp (SNL)	(September 1980 to present)
B. L. Hartway (LATA)	(November 1980 to present)

Table 1. Representatives on NNWSI Area-to-Location Screening Organizations

Organization of NNWSI Screening Documents

Organization of This Report

This report has four chapters. Chapter 1 provides background information regarding the NNWSI screening activity and its relationship to the national program. Chapter 2 describes the systems method used for quantitative evaluation of various locations and rock types in the screening area. It includes definitions of specific screening parameters and descriptions of the mathematical equations for calculating ratings for various locations and host rocks. Chapter 3 presents selected results of the numerical analyses. It shows and describes maps of location ratings and lists of saturated and unsaturated host-rock ratings. Chapter 4 summarizes the results and presents conclusions about which locations and rock types are most favorable.

Appendices A through C contain supporting information for the discussions in the text.

Relation of This Report to Other Screening Documents

This report is one of five documents which describe the NNWSI screening activity. Each document details a separate part of the activity. "A Method for Screening the Nevada Test Site and Contiguous Areas for Nuclear Waste Repository Locations" was published previously [9] and provides a general description of the screening method, but it contains no specific data about the NTS. Its purpose was to document the proposed method prior to its implementation.

Three companion documents [10,11,12] to this report are being prepared to provide detailed background material about, respectively, (1) performance objectives for repository locations; (2) physical characteristics of the screening area and associated quantitative criteria; and (3) software for rating alternative locations.

CHAPTER 2. SCREENING METHOD

Screening Method Elements and Parameters

The method used for the NNWSI area-to-location screening consists of four basic elements: (1) weighted hierarchical performance objectives for ideal repository locations; (2) physical attributes which discriminate among locations or rock types in the screening area; (3) relative favorability graphs which rate physical attributes with respect to objectives; and (4) mathematical equations, expressed as computer algorithms, which calculate ratings for alternative locations and host rocks. The first three elements are defined by a set of parameters amenable for use in equations of the fourth element.

NNWSI Performance Objectives for Repository Locations

Criteria for ideal repository locations have been expressed previously (e.g., [13-19]). These criteria were organized for screening by the TOC into a hierarchical format, herafter called the objectives tree. This tree ties independent desires for specific physical characteristics of individual repository locations to the overall national goal of long-term safety, cost-effectiveness, and environmental soundness for the disposal of radioactive waste. Hierarchically organizing the objectives clarifies the logical relations between the previously unstructured site-selection criteria and the overall national program goals (Figure 3, Table 2). Each objective in the tree is assigned a designator number shown on the figure and table.

The overall national goal is divided into the four major objectives which form the upper-level of the objectives tree. The goal for long-term safety is addressed by two separate upper-level objectives, containment (objective 1.0) and isolation (objective 2.0). Cost-effective repository facilities are addressed by an operational or short-term objective (objective 3.0). Near-term environmental concerns are addressed by objective 4.0. Though containment and isolation objectives are considered separately from environmental objectives, it is recognized that both containment and isolation strictly address long-term environmental concerns. The upper-level objectives of the NNWSI objectives tree correspond to the first four of seven NWTS repository performance objectives [4]. The other three NWTS performance objectives are conservatism of approach, use of current technology, and independence of waste disposal concepts from specific fuel cycle options. These three objectives do not discriminate among alternative locations and, therefore, could not be used in area-to-location screening.

Each upper-level objective of the tree is addressed by a set of middle-level objectives. The resulting tree is thereby divided into four major branches, each characterized by a set

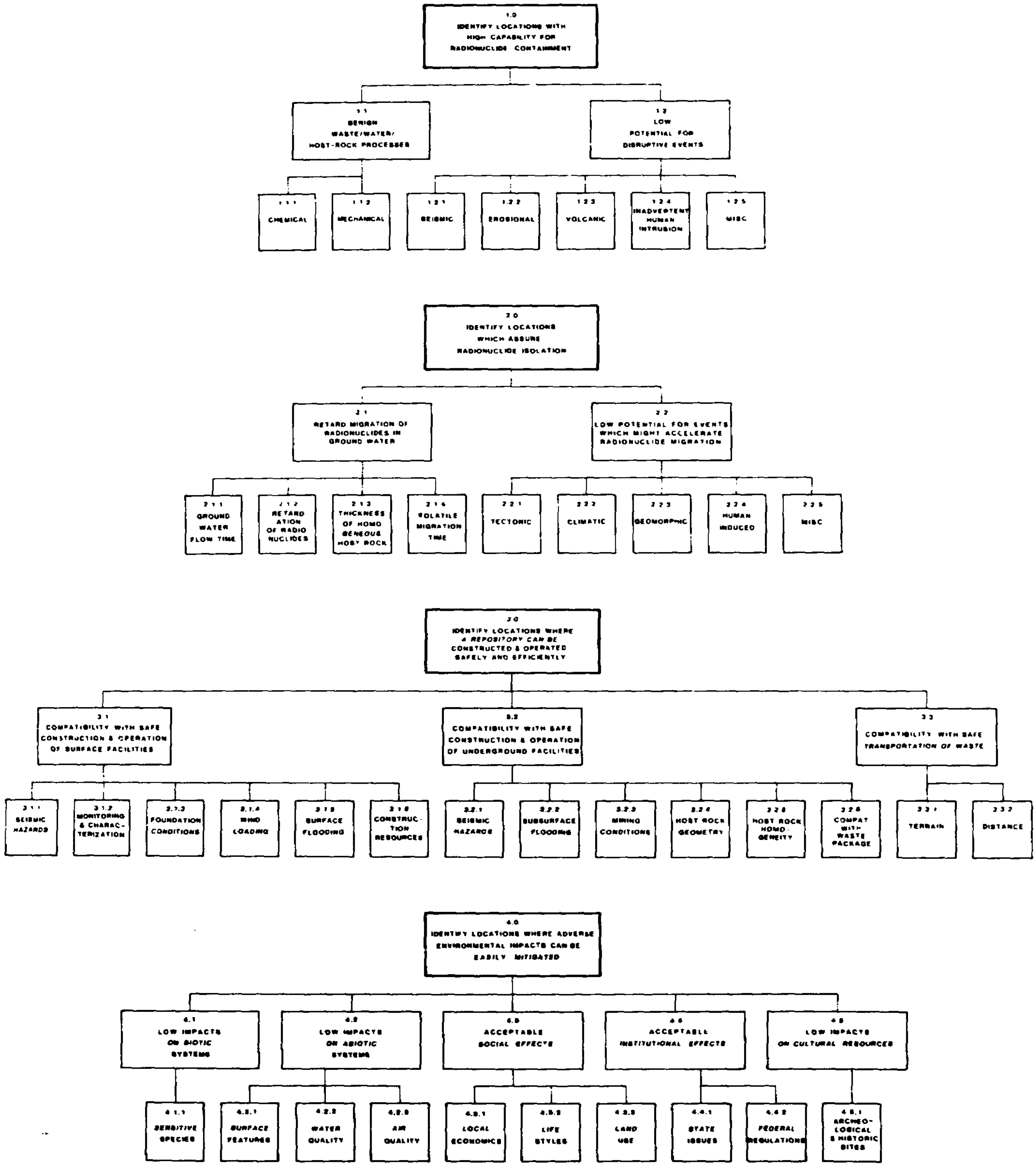

Figure 3. Hierarchical Tree of Performance Objectives for NNWSI Screening Activity

NNWSI PERFORMANCE OBJECTIVES FOR REPOSITORY LOCATIONS FOR SATISFYING THE OVERALL NATIONAL GOAL

<u>To Provide Safe, Cost-Effective, Environmentally Sound Disposal of Heat-Generating, Commercially Produced Radioactive Waste</u>

- 1.0 Identify Locations Which Permit Adequate Containment of Radionuclides in a Sealed Repository
  - 1.1 Screen for Natural Systems with Potential to Resist Waste Package Disruption Processes
    - 1.1.1 Minimize Potential for Chemically Induced Release
    - 1.1.2 Minimize Potential for Mechanically Induced Release
  - 1.2 Screen for Natural Systems with Minimum Potential for Waste Package Disruption Events
    - 1.2.1 Minimize Potential for Seismic Hazards to Containment in a Sealed Repository
    - 1.2.2 Minimize Potential for Erosional Disruption of Waste Packages
    - 1.2.3 Minimize Potential for Volcanic Disruption of Waste Packages
    - 1.2.4 Minimize Potential for Inadvertent Human Intrusion of a Sealed Repository
    - 1.2.5 Minimize Potential for Miscellaneous Events that Might Disrupt Containment
- 2.0 Identify Locations Which Permit Adequate Isolation of Radioactive Waste from the Biosphere
  - 2.1 Screen for Natural Systems Which Will Retard Migration of Radionuclides
    - 2.1.1 Maximize Extent of Relatively Homogeneous Host Rock
    - 2.1.2 Maximize Groundwater Flow Time to the Accessible Environment
    - 2.1.3 Maximize Retardation of Radionuclides Along Flow Paths
    - 2.1.4 Maximize Migration Times of Volatile Radionuclides
  - 2.2 Screen for Natural Systems with Low Potential for Adverse Changes to Isolation Processes
    - 2.2.1 Minimize Potential for Adverse Impacts on Isolation Due to Tectonic Changes
    - 2.2.2 Minimize Potential for Adverse Impacts on Isolation Due to Climatic Changes
    - 2.2.3 Minimize Potential for Adverse Impacts on Isolation Due to Geomorphic Changes
    - 2.2.4 Minimize Potential for Adverse Impacts on Isolation Due to Human Activities
    - 2.2.5 Minimize Potential for Miscellaneous Events Which Might Disrupt Isolation
- 3.0 Identify Locations Where Safe Repository Construction and Operations Can Be Implemented Effectively with Respect to Cost
  - 3.1 Screen for Locations Compatible with Safe Surface Facility Construction and Operation
    - 3.1.1 Minimize Seismic Hazards to Surface Facilities
    - 3.1.2 Minimize Surface Monitoring System Cost
    - 3.1.3 Minimize Adverse Foundation Conditions
    - 3.1.4 Minimize Wind Loading on Surface Structures
    - 3.1.5 Minimize Flooding Hazards to Surface Facilities
    - 3.1.6 Assure Availability of Natural Resources to Construct and Operate the Repository
  - 3.2 Screen for Locations Suitable for Subsurface Facility Construction and Safe Operation
    - 3.2.1 Minimize Seismic Hazards to Subsurface Facilities
    - 3.2.2 Minimize Flooding Hazards to Subsurface Facilities
    - 3.2.3 Minimize Adverse Mining Conditions
    - 3.2.4 Optimize the Geometry (Thickness and Lateral Extent) of the Host Rock
    - 3.2.5 Optimize Host Rock Homogeneity
    - 3.2.6 Maximize Compatability of a Host Rock with Standardized Waste Package
  - 3.3 Screen for Locations with Characteristics Compatible with Safe Transport of Radioactive Waste to a Repository
    - 3.3.1 Minimize Adverse Terrain Along Potential Waste Transport Routes
    - 3.3.2 Optimize Distance from Existing Transportation Corridors
- 4.0 Identify Locations for Which Environmental Impacts Can Be Mitigated to the Extent Reasonably Achievable
  - 4.1 Minimize or Avoid Adverse Impacts on or from Sensitive Biotic Systems
  - 4.2 Minimize Adverse Impacts on Abiotic Systems
    - 4.2.1 Minimize Impacts on Surface Geology
    - 4.2.2 Minimize Impacts on Water Quality and Availability
    - 4.2.3 Minimize Impacts on Air Quality
  - 4.3 Minimize Adverse Impacts on the Existing Socioeconomic Status of Individuals in the Affected Area
    - 4.3.1 Minimize Adverse Impacts on Local Economies
    - 4.3.2 Minimize Adverse Impacts on Life Styles
    - 4.3.3 Minimize Conflicts with Private Land Use
  - 4.4 Conduct All Activities in a Spirit of Institutional Cooperation
    - 4.4.1 Cooperate with States
    - 4.4.2 Facilitate Compliance with Federal Regulations
  - 4.5 Minimize Adverse Impacts on Significant Historic and Prehistoric Cultural Resources

Table 2. Numbers and Titles of Performance Objectives

of middle-level objectives which are independent of those in the other branches.

Containment Objectives

The containment branch is composed of two middle-level objectives, 1.1 and 1.2, respectively, which seek locations where neither expected ongoing processes nor possible future events will disrupt radioactive waste in a repository. Disruption by some expected, natural process or by some unexpected, relatively short-lived event is the only way containment can be lost. This illustrates a requirement of the structure of the tree; that is, all possible ways an objective can be met or compromised must be addressed by the next lower-level of component objectives.

Each of the two middle-level objectives for containment has a subordinate branch composed of a set of lower-level objectives. Seeking locations with benign chemical and mechanical characteristics, objectives 1.1.1 and 1.1.2, respectively, make up the lower-level objectives of the process branch of containment objectives. Likewise, locations with low potential for seismic, erosional, volcanic, and human-caused events which might disturb buried wastes--objectives 1.2.1, 1.2.2, 1.2.3, and 1.2.4--make up the lower-level objectives of the events branch of containment objectives. An objective for avoiding miscellaneous events, objective 1.2.5, is included to account for ancillary events, such as meteorite impacts or supernovas, which are either extremely improbable or nondiscriminating. The discriminating events explicitly addressed by the lower-level objectives are only those considered to pose real, though perhaps unlikely threats to radioactive waste buried in the screening area.

Isolation Objectives

There are two middle-level objectives in the isolation branch of the objectives tree. The first seeks locations where, if containment fails, expected radionuclide migration mechanisms assure that wastes will not reach the human environment until very long times into the future, if ever (objective 2.1). There are four radionuclide migration mechanisms of importance which form the basis for the lower-level objectives of this branch of the tree. These are objective 2.1.1, long groundwater flow times from a repository to the accessible environment; objective 2.1.2, geochemical conditions that retard radionuclide migration along flow paths; objective 2.1.3, a thick and extensive host rock for waste emplacement that provides a reliable barrier to radionuclide migration in all directions from a repository; and, objective 2.1.4, a set of effective barriers to migration of volatile or gaseous waste components which may behave differently than those dissolved in water.

The second middle-level isolation objective seeks to avoid locations where possible, though perhaps unlikely events might accelerate radionuclide migration rates or shorten radionuclide migration times to the accessible environment (objective 2.2). The types of events which make up the lower-level objectives of this branch of the tree are tectonic (objective 2.2.1), climatic (objective 2.2.2), geomorphic (objective 2.2.3), human-induced (objective 2.2.4), and miscellaneous (objective 2.2.5).

Operational Objectives

The upper-level operational objective is composed of three middle-level objectives. Each seeks locations compatible with different aspects of low-cost construction and operation of repository facilities. The three objectives address, respectively: surface facilities (objective 3.1), subsurface facilities (objective 3.2), and waste transportation systems (objective 3.3).

Lower-level objectives for surface facilities include low expected seismic motions (objective 3.1.1), low surface complexity for reducing costs of characterization and monitoring of radioactivity (objective 3.1.2), stable foundation conditions (objective 3.1.3), low potential for tornadoes or other damaging winds (objective 3.1.4), low potential for surface flooding (objective 3.1.5), and availability of abundant, nearby construction materials (objective 3.1.6).

Subsurface facilities can be built for less cost where natural features and conditions include low expected seismic motions (objective 3.2.1), low potential for underground flooding (objective 3.2.2), stable, strong rocks and other favorable mining conditions (objective 3.2.3), geometry of a host rock that allows full and simple repository development (objective 3.2.4), a relatively homogeneous host rock that allows a standard design throughout a repository (objective 3.2.5), and host-rock characteristics compatible with easy emplacement and retrieval of waste packages (objective 3.2.6).

Waste transportation systems will be less costly if the terrain is flat (objective 3.3.1) and the distance is short (objective 3.3.2) between a repository site and existing corridors suitable for transporting radioactive waste.

Environmental Objectives

Sound environmental practice during repository development is addressed by five middle-level objectives. Four of these objectives seek locations where anticipated adverse impacts will be small on biotic systems (objective 4.1), abiotic systems (objective 4.2), the local socioeconomic milieu (objective 4.3), and cultural resources, both historic and prehistoric sites (objective 4.5). The fifth middle-level environmental objective seeks locations where institutional factors are not likely to impede or disrupt construction or operation of a repository (objective 4.4).

Lower-level objectives of the abiotic system address potential impacts on natural surface features (objective 4.2.1), water quality (objective 4.2.2), and air quality (objective 4.2.3). Lower-level socioeconomic objectives address potential effects of repository development on local economic conditions (objective 4.3.1), lifestyles (objective 4.3.2), and possible private uses of land in the vicinity of a repository (objective 4.3.3). Institutional factors to consider are the possible impacts of state issues on repository development schedules (objective 4.4.1) and the effective implementation of federal regulations and procedures (objective 4.4.2).

Objectives 4.2, biotic systems, and 4.5, cultural resources, have no component lower-level objectives; consequently, the middle level of these branches serves also as the lowest level.

Weighting of Objectives

Qualitative descriptions of the objectives are an integral part of the screening methodology. Such descriptions allow correlation of each objective with NWTS and draft NRC criteria (Table 3). This assures compatibility of this

NNWSI Screening Objectives		Comparable National Criteria		
Number & Title		NWTS 33(1) (Ref. 13)	NWTS 33(2) (Ref. 14)	10 CFR 60 (July, 1981 Proposed Rule)
1.0	CONTAINMENT	3.1.2, 3.2.2(1), 4.2	3.2(¶1), 3.4(¶1), 3.3(¶1)	60.111(b)(2)(i), 60.111(b)(2)(ii)(A) 60.111(b)(3)(i)
1.1	Processes		3.4(2)	
1.1.1	Chemical Release		3.3(1), 3.4(2), 3.2(1), 3.2(4)	60.123(b)(5),60.123(b)(13-14)
1.1.2	Mechanical Release		3.4(2)	60.123(b)(15), 60.132(k)(1)
1.2	Events		3.5(¶1), 3.5(1)	60.123(a)(7), 70.123(b)(6,7,10)
1.2.1	Seismic		3.5(2), 3.5(5)	60.112(a), 60.123(a)(5), 60.123(b)(9)
1.2.2	Erosion		3.5(4)	60.112(b), 60.122(i), 60.123(b)(4)
1.2.3	Volcanic		3.5(3)	60.112(a), 60.123(b)(11)
1.2.4	Human Intrusion	3.2.2(3), 3.3.2(4)	3.6(¶1), 3.6(2)	60.123(b)(1-3)
1.2.5	Miscellaneous	2.3		60.122(j)
2.0	ISOLATION	2.1, 3.1.2, 3.2.2(2), 4.2	3.4(¶1), 3.1(¶1), 3.2(¶1), 3.3(¶1)	60.111(b)(1), 60.111(b)(3)(ii)
2.1	Nuclide Migration			
2.1.1	Groundwater Flow Time		3.2(1), 3.2(2)	60.112(c), 60.122(c), 60.122(f)(1-4)
2.1.2	Nuclide Retardation		3.3(1)	60.122(d), 60.122(g)(1-3), 60.122(h) 60.123(b)(13-15)
2.1.3	Host Rock Homogeneity			
2.1.4	Volatile Migration			
2.2	Changes to Existing Systems		3.5(¶1), 3.5(1)	60.123(a)(7),60.123(b)(7,12)
2.2.1	Tectonic		3.5(2-5)	60.112(1), 60.122(a,b), 60.123(a)(5), 60.123(b)(6,8,10,11)
2.2.2	Climatic		3.3(1)	60.112(b), 60.123(a)(8)
2.2.3	Geomorphic		8.1(1), 3.5(4)	60.112(b), 60.122(e,i), 60.123(b)(4)
2.2.4	Human Activities	3.3.2(4)	3.6(¶1), 3.6(2)	60.123(a)(3), 60.123(b)(1-3), 60.133(a)
2.2.5	Miscellaneous		3.4(1)	60.122(j)
3.0	CONSTRUCTION	3.1.1, 3.3.1, 3.3.2, 4.1		60.111(a)(1,2), 60.130(b)(1), 60.130(b)(2)(ii) 60.131(e)
3.1	Surface Facilities	3.2.1	3.7(¶1)	60.123(a)(6), 60.131(a), 60.131(c)(1)
3.1.1	Seismic Hazards		3.5(5)	60.123(a)(4), 60.123(b)(9,10)
3.1.2	Monitoring and Characterization Costs	3.3.2(3)	3.7(2)	60.130(9), 60.131(c)(2)
3.1.3	Foundation Conditions		3.7(2)	
3.1.4	Wind Loads		3.7(3)	
3.1.5	Flooding		3.7(1)	60.123(a)(1)
3.1.6	Net Resource Availability	2.6	3.7(4), 3.10(2)	
3.2	Subsurface Facilities	3.1.2, 3.3.2(2)	3.4(3)	60.123(b)(16), 60.130(10), 60.132(l)(1.4) 59,133(b)(4,5)
3.2.1	Seismic Hazared		3.5(5)	60.123(a)(4), 60.123(b)(9,10)
3.2.2	Flooding		3.2(3)	60.122(f)(3), 60.132(a)(2), 60.132(i)(1) 60.132(g)(1,5)
3.2.3	Mining Conditions		3.4(3)	60.123(b)(15,17), 60.132(l)(2), 60.132(e)(1,3), 60.132(f)
3.2.4	Host Rock Geometry		3.1(¶1),3.1(2)	60.122(i), 60.132(a)(3)
3.2.5	Host Rock Homogeneity		3.4(3)	
3.2.6	Waste Package Compatibility	3.4.1, 3.4.2, 3.3.2(1,2)		60.132(l)(1,2), 60.132(i)(2), 60.135(1)(1,2) 60.135(c)(3)
3.3	Transportation			
3.3.1	Terrain		3.7(2)	
3.3.2	Distance		3.8(2)	
4.0	ENVIRONMENT	4.3	3.9(¶1), 3.9.1, 3.9(2)	60.130(b)(2)(i)
4.1	Sensitive Biotic Systems			
4.2	Abiotic Systems			
4.2.1	Geologic Quality		3.9(1)	
4.2.2	Water Quality		3.9(1)	
4.2.3	Air Quality		3.9(1)	
4.3	Socioeconomics		3.8(¶1), 3.10(¶1)	
4.3.1	Local Economies		3.10(1)	
4.3.2	Life Styles			
4.3.3	Private Land Use		3.6(2)	60.121(a)
4.4	Institutional Issues	2.2	2.9(2)	60.121(b)
4.4.1	State Issues		3.6(2), 3.9(2)	
4.4.2	Federal Regulation	4.1.1, 4.1.2	3.9(2)	
4.5	Historic & Prehistoric Res.		3.9(1)	

Table 3. Relation of NNWSI Performance Objectives to DOE and Draft NRC Site Selection Criteria. 10 CFR 60 Criteria from Reference 16.

screening with national efforts to find acceptable repository sites. However, the objectives must be quantified for use in computer algorithms which were developed to rate alternative locations and host rocks. To accomplish this, weights were assigned to each objective (Table 4).

The weighting scheme assumes a weight of 100 percent for the overall goal of safe, cost-effective, environmentally sound waste disposal. Each upper-level objective accounts for some fraction of this overall weight, expressed as a percentage of the overall goal (Table 4, column 2). The sum of weights for the four upper-level objectives in the tree equals 100 percent, i.e., the total weight of the overall goal.

To obtain weights for middle-level objectives, each upper-level objective is assumed, in turn, to equal 100 percent. Middle-level objectives within each branch of the tree then are assigned percentage weights equal to their presumed fractional contribution to satisfying the appropriate upper-level objective (Table 4, column 5). Thus, the sum of the weights within each of the four sets of middle-level objectives is 100 percent. To obtain the percentage weight of a middle-level objective relative to the overall goal, its weight relative to the corresponding upper-level objective--some fraction of 100 percent--is multiplied by the weight of the upper-level objective relative to the overall goal--which is also some fraction of 100 percent (Table 4, column 6). Similarly, each lower-level objective is assigned a weight relative to the

NNWSI WEIGHTING DATA FOR THE AREA-TO-LOCATION SCREENING OBJECTIVES TREE

Level 1			Level 2						Level 3					
(1) Obj No.	(2) Average + 1σ from Poll (see note 1)	(3) Rank	(4) Obj No.	(5) Average + 1σ from Poll (see note 2)	(6) Relative Weight (see note 3)	(7) Rank	(8) Variance (σ^2) (see note 4)	(9) Standard Deviation (σ)	(10) Obj No.	(11) Average + 1σ from Poll (see note 2)	(12) Relative Weight (see note 3)	(13) Rank	(14) Variance (σ^2) (see note 5)	(15) Standard Deviation (σ)
1.0	0.31 ± 0.11	2	1.1	0.68 ± 0.08	0.2108	2	0.00621	0.0788	1.1.1	0.68 ± 0.12	0.1433	1	0.00351	0.0593
									1.1.2	0.32 ± 0.12	0.0675	3	0.00128	0.0357
			1.2	0.32 ± 0.08	0.0992	5	0.00185	0.0431	1.2.1	0.37 ± 0.18	0.0367	8	0.00057	0.0239
									1.2.2	0.14 ± 0.08	0.0139	23	0.00082	0.0287
									1.2.3	0.21 ± 0.09	0.0208	16	0.00016	0.0127
									1.2.4	0.23 ± 0.15	0.0228	14	0.00032	0.0179
									1.2.5	0.05 ± 0.07	0.0050	36	0.00005	0.0073
2.0	0.34 ± 0.14	1	2.1	0.65 ± 0.11	0.2210	1	0.00968	0.0984	2.1.1	0.39 ± 0.15	0.0862	2	0.00243	0.0493
									2.1.2	0.30 ± 0.09	0.0663	4	0.00127	0.0356
									2.1.3	0.23 ± 0.13	0.0508	6	0.00133	0.0366
									2.1.4	0.08 ± 0.08	0.0177	19	0.00037	0.0194
			2.2	0.35 ± 0.11	0.1190	3	0.00380	0.0616	2.2.1	0.31 ± 0.11	0.0369	7	0.00054	0.0232
									2.2.2	0.21 ± 0.07	0.0250	11	0.00024	0.0154
									2.2.3	0.20 ± 0.10	0.0238	12	0.00029	0.0171
									2.2.4	0.25 ± 0.16	0.0298	10	0.00060	0.0245
									2.2.5	0.03 ± 0.03	0.0036	38	0.00002	0.0040
3.0	0.26 ± 0.17	3	3.1	0.27 ± 0.08	0.0702	7	0.00254	0.0504	3.1.1	0.21 ± 0.08	0.0147	21	0.00014	0.0120
									3.1.2	0.12 ± 0.10	0.0084	31	0.00015	0.0121
									3.1.3	0.26 ± 0.15	0.0183	18	0.00028	0.0168
									3.1.4	0.10 ± 0.05	0.0070	34	0.00004	0.0061
									3.1.5	0.18 ± 0.11	0.0126	25	0.00014	0.0119
									3.1.6	0.13 ± 0.08	0.0091	28	0.00007	0.0086
			3.2	0.43 ± 0.12	0.1118	4	0.00631	0.0795	3.2.1	0.15 ± 0.07	0.0168	20	0.00021	0.0145
									3.2.2	0.21 ± 0.13	0.0235	13	0.00049	0.0221
									3.2.3	0.27 ± 0.15	0.0302	9	0.00074	0.0272
									3.2.4	0.15 ± 0.11	0.0168	20	0.00029	0.0171
									3.2.5	0.12 ± 0.04	0.0134	24	0.00011	0.0105
									3.2.6	0.10 ± 0.10	0.0112	26	0.00019	0.0137
			3.3	0.30 ± 0.14	0.0780	6	0.00393	0.0627	3.3.1	0.71 ± 0.15	0.0554	5	0.00212	0.0460
									3.3.2	0.29 ± 0.15	0.0226	15	0.00047	0.0216
4.0	0.09 ± 0.06	4	4.1	0.22 ± 0.08	0.0198	8	0.00023	0.0150	4.1.1	1.00 ± 0.0	0.0198	17	0.00023	0.0150
			4.2	0.21 ± 0.09	0.0189	9	0.00022	0.0150	4.2.1	0.22 ± 0.11	0.0042	37	0.00002	0.0039
									4.2.2	0.46 ± 0.07	0.0087	30	0.00005	0.0070
									4.2.3	0.32 ± 0.11	0.0060	35	0.00003	0.0052
			4.3	0.20 ± 0.13	0.0180	10	0.00028	0.0168	4.3.1	0.41 ± 0.18	0.0074	33	0.00006	0.0076
									4.3.2	0.42 ± 0.23	0.0076	32	0.00007	0.0082
									4.3.3	0.17 ± 0.15	0.0031	39	0.00002	0.0039
			4.4	0.21 ± 0.08	0.0189	9	0.00021	0.0145	4.4.1	0.53 ± 0.24	0.0100	27	0.00008	0.0089
									4.4.2	0.47 ± 0.24	0.0089	29	0.00007	0.0082
			4.5	0.16 ± 0.09	0.0144	11	0.00016	0.0126	4.5.1	1.00 ± 0.0	0.0144	22	0.00016	0.0126
	Σ=1.00				Σ= 1.0000						Σ=1.0002			

[1] Average and standard deviation $(x \pm 1\sigma)$ are based on responses of eight individuals who were asked to estimate what % each objective of this level contributes to overall goal of safe, effective, environmentally sound radioactive waste disposal.

[2] Average and standard deviation $(x \pm 1\sigma)$ are based on responses of eight individuals who were asked to estimate what % each objective of this level contributes to the appropriate upper level objective; each set of subobjectives of this level was assumed to sum to 100% with respect to the appropriate objective of the next higher level.

[3] Relative weight is the proportion of the overall goal of safe, effective, environmentally sound waste disposal attributed to this objective; it is calculated by multiplying average value of this level by the average value of each appropriate higher level from columns 2, 5, and 12.

[4] Variance, σ^2, is calculated by $\sigma^2 = x_1^2\sigma_2^2 + x_2^2\sigma_1^2$, where x_1 and σ_1 are the appropriate values from column 2; x_2 and σ_2 are appropriate values from column 5.

[5] Variance, σ^2, is calculated by $\sigma^2 = (x_1x_2)^2\sigma_3^2 + (x_2x_3)^2\sigma_1^2 + (x_1x_3)^2\sigma_2^2$, where x_1 and σ_1 are the appropriate values from column 2; x_2 and σ_2, from column 5; x_3 and σ_3 from column 11.

Table 4. Weights, Ranks, Variances and Standard Deviations

appropriate middle-level objective (Table 4, column 11). Weights of lower-level objectives with respect to the overall goal are similarly obtained by multiplying the appropriate weights assigned to all three objective levels (Table 4, column 12).

The weights and accompanying standard deviations, shown in Table 4, columns 2, 5, and 11, were obtained by averaging the responses of fifteen individuals to a weighting poll. Participants in the poll were experienced and knowledgeable in the technical aspects of radioactive waste disposal. They were asked to assign weights only to those objectives corresponding to their particular area of expertise. The polling form consisted of separate sheets for each branch and subbranch of the objectives tree. Thus, responses to the poll by a particular individual were a series of opinions about (1) how the weight of 100 percent for the overall goal should be divided among the upper-level objectives, (2) how the weights of 100 percent for each upper-level objective should be divided among its component middle-level objectives, and (3) how the weights of 100 percent for each middle-level objective should be divided among its component lower-level objectives. The participants in the poll, their affiliations, and their individual responses are reproduced in Appendix A.

Weights for middle and lower-level objectives relative to the overall goal were obtained by multiplying average weights for different levels from the poll. Each average weight is associated with its own standard deviation (columns 2, 9, and 15; Table 4). The standard deviations in columns 9 and 15, are obtained by a formula for propagation variance through a series of multiplications:

$$\sigma(x_1 x_2 \ldots x_n) = \left\{ \left(\frac{\partial y}{\partial x_1}\right)^2 \sigma_1^2 + \left(\frac{\partial y}{\partial x_2}\right)^2 \sigma_2^2 + \ldots \left(\frac{\partial y}{\partial x_n}\right) \sigma_n^2 \right\}^{1/2} \qquad (1)$$

where σ is the standard deviation of a variable, x. The discrete forms of this general equation used to obtain σ's in columns 9 and 15 are given in footnotes to Table 4.

Columns 3, 7, and 13 of Table 4 rank the objectives by their weight relative to all other objectives of the same level. By ordering the objectives from the highest to the lowest rank and plotting their weights, graphs are obtained which show the relative importance of each objective from each level of the tree (Figure 4).

This weighting scheme thus accommodates the necessary tradeoffs as to which objectives are more important to meet at the possible expense of others. Such tradeoffs are required, because the search for repository locations will never encounter a place on the earth's surface that is ideal with respect to all or perhaps any of the objectives.

It should be noted that this weighting scheme does not account for possible mutual dependency among weights for individual objectives. For example, if a site had virtually zero

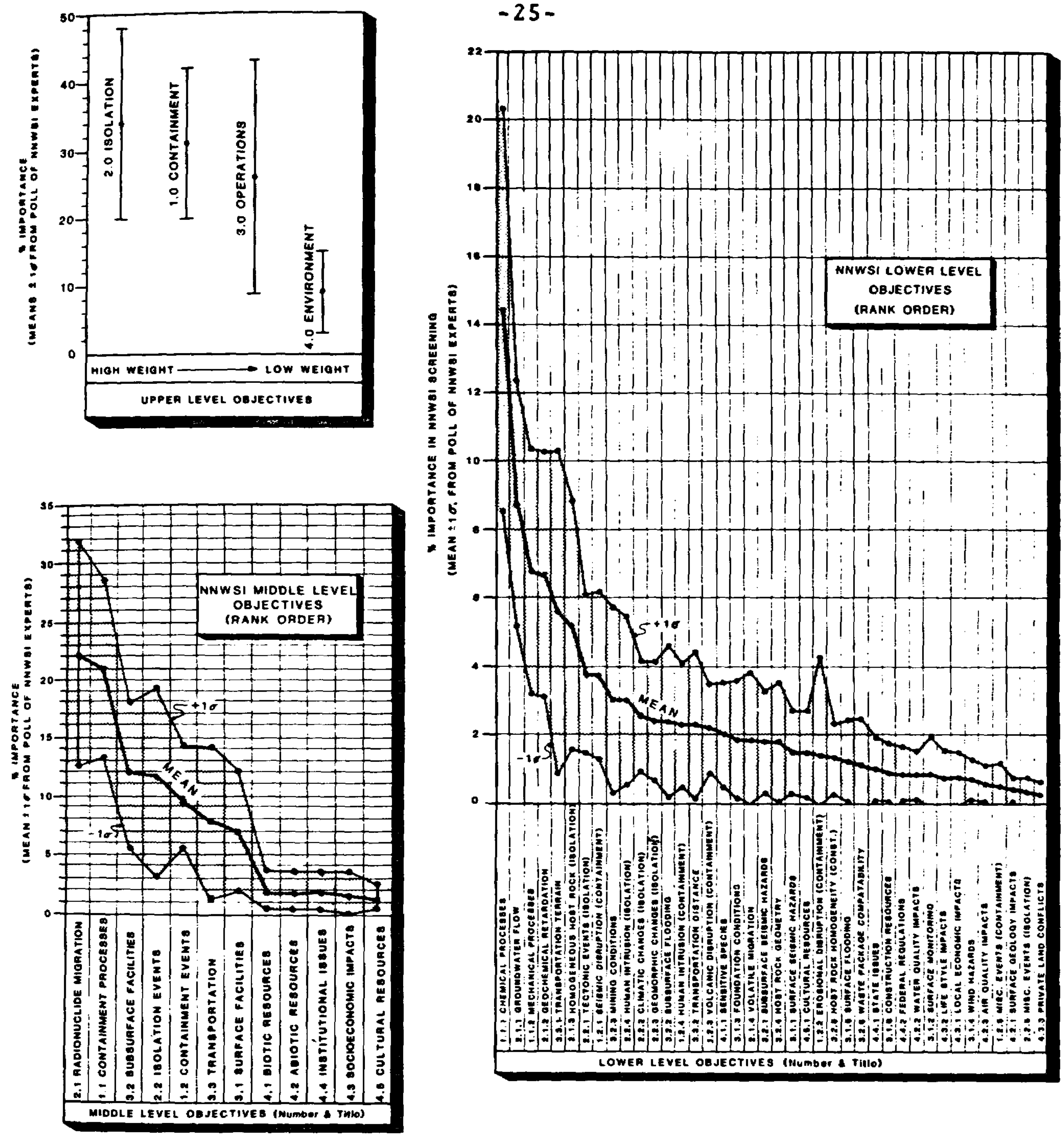

Figure 4. Upper, Middle, and Lower-Level Performance Objectives Ordered Average Weight; Average Values and Standard Deviations Obtained from a Poll of Experts; See Table 4 for Exact Values and Appendix A for results of poll.

water movement for transporting radioactive waste (objective 2.1.1), the geochemical retardation (objective 2.1.2) would be of less importance than if water movement were rapid. Thus, variable weights based on mutual dependency of processes or conditions are not addressed. It should also be noted that the number of objectives within a given branch of the tree influences the weights assigned to those objectives. As a result, branches with fewer objectives tend to contain more heavily weighted objectives.

NNWSI Screening Attributes

Locations are evaluated by assessing how well each performance objective is achieved at each location. This is done, in turn, by independently evaluating how well pertinent physical conditions in alternative locations satisfy the individual performance objectives. These pertinent physical conditions are called attributes in this report. To be useful in screening, such attributes must meet three criteria: they must (1) address the objectives; (2) discriminate among alternative locations or host rocks within the screening area; and (3) be able to be measured or inferred on a standard basis throughout the screening area. The last restriction permits comparisons of locations and host rocks based on roughly equivalent data.*

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*In some cases detailed data available from restricted locations had to be sacrificed so that more general, but equivalent detail could be expressed throughout the screening area.

Accordingly, the attributes were made sufficiently general to allow their extrapolation or interpolation into portions of the screening area where specific data are not available.

Attributes were selected by identifying all physical conditions which are important for characterizing a mined geologic repository. Sets of these pertinent attributes were listed as candidates for characterizing each component of a general repository model (Figure 5). This step assured that due consideration was given to all possibly useful attributes for assessing near, intermediate, and far-field conditions and for distinguishing short-term operational and environmental concerns from long-term concerns for containment and isolation (Figure 6).

The list of candidate attributes in Figure 6 was then screened to select those which satisfy the three criteria listed above for use in screening. This was accomplished during a series of meetings among experts familiar with the attributes in question. After lengthy review and discussion, a set of 31 usable attributes was defined (Table 5). Each attribute was assigned a designator number for use in the computer programs.

Confidence in extrapolations and interpolations of attribute data varies from place to place, rock type to rock type, and attribute to attribute. Attempts to quantify this confidence as proposed in Reference 9 were deferred by constraints

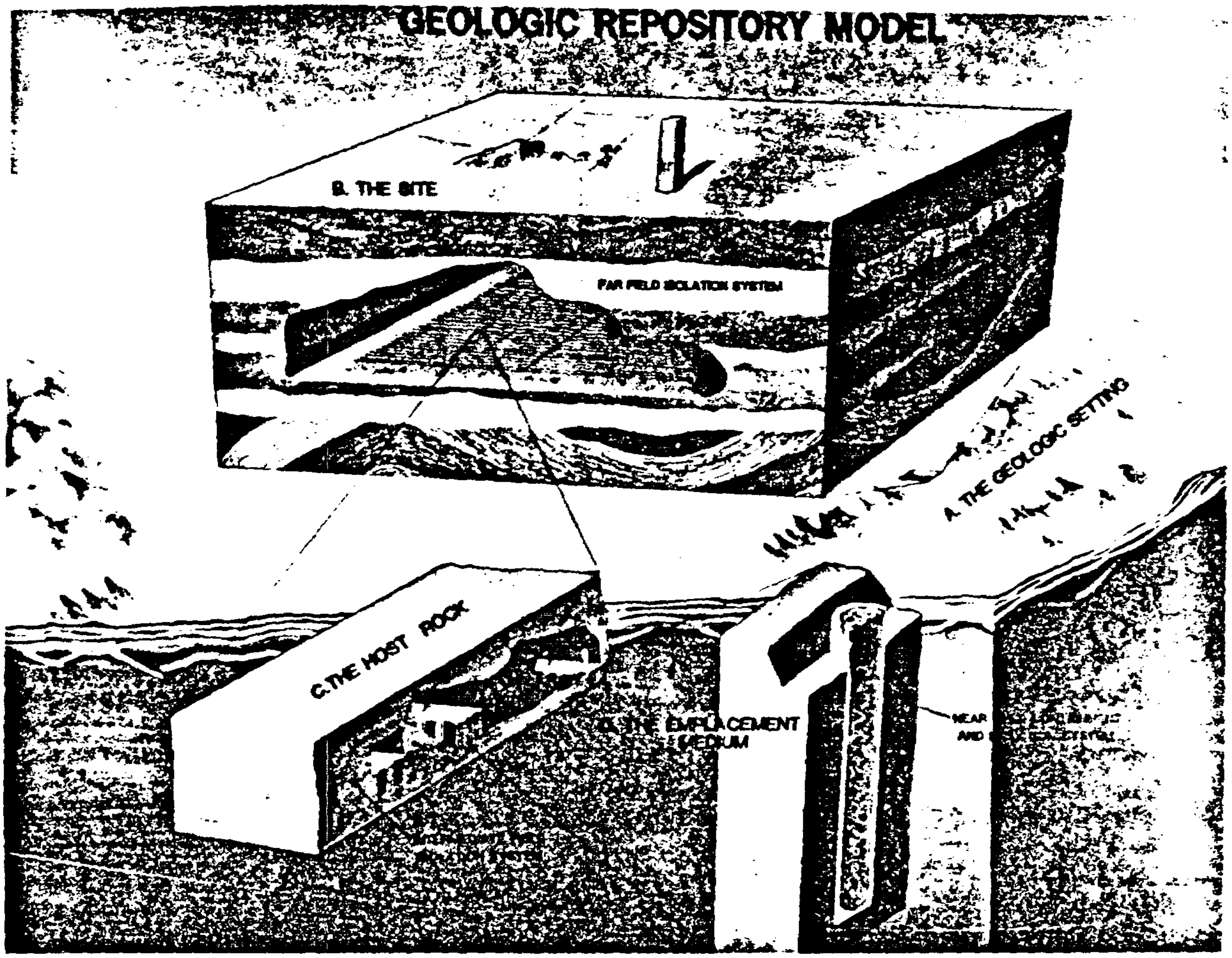


Figure 5. General Model of a Mined Geologic Repository System

of other work commitments by NNWSI technical experts and by schedules for completing the screening activity. However, data for the attributes represent the best judgments of experts familiar with the corresponding subject matter. Confidence in attribute data is therefore retained as a qualitative factor

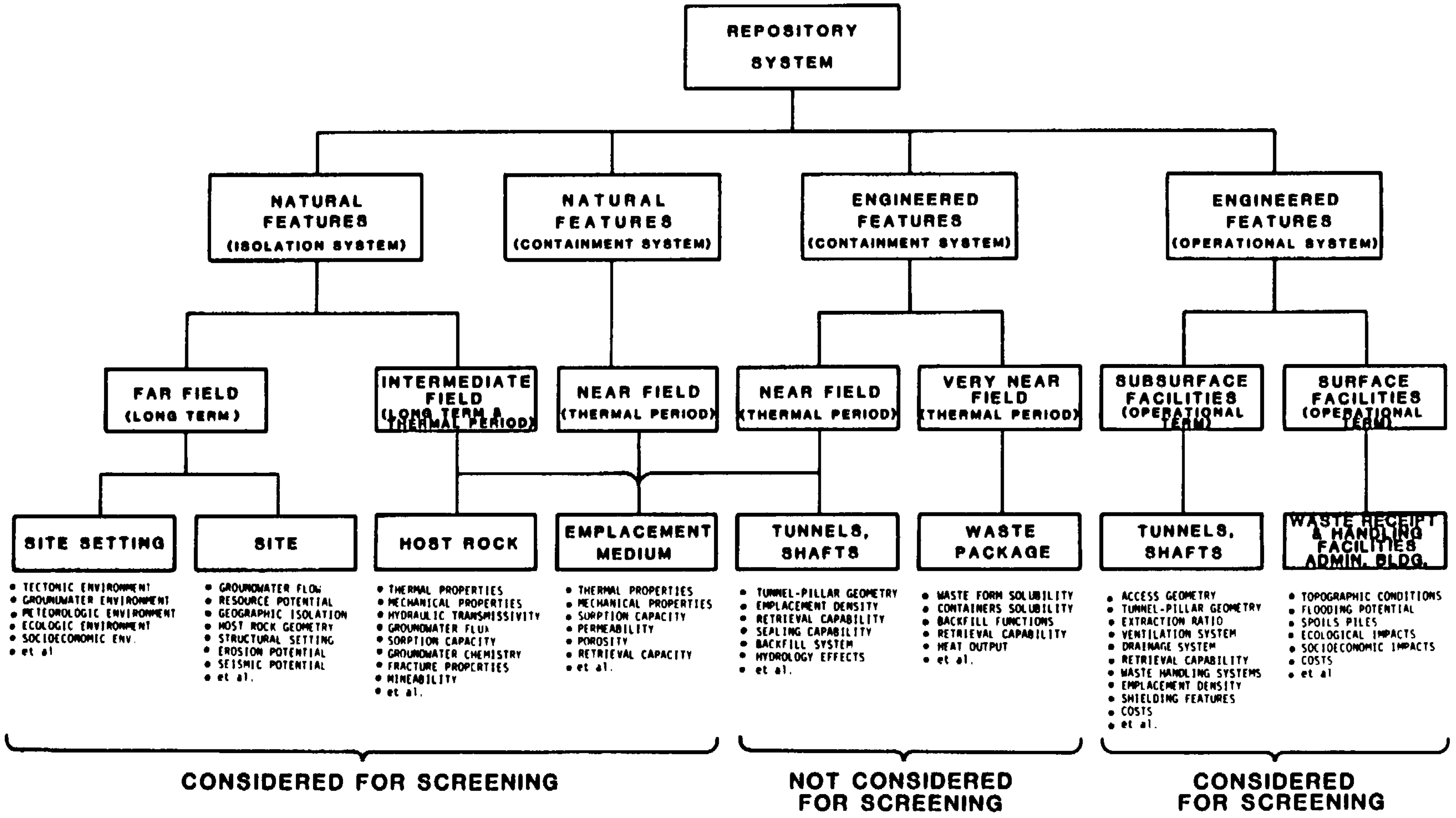


Figure 6. Candidate Attributes for Assessing Repository Components

NNWSI SCREENING ATTRIBUTES

No.	Title	Discriminating Conditions	Major Contributor
1	Volcanic Potential	4 Zones of Relative Potential	USGS
2	Fault Density	3 Zones of Relative Density	USGS
3	Fault Trend	3 Zones of Compass Direction	USGS
4	Age of Faulting	3 Zones of Fault Ages	USGS
5	Natural Seismic Potential	Discrete Values of Expected Ground Acceleration (g's)	USGS
6	Weapons Seismic Potential	5 Zones of Expected Ground Acceleration (g's)	SNL
7	Bed Attitude	3 Zones of Amount of Rock Dip (degrees)	USGS
8	Erosion Potential	5 Zones of Erosional Intensity	SNL
9	Flood Potential	4 Zones of Flooding Hazards	SNL
10	Terrain Ruggedness	4 Zones of Slope Steepness (%)	SNL
11	Resource Potential	3 Zones of Potential for Finding Metal Ores	USGS
12	Groundwater Resources Potential	5 Zones of Potential for Groundwater Use	USGS
13	Groundwater Flux	6 Zones of Groundwater Flux (m^3/sec)	USGS
14	Groundwater Flow Direction	5 Zones of Upgradient Distance from Production Areas	SNL
15	Thickness of Unsaturated Zone	3 Zones of Depth to Water Table (meters)	USGS
16	Sensitive Floral Species	14 Units of Potential for Finding Sensitive Species	EG&G
17	Sensitive Faunal Species	5 Zones of Species Habitats	EG&G
18	Revegetation Potential	5 Zones Vegetation Assemblages	EG&G
19	Known Cultural Resources	3 Zones of Types of Cultural Resources	DRI
20	Potential Cultural Resources	10 Units of Potential Density of Cultural Resources	DRI
21	Air Pollution Potential	5 Zones of Air Quality	DRI
22	Permitting Difficulties	4 Zones of Land Ownership and Control	SNL
23	Private Land Use	Private and Nonprivate Land	UNLV
24	Thermal Conductivity	5 Ranges of Thermal Conductivity (W/m-^{o}K)	SEWG
25	Compressive Strength (Containment)	3 Ranges of Unconfined Compressive Strength (psi)	SEWG
26	Compressive Strength (Construction)	3 Ranges of Unconfined Compressive Strength (psi)	SNL
27	Expansion-Contraction	Expansion or Contraction Behavior upon Heating	SEWG
28	Mineral Stability	7 Rank Orders of Mineral Stability upon Heating	LANL
29	Stratigraphic Setting	14 Conditions of Stratigraphically Weighted Sorption	LANL
30	Hydraulic Retardation	6 Rank Orders, Radionuclide Diffusion into Rock Matrix	LANL
31	Hydraulic Transmissivity	4 Ranges of Hydraulic Transmissivity (m^2/sec)	USGS

Table 5. Discriminating Attributes for Screening Area and Host Rocks.

for interpreting the screening results. In lieu of a quantitative evaluation of confidence in the attribute data, confidence estimates in location ratings were quantified based on the uncertainty associated with the weights assigned to the objectives. (See "Analysis of Variance" in Chapter 3.)

Geographical Attributes

Twenty-three of the 31 attributes vary geographically (attributes 1-23, Table 5). Eight vary from rock type to rock type (attributes 24-31, Table 5). For each geographical attribute, a map was prepared that shows the distribution of attribute conditions throughout the screening area. The attribute maps are reproduced in Appendix B in the order of their designator numbers from Table 5. Experts primarily from LANL, LLNL, SNL, USGS and others worked closely with the TOC to define discriminating conditions for each of the attributes (Table 5). For the geographical attributes (numbers 1-23) these discriminating conditions which define the mapping units shown on the maps in Appendix B. The mapping units were selected so as to divide the screening area into discrete zones which discriminate among alternative locations. The specific favorability of each mapping unit for satisfying the performance objectives was not a factor in selecting the units. The maps were thus compiled solely from judgments about how physical conditions vary within the screening area. This separated relatively objective judgments about the physical data from more subjective judgments about their favorability for repositories (see "Quantitative Criteria for Attributes" later in this chapter). Each mapping unit for each attribute was assigned a different designator number for use in the computer programs.

Detailed discussion of the rationale for selecting the mapping units, descriptions of the maps themselves, and supporting references are contained in the companion report devoted solely to the attributes and their favorability (11).

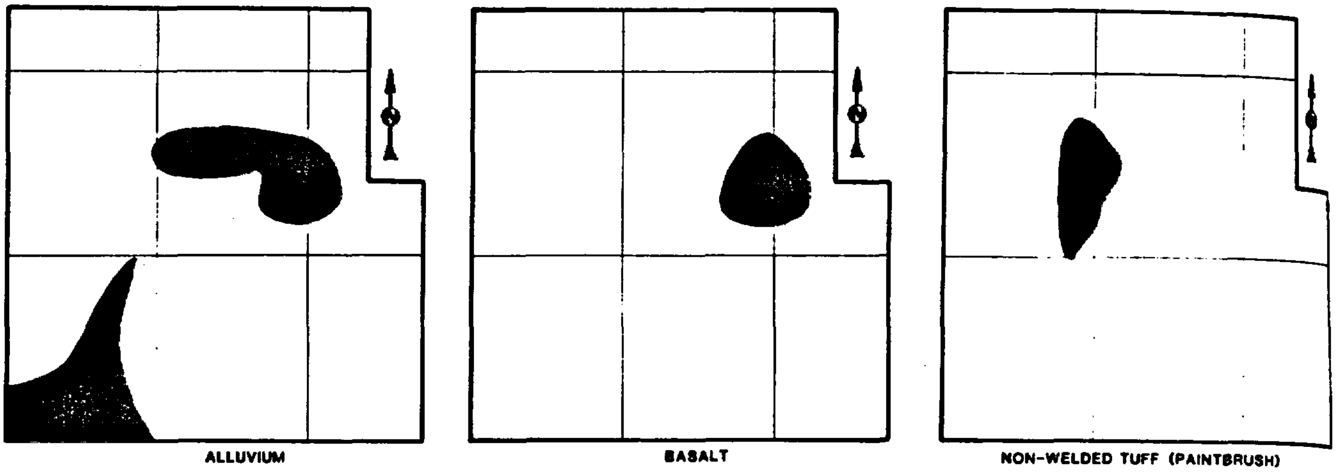
Host-Rock Attributes

Because a suitable underground rock mass is required for repository development, and because different locations within the screening area have different rocks with differing properties, certain properties of the available rock types were evaluated. Though the purpose of screening is limited to identifying favorable geographic locations, preliminary evaluations of candidate host rocks were performed to determine if at least one usable rock type occurs beneath those locations rated most favorable. Accordingly, eight of the 31 attributes vary as a function of rock type rather than geographical position (attributes 24-31, Table 5).

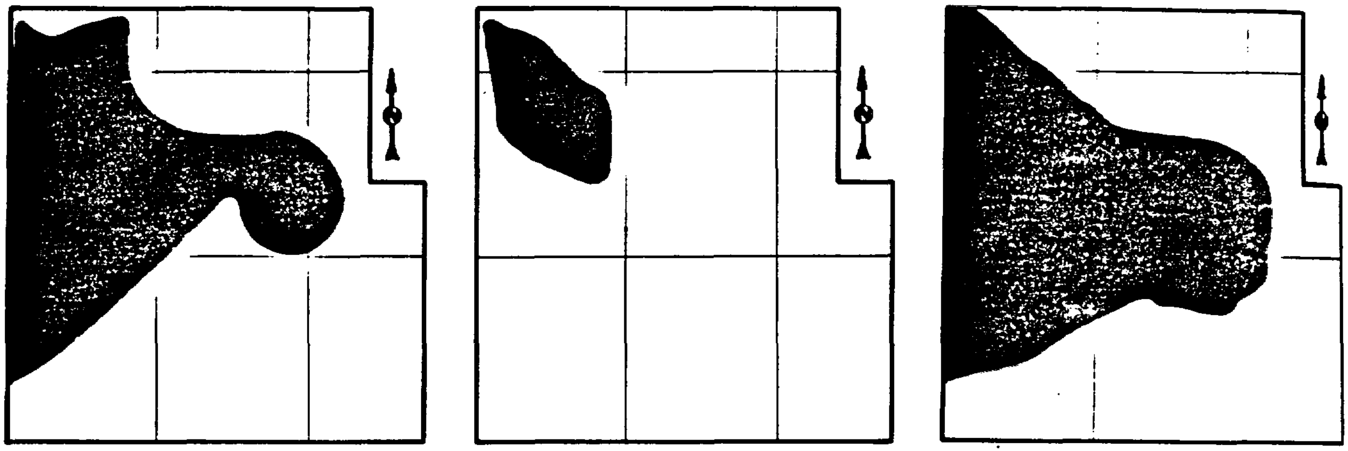
Nine rock types known to occur in the screening area were selected for evaluation. Maps were prepared showing where a thickness of at least 100 feet for each of these candidate host rocks is inferred to occur between depths of 500 feet and 4000 feet (Figure 7). These criteria for thickness and depth rule out unrealistic alternatives while retaining a significant number of candidate host rocks for comparison.

For each of the eight host-rock attributes (Table 5, attributes 24-31), a single discriminating value was assigned to each rock type (see Table B-1, Appendix B, page B-25). Host-rock attributes which vary with depth were not considered because each rock type occurs at different depths below different portions of the screening area. In addition, only one value for each attribute could be conveniently assigned to each rock type due to space limitations in the computer. Pertinent attributes for rating the relative merits of rock masses such as in situ stress, water saturation conditions, geothermal gradient, and vertical mining haulage costs, therefore, were not addressed in this screening. Accordingly, evaluations of alternative rock types presented in this report should not be construed as a comprehensive basis for selecting a particular rock type or depth horizon for repository development. Rather, these evaluations ascertain in a general way only whether one or more rock types with potentially satisfactory conditions for repository performance occur beneath locations that rate highest with respect to geographical attributes.

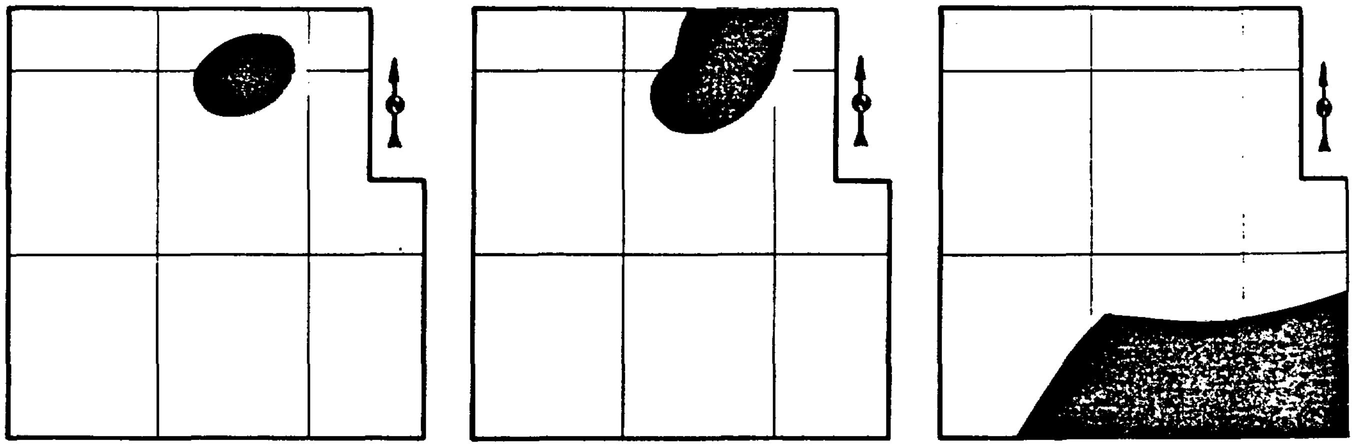
A separate study will evaluate the suitability of various rock types and depth horizons for repository development. The forthcoming horizon study and analysis will include depth-related attributes and more refined data for a larger number of attributes than considered in this report. This horizon evaluation activity, which commenced while this report was being written, will be the basis for selecting a rock type or combination of rock types at a particular depth horizon for possible repository development. Horizon evaluation is scheduled for late 1982.



ALLUVIUM BASALT NON-WELDED TUFF (PAINTBRUSH)



DENSELY WELDED TUFF (TOPOPAH SPRING) NON-WELDED TUFF (CALICO HILLS) MODERATELY WELDED TUFF (CRATER FLAT)



GRANITE ARGILLITE CARBONATES

Figure 7. Maps of Underground Extent of Candidate Host Rocks Showing the Inferred Geographic Extent Where a Thickness of at least 100' Occurs Between Depths of 500' and 4000'

Relationships Between Attributes and Objectives

To evaluate the relative merits of alternative locations, attributes must be quantitatively related to performance objectives. Relationships that make this necessary link have two basic facets. The first establishes which attributes are useful for evaluating locations with respect to each performance objective. The second defines the relative favorability of discriminating attribute conditions for satisfying the performance objectives.

Attributes Used to Evaluate Individual Objectives

A systems matrix was established wherein attributes form the rows and objectives form the columns (Table 6). This matrix is referred to as the attribute-objective matrix and allows one to graphically consider the usefulness of every attribute with respect to each lower-level objective. If an attribute is useful for evaluating a particular objective, a weight must be assigned at the intersection of the appropriate column and row. For an objective having only one pertinent attribute, a weight of 100 percent is assigned to that attribute. For an objective having more than one pertinent attribute, the total weight of 100 percent must be divided among the attributes according to the percent contribution of each attribute in evaluating the objective. By considering every matrix intersection and making a judgment about each, weights are obtained for all the attributes with respect to all performance objectives.

These weights define the contribution of individual attributes to evaluating specific objectives.

The weight of each attribute-objective intersection with respect to the overall evaluations is determined by multiplying the attribute weights shown at the matrix intersections on Table 6 by the weights of the appropriate column-heading objectives from all three levels of the objectives tree (Table 4, column 12). Adding all the weights thus obtained for a single attribute defines a total weight for each attribute relative to the overall goal of safe, cost-effective, and environmentally sound waste disposal. Figure 8 plots these total attribute weights and orders them from the highest to the lowest.

Attribute weights were not determined by a poll. In lieu of a poll, the TOC developed the attribute weights shown in Table 6. Weights in each column sum to 100 percent. Consequently, the combined contributions of all attributes for a particular objective allows comprehensive numerical analysis of locations with respect to that objective. For some objectives (i.e., 3.1.4, 3.3.2, 4.3.1, and 4.3.2), no discriminating attributes were identified or no data were available. As a result, the weights associated with these objectives do not affect the screening analyses. Discussion of the rationale for weights assigned to each attribute with respect to particular objectives is provided in the companion report on the performance objectives [10].

OBJECTIVES
(WEIGHTS IN PARENTHESES)

OVERALL GOAL: PROVIDE SAFE, EFFECTIVE & ENVIRONMENTALLY SOUND RADIOACTIVE WASTE DISPOSAL

ATTRIBUTES
(WEIGHTS AT MATRIX INTERSECTIONS)

		LEVEL 1	1.0 PROVIDE CONTAINMENT (31%)							2.0 PROVIDE ISOLATION (34%)									3.0 PROVIDE SAFE COST EFFECTIVE CONSTRUCTION & OPERATIONS (26%)														4.0 PROVIDE ACCEPTABLE ENVIRONMENTAL IMPACTS (9%)									
		LEVEL 2	1.1 DISRUPTIVE PROCESSES (68%)		1.2 DISRUPTIVE EVENTS (32%)					2.1 RADIONUCLIDE MIGRATION (65%)				2.2 DISRUPTIVE EVENTS (35%)					3.1 SURFACE FACILITIES (27%)						3.2 SUBSURFACE FACILITIES (43%)						3.3 TRANSPORTATION SYSTEMS (30%)		4.1 BIOTIC SYS.(22%)	4.2 ABIOTIC SYSTEMS (21%)			4.3 SOCIOECONOMIC IMPACTS (20%)			4.4 INSTITUTIONAL IMPACTS (21%)		4.5 CULT. RES. (16%)
		LEVEL 3	1.1.1 CHEMICAL (68%)	1.1.2 MECHANICAL (32%)	1.2.1 SEISMIC (37%)	1.2.2 EROSIONAL (14%)	1.2.3 VOLCANIC (21%)	1.2.4 HUMAN INTRUSION (23%)	1.2.5 MISCELLANEOUS (5%)	2.1.1 GROUNDWATER FLOW(36%)	2.1.2 NUCLIDE RETARD. (30%)	2.1.3 HOST ROCK THICK. (25%)	2.1.4 VOLATILE MIGRATION (9%)	2.2.1 TECTONIC (31%)	2.2.2 CLIMATIC (31%)	2.2.3 GEOMORPHIC (20%)	2.2.4 HUMAN INDUCED (9%)	2.2.5 MISC. & COMPLEXITY (3%)	3.1.1 SEISMICITY (21%)	3.1.2 MONITORING RQMT'S (12%)	3.1.3 FOUNDATION COND. (26%)	3.1.4 WIND LOADS (10%)	3.1.5 FLOODING (18%)	3.1.6 AVAIL. NAT. RES. (13%)	3.2.1 SEISMICITY (15%)	3.2.2 FLOODING (21%)	3.2.3 MINING COND. (27%)	3.2.4 HOST ROCK GEOM. (15%)	3.2.5 HOST ROCK HOMOG. (12%)	3.2.6 WASTE PKG ACCEPT. (10%)	3.3.1 TERRAIN (71%)	3.3.2 EXISTING CORRIDOR (29%)	4.1.1 SENSITIVE SYS. (100%)	4.2.1 SURFACE GEOLOGY (32%)	4.2.2 WATER QUALITY (46%)	4.2.3 AIR QUALITY (22%)	4.3.1 LOCAL ECONOMIES (41%)	4.3.2 LIFE STYLES (42%)	4.3.3 LAND USE (17%)	4.4.1 STATE ISSUES (53%)	4.4.2 FEDERAL REGS. (47%)	4.5.1 ARCH. & HIST. SITES (100%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL			5		100							40																												
		2 FAULT DENSITY	5							5			10					50							10	10	20		50													
		3 FAULT TREND			5									10																												
		4 AGE OF FAULTING			30									10																												
		5 NATURAL SEISMIC POTENTIAL			60									40					90						85																	
		6 WEAPONS SEISMIC POTENTIAL							100								10		10						5																	
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)																30										100	40													
		8 EROSION POTENTIAL				100										80					10																					
		9 FLOOD POTENTIAL														10					20		100			5					30			50								
		10 TERRAIN RUGGEDNESS														10		20		70	70										70			50								
		11 BASE & PRECIOUS METAL RESOURCE POT						50									45												10													
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL						50									45																		100							
		13 GROUNDWATER FLUX	5							10	10															15																
		14 GROUNDWATER FLOW DIRECTION								30																10	10															
		15 THICKNESS OF UNSATURATED ZONE								5					100																											
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES																		3													40									
		17 SENSITIVE FAUNAL SPECIES																		7													50									
		18 REVEGETATION POTENTIAL																															10									
		19 KNOWN CULTURAL RESOURCES																		5																						30
		20 POTENTIAL CULTURAL RESOURCES																		15																						70
		21 AIR POLLUTION POTENTIAL																																		100						
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES																																							100	
		23 PRIVATE LAND USE																																					100			
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY	20	30																							10			20												
		25 COMPRESSIVE STRENGTH (CONTAINMENT)		40								20																														
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)																									40															
		27 EXPANSION-CONTRACTION		20																										40												
	GEOCHEMICAL	28 MINERAL STABILITY	10	10							10		5														10			40												
		29 STRATIGRAPHIC SETTING									70	80	30																													
		30 HYDRAULIC RETARDATION								10	10		15																													
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	60							40			40													60	10															

Table 6. Attribute-Objective Matrix with Weights Used in Screening Calculations

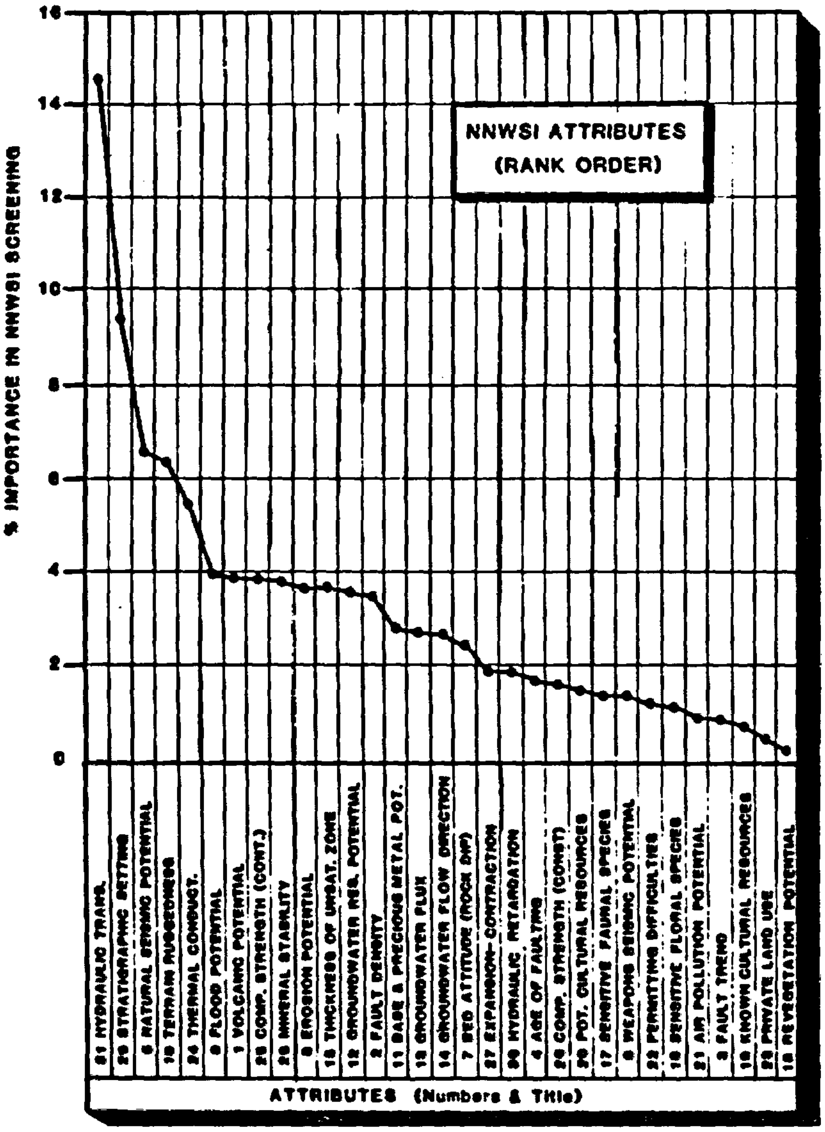


Figure 8. Attributes Ordered by Total Weight

Quantitative Criteria for Attributes (Favorability Graphs)

The second facet of quantitative relationships between objectives and attributes establishes the relative favorability for each discriminating condition for each attribute. These relationships are expressed as relative favorability graphs.

Attribute conditions which discriminate place from place or rock type from rock type are independent variables of the favorability graphs. The dependent variables are favorability numbers of a scale of zero to ten. The independent and dependent variables for each attribute are plotted on the abscissa and ordinate, respectively.

In effect, these graphs constitute the quantitative criteria of the screening activity. They tie objectives to data as follows: performance objectives establish goals; attributes define discriminating physical conditions in the screening area; and favorability graphs provide a quantitative standard for assessing how well the physical conditions meet the objectives.

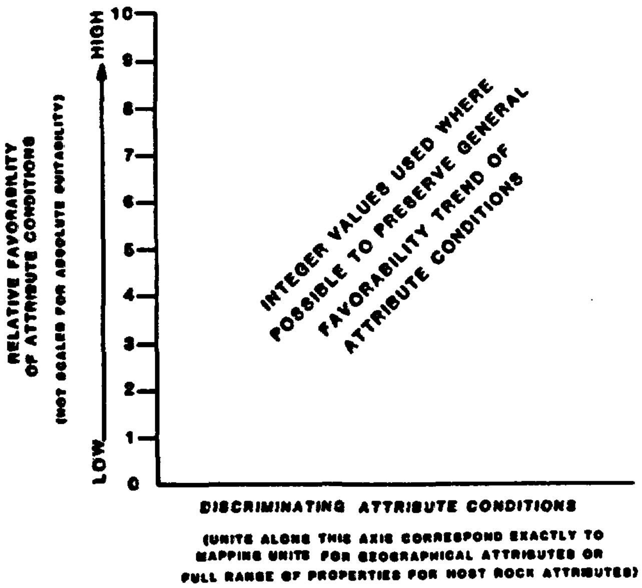


Figure 9. General Form of Favorability Graphs

The favorability graphs were developed by the TOC. A general trend of favorability values for the conditions of each attribute was first established. Next, high and low values were assigned, respectively, to the most and least favorable conditions. Lastly, intermediate values were interpolated between these extremes. Whole integers were used whenever possible, while preserving the general trends of the graphs.

Favorability values of zero were generally reserved for possibly exclusionary conditions such as the presence of Quaternary faults, private land, or extensive mineral deposits. However, no reasons are known which establish these conditions as necessarily exclusionary. Nonetheless, their definition as "undesirable conditions or features" in the current NRC draft technical criteria for geologic repositories [12] warranted drawing attention to such conditions by assigning them a favorability of zero. Equations for calculating location and host-rock ratings permit favorability values of zero to be either exclusionary or nonexclusionary (see next section of this chapter, "Calculation of Ratings for Locations and Host Rocks"). In this screening, the zero values were used only as nonexclusionary.

For attributes whose least desirable condition was not specifically mentioned in NRC draft criteria, a low favorability value of one, or in some cases two or more, was assigned.

A value of nine or ten was generally used for the highest attainable favorability. Both high and low values were adjusted to the nearest integer, when possible, depending on the desired shape of the curve. If, for example, linear interpolation between high and low values was most appropriate, the upper and lower favorability values were adjusted to the nearest integers compatible with a straight line on the graph. For nonlinear graphs, high and low values were similarly adjusted to allow the desired general shape of the curve to be expressed without causing undue fractional values. Intermediate favorabilities were likewise adjusted to the nearest integers, or in some cases half integers, compatible with simple curve trends.

With one exception, the general trend of favorabilities for attributes used to assess more than one objective is the same for each of the different objectives. Therefore, only one favorability graph was required for most attributes. The exception, compressive strength of host rocks, required two separate graphs, one for the mining objective and one for containment and isolation objectives.

The range of favorability numbers for each attribute generally encompasses the largest range from zero to ten compatible with simple graphs. This provides as much discriminating capability as possible for each attribute. For comparison, favorability graphs could be constructed to reflect absolute suitability in relation to all possible attribute conditions throughout the world, not just those expressed in the screening area. The purpose of this screening, however, is to determine the relative favorability of alternative locations in the screening area, not to assess absolute suitability with respect to all possible locations and host rocks in the United States. To effectively achieve this purpose, differences among the relative merits of various locations and host rocks have been enhanced and perhaps even exaggerated by the favorability graphs to allow clear distinction among the most and least favorable. Therefore, the results of this screening should not be considered assessments of suitability. Rigorous assessments of absolute suitability in terms of regulatory criteria will come later when the criteria are formulated and when sufficient data about specific locations and host rocks have been collected and analyzed.

The favorability graphs for geographical attributes are reproduced on the same pages as the attribute maps in Appendix B. The eight host-rock favorability graphs are on page B-26, Appendix B. The rationale for ascribing favorability values to specific attribute conditions is provided in the companion report on attributes and favorability graphs [11].

Calculation of Ratings for Locations and Host Rocks

The discussion to this point has outlined the screening method elements and associated parameters used in calculating numerical ratings for various locations. To summarize, the numerical parameters are (1) designator numbers for the performance objectives, (2) weights for the objectives, (3) standard deviations of these weights, (4) designator numbers for the attributes, (5) designator numbers for each discriminating condition of each attribute, (6) favorability values for each discriminating attribute condition, and (7) weights for the attributes relative to the appropriate objectives. These parameters are used in a set of computer algorithms developed for use on the APPLICON Graphics System (AGS) [20,21]. The algorithms calculate numerical favorability ratings for alternative locations and host rocks in the NNWSI screening area.

General Description of the Rating Process

Ratings were calculated for each of 1,514 half-mile square grid cells* and for each of the nine, candidate host rocks. The grid cells were defined by a set of geographical X-Y coordinates, and they comprise a digital base map of the screening area (Figure 10). Each attribute map was digitized by assigning Z values to the designator numbers for mapping units at the appropriate X-Y coordinates (Figure 11). Favorability numbers

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* Alternative locations in the screening area are strictly defined as these one-half mile square grid cells. Each of these grid locations is separately evaluated by data digitized and processed in an APPLICON Graphics system. Alternative repository locations are identified from the screening results where about 40 or more grid cells (~ 10 square miles) are rated similarly.

from the favorability graphs were also digitized for each attribute. By replacing mapping unit numbers on the base map with corresponding favorability numbers, a favorability surface was generated for each attribute. Z values (or elevations) on these surfaces correspond to the favorability of an attribute at each grid cell (Figure 12). Digital attribute maps were preserved to keep the attribute data separate from judgments about their favorability. If the judgments change and a new favorability graph is considered appropriate, a new favorability surface can be generated easily from the preserved, digital attribute map.

Designator numbers and average weights for the objectives and attributes were also digitized (Figure 13). These weights were organized in the computer as a matrix analogous to Table 6. Designator numbers of the attributes and lower-level objectives define, respectively, the locations in the computer of the weights corresponding to the rows and columns of the attribute- objective matrix.

The weights assigned to objectives and attributes as well as the favorability values assigned to the attributes can be changed easily at an interactive cathode ray tube (CRT) terminal of the AGS. Different results of favorability calculations based on different weights or favorability values are thus readily obtained.

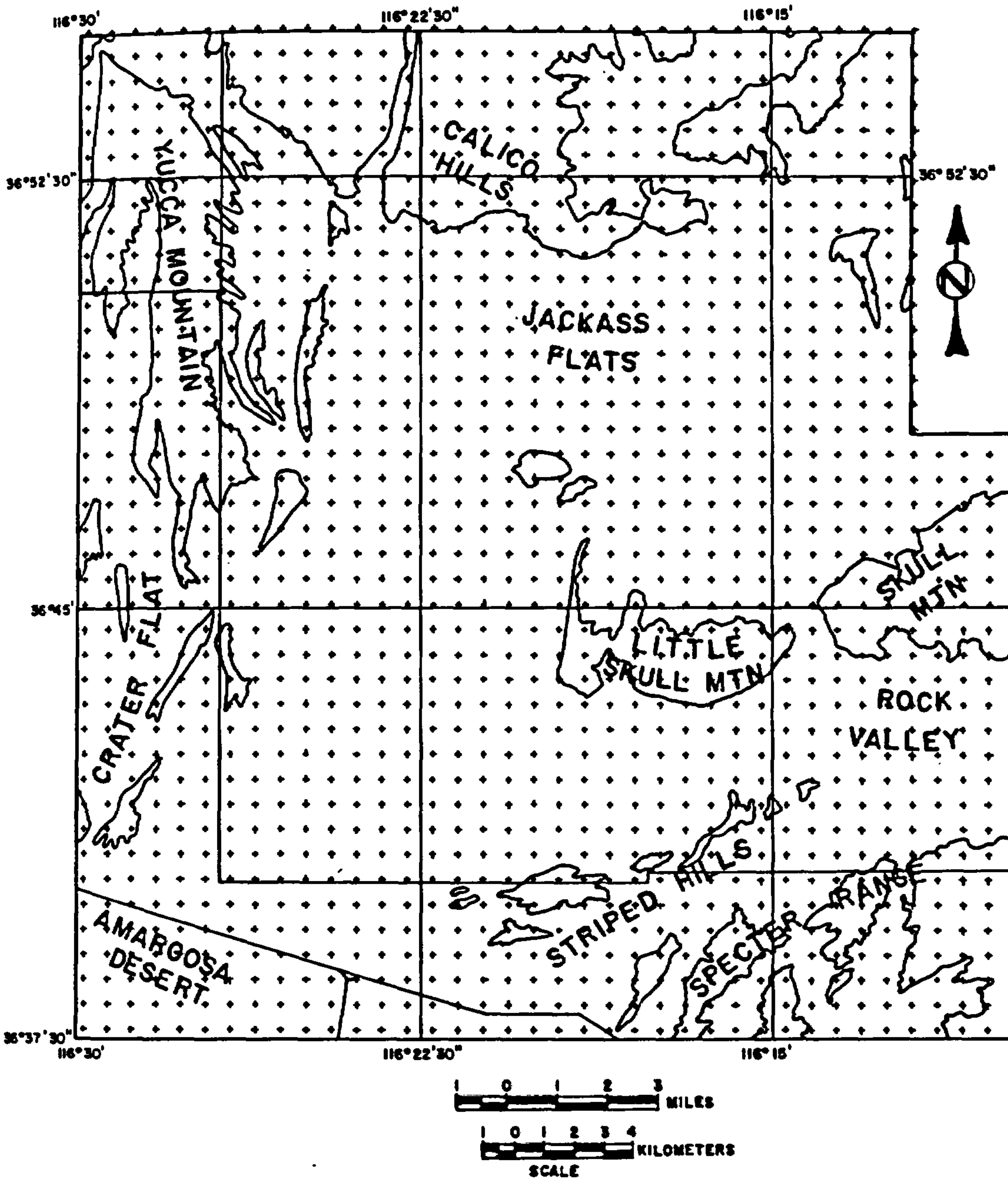


Figure 10. Digital Base Map of the Screening Area; Crosses Correspond to the Centers of the 1,514 Half-Mile Square Grid Cells Which Make Up the Screening Area

Favorability ratings were calculated for alternative locations using the weights and favorability values of attributes

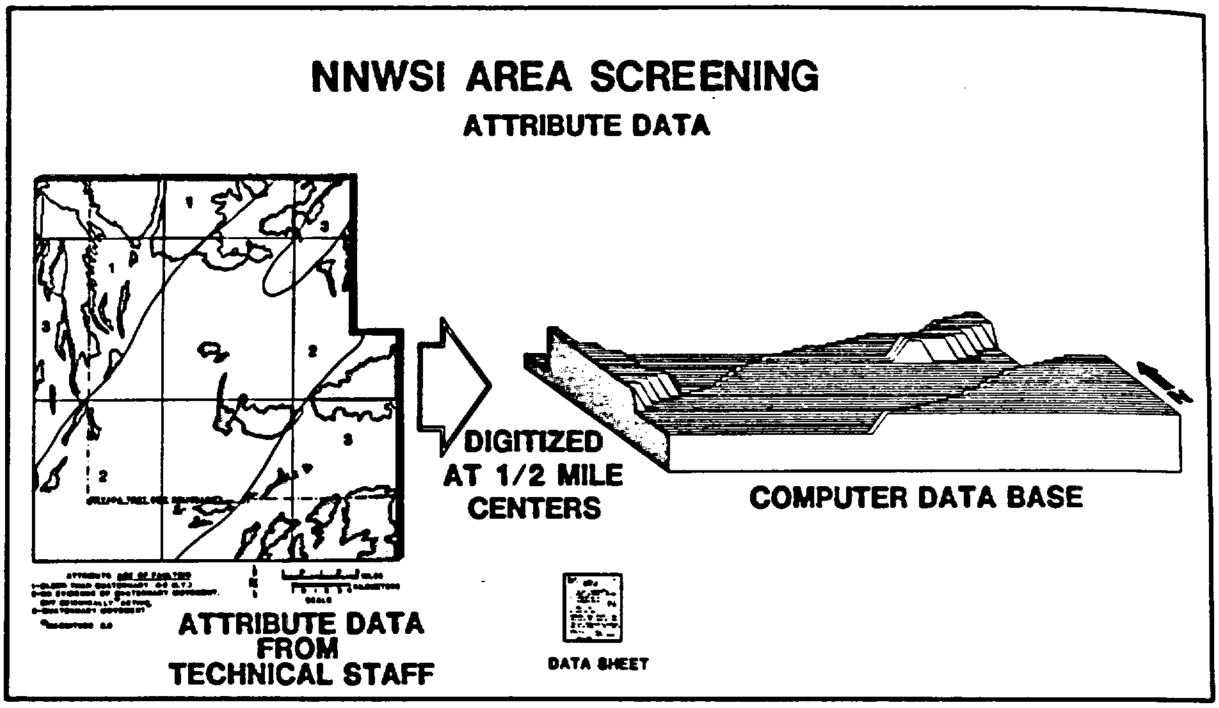


Figure 11. Example of Digitized Attribute Map; Left is the Data Form Provided (in this case by USGS geologists); Right is Digital Form Where Map Units Are Plotted as Z Values on X-Y Coordinates of Base Map (Figure 10)

1-23. Host-rock ratings are based only on attributes 24-31. Weights used in the calculations were obtained by multiplying the attribute weights (Table 6) by the product of weights for each objective from levels 1, 2, and 3 of the appropriate branches of the tree (Table 4, columns 2, 5, and 11; Table 6). This defines a weight for each attribute-objective intersection of the matrix. These weights, in turn, were multiplied by the appropriate favorability values of the corresponding attributes. The favorability values were obtained by picking Z

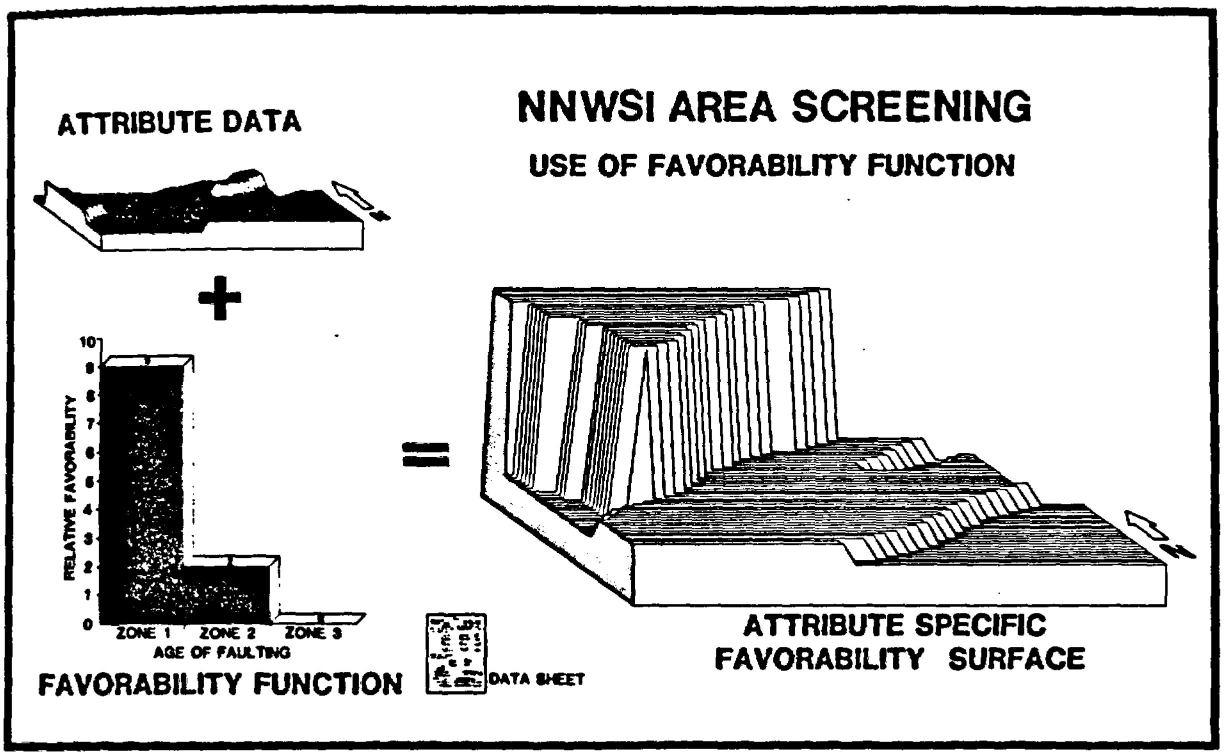


Figure 12. Example of Digitized Favorability Surface. Surfaces Are Obtained for Each Geographical Attribute by Assigning Appropriate Favorability Values to Mapping Units and Plotting Favorability Z Values on the Base Map.

values for pertinent attributes from the appropriate X-Y locations of the digital favorability surfaces. The weighted favorability values from all attribute-objective matrix intersections were summed for each grid cell of the base map. This process produces a map of 1,514 individual favorability scores for the screening area. Thus, each of the 1,514 grid cells is, in effect, an alternative location with its own rating.

The grid cell ratings were stored as Z values corresponding to the appropriate X-Y coordinates of the base map. Ranges of Z values were displayed on the base map providing a graphical map of clusters of grid cells with high and low Z values. These clusters, if large enough, represent, respectively, locations with high and low favorability. Though each grid cell is

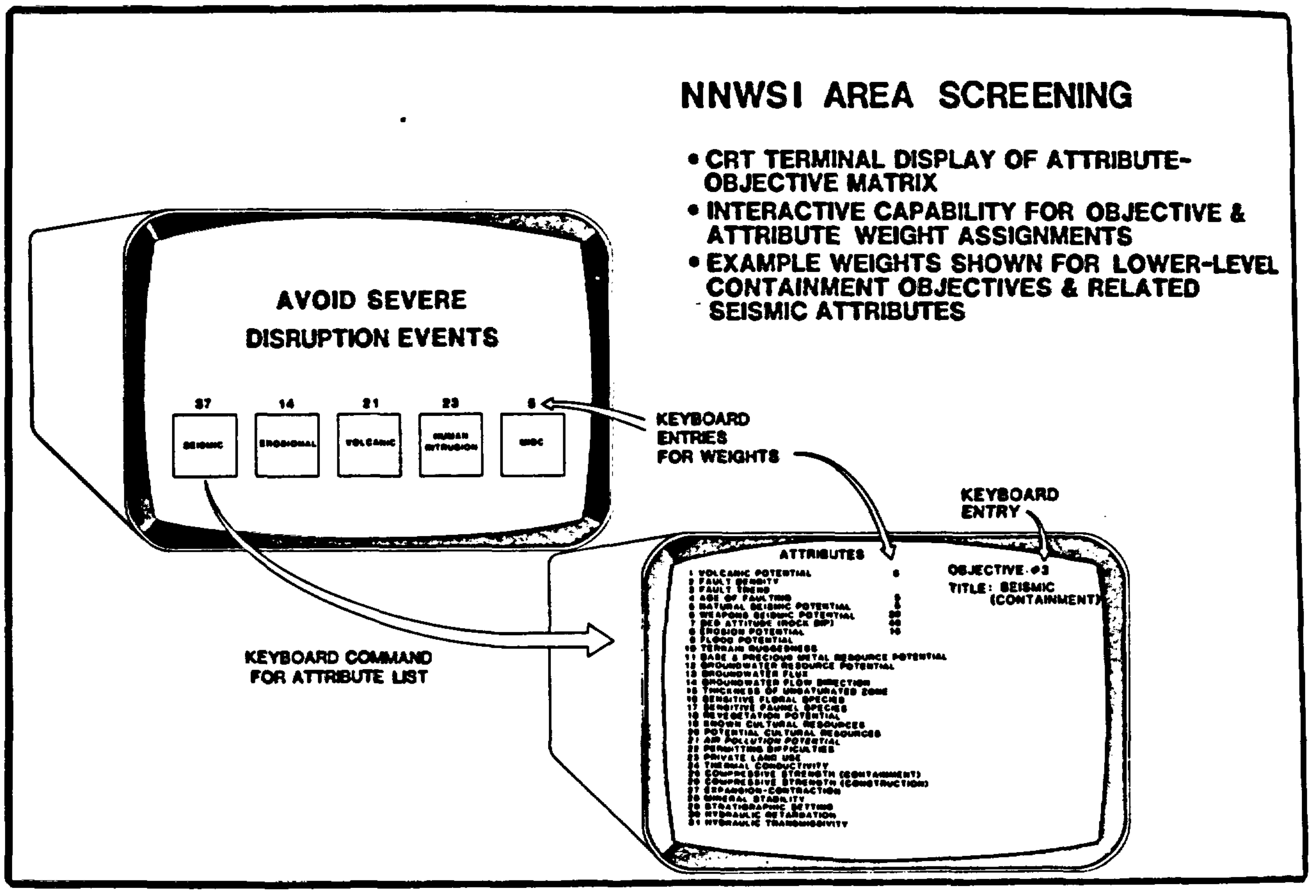


Figure 13. Schematic CRT Terminal Capability for Assigning Weights to Objectives and Attributes

strictly an alternative location, distinct locations for repositories require about 40 similarly rated, contiguous grid cells (~ 10 square miles).

Results can be viewed on a CRT terminal, copied on an electrostatic printer, or reproduced on a CALCOMP plotter. The favorability ranges chosen for map display can be changed easily to allow assessment of the sensitivity of location sizes and shapes to threshold Z values. Due to uncertainties inherent in the many assumptions used in screening, confident discrimination among various locations is probably limited to about three meaningful categories: favorable, neutral, and unfavorable.

Histograms of the favorability ratings for the 1,514 grid cells were plotted which show the number of grid cells with particular scores. These histograms help determine where thresholds between favorable, neutral, and unfavorable rating values should be defined for map displays.

Host-rock ratings were obtained by the same process. Because the host-rock attributes do not vary geographically for a single rock type, but do vary from rock type to rock type, host-rock calculations were repeated only for each of the nine rock types rather than for each grid cell. The output of host-rock evaluations is a list of rating numbers for each of the nine potential host rocks. These values can be assigned to the geographical grid cells corresponding to the subsurface distribution of appropriate rocks yielding a geographical rating which includes the contribution of host-rock attributes.

General Equation for Rating Process

The process for calculating ratings, R, for each half-mile square cell of the base map or each host rock can be summarized as follows.

$$R = \sum_{i=1}^{m} \left(\sum_{j=1}^{n} F_j w_{ij} \right) \tag{2}$$

where

m is the total number of lower-level objectives

n is the total number of attributes

i is the lower-level objective number

j is the attribute number

F_j is the favorability value for the j^{th} attribute at the grid cell or host-rock in question

w_{ij} is the weight of the j^{th} attributed applied to the i^{th} objective and is obtained by multiplying the weight of the i^{th} objective from Table 4, column 12, by the weight of the appropriate j^{th} attribute from Table 6.

Because weights assigned to attributes and objectives are integers between 1 and 100 rather than decimals (e.g., a weight of 55 percent is assigned a value of 55 rather than 0.55), the total possible rating score is 1×10^9. This is because w_{ij} is obtained by multiplying the weights assigned to objective levels 1, 2, and 3 and the attributes in a corresponding column of the attribute-objective matrix shown on Table 6. Because the objective weights at each level of the tree and the attribute weights within a given column of the matrix all sum to 100 percent, the total possible rating, assuming all favorabilities are 10 and at least one attribute applies to each lower-level objective, is obtained by

10 (maximum favorability value of attributes)
times 100 (sum of weights for attributes in a given column of the objective-attribute matrix)
times 100 (sum of weights from Table 4, column 11, for level 3 objectives)
times 100 (sum of weights from Table 4, column 5, for level 2 objectives)
times 100 (sum of weights from Table 4, column 2, for level 1 objectives)
equals 1×10^9.

This total must be divided between location and host-rock ratings based on the proportional contribution of w_{ij} for attributes 1-23 (locations) and 24-31 (host rocks). For convenience, the resulting ratings for locations and host rocks are each divided by 10,000 at the end of the summing process so all ratings are scaled to a maximum combined value of 100,000. These large rating numbers are used primarily to allow their extensive manipulation in the computer system and do not imply that the ratings are meaningful to six significant digits.

Variations of the General Equation

The interactive capabilities of the AGS CRT terminals permit the sensitivity of screening results to various assumptions about the weights and favorability graphs to be easily investigated. However, only the weights were varied because general trends of the favorability graphs are less subject to different interpretations than the proper weights for various objectives.

The method by which various weighting assumptions were investigated was to assign all the weight to selected subsets of objectives or attributes. This allows assessments of which combinations of objectives or attributes are responsible for high and low ratings of different locations and host rocks in the screening area. The results of these variations will be discussed in Chapter 3, but they are mentioned here because different sets of weights affect the maximum possible value of the ratings.

For example, if a particular calculation is restricted to the containment and isolation objectives by assigning zero weights to the other two upper-level objectives, the maximum possible rating is lowered from 100,000 to an amount proportional to the combined weight of the containment and isolation objectives. Assuming weighting values from Table 4, column 2 in this example, the containment and isolation objectives account for only 65 percent of the total weight for upper-level objectives. Accordingly, the maximum possible rating is 65,000.

Because each set of assumptions produces different maximum possible ratings, a means of normalizing all evaluations to a maximum of 100,000 was developed. This involves modifying Equation (2) to

$$R = \left[\sum_{j=1}^{n} F_j [W_j/(F_j)^x]\right]\left[\sum_{j=1}^{n} W_j/(F_j)^x\right]^{-1} \qquad (3)$$

$$W_j = \sum_{i=1}^{m} w_{ij} \qquad (3a)$$

where x is an integer exponent of F_j, and other symbols in Equation (3) and (3a) are the same as in Equation (2). If the exponent, x, is zero, the maximum possible rating, R, divided by 10,000 is 100,000 because $(F_j)^0$ is 1 and Equation (3) becomes

$$R = \left[\sum_{j=1}^{n} (F_j W_j)\right] \left[\sum_{j=1}^{n} (W_j)\right]^{-1} \qquad (4)$$

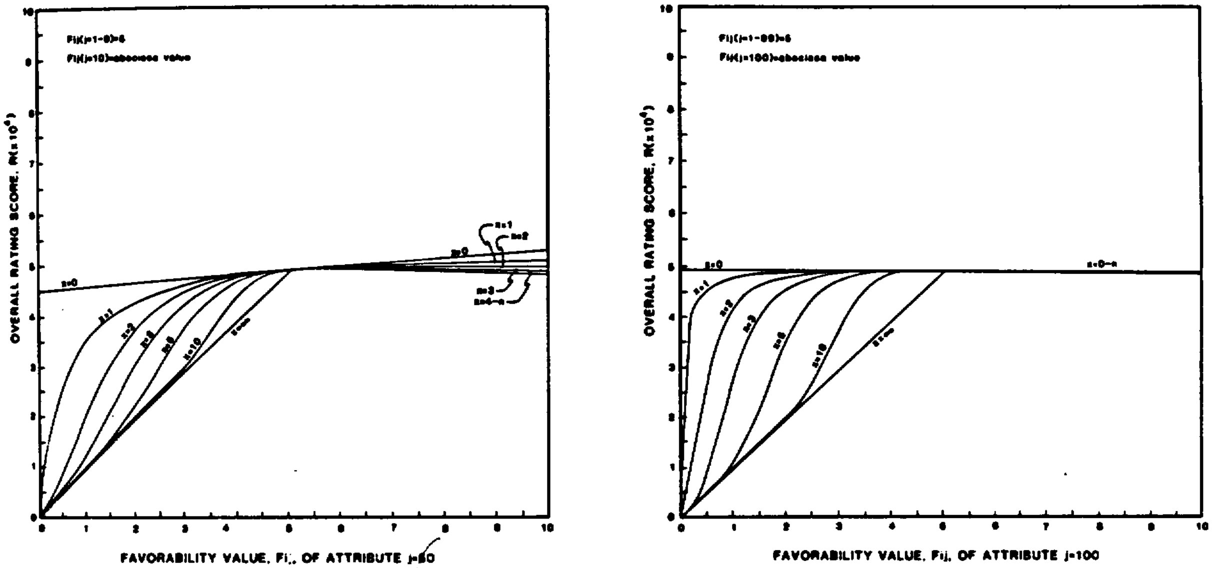
This, rather than Equation (2), was used as the nominal case for calculations because of its independent, normalizing effect on both location and host-rock ratings.

Equation (3) was developed by the LLNL representative on the SEWG, R. C. Carlson, because of its properties when the exponent of F_j is an integer greater than zero. In this case, the effective weight of an attribute is increased as its favorability approaches zero. If the favorability value for attribute, j, at a given attribute-objective matrix intersection, ij, is very low, the ratings of the geographical grid cells or host rocks with these low favorabilities are depressed relative to the nominal evaluations using $(F_j)^o$ (Figure 14). If the location or host-rock ratings are significantly lowered by high exponents in Equation (3), it might be imprudent to locate a repository nearby, though the nominal case may indicate the location or host rock is highly favorable.

Because the weight of low favorability values increases as the exponent is increased (Figure 14), Equation (3) can be used to accentuate to the desired degree those locations with low favorability attributes. If the favorability is zero, the weight is infinite, the total rating is zero, and the zero favorability acts as an exclusionary condition. Parts A and B of Figure 16 show that the effects of Equation (3) are also sensitive to the number of attribute-objective intersections. Equation (3) with exponents greater than zero thus provides a valuable check on the nominal case (exponent = 0) by pointing out whether otherwise favorable locations have one or more undesirable conditions that might become licensing issues later, despite their presumed low weights.

Another variation of Equation (2) used in this screening is

$$Y_R = \sum_{i=1}^{m} (r_i)^2(\sigma_i)^2 \qquad (5)$$



A

B

Figure 14. Effects on the Rating Score of Different Exponents (x) for F_j in Equation 3 and of Different Numbers of Attribute-Objective Interactions, F_{ij}. Figure 14A shows the effect on the overall score of varying the favorability associated with only one out of a possible 10 attribute-objective interactions, all 9 other favorabilities equal 5; Figure 14B shows the related effect for one out of a possible 100 interactions (see upper-left corner of parts A and B).

where

Y_R is the variance of ratings for each grid cell or host rock due to the variances of weights for individual objectives from Table 4, column 14;

$$r_i = \sum_{j=1}^{n} a_{ij}F_j, \qquad (6)$$

or the rating value associate with lower-level objective, and applicable attributes, j;

a_{ij} is the weight of the j^{th} attribute with respect to the i^{th} objective; and

σ_i is the standard deviation of the weight of the i^{th} lower-level objective from Table 4, column 15.

By definition $\sigma_R = (Y_R)^{1/2}$, where σ_R is the standard deviation of the rating for each grid cell or host rock arising from different assumptions by different individuals about the proper weights for various performance objectives. Thus, σ_R provides a measure of confidence in the ratings as a function of a reasonable range for the weights assigned to performance objectives.

Another software application allows one set of ratings for grid cells or host rocks to be added to, subtracted from, multiplied or divided by another. For example, the maximum host-rock score at each grid cell can be added to location ratings to obtain a favorability map of locations including host-rock ratings. The results of Equation (3) with an exponent greater than zero can be divided by results with an exponent of zero to show where low favorability attributes have the largest effect on the ratings. Similarly, the results of Equation (5) can be divided by those of Equation (3) (exponent = 0) to determine the relative rather than the absolute uncertainty due to variance of the objective weights. Such capabilities allow detailed investigation of the sensitivity of the results to many assumptions inherent in the analytical method.

A listing and discussion of computer algorithms will be available soon in the companion report devoted solely to documentation of AGS software developed for the NNWSI screening activity [12].

CHAPTER 3. NUMERICAL RESULTS

The results of the screening analyses are presented in this chapter. First, overall* results which show location and host-rock ratings are discussed. Then, results which segregate for separate analysis selected subsets of objectives and attributes are presented. For each set of results in this chapter, the following information, as appropriate, is provided:

1. a map, based solely on host-rock independent attributes 1-23, showing the geographic distribution of high, intermediate and low ratings for the 1,514 half-mile square grid cells of the screening area;
2. a histogram of ratings for the 1,514 grid cells;
3. two lists for the nine potential host rocks, based solely on host-rock attributes 24-31, showing separate ratings for site-independent saturated and unsaturated rocks;
4. discussion of the ratings with respect to the relative favorability of various locations and host rocks.

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*"Overall" is used in this report to describe ratings based on weighted objectives from all branches of the objectives tree (Table 4, column 12) and all weighted attributes (Table 6) applicable to geographical ratings (attributes 1-23) and host-rock ratings (attributes 24-31). These ratings are the most comprehensive analyses available from the screening method and provide the best approximations of the most and least favorable locations and host rocks based on all of the assumptions inherent to the method.

Maps of location ratings in this chapter show three categories of relative favorability: high, intermediate, and low. Three categories of favorability generally fall within the discriminating capabilities of this screening, given the necessary assumptions and generalizations about the objectives, attribute data, and favorability graphs. A larger number of rating categories is unnecessary for distinguishing which locations rate highest and lowest. Discussion of the maps will emphasize locations with high ratings because these are of most interest for future repository siting. Locations with low ratings will be mentioned to point out areas which should be avoided if relative favorability based on this screening is a valid factor for location selection. Locations with intermediate ratings may or may not be favorable within the discriminating capabilities of this screening; therefore, they are either not discussed or are only briefly mentioned, leaving to the reader the judgment about whether they should be considered as options for repository exploration.

Flexibility is also retained for the reader to judge the proper extent and boundaries of various locations based on appropriate threshold values for defining favorable and unfavorable ratings. In this report, favorable locations are considered to occur where a high density of 40 or more grid cells is rated above some discretionary value, generally corresponding to the upper 10-20 percent of the rating scores.

Assuming a Gaussian distribution for ratings of the 1,514 grid cells, the upper threshold on the maps in this chapter generally corresponds to one standard deviation above the mean, rounded to the nearest 5,000. This corresponds to numerical discrimination among locations to two significant digits. Similarly, a lower threshold is generally set at one standard deviation below the mean, rounded to the nearest 5,000. Upper thresholds usually fall between about 50,000 and 70,000 out of a possible 100,000 and lower thresholds between 40,000 and 50,000. If discrete polymodal distributions occur on the histograms, upper and lower thresholds occasionally are defined at rating values separating the modal groupings--even if these values are different than about one standard deviation away from the mean.

Host-rock ratings are also rounded to two significant digits. This degree of discrimination is compatible with the generalizations of this method. Therefore, the host-rock ratings present the same numerical discrimination as provided on the maps of location ratings.

Weights used for each set of results are shown on attribute-objective matrices in Appendix C.

Overall Results

The overall relative favorabilities of selected locations and site-independent host rocks as well as confidence in these ratings are discussed in this section.

Overall ratings for locations (maps) and host rocks (lists) were obtained separately using Equation (3) with an exponent of zero for Fj. Accordingly, the overall ratings for geographical locations and site-independent host rocks are discussed separately in this section. Then a map is presented which combines the separate, overall ratings for geographical locations and host rocks. Lastly, this section provides an analysis of confidence in the overall ratings due to the variance in weights assigned to the lower-level performance objectives.

Overall Location Ratings

Based solely on geographically discriminating attributes (1-23), only two locations with sufficient area for repository development (about 10 square miles or 40 grid cells) have highly favorable ratings, in this case greater than 60,000 out of a possible 100,000 (Figure 15, map). The first location is the northern portion of Yucca Mountain and the second is the northeastern portion of Jackass Flats. The highly rated part of Yucca Mountain shows up on Figure 15 as the northwest trending, dark grey location near the northwest corner of the screening area. It is approximately bounded on the northeast by Yucca Wash* and on the south by the boundary between the Nellis Air Force Range and BLM land. To the east it is approximately bounded by Fortymile Wash.

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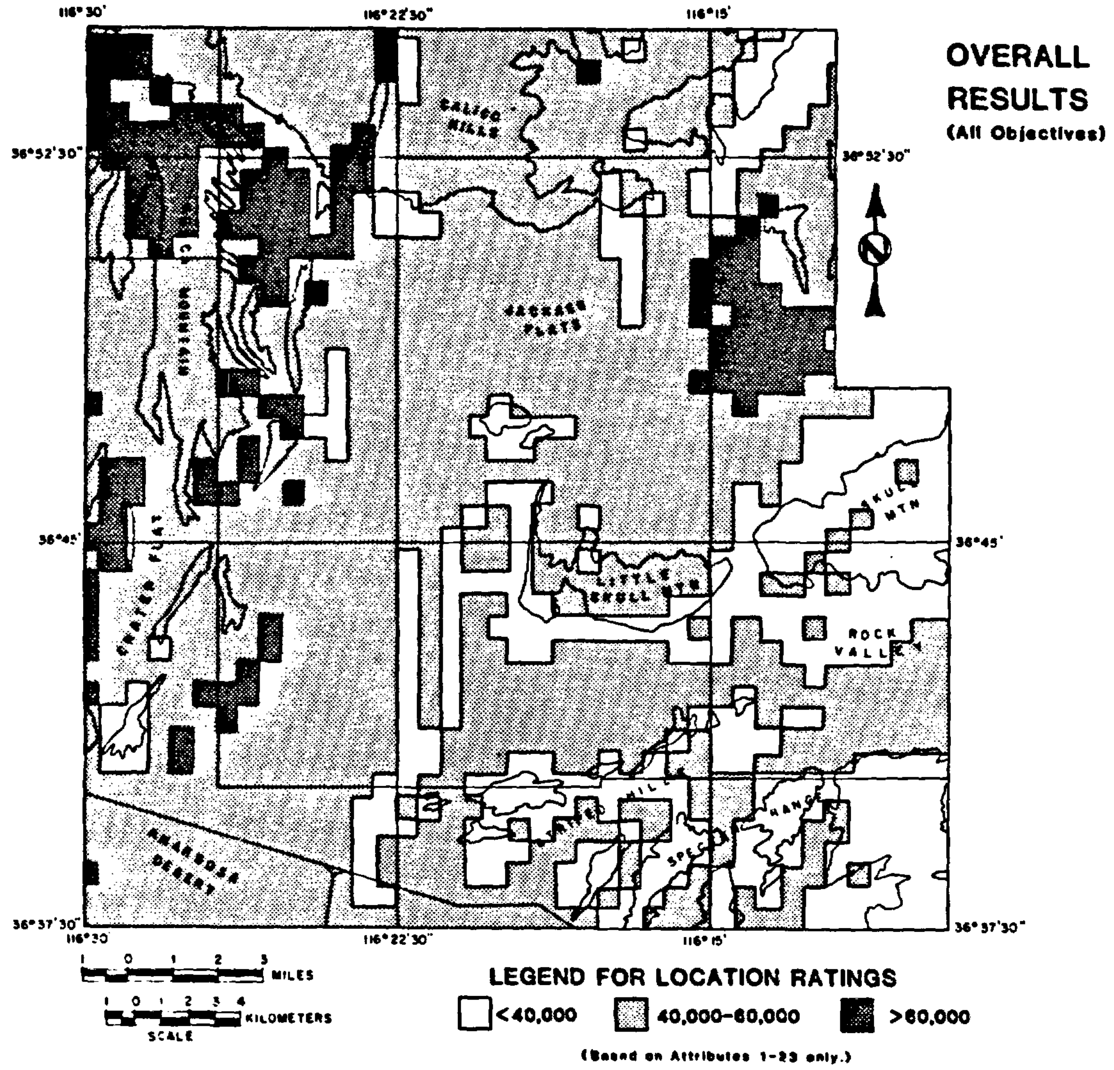
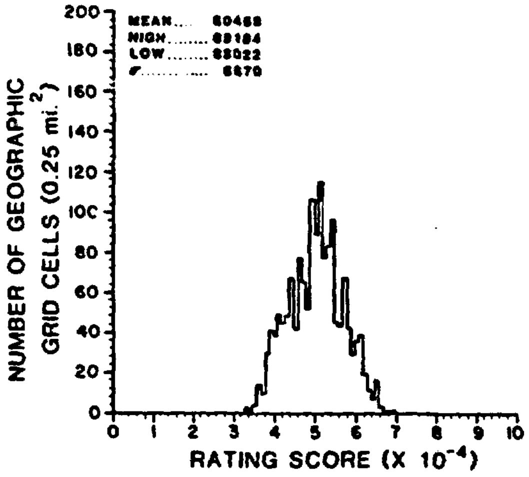
*See Figure 16 for the location of many of the minor geographical features mentioned in the text.





HOST ROCK RATINGS

		SATURATED		UNSATURATED	
AGE	ROCK TYPE	RATING	RANK	RATING	RANK
YOUNGER	Alluvium	45000	7	43000	8
	Basalt	49000	6	48000	7
	Non-welded Paintbrush Tuff	55000	5	42000	9
	Topopah Spring Tuff	41000	8	58000	5
	Calico Hills Tuff	75000	3	62000	3
	Crater Flat Tuff	67000	4	60000	4
	Granite	76000	2	63000	2
	Argillite	82000	1	72000	1
OLDER	Carbonate	39000	9	55000	6

NOTE: Host rock ratings based solely on host rock attributes (numbers 24-31 for saturated list; for unsaturated list numbers 24-30 only). Ratings do not account for site dependent rock conditions such as in-situ stress, in-situ temperature, depth, local structures and others. Unsaturated ratings omit hydraulic transmissivity, attribute #31.

Figure 15. Overall Ratings of Locations and Host Rocks See Table 6, page 37, for applied weights.

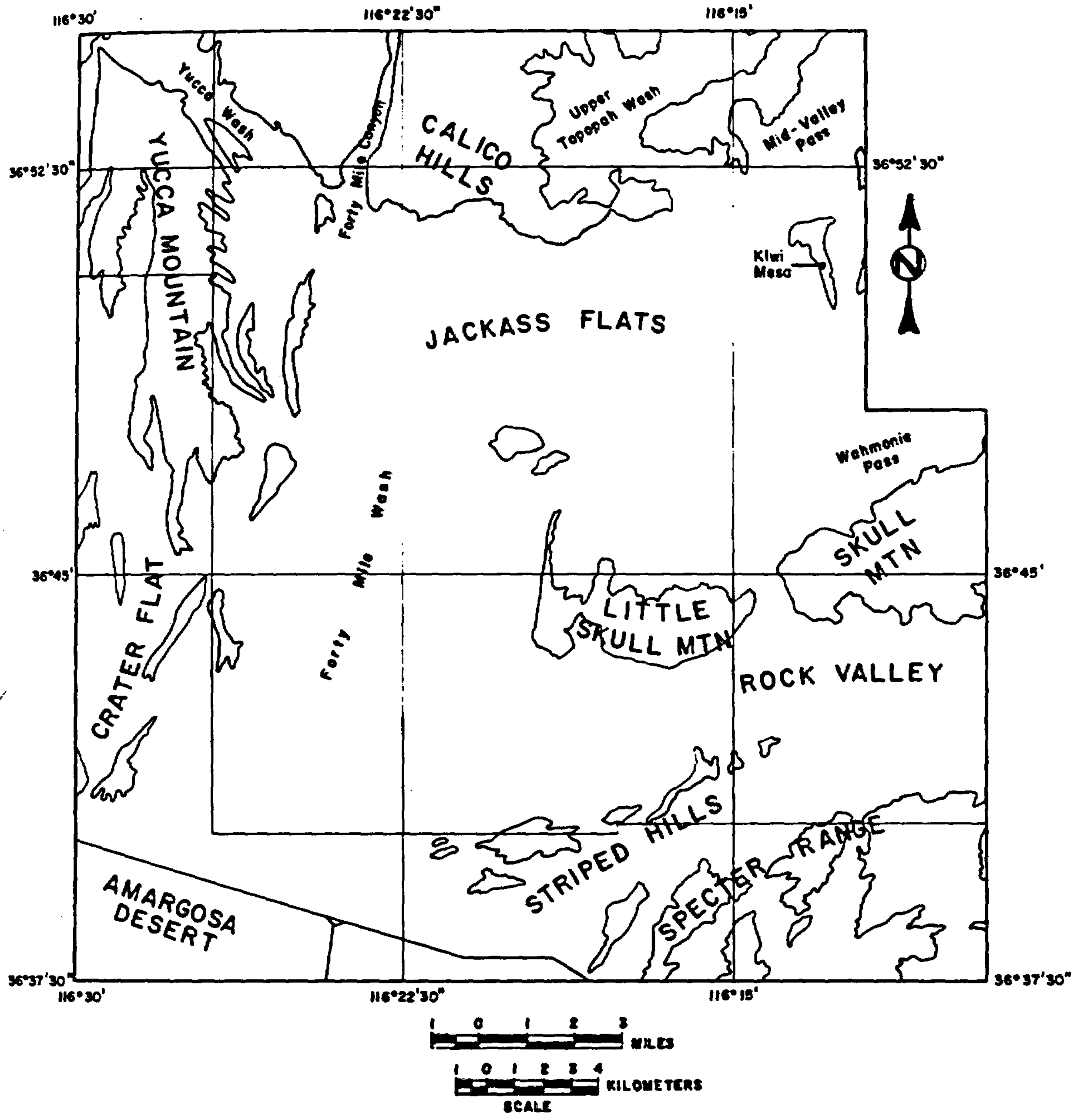
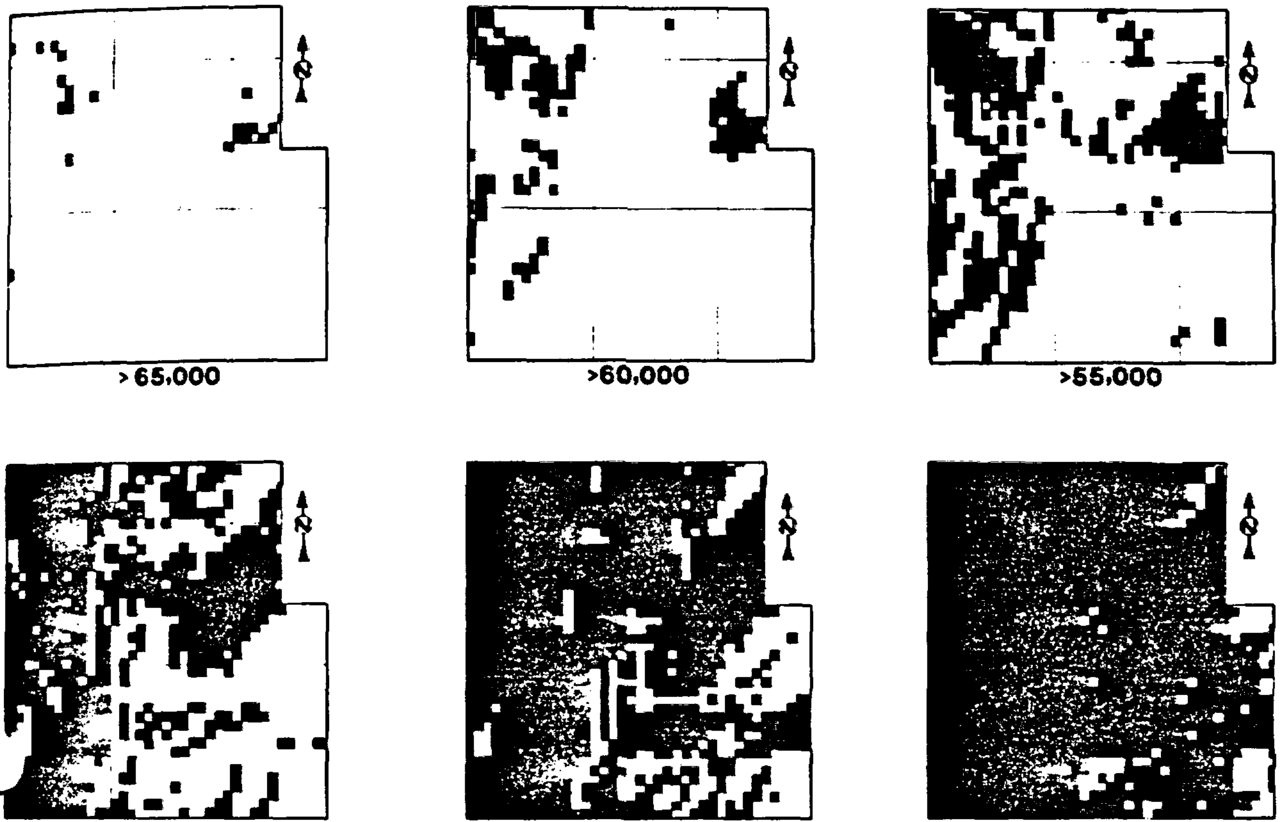


Figure 16. Index Map of Various Geographical Features Referred to in the Text

The highly rated location at northeastern Jackass Flats is just north of the dogleg along the eastern edge of the screening area. It occurs immediately west and south of Kiwi Mesa and lies within the transition zone between Jackass Flats and Wahmonie Pass. Other favorably rated grid cells occur in clusters too small for repository development. These clusters are distributed among the alluvial valleys of southern Yucca Mountain.

The lowest rated locations (ratings of less than 45,000) are concentrated in the southeast portion of the screening area. They are distributed throughout the Specter Range, Striped Hills, Rock Valley, Skull Mountain, and Little Skull Mountain. The unfavorable zone at Little Skull Mountain extends northward to the small hills just south of the E-MAD Facility in Jackass Flats. Another relatively unfavorable location occurs in the northeast portion of the screening area along the pass between Jackass Flats and Mid-Valley. Four smaller unfavorable zones occur in a line from Fortymile Canyon to southern Yucca Mountain.

Figure 17 shows the geographical effects of varying the rating threshold for display of overall results. The size of locations displayed expands as the threshold for favorable ratings is lowered. This indicates the discretionary nature of thresholds and resulting boundaries for favorably rated locations. As lower scores are included within the threshold for highly rated locations (upper left to lower right, Figure 17), the Yucca Mountain and northeast Jackass Flats locations expand, respectively, to the south and southeast (Figure 17 A through D). No distinctly new locations with favorable ratings



>65,000 >60,000 >55,000

>50,000 >45,000 >40,000

Figure 17. Geographic Effect of Different Upper Rating Thresholds for Favorable Locations. Thresholds are Given Below Each Map. Dark Areas Show Favorably Rated Grid Cells. Weights are same as for Figure 15.

emerge other than southern Yucca Mountain and central Jackass Flats until all rating values above 45,000 (less than the mean of 50,459) are shown (see histogram on Figure 15). In this case, so much of the screening area is shown as favorable that the discriminating effect of the threshold is reduced to questionable value. Therefore, it appears that northern Yucca Mountain and northeastern Jackass Flats are the only distinctly superior repository locations in the screening area based on the overall screening analysis of host-rock independent attributes.

The histograms on Figure 15 and others later in this chapter show the average, high, and low values and standard deviations of geographical ratings. These numbers in conjunction with the histograms are included to aid the reader in arriving at personal judgments about whether appropriate thresholds were selected for the maps of the most and least favorable locations.

Overall Host-Rock Ratings

Figure 15 also lists overall ratings for the nine alternative rock types considered in this screening. These ratings are based solely on attributes 24-31 and are meant only to distinguish among site-independent rock qualities. Site-specific host-rock factors will be evaluated during the last half of 1982 in a separate horizon evaluation activity. The host-rock ratings presented here are only intended as general guidelines about which rocks, independent of local conditions, are better suited to meet the performance objectives addressed by this screening.

Host-rock ratings are obtained by calculations performed separately from those represented on the maps. The two separate lists (Figure 15, lower-right) grossly distinguish between saturated and unsaturated conditions. Both lists are based on identical weights for attributes 24-30. However, attribute 31, hydraulic transmissivity, was assigned weights shown on Table 6 for saturated conditions and a weight of zero for unsaturated conditions. These weights were assigned on the assumptions that (1) near-field water flow is controlled by hydraulic transmissivity and (2) this attribute is essentially unimportant in the unsaturated zone.*

For both saturated and unsaturated ratings, the four highest rated rock types are the same. From highest to lowest, these rock types are: argillite, granite, the Calico Hills Tuff, and the Crater Flat Tuff (see Table 7 for relation of rock names used in this report to formal stratigraphic nomenclature). Argillite rates significantly higher than granite and Calico Hills Tuff, which have almost identical ratings. The Crater Flat Tuff rates significantly lower for saturated conditions than either granite or Calico Hills Tuff. Its rating is about the same as these rocks for unsaturated conditions. However, ratings for argillite, granite, and Calico Hills Tuff drop by more than 10,000 from saturated to unsaturated conditions, indicating the importance of low hydraulic

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*These assumptions provide the only convenient means within the limitations of this screening to distinguish the relative merits of saturated and unsaturated rocks. It should be noted that these assumptions may be overly simplistic and result in exaggerated differences among the ratings of the unsaturated rocks due to attributes other than hydraulic transmissivity. If hydraulic transmissivity is, indeed, important in the unsaturated zone, the list for "Saturated" rocks may better approximate unsaturated conditions than the "Unsaturated" list. The separate lists should be interpreted accordingly--especially considering that hydraulic transmissivity ranks as the highest weighted attributed (Figure 8).

transmissivity on their ratings. The rating of Crater Flat Tuff drops less from saturated to unsaturated conditions, indicating less sensitivity to hydraulic transmissivity.

Ratings of the five lowest ranked rock types fall off sharply from the score of the Crater Flat Tuff. In descending order, lower ratings for saturated conditions are obtained for the nonwelded Paintbrush Tuff, basalt, alluvium, Topopah Spring Tuff, and carbonates. For unsaturated rocks, the Topopah Spring Tuff and carbonates rise from rankings of eighth and ninth to fifth and sixth, respectively. This shows the effect of ignoring their high hydraulic transmissivities. In the

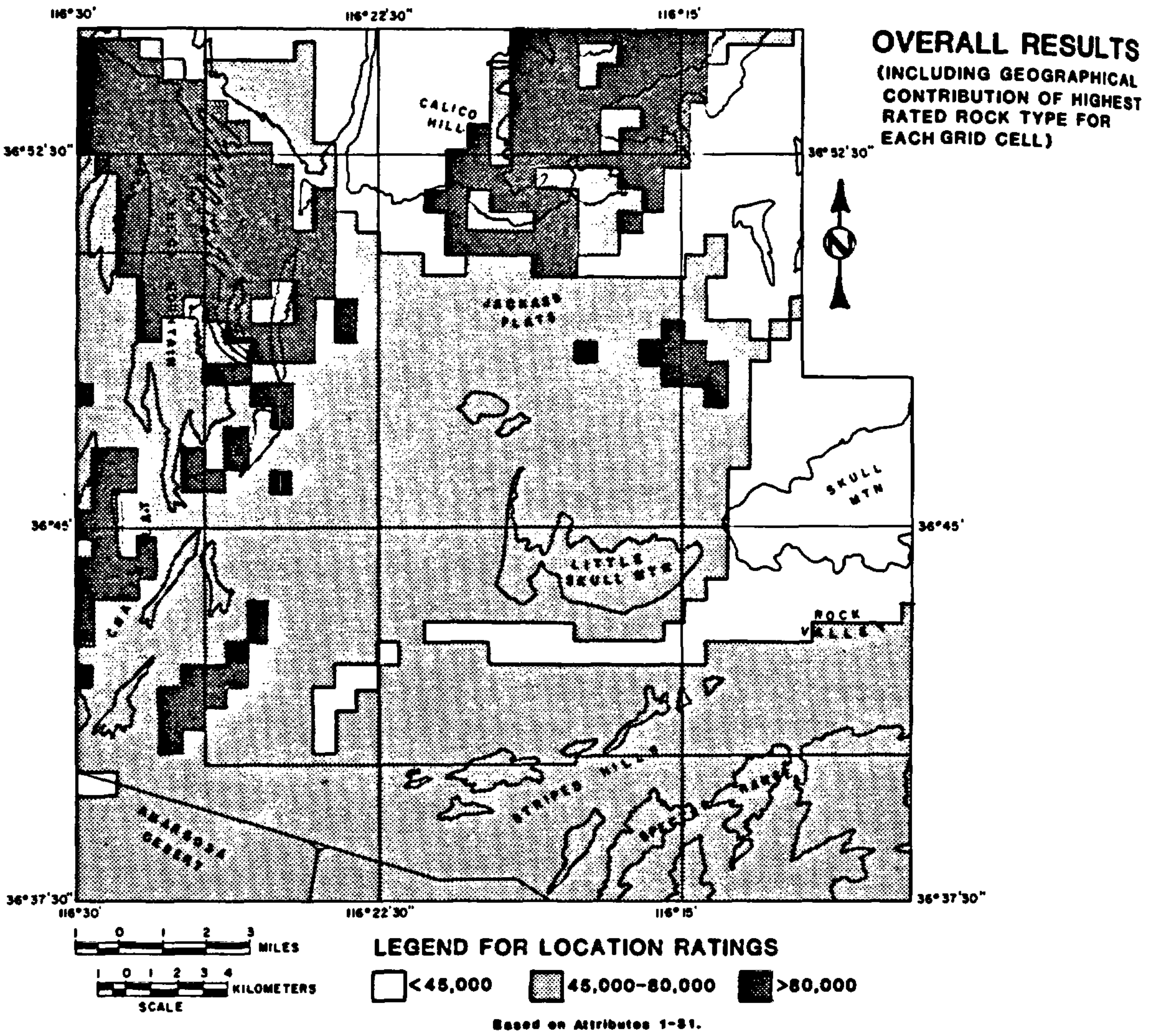
Candidate Rock Units for Screening	Formal Stratigraphic Equivalents
Alluvium	Tertiary and Quaternary alluvium (undifferentiated)
Basalt	Basalt of Kiwi Mesa Basalt of Skull Mountain
Nonwelded Paintbrush Tuff	Pah Canyon Member, Paintbrush Tuff Yucca Mountain Member, Paintbrush Tuff Topopah Spring Member, Paintbrush Tuff (nonwelded upper portion)
Topopah Spring Tuff	Topopah Spring Member, Paintbrush Tuff (densely welded central portion)
Calico Hills Tuff	Bedded Tuffs of Calico Hills (nonwelded ash-flow portions)
Crater Flat Tuff	Tuff of Crater Flat (Prow Pass, Bullfrog and Tram Members and underlying unnamed tuffs to 4000' depth)
Argillite	Eleana Formation (argillaceous units)
Granite	No formal name, inferred Tertiary intrusive beneath Calico Hills
Carbonate	Bonanza King Formation, Nopah Formation Goodwin Limestone, Antelope Valley Limestone Unnamed Silurian Dolomites, Nevada Formation

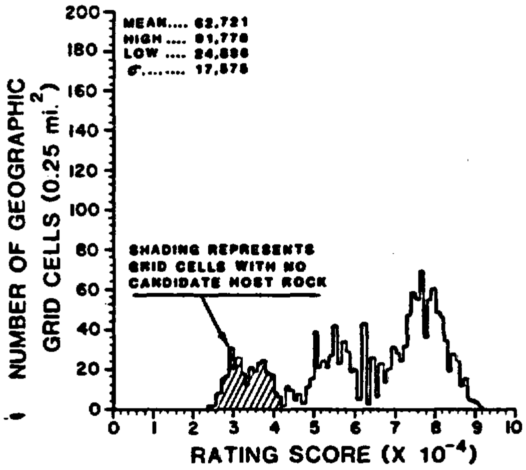
Table 7. Relation of Rock Units Considered in Screening to Stratigraphic Nomenclature

opposite sense, the nonwelded Paintbrush Tuff drops from a rank of fifth to ninth from saturated to unsaturated ratings, indicating that its low hydraulic transmissivity accounts for a significant portion of its saturated rating. Alluvium and basalt generally retain low ratings for both saturated and unsaturated conditions.

Combined Overall Host-Rock and Location Ratings

When the score of the highest rated rock type at each grid cell is added to the location rating, a map is obtained which shows the relative favorabilities of locations, including the contribution of host-rock properties (Figure 18). This combined rating of geographical and host-rock attributes is scaled to a maximum of 100,000. It retains high scores for northern Yucca Mountain due, in large part, to the contribution of high ratings for the Calico Hills Tuff (Figure 7). The nonwelded Calico Hills Tuff is generally highly zeolitic and occurs both above and below the water table at Yucca Mountain. Another of the more highly rated rock types, the Crater Flat Tuff also occurs at appropriate depths (500 to 4,000 feet) at Yucca Mountain. The Crater Flat Tuff is moderately to densely welded, zeolitic at some depths, and entirely below the water table. Different strata of this unit have different hydrologic, thermomechanical, and geochemical characteristics not distinguished in this screening. The other potentially usable





		SATURATED		UNSATURATED	
AGE	ROCK TYPE	RATING	RANK	RATING	RANK
YOUNGER	Alluvium				
	Basalt				
	Non-welded Paintbrush Tuff				
	Topopah Spring Tuff				
	Calico Hills Tuff				
	Crater Flat Tuff				
	Granite				
	Argillite				
OLDER	Carbonate				

LOCATION & HOST ROCK RATINGS FROM FIGURE 16 ARE COMBINED IN THIS MAP AND HISTOGRAM.

Figure 18. Overall Location Ratings Including the Contribution of the Most Highly Rated Host Rocks. Same weights as Figure 15.

rock type occurring at Yucca Mountain is the unsaturated, densely welded Topopah Spring Tuff.

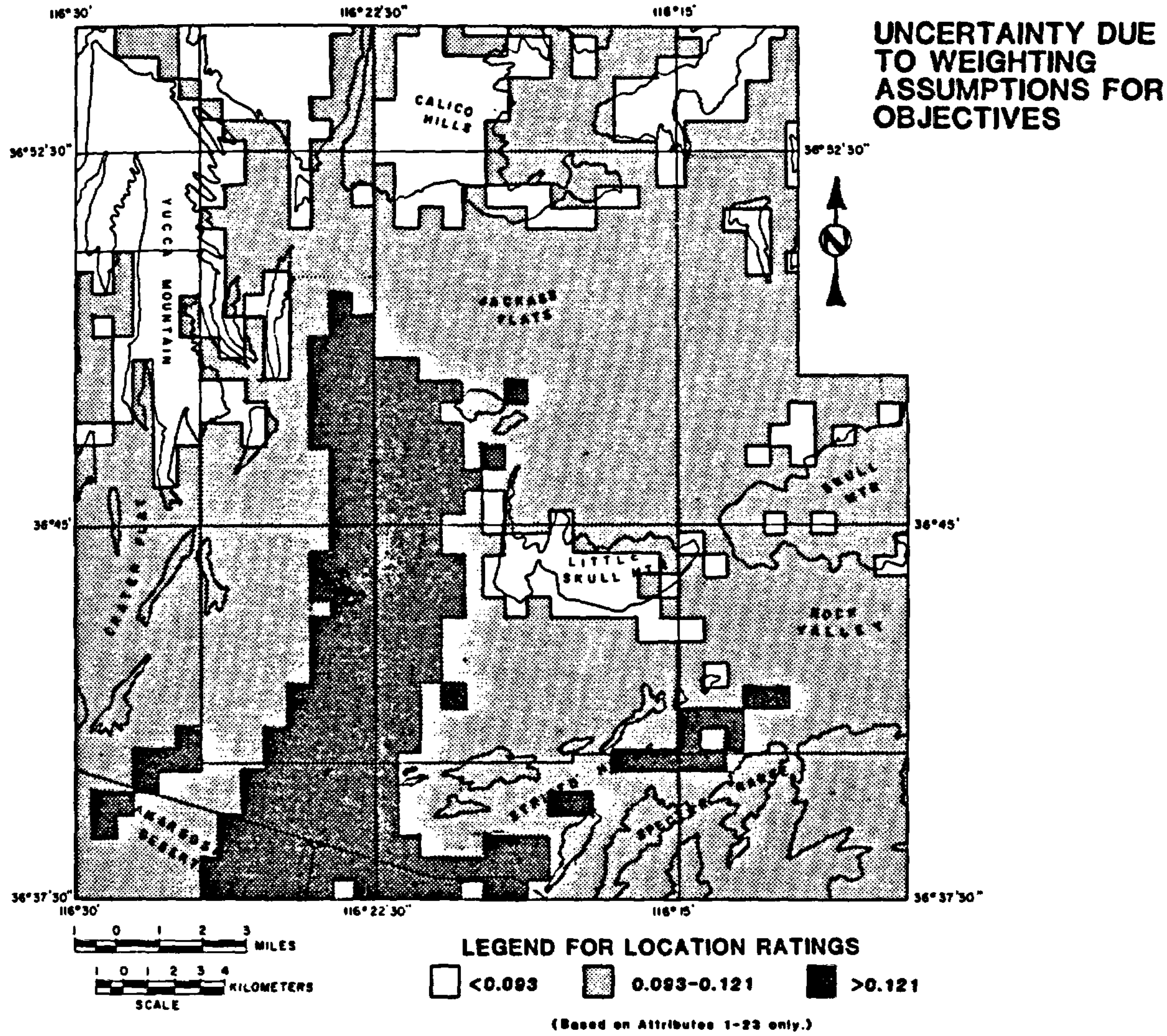
The area around Calico Hills (a location, not to be confused with the rock type) and Upper Topopah Wash emerges on Figure 18 as a distinct, alternative favorable location, due in large part to the contribution of argillite, the most highly rated rock type in the screening area. This location therefore generally corresponds to where argillite occurs at appropriate depths (Figure 7). Granite, the second most highly rated rock type, also may occur beneath the Calico Hills-Upper Topopah Wash location. However, granite does not contribute to the overall ratings shown on Figure 18, for two reasons. First, granite only occurs beneath the same locations as argillite; second, only the scores of the highest rated rock type at a given location are included in the map on Figure 18.

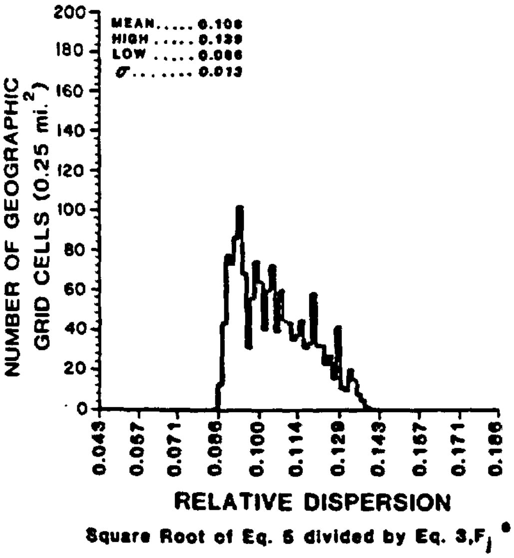
At northeastern Jackass Flats, the other location rated highly for host-rock independent attributes (Figure 15), the Crater Flat Tuff, Topopah Spring Tuff, alluvium, and basalt may occur at appropriate depths only beneath the westernmost edge of this location. However, none of these rock types occur beneath a large enough portion of this location for adequate repository development. Rocks at appropriate depths beneath the main portion of northeastern Jackass Flats are inferred to be interlayered tuffs and rhyolites whose presumed complexity precluded their consideration as candidates for repository host rocks.

For combined host rock-location ratings, the least favorable areas correspond to portions of the screening area where no candidate host rocks occur. Similar results are obtained for both saturated and unsaturated conditions, though Figure 18 only shows results for saturated conditions.

Analysis of Variance

Relative confidence in the overall ratings is, in part, a function of the variances of the weights assigned to different performance objectives (Table 4, column 14). Figure 19 portrays such relative confidence in the overall ratings. The map and host-rock lists on Figure 19 were obtained by dividing ratings obtained with Equation (3), x = 0, by those obtained from Equa- tion (5) (Figure 20). Blank areas on the map of Figure 19 oc- cur where greater confidence can be placed in the location ratings based on variances of the weights for lower-level ob- jectives. Likewise, lower values on the host-rock lists indi- cate higher confidence in the ratings. High values (dark areas on the map) occur where the absolute variances of grid cell and host-rock ratings are high compared to the overall rating; therefore, relative confidence is low. Statistically, this ratio is referred to as "relative dispersion" [22] and, as the name implies, provides a measure of uncertainty in a value relative to the magnitude of the value itself.

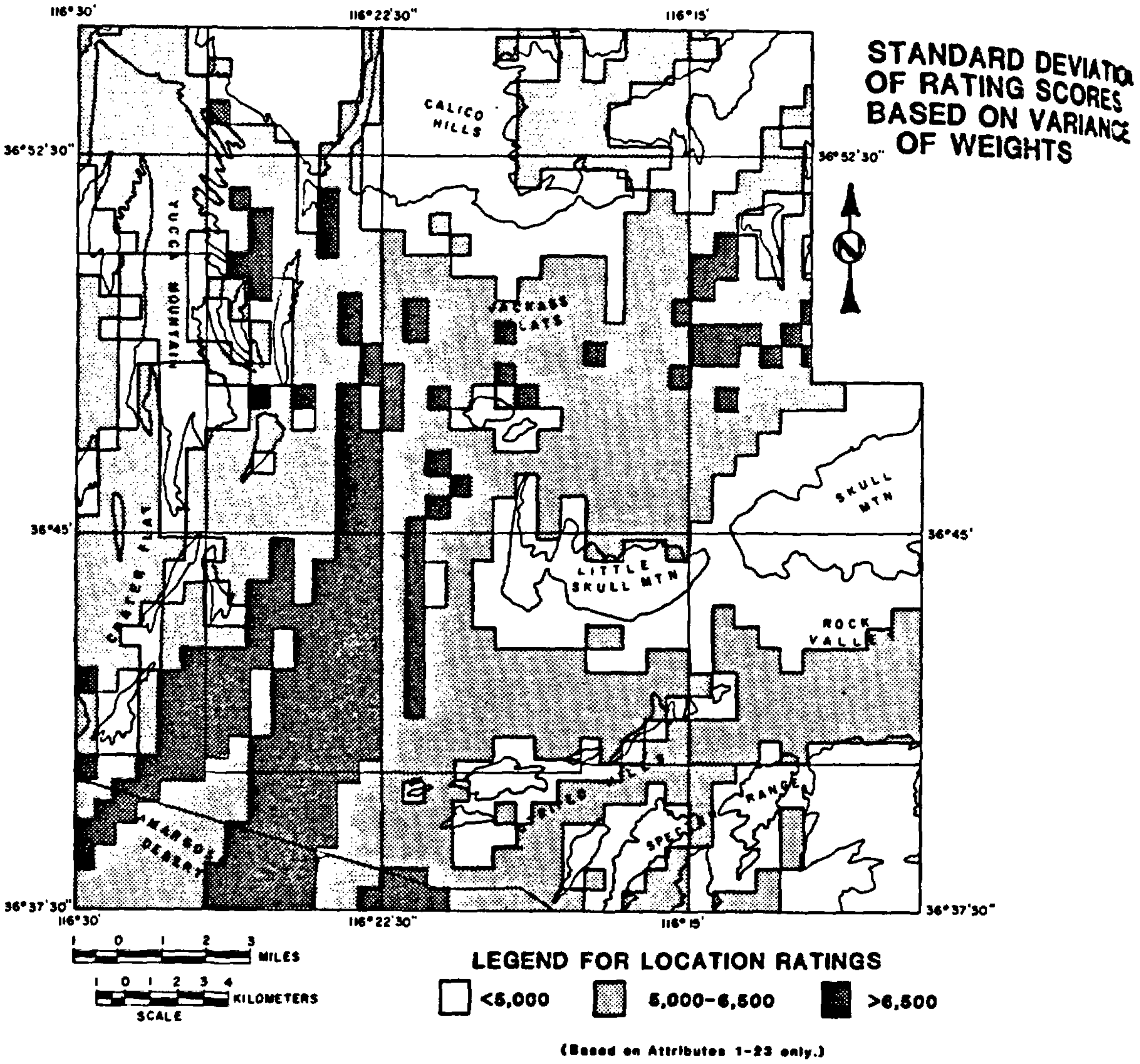


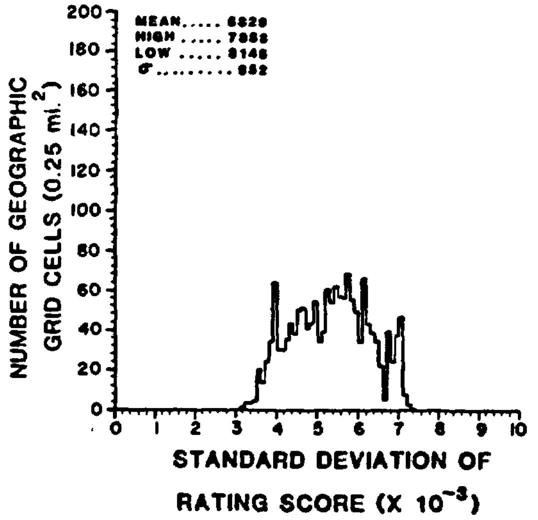


		SATURATED*		UNSATURATED*	
AGE	ROCK TYPE	RATING	RANK	RATING	RANK
YOUNGER	Alluvium	0.091	1	CALCULATIONS NOT PERFORMED	
	Basalt	0.094	4		
	Non-welded Paintbrush Tuff	0.092	2		
	Topopah Spring Tuff	0.100	5		
	Calico Hills Tuff	0.093	3		
	Crater Flat Tuff	0.091	1		
	Granite	0.094	4		
	Argillite	0.093	3		
OLDER	Carbonate	0.109	6		

NOTE: Host rock ratings based solely on host rock attributes (numbers 24-31 for saturated list; for unsaturated list numbers 24-30 only). Ratings do not account for site dependent rock conditions such as in-situ stress, in-situ temperature, depth, local structures and others. Unsaturated ratings omit hydraulic transmissivity, attribute #31.

Figure 19. Relative Dispersion (Uncertainty) of the Overall Ratings Due to Variances Associated With Weights of the Objectives





		SATURATED		UNSATURATED	
AGE	ROCK TYPE	RATING	RANK	RATING	RANK
OLDER — YOUNGER	Alluvium	4092	1	CALCULATIONS NOT PERFORMED	
	Basalt	4572	4		
	Non-welded Paintbrush Tuff	5086	5		
	Topopah Spring Tuff	4114	2		
	Calico Hills Tuff	6960	7		
	Crater Flat Tuff	6113	6		
	Granite	7109	8		
	Argillite	7552	9		
	Carbonate	4290	3		

NOTE: Host rock ratings based solely on host rock attributes (numbers 24-31 for saturated list; for unsaturated list numbers 24-30 only). Ratings do not account for site dependent rock conditions such as in-situ stress, in-situ temperature, depth, local structures and others. Unsaturated ratings omit hydraulic transmissivity, attribute #31.

Figure 20. Standard Deviations of the Ratings Due to Standard Deviations of the Weights for Objectives

Therefore, Figure 19 indicates that the high ratings at northern Yucca Mountain and Calico Hills-Upper Topopah Wash (Figures 15 and 18) are less sensitive than most other locations due to assumptions by different individuals about the proper weights for specific objectives. Relatively high confidence also can be placed in the low overall ratings at Little Skull Mountain and moderate overall ratings just west of Fortymile Canyon. Moderate sensitivity to weighting assumptions is indicated for the high geographical ratings at northeastern Jackass Flats. The greatest uncertainty is associated with a strip of land along and east of Fortymile Wash.

Analysis of Objectives and Contributing Attributes

To determine which factors are most important in the overall ratings at various locations and for various host rocks, selected subsets of objectives and attributes were analyzed separately. The rest of this chapter will discuss these analyses to determine which factors are responsible for the overall ratings. The discussion will emphasize locations that rate highly in the overall analysis; namely, northern Yucca Mountain, northeastern Jackass Flats, and Calico Hills-Upper Topopah Wash.

It bears repeating here that the overall ratings shown on Figures 15 and 18 aggregate the effects of all screening objectives and attributes. The overall ratings discussed in the preceding section thus represent the most comprehensive approximations available from this method of where in the screening area the best and worst locations and host rocks occur. The following analyses segregate limited portions of the overall results for separate evaluation. Therefore, the following results are not valid for determining by themselves which locations or host rocks are more favorable. For this reason, only favorable locations and host rocks based on the overall ratings are emphasized in the subsequent discussion. This provides a basis for comparison of their relative strengths and weaknesses. Similar comparisons could be made for all potential locations and host rocks in the screening area, but this is considered unnecessary given that the overall ratings establish which locations and host rocks warrant more detailed consideration. In addition, the following analyses will point out whether any poorly rated objectives or attributes occur at the most favorable locations, thereby indicating potential licensing issues.

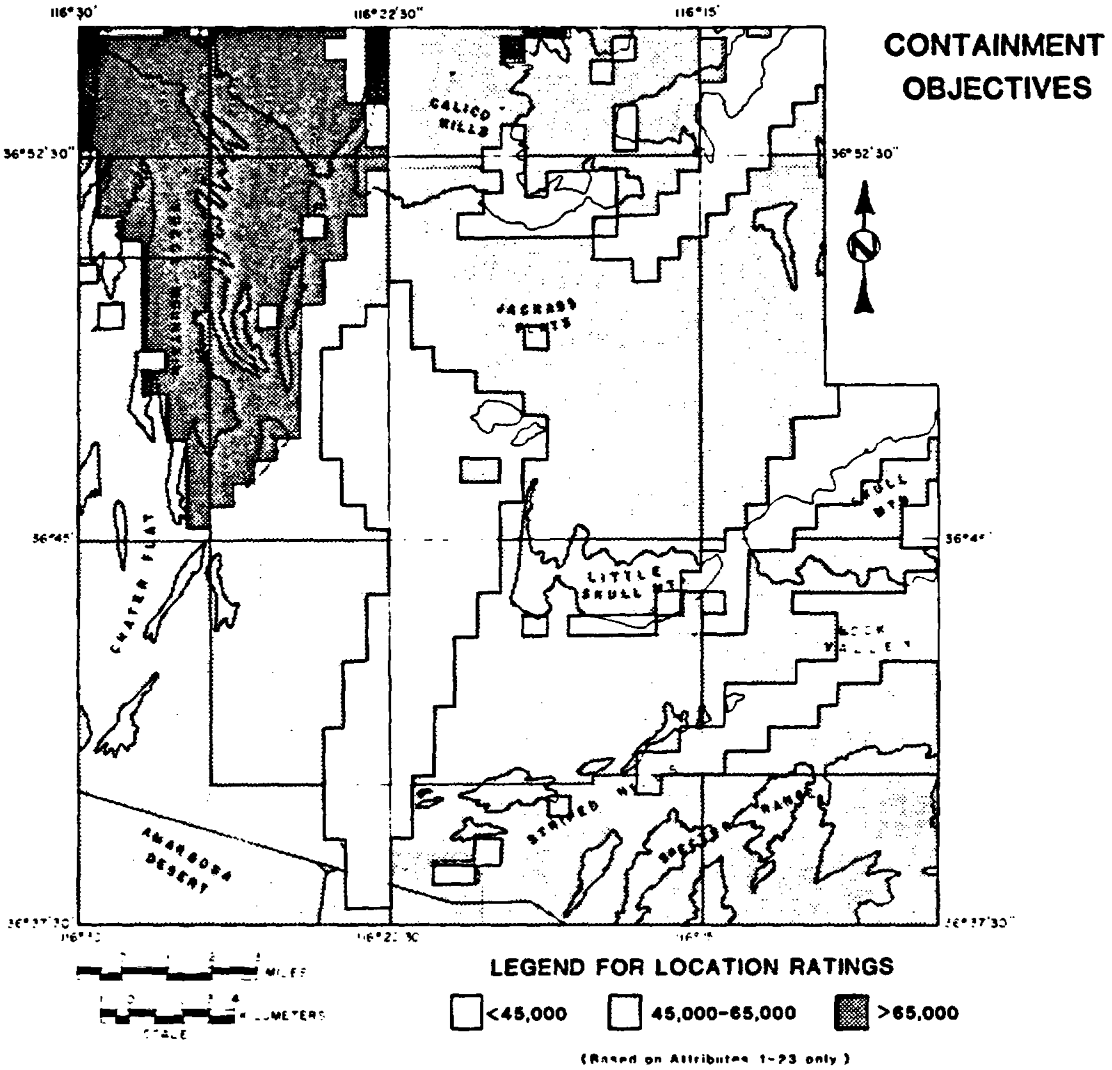
Unless otherwise noted, the following analyses were all performed using Equation (3) with an exponent of zero for F_j. Identical weights as in the overall analyses were retained for the objectives or attributes under investigation. The weights of all other objectives and attributes were set to zero (Appendix C). This allows the effects of independent ratings for particular elements of the attribute-objective matrix (Table 6) to be discerned.

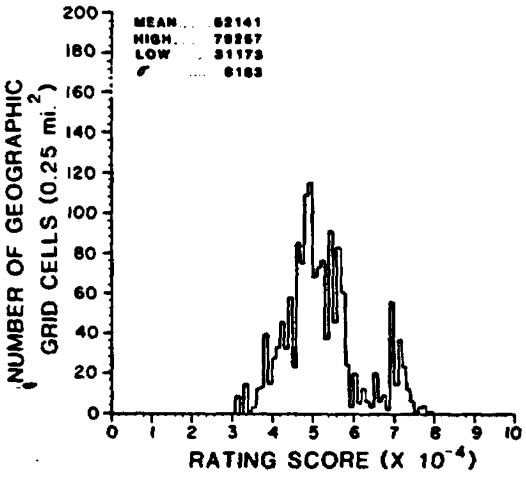
Containment Objectives

Figure 21 demonstrates that containment objectives based on geographical attributes are best satisfied at northern and central Yucca Mountain. These high ratings encompass a large wedge-shaped area extending from north of Yucca Mountain, southwest to the central part of the screening area. The ratings for containment, and other upper-level objectives presented later in this chapter, are primarily the result of ratings for certain combinations of subobjectives and attributes. To elucidate these causes, separate analyses of selected lower-level and middle-level objectives and combinations of attributes are presented which correlate strongly with the analyses of upper-level objectives. For the upper-level containment objective, high ratings at northern and central Yucca Mountain are due primarily to favorable tectonic attributes (Figure 22), though attributes which address erosional disruption of containment are not favorable there (Figure 23, Appendix B, page B-8).

The Calico Hills-Upper Topopah Wash location generally rates low to medium for geographical attributes related to containment. This is primarily because of low ratings for attributes related to faults, earthquakes (Figure 22) and inadvertant human intrusion (Figure 24.).

Low ratings for containment occur in a band along the lower reaches of Fortymile Wash and in two southwest trending strips in the east-central third of the screening area. Volcanic and



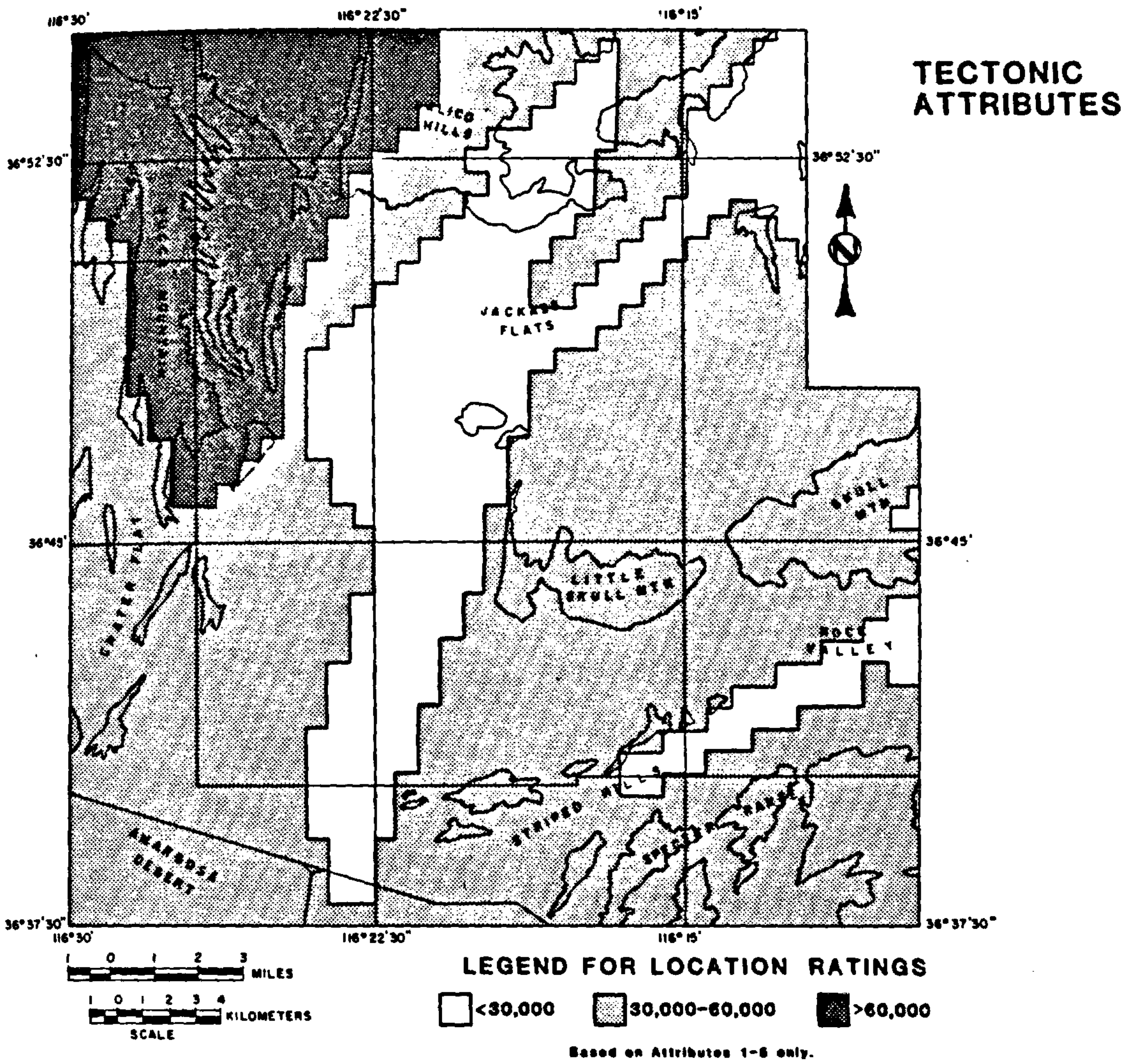


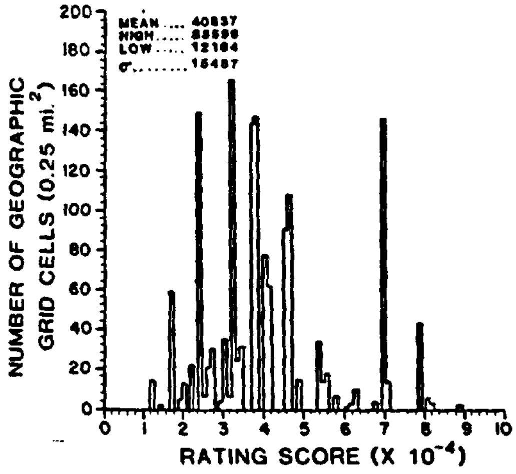
HOST ROCK RATINGS

AGE	ROCK TYPE	SATURATED		UNSATURATED	
		RATING	RANK	RATING	RANK
YOUNGER	Alluvium	47000	8	46000	6
	Basalt	58000	6	65000	5
	Non-welded Paintbrush Tuff	61000	5	46000	6
	Topopah Spring Tuff	47000	8	76000	3
	Calico Hills Tuff	67000	4	41000	7
	Crater Flat Tuff	74000	3	69000	4
	Granite	90000	1	82000	2
	Argillite	80000	2	65000	5
OLDER	Carbonate	54000	7	88000	1

NOTE: Host rock ratings based solely on host rock attributes (numbers 24-31 for saturated list; for unsaturated list numbers 24-30 only). Ratings do not account for site dependent rock conditions such as in-situ stress, in-situ temperature, depth, local structures and others. Unsaturated ratings omit hydraulic transmissivity, attribute #31.

Figure 21. Ratings Based Solely on Containment Objectives. See page C-1, Appendix C, for applied weights.

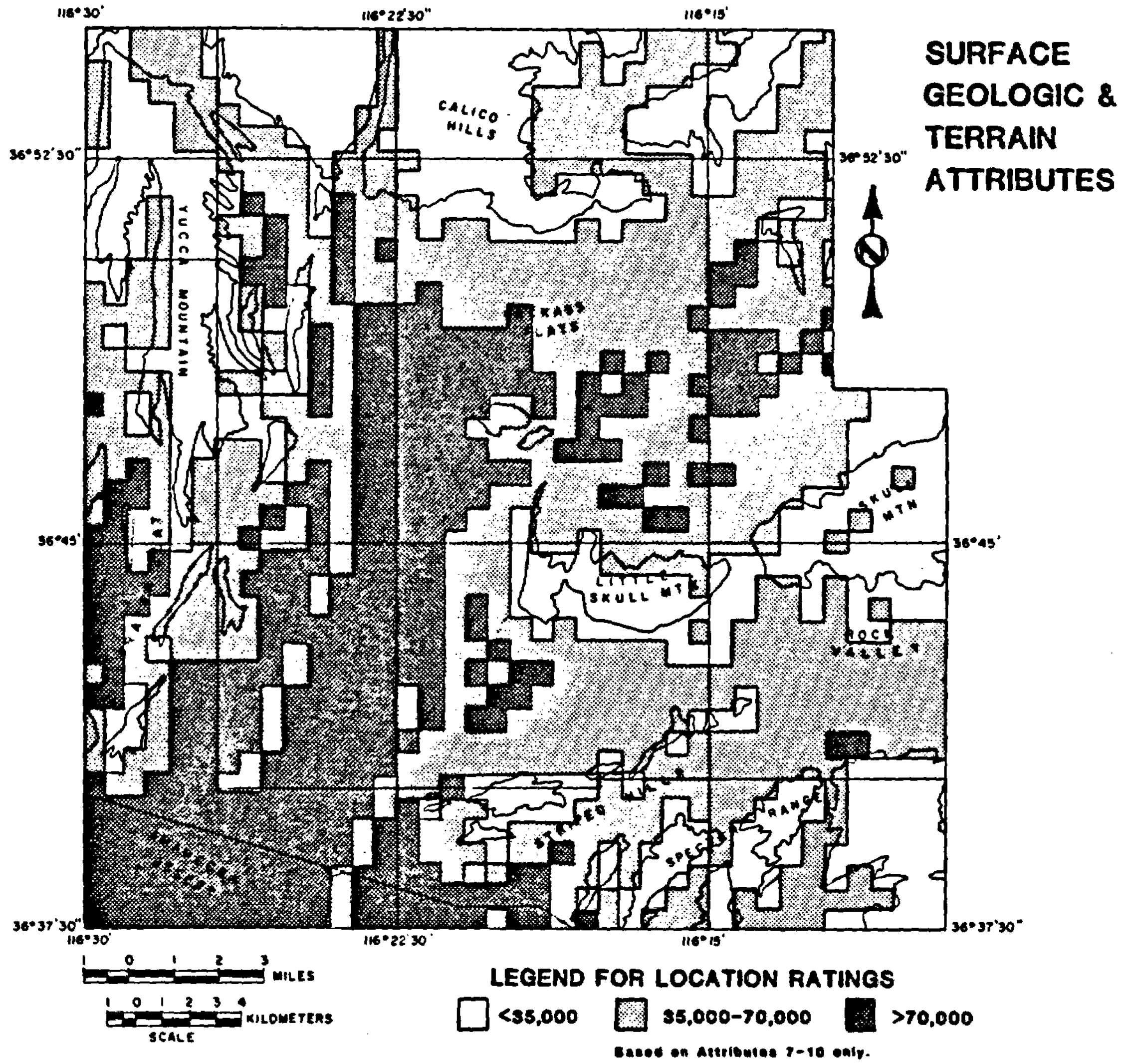


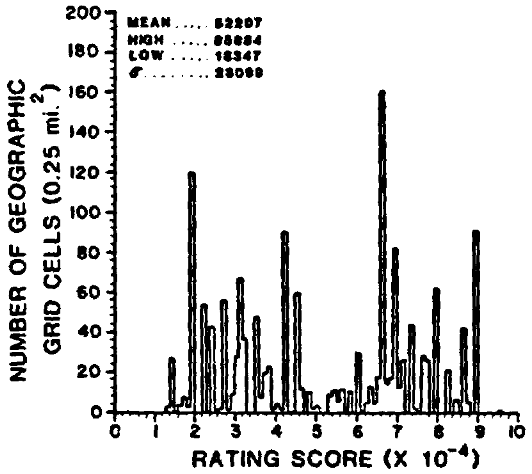


		SATURATED		UNSATURATED	
AGE	ROCK TYPE	RATING	RANK	RATING	RANK
YOUNGER	Alluvium				
	Basalt				
	Non-welded Paintbrush Tuff				
	Topopah Spring Tuff				
	Calico Hills Tuff				
	Crater Flat Tuff				
OLDER	Granite				
	Argillite				
	Carbonate				

NOT APPLICABLE

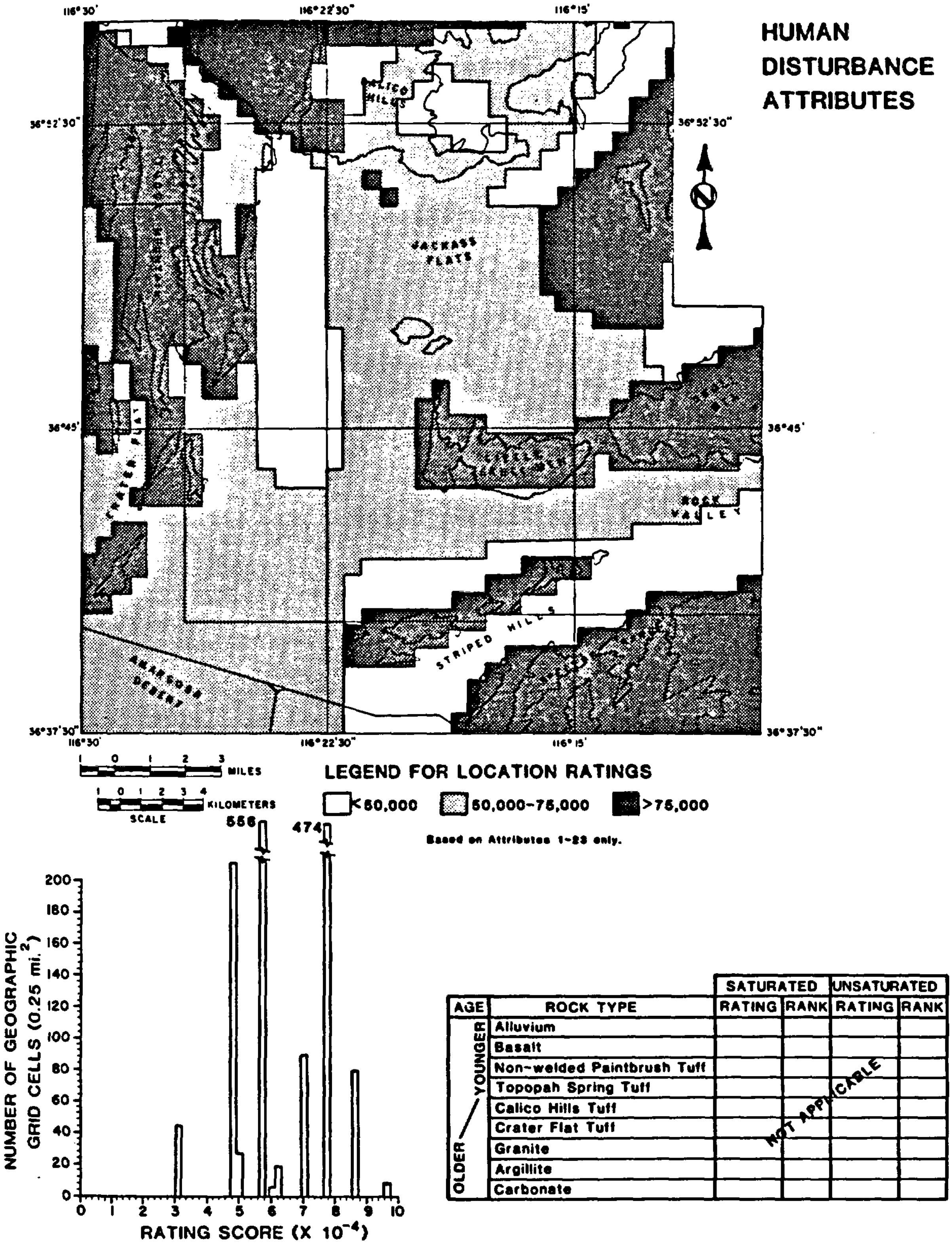
Figure 22. Ratings Based Solely on Tectonic Attributes. See page C-2, Appendix C, for applied weights.





		SATURATED		UNSATURATED	
AGE	ROCK TYPE	RATING	RANK	RATING	RANK
YOUNGER	Alluvium				
	Basalt				
	Non-welded Paintbrush Tuff				
	Topopah Spring Tuff	NOT APPLICABLE			
	Calico Hills Tuff				
	Crater Flat Tuff				
	Granite				
	Argillite				
OLDER	Carbonate				

Figure 23. Ratings Based Soley on Geologic and Terrain Attributes. See page C-3, Appendix C, for applied weights.



AGE	ROCK TYPE	SATURATED RATING	SATURATED RANK	UNSATURATED RATING	UNSATURATED RANK
YOUNGER	Alluvium				
	Basalt				
	Non-welded Paintbrush Tuff				
	Topopah Spring Tuff				
	Calico Hills Tuff	NOT APPLICABLE			
	Crater Flat Tuff				
OLDER	Granite				
	Argillite				
	Carbonate				

Figure 24. Ratings Based Soley on Attributes Relating to the Potential for Inadvertent Human Disturbances. See page C-4, Appendix C for applied weights.

seismic attributes depress the ratings along Fortymile Wash in southwestern Jackass Flats whereas only seismic attributes dominate the low ratings along Rock Valley in the east-central part of the screening area (Appendix B, page B-5). Geographical attributes for containment thus enhance the relatively high overall favorability of northern Yucca Mountain; whereas these attributes are generally neutral for northeast Jackass Flats and may even detract from high overall ratings at Calico Hills-Upper Topopah Wash.

Ratings of the nine host rocks based solely on containment objectives (Figure 21) show that for unsaturated rocks occurring at Yucca Mountain, the Topopah Spring Tuff is the highest rated, followed in order by the Calico Hills and Crater Flat tuffs. For saturated rocks, the Crater Flat Tuff is most highly rated at Yucca Mountain followed by the Calico Hills and Topopah Spring tuffs. Granite and argillite are the most highly rated rocks in the screening area for containment objectives and saturated conditions. Both these rock types occur beneath the Calico Hills-Upper Topopah Wash location, though the presence of granite is only inferred. For unsaturated rocks, the ranking of argillite drops to sixth while carbonates rise to the highest rated rock type. The high rating for unsaturated carbonates is due to their generally favorable thermal and mechanical properties and high mineral stability (Table 8, Table B-1, p. B-25).

Chemical, mechanical, and hydraulic attributes are generally well satisfied only for granite (Table 8). For argillite, Calico Hills Tuff, and Crater Flat Tuff attributes that contribute to containment are generally favorable in the saturated state where hydraulic transmissivity is considered (Figure 21, Table 8). However, the Calico Hills Tuff is significantly less highly rated for containment when hydraulic transmissivity is ignored for the unsaturated state. This lower rating is due to generally low thermal conductivity, poor mineral stability, and contraction upon heating. Argillite also has abundant unstable minerals which may dehydrate and contract upon heating, but its thermal conductivity is generally favorable. Unsaturated Topopah Spring Tuff has highly

Table 8. Host-Rock Ratings Based Solely on Geomechanical (numbers 24-27), Geochemical (numbers 28-30), and Hydrological (number 31) Attributes

		GEOMECHANICAL		GEOCHEMICAL		HYDROLOGICAL	
AGE	ROCK TYPE	RATING	RANK	RATING	RANK	RATING	RANK
YOUNGER	Alluvium	54000	6	34000	5	50000	3
	Basalt	64000	5	33000	6	50000	3
	Non-welded Paintbrush Tuff	54000	6	34000	5	80000	2
	Topopah Spring Tuff	73000	4	42000	4	10000	4
	Calico Hills Tuff	54000	6	70000	1	100000	1
	Crater Flat Tuff	73000	4.	47000	3	80000	2
OLDER	Granite	74000	3	52000	2	100000	1
	Argillite	78000	2	70000	1	100000	1
	Carbonate	83000	1	30000	7	10000	4

rated thermal and mechanical properties for containment* (Table 8). It's chemical attributes are moderatly favorable. However, its hydraulic transmissivity is very high and hence of low favorability, explaining its higher rating for unsaturated conditions. The Crater Flat Tuff is moderatly favorable for both chemical and mechanical attributes that influence containment, and accordingly rates moderately high for containment (Figure 21).

Isolation Objectives

For isolation objectives high ratings occur at northern Yucca Mountain, Calico Hill-Upper Topopah Wash, and northeast Jackass Flats (Figure 25). The high ratings at the latter two locations are due in large part to favorable hydrologic attributes (Figure 26); whereas tectonic (Figure 22) and human disturbance (Figure 24) attributes are significant in the high isolation ratings at northern Yucca Mountain and northeastern Jackass Flats. Low ratings for isolation objectives occur primarily along Fortymile Wash in western Jackass Flats due to a combination of unfavorable tectonic, human disturbance, and hydrologic attributes (Figures 22, 24, and 26). Seismic concerns depress isolation ratings to low values near Wahmonie

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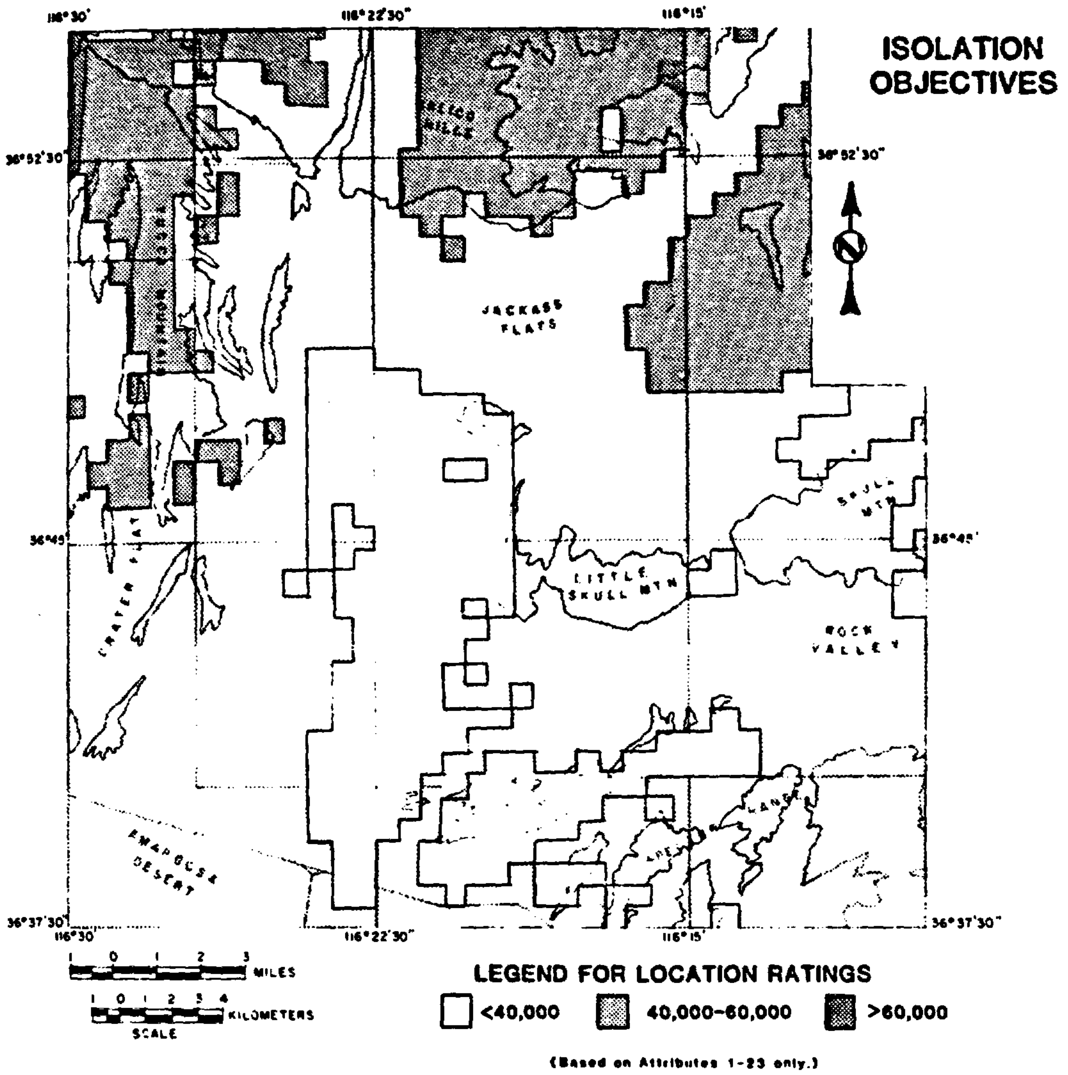
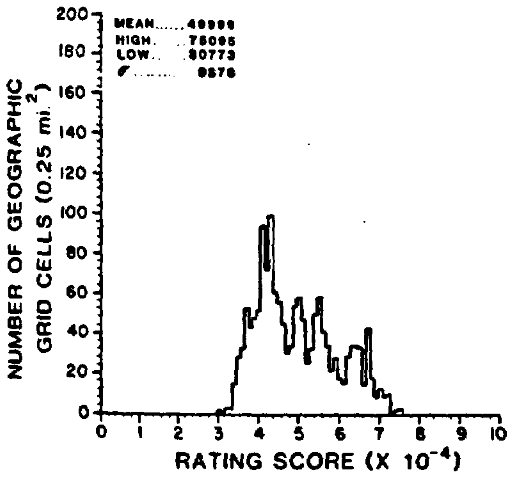
*This screening does not account for lithosphysal cavities which are common in the Topopah Spring Tuff. These cavities may make thermal and mechanical properties less favorable than assumed in this analysis.



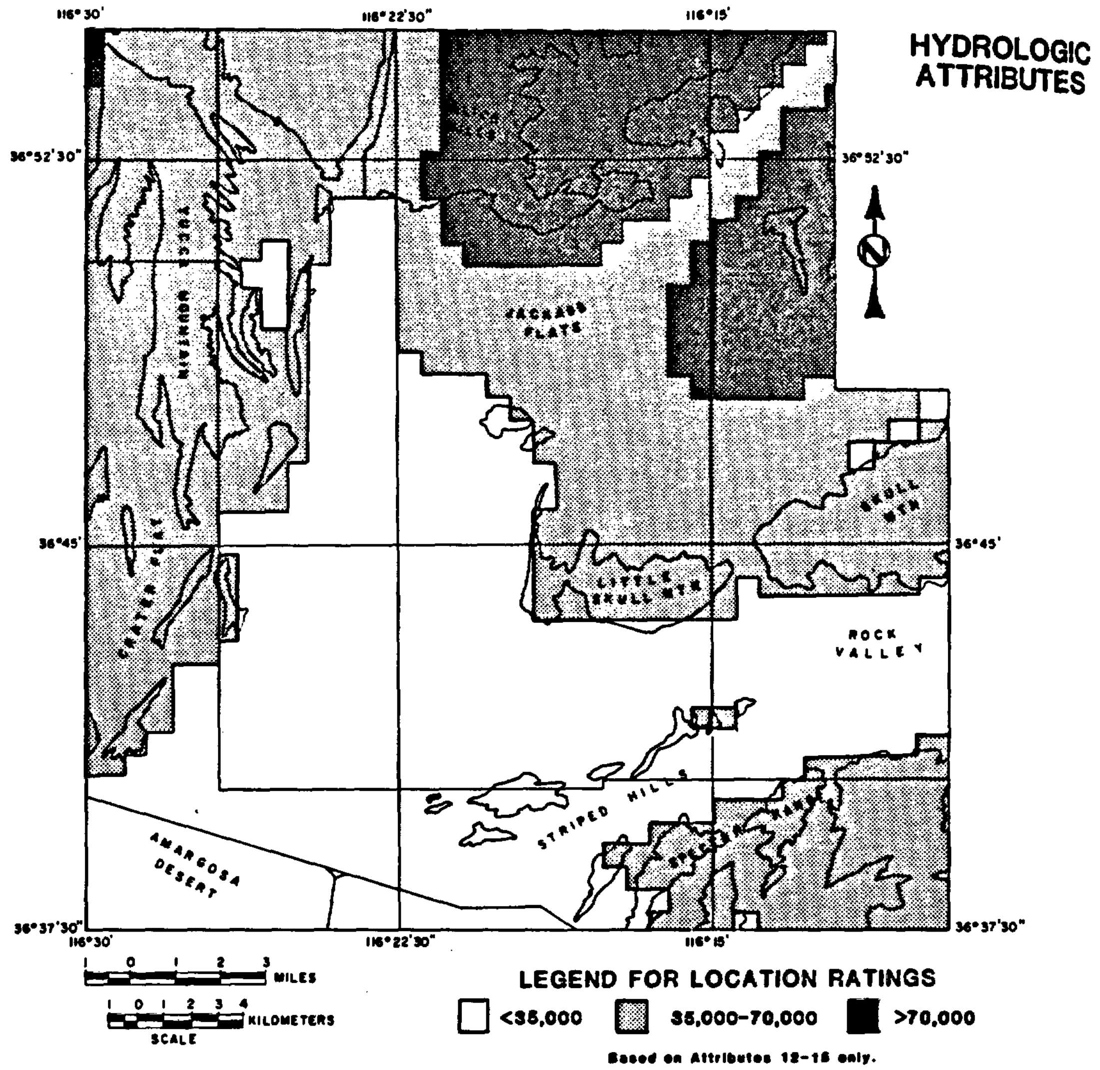


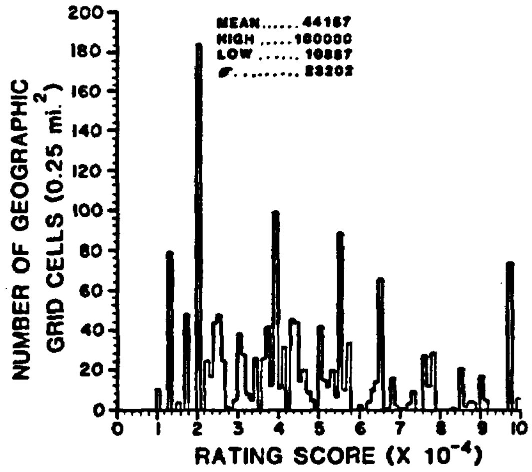
HOST ROCK RATINGS

AGE	ROCK TYPE	SATURATED		UNSATURATED	
		RATING	RANK	RATING	RANK
YOUNGER	Alluvium	44000	5	41000	4
	Basalt	33000	6	27000	7
	Non-welded Paintbrush Tuff	50000	4	41000	4
	Topopah Spring Tuff	25000	7	34000	6
	Calico Hills Tuff	90000	1	67000	1
	Crater Flat Tuff	55000	3	47000	3
OLDER	Granite	55000	3	40000	5
	Argillite	68000	2	64000	2
	Carbonate	15000	8	17000	8

NOTE: Host rock ratings based solely on host rock attributes (numbers 24-31 for saturated list; for unsaturated list numbers 24-30 only). Ratings do not account for site dependent rock conditions such as in-situ stress, in-situ temperature, depth, local structures and others. Unsaturated ratings omit hydraulic transmissivity, attribute #31.

Figure 25. Ratings Based Solely on Isolation Objectives. See page C-5, Appendix C, for applied weights.





		SATURATED		UNSATURATED	
AGE	ROCK TYPE	RATING	RANK	RATING	RANK
OLDER — YOUNGER	Alluvium				
	Basalt				
	Non-welded Paintbrush Tuff				
	Topopah Spring Tuff				
	Calico Hills Tuff	NOT APPLICABLE			
	Crater Flat Tuff				
	Granite				
	Argillite				
	Carbonate				

Figure 26. Ratings Based Solely on Hydrologic Attributes. See page C-6, Appendix C, for applied weights.

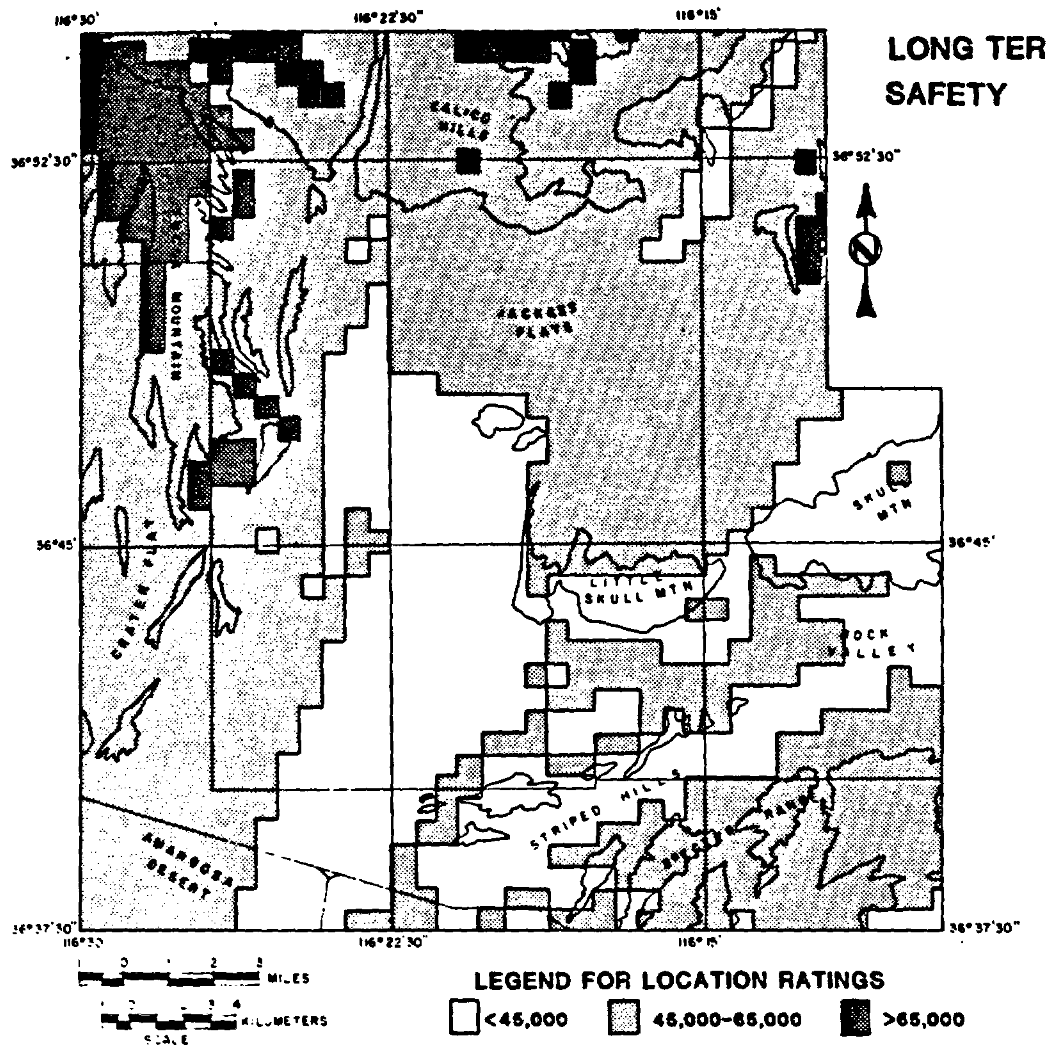
Pass (Appendix B, page B-5), while geomorphic disruption detracts from isolation potential at northern and central Yucca Mountain, Calico Hills-Upper Topopah Wash, Skull and Little Skull Muntains, and the Specter Range-Striped Hills area (Figure 23). This latter location and adjacent Rock Valley are also poorly rated for hydrologic attributes which contribute to isolation (Figure 26).

Of the nine candidate host rocks, the Calico Hills Tuff and argillite are by far the most highly rated for isolation objectives under both saturated and unsaturated conditions (Figure 25). These rock types occur, respectively, at northern Yucca Mountain and Calico Hills-Upper Topopah Wash (Figure 7). These high ratings are due primarily to excellent hydrologic and geochemical properties for both rock types (Table 8). Carbonates rate lowest of the nine rock types for isolation, reflecting their generally poor hydrologic and geochemical properties (Table 8). For the same reasons, the Topopah Spring Tuff also rates low for isolation objectives. Granite rates relatively high for saturated conditions, but ranks sixth out of the nine rock types for unsaturated conditions. The rest of the rock types are all moderately favorable for isolation under saturated and unsaturated conditions. It should be noted that the isolating qualities of a particular rock type may be employed by a repository, even if the repository is not constructed in that rock type. This situation is possible if the rock type in question occurs along flow paths between the biosphere and a repository in another rock type.

Long-Term Safety Objectives

If containment and isolation objectives are combined, a rating of locations and host rocks is obtained that addresses the multiple barrier concept for the long-term safety of repositories (Figure 27). These ratings show that, based on host rock-independent attributes, northern Yucca Mountain is the location with greatest potential for protecting humans from the long-term hazards associated with repositories. At Yucca Mountain the most favorably rated rock type for long-term safety is clearly the Calico Hills Tuff, with the Crater Flat Tuff a strong second, and the Topopah Spring Tuff significantly less desirable. Argillite, which occurs at the Calico Hills-Upper Topopah Wash location, ranks as the best of the nine rock types for ensuring long-term safety, though this location rates only moderate to high for geographical attributes. Western Jackass Flats, Rock Valley, Skull Mountain, and Little Skull Mountain are least desirable for long-term safety, independent of host-rock properties.

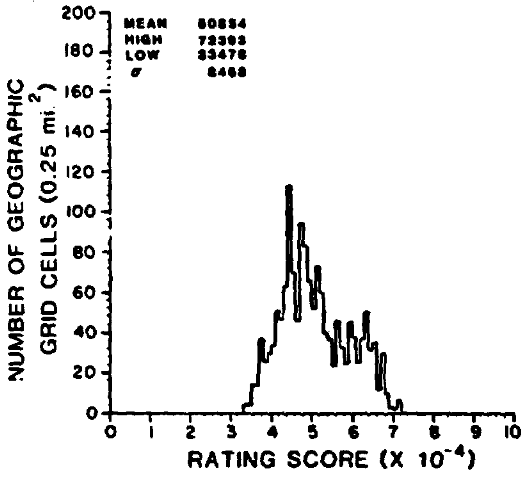
Long-term safety depends on satisfactory performance with respect to both expected natural processes and possible disruptive events. Therefore, it is instructive to consider separately the contribution of each of these facets of long-term risk.



LEGEND FOR LOCATION RATINGS

☐ <45,000 ▨ 45,000-65,000 ■ >65,000

(Based on Attributes 1-23 only.)



HOST ROCK RATINGS

		SATURATED		UNSATURATED	
AGE	ROCK TYPE	RATING	RANK	RATING	RANK
YOUNGER	Alluvium	46000	7	43000	8
	Basalt	47000	6	45000	7
	Non-welded Paintbrush Tuff	56000	5	43000	8
	Topopah Spring Tuff	38000	8	53000	5
	Calico Hills Tuff	78000	2	66000	2
	Crater Flat Tuff	65000	4	57000	4
	Granite	74000	3	59000	3
	Argillite	83000	1	75000	1
OLDER	Carbonate	36000	9	50000	6

NOTE: Host rock ratings based solely on host rock attributes (numbers 24-31 for saturated list; for unsaturated list numbers 24-30 only). Ratings do not account for site dependent rock conditions such as in-situ stress, in-situ temperature, depth, local structures and others. Unsaturated ratings omit hydraulic transmissivity, attribute #31.

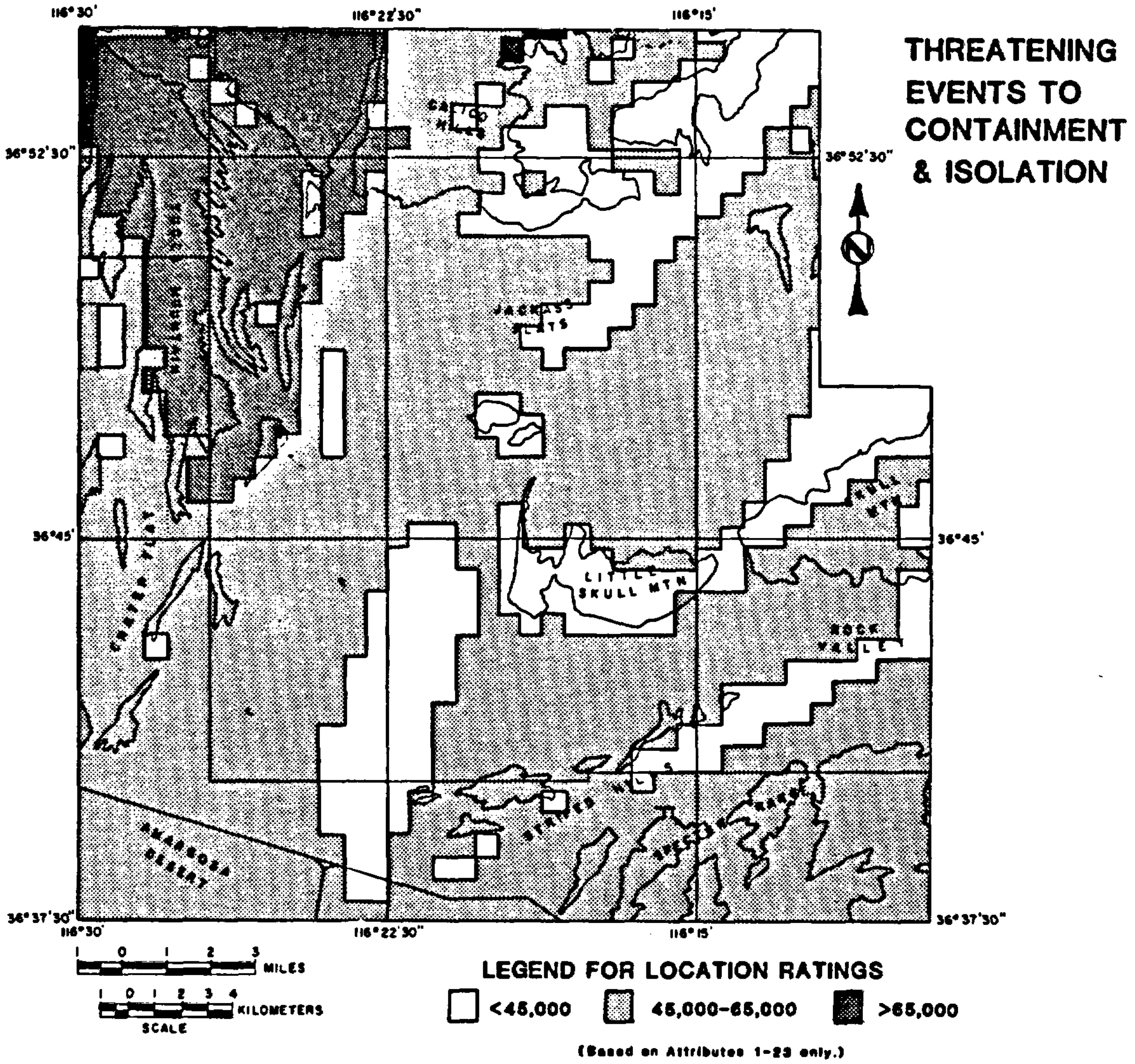
Figure 27. Ratings Based Solely on Long-Term Safety Objectives (Containment plus Isolation). See page C-7, Appendix C, for applied weights.

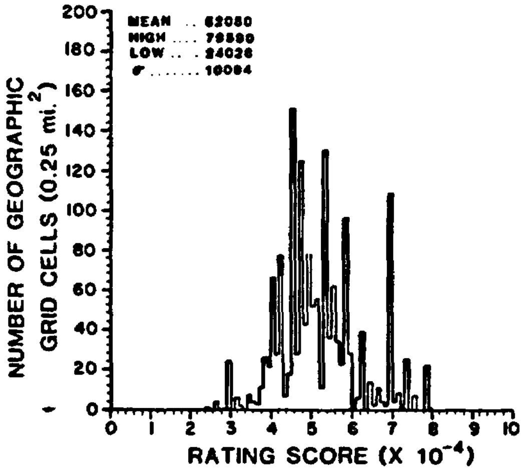
Untoward events are least likely at the northern and central portions of Yucca Mountain (Figure 28). The size, shape and location of the high, intermediate, and low-rated portions of Figure 28 are almost identical to the similarly rated locations for containment objectives (Figure 21). This indicates that a dominant factor for containment qualities of locations is the potential for disruptive events. Therefore the relatively high possibility of disruptive events is the dominant discriminating factor for low containment ratings at Calico Hills, western Jackass Flats, and Skull Mountain (Figure 21).

On the other hand, benign processes affecting radionuclide migration (Figure 29) correlate strongly with isolation qualities of locations (Figure 25). This is shown by the high ratings for both at Calico Hills-Upper Topopah Wash and at northeastern Jackass Flats. Similarly, the dominant factors for low isolation ratings in western Jackass Flats and Striped Hills are processes that jeopardize slow migration of wastes toward the biosphere.

Operational Objectives

Figure 30 shows location and host-rock ratings for construction objectives. The most suitable locations are generally limited to flat areas with low potential for flooding. A large, highly rated area is aligned along the low relief, flood-free zones parallel to the lower reaches of Fortymile Wash. Smaller, highly rated locations occur in eastern Crater

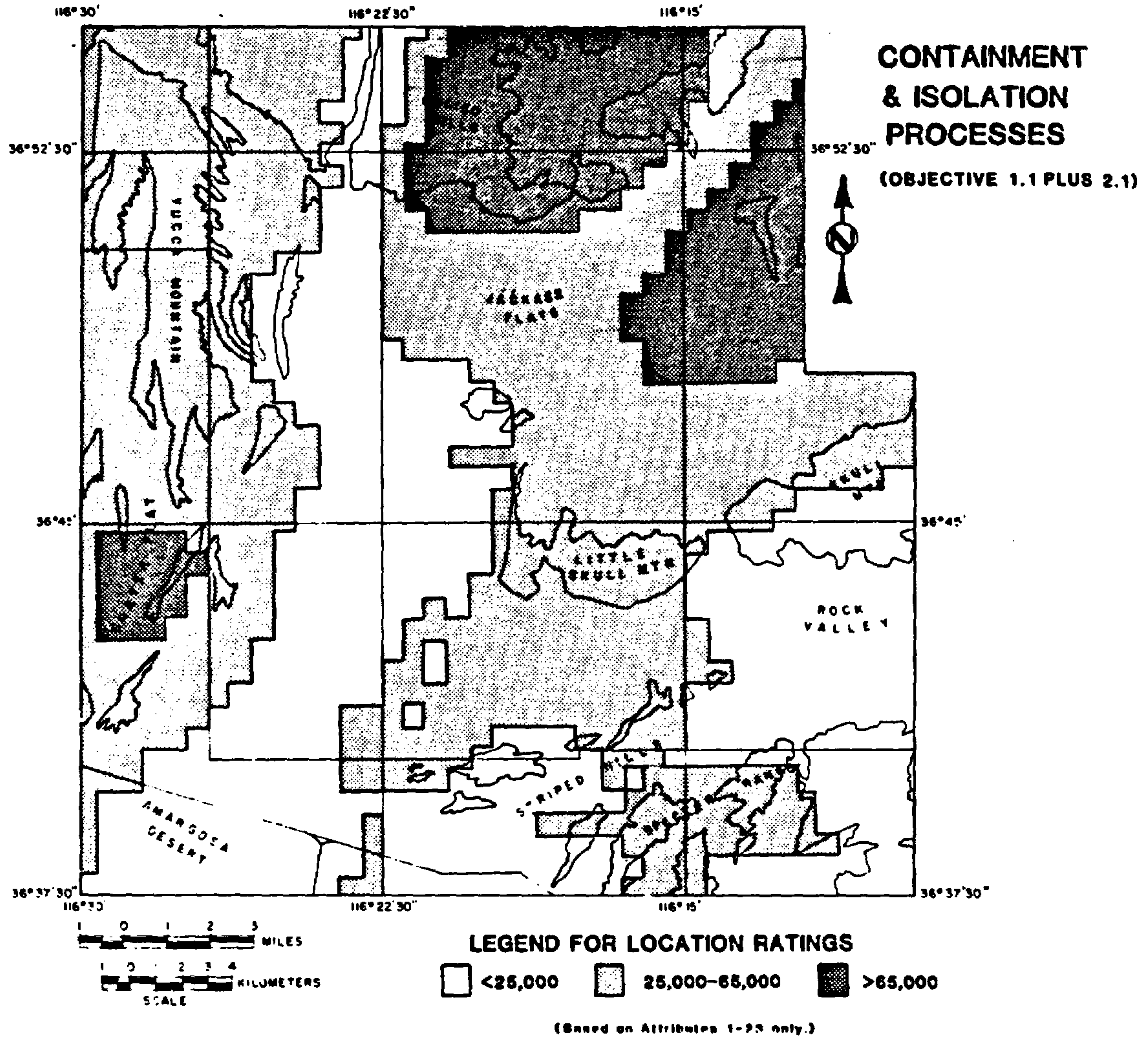


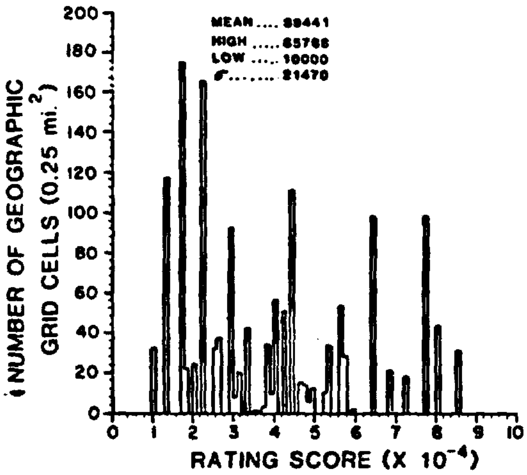


		SATURATED		UNSATURATED	
AGE	ROCK TYPE	RATING	RANK	RATING	RANK
YOUNGER	Alluvium				
	Basalt				
	Non-welded Paintbrush Tuff				
	Topopah Spring Tuff				
	Calico Hills Tuff				
	Crater Flat Tuff				
	Granite				
	Argillite				
OLDER	Carbonate				

NOT APPLICABLE

Figure 28. Ratings Based Solely on Objectives for Avoiding Events Which Might Disrupt Long-Term Safety. See page C-8, Appendix C, for applied weights.





HOST ROCK RATINGS

AGE	ROCK TYPE	SATURATED		UNSATURATED	
		RATING	RANK	RATING	RANK
YOUNGER / OLDER	Alluvium	46000	6	NO CALCULATIONS PERFORMED	
	Basalt	46000	6		
	Non-welded Paintbrush Tuff	56000	5		
	Topopah Spring Tuff	37000	7		
	Calico Hills Tuff	79000	2		
	Crater Flat Tuff	66000	4		
	Granite	73000	3		
	Argillite	85000	1		
	Carbonate	35000	8		

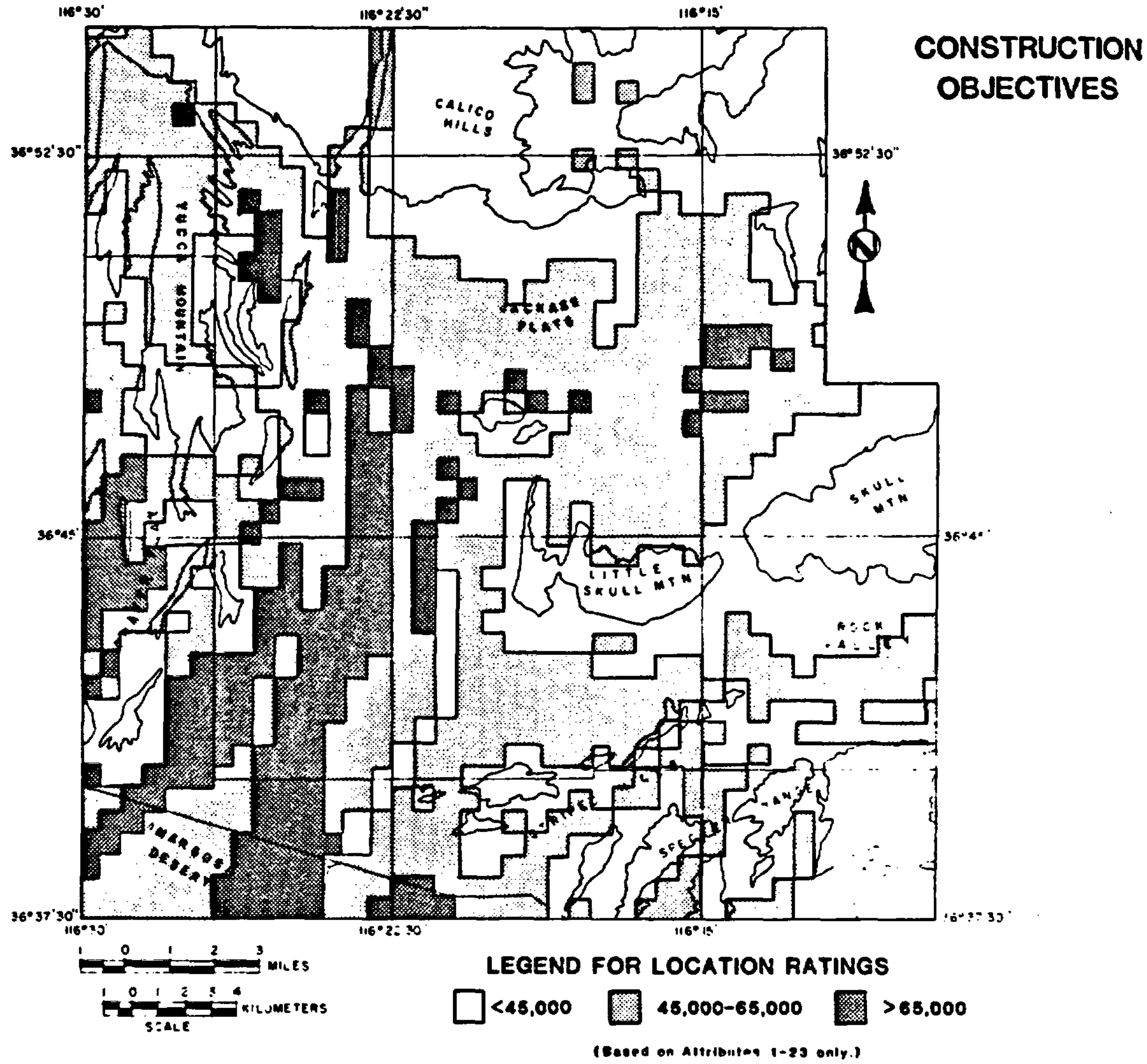
NOTE: Host rock ratings based solely on host rock attributes (numbers 24-31 for saturated list; for unsaturated list numbers 24-30 only). Ratings do not account for site dependent rock conditions such as in-situ stress, in-situ temperature, depth, local structures and others. Unsaturated ratings omit hydraulic transmissivity, attribute #31.

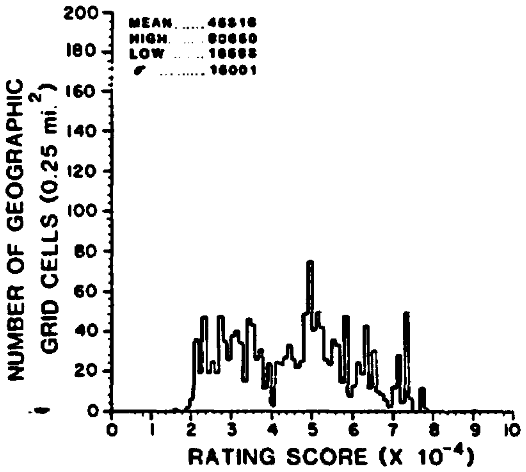
Figure 29. Ratings Based Solely on Objectives for Ongoing, Existing Processes Which Contribute to Long-Term Safety. See page C-9, Appendix C, for applied weights.

Flat, in northeastern Jackass Flats, and just east of the northern portion of Yucca Mountain. Poorly rated locations for construction correspond to major floodways and rugged mountainous terrain, including most of northern Yucca Mountain and Calico Hills-Upper Topopah Wash. Thus, construction objectives tend to detract from the high overall ratings for northern Yucca Mountain and Calico Hills-Upper Topopah Wash. However, favorable conditions for construction contribute substantially to the high overall ratings at northeastern Jackass Flats and in the small valleys nestled within the southern Yucca Mountain area (Figure 15).

Objectives for surface and subsurface facilities are sufficiently different that these two branches of the tree were analyzed separately. Surface facility ratings (Figure 31) correlate well with ratings for terrain and flooding attributes (Figure 23) and are almost identical to ratings for the entire construction branch of the objectives tree (Figure 30).

In contrast, rock-type independent ratings for underground facilities (Figure 32) are strongly influenced by tectonic (Figure 22) and rock-dip attributes (Appendix B, page B-7). For underground facilities, northern Yucca Mountain, eastern Crater Flat and western Little Skull Muntain rate highly. Low ratings occur along a strip of land from Calico Hills-Upper Topopah Wash through western Jackass Flats to Lathrop Wells, as well as throughout the southeast corner of the screening area.



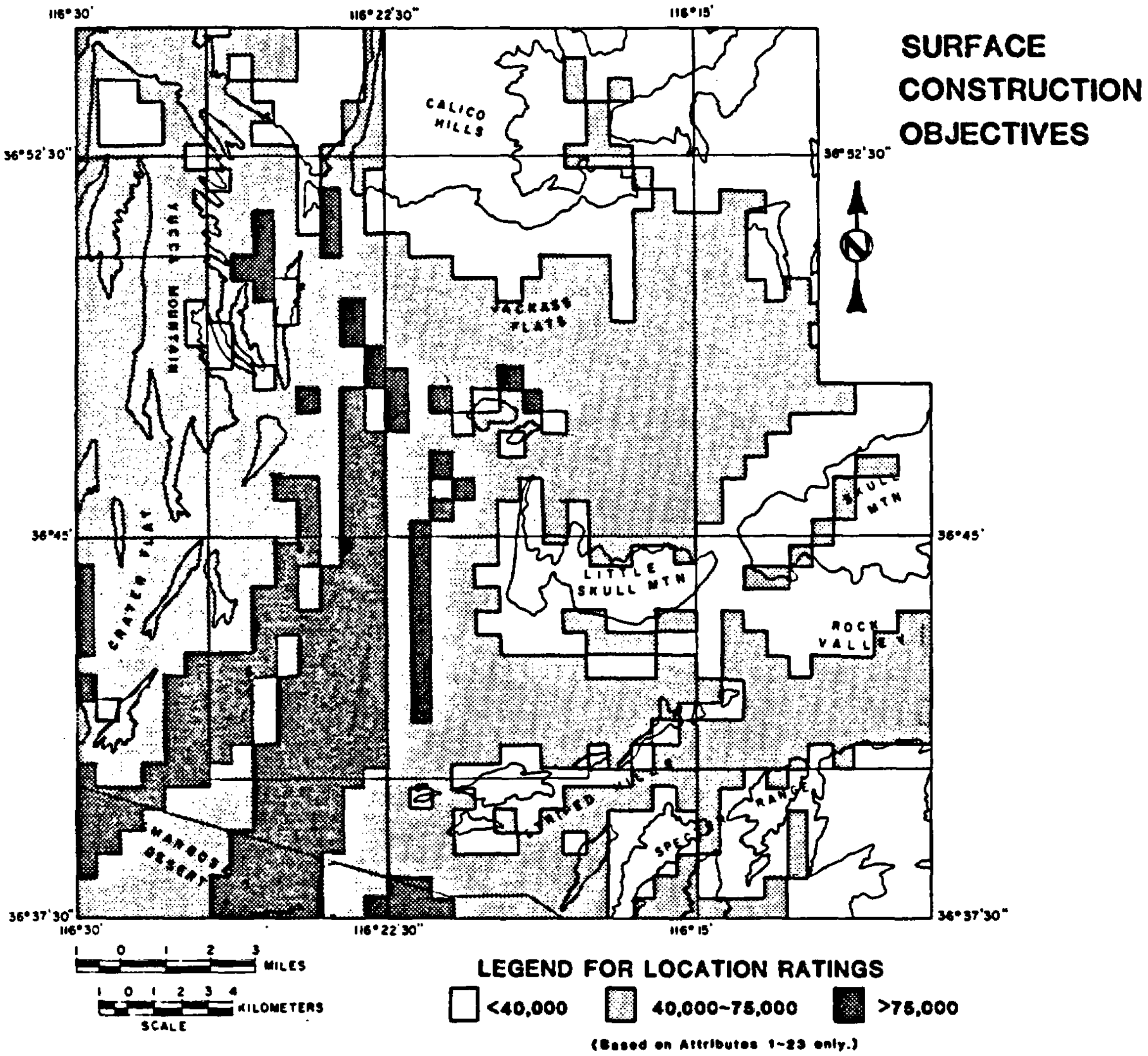


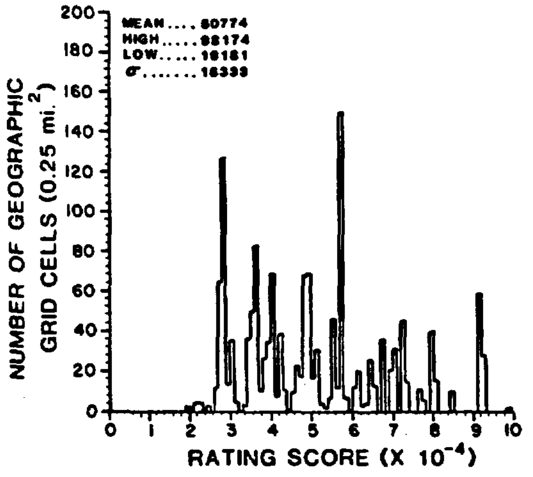
HOST ROCK RATINGS

AGE	ROCK TYPE	SATURATED		UNSATURATED	
		RATING	RANK	RATING	RANK
YOUNGER	Alluvium	41000	9	36000	7
	Basalt	66000	4	76000	5
	Non-welded Paintbrush Tuff	52000	8	36000	7
	Topopah Spring Tuff	62000	6	93000	2
	Calico Hills Tuff	56000	7	30000	8
	Crater Flat Tuff	82000	2	84000	4
	Granite	93000	1	87000	3
	Argillite	63000	5	41000	6
OLDER	Carbonate	67000	3	100000	1

NOTE: Host rock ratings based solely on host rock attributes (numbers 24-31 for saturated list; for unsaturated list numbers 24-30 only). Ratings do not account for site dependent rock conditions such as in-situ stress, in-situ temperature, depth, local structures and others. Unsaturated ratings omit hydraulic transmissivity, attribute #31.

Figure 30 Ratings Based Solely on Objectives for Construction and Operation of a Repository. See page C-10, Appendix C, for applied weights.





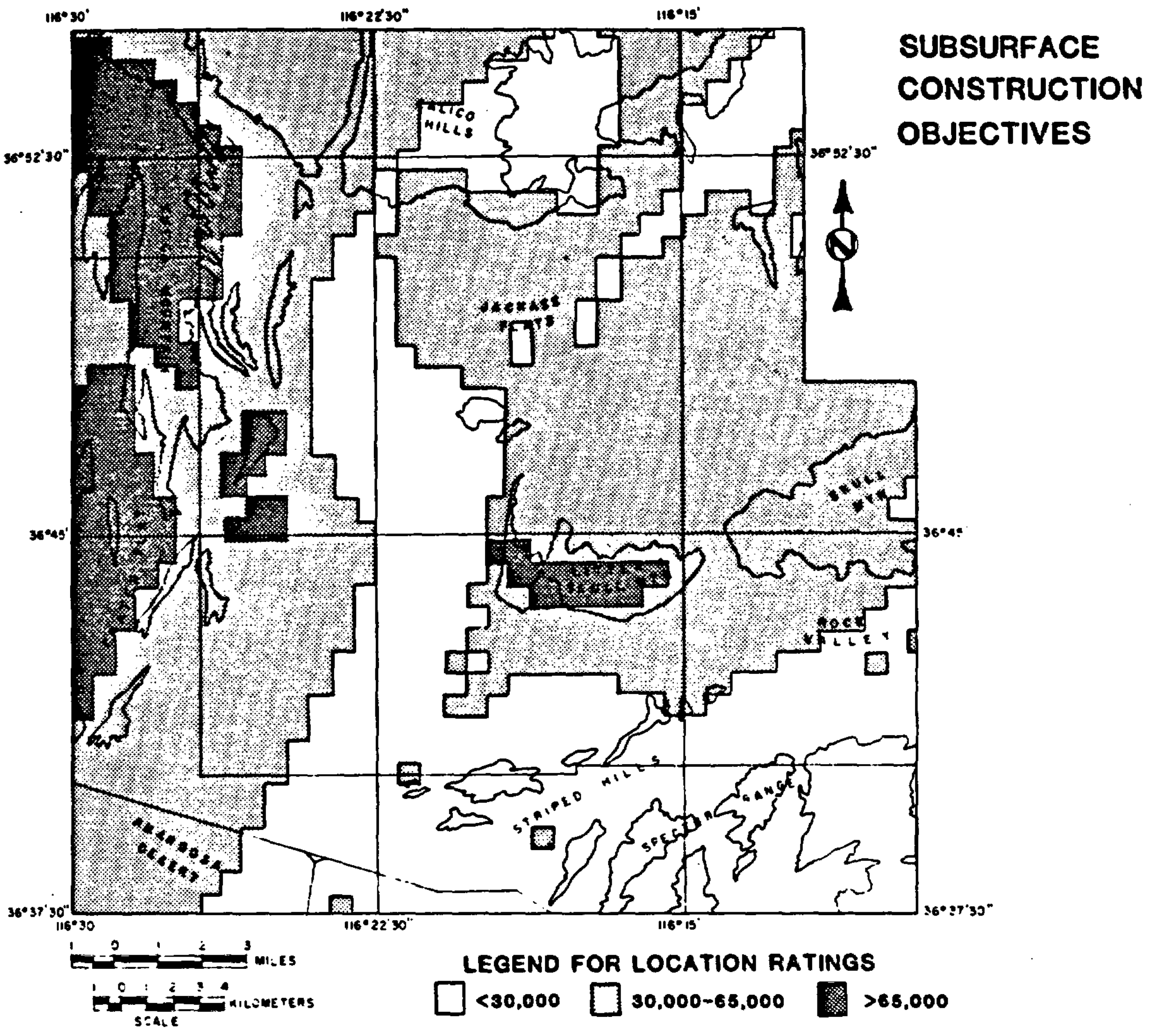
		SATURATED		UNSATURATED	
AGE	ROCK TYPE	RATING	RANK	RATING	RANK
YOUNGER	Alluvium				
	Basalt				
	Non-welded Paintbrush Tuff				
	Topopah Spring Tuff				
	Calico Hills Tuff	NOT APPLICABLE			
	Crater Flat Tuff				
OLDER	Granite				
	Argillite				
	Carbonate				

Figure 31. Ratings Based Solely on Objectives for Surface Facilities. See page C-11, Appendix C, for applied weights.

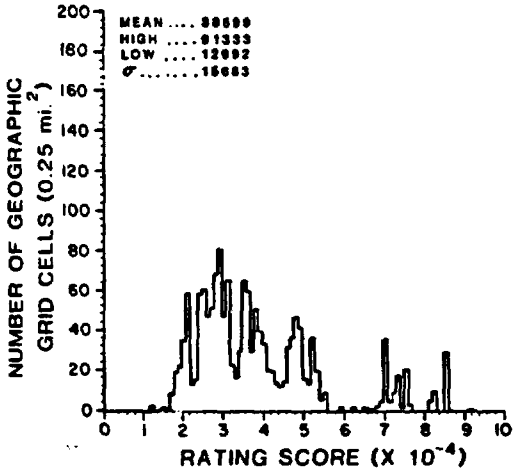
Because these ratings differ considerably from the total construction ratings, geographical ratings for the construction branch of the objectives tree are not significantly influenced by subsurface facilities.

Significant differences occur between construction ratings for saturated and unsaturated host rocks (Figure 32). Carbonates received a maximum possible rating of 100,000 and rank first for unsaturated conditions, but drop to a rank of fifth out of nine for saturated conditions. For rocks available at Yucca Mountain, the Topopah Spring Tuff drops similarly from a rank of second to sixth, for unsaturated and saturated conditions, respectively. In the opposite sense, the Crater Flat Tuff ranks higher for saturated conditions, though its rating is about the same in both cases. Unsaturated Calico Hills Tuff ranks lowest of the nine rock types for construction and next to lowest for saturated conditions. Argillite rates fifth and sixth, respectively, for saturated and unsaturated conditions. All saturated rocks except alluvium receive a rating better than 50,000, whereas four of nine unsaturated rocks score less than 50,000.

These ratings are based only on thermal conductivity, compressive strength, mineral stability, and hydraulic transmissivity (the latter for saturated ratings only). It again should be noted that host-rock ratings do not account for depth-dependent factors such as in situ stress, in-situ temperature, and access costs; nor is rock competence as a function



(Based on Attributes 1-23 only.)



HOST ROCK RATINGS

AGE	ROCK TYPE	SATURATED RATING	SATURATED RANK	UNSATURATED RATING	UNSATURATED RANK
YOUNGER	Alluvium	41000	9	36000	7
	Basalt	66000	4	76000	5
	Non-welded Paintbrush Tuff	52000	8	36000	7
	Topopah Spring Tuff	62000	6	93000	2
	Calico Hills Tuff	56000	7	30000	8
	Crater Flat Tuff	82000	2	84000	4
OLDER	Granite	93000	1	87000	3
	Argillite	63000	5	41000	6
	Carbonate	67000	3	100000	1

NOTE: Host rock ratings based solely on host rock attributes (numbers 24-31 for saturated list; for unsaturated list numbers 24-30 only). Ratings do not account for site dependent rock conditions such as in-situ stress, in-situ temperature, depth, local structures and others. Unsaturated ratings omit hydraulic transmissivity, attribute #31.

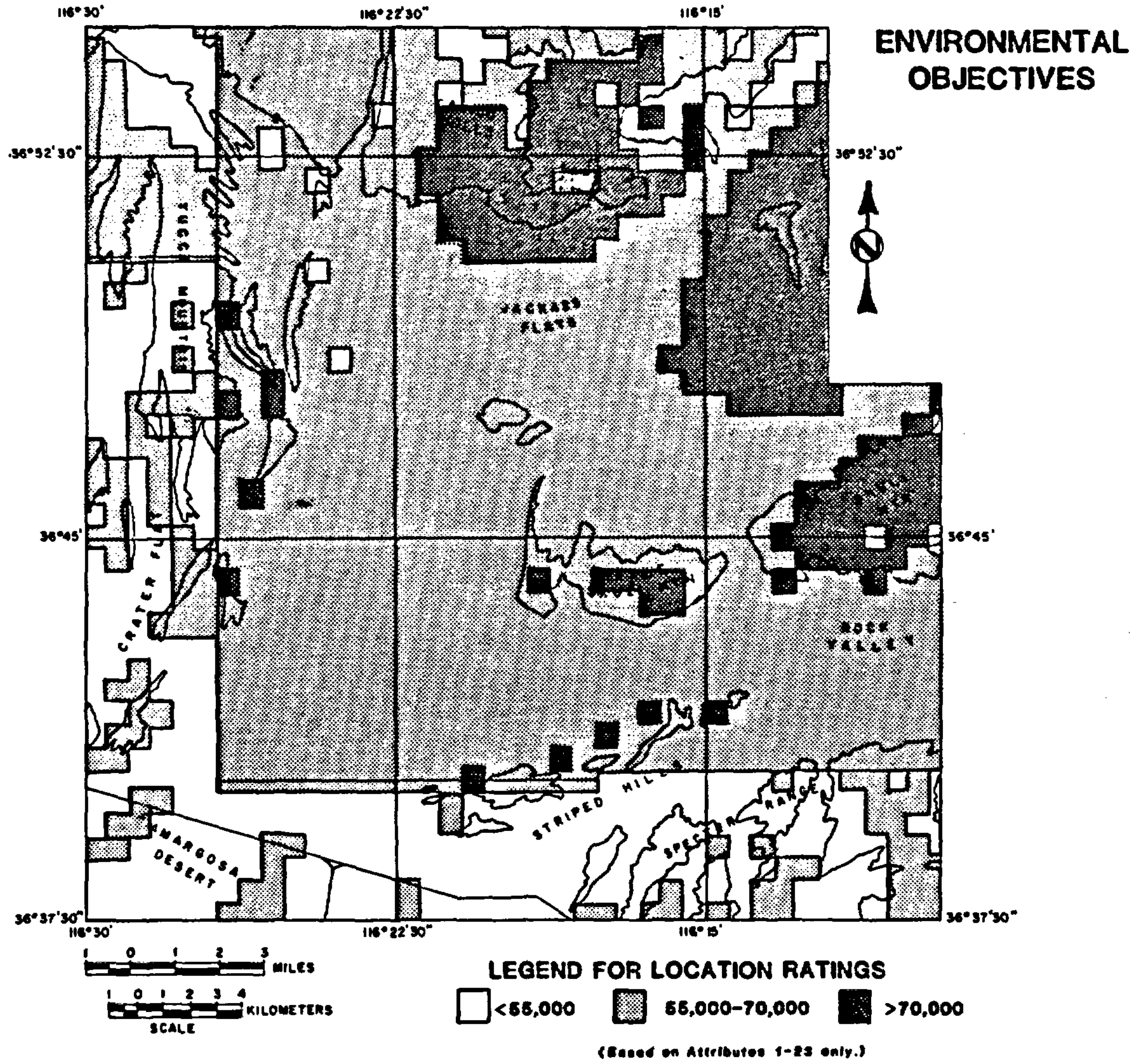
Figure 32. Ratings Based Solely on Objectives for Underground Facilities. See page C-12, Appendix C, for applied weights.

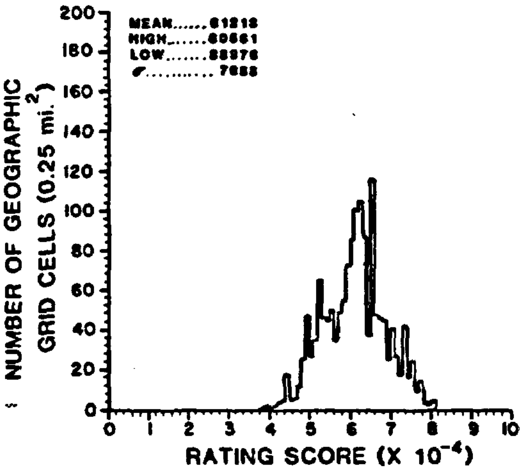
of local fracturing or lithophysal cavities considered. As a result, actual suitability for mining a repository in the various host rocks is likely to vary somewhat from the rankings presented here.

Environmental Objectives

Figure 33 shows that environmental objectives are best satisfied in three locations, from north to south: Calico Hills-Upper Topopah Wash, northeastern Jackass Flats, and Skull Mountain. The high ratings at the two former locations are due to low potential for disturbance of groundwater quality (Figure 28; Appendix B, page B-12) and sensitive biotic or cultural resources (Figure 34). The latter location at Skull Mountain is generally favorable only because of biotic and cultural resources (Figure 34). Smaller favorable areas occur at Little Skull Mountain, on the Striped Hills, and along a few ridge tops in eastern Yucca Mountain due primarily to low air pollution potential.

The least favorable locations from an environmental perspective are south and west of the NTS boundary and north of Yucca Mountain along Yucca Wash. Institutional factors are paramount in depressing the ratings outside the NTS. It is apparent that environmental attributes detract from the high overall ratings at portions of northern Yucca Mountain off the NTS, but enhance the high ratings at Calico Hills-Upper Topopah Wash and northeastern Jackass Flats.

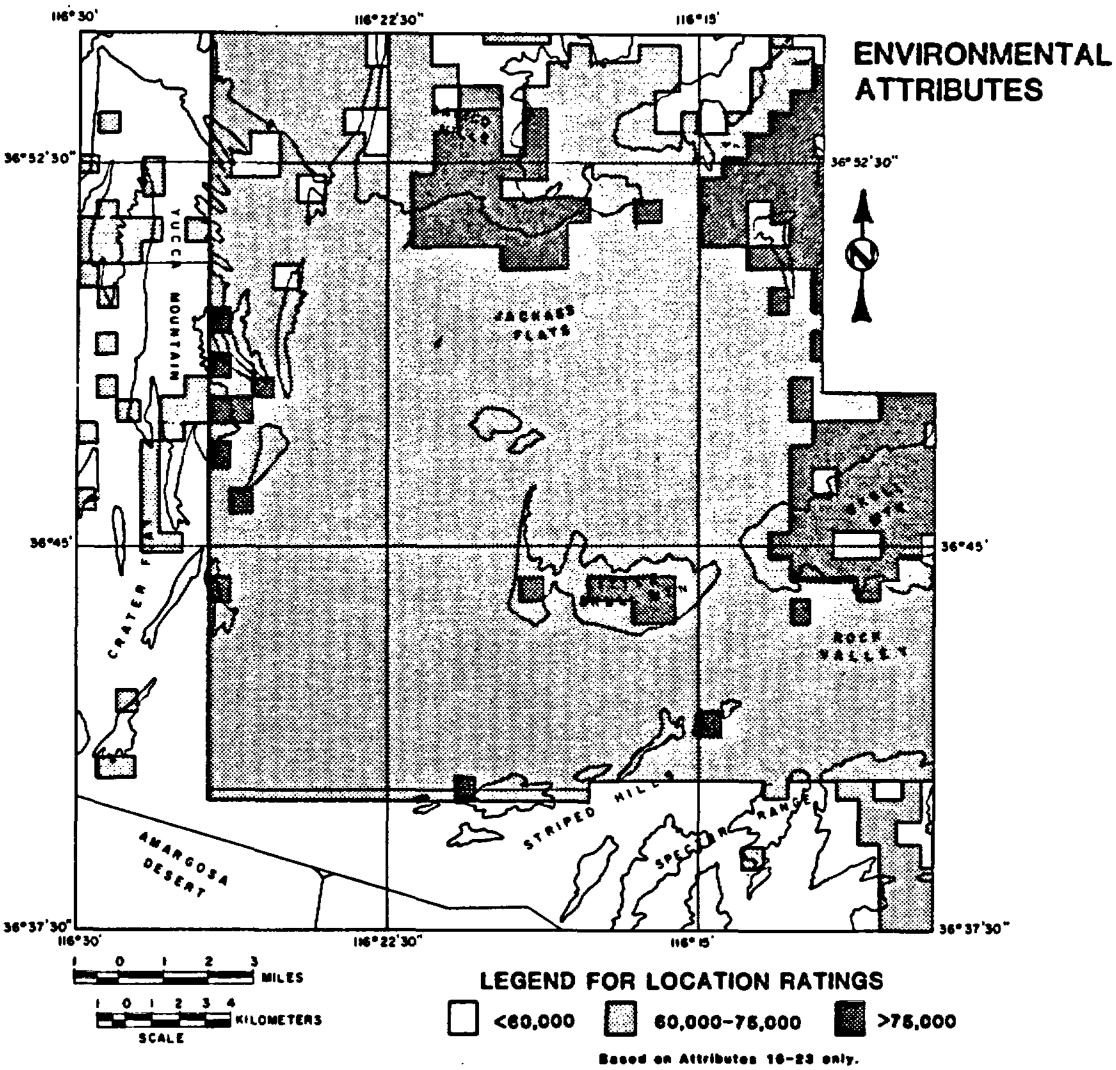


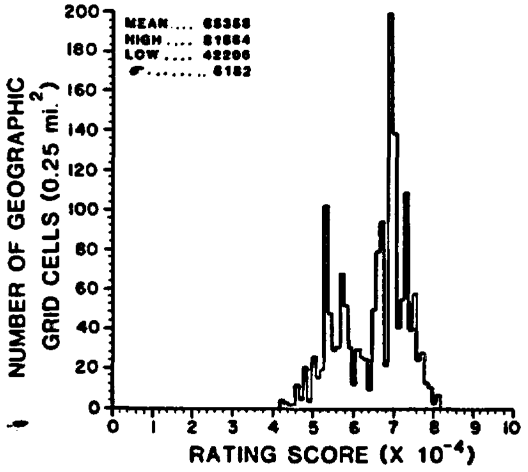


		SATURATED		UNSATURATED	
AGE	ROCK TYPE	RATING	RANK	RATING	RANK
YOUNGER	Alluvium				
	Basalt				
	Non-welded Paintbrush Tuff				
	Topopah Spring Tuff				
	Calico Hills Tuff				
	Crater Flat Tuff				
	Granite				
	Argillite				
OLDER	Carbonate				

NOT APPLICABLE

Figure 33. Ratings Based Solely on Environmental Objectives. See page C-13, Appendix C, for applied weights.





		SATURATED		UNSATURATED	
AGE	ROCK TYPE	RATING	RANK	RATING	RANK
YOUNGER	Alluvium				
	Basalt				
	Non-welded Paintbrush Tuff				
	Topopah Spring Tuff				
	Calico Hills Tuff				
	Crater Flat Tuff				
OLDER	Granite				
	Argillite				
	Carbonate				

NOT APPLICABLE

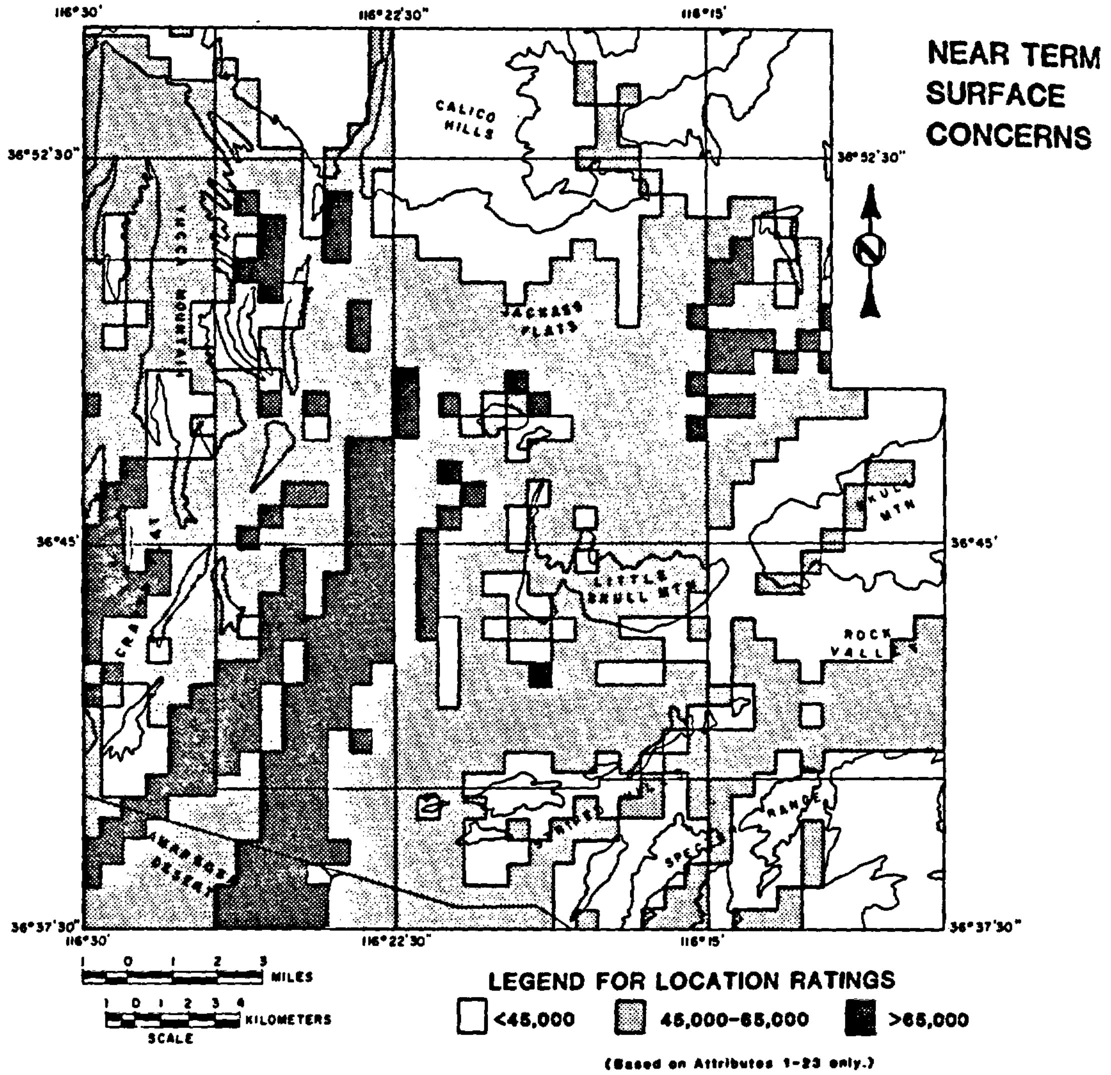
Figure 34. Ratings Based Solely on Environmental Attributes. See page C-14, Appendix C, for applied weights.

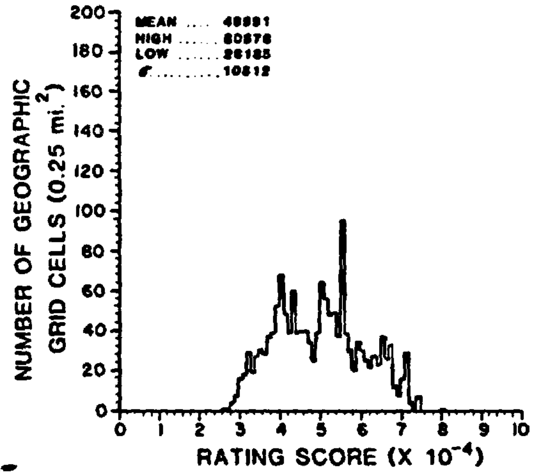
By combining construction and environmental objectives, a rating of various locations is obtained with respect to short-term operational concerns (Figure 35). This figure confirms that high overall ratings for northern Yucca Mountain and Calico Hills-Upper Topopah Wash are not greatly influenced by short-term objectives. However, short-term objectives contribute substantially to high overall ratings at northern Jackass Flats.

Assessment of Low Attribute Favorabilities

For all the foregoing analyses, weighted favorabilities of several or even many attributes were added to obtain ratings for various locations and host rocks. This process tends to mask the effects of attributes with very low weights. However, even if an attribute is considered to be of relatively minor importance (i.e., has a low weight), it might become an issue of concern in licensing hearings if its favorability is quite low. To determine where attributes with both low favorabilities and low weights occur, the overall results shown on Figure 15 were reanalyzed using Equation 3 with an exponent of 3 for F_j (Figure 36).

If an attribute has a low favorability and a high weight, it will depress the ratings of pertinent locations and host rocks below the ratings for the nominal case where an exponent of zero is used in Equation 3 (Figure 15). Therefore, locations or host rocks which rate relatively low on Figure 36 but





AGE	ROCK TYPE	SATURATED		UNSATURATED	
		RATING	RANK	RATING	RANK
YOUNGER	Alluvium				
	Basalt				
	Non-welded Paintbrush Tuff				
	Topopah Spring Tuff				
	Calico Hills Tuff				
	Crater Flat Tuff				
OLDER	Granite				
	Argillite				
	Carbonate				

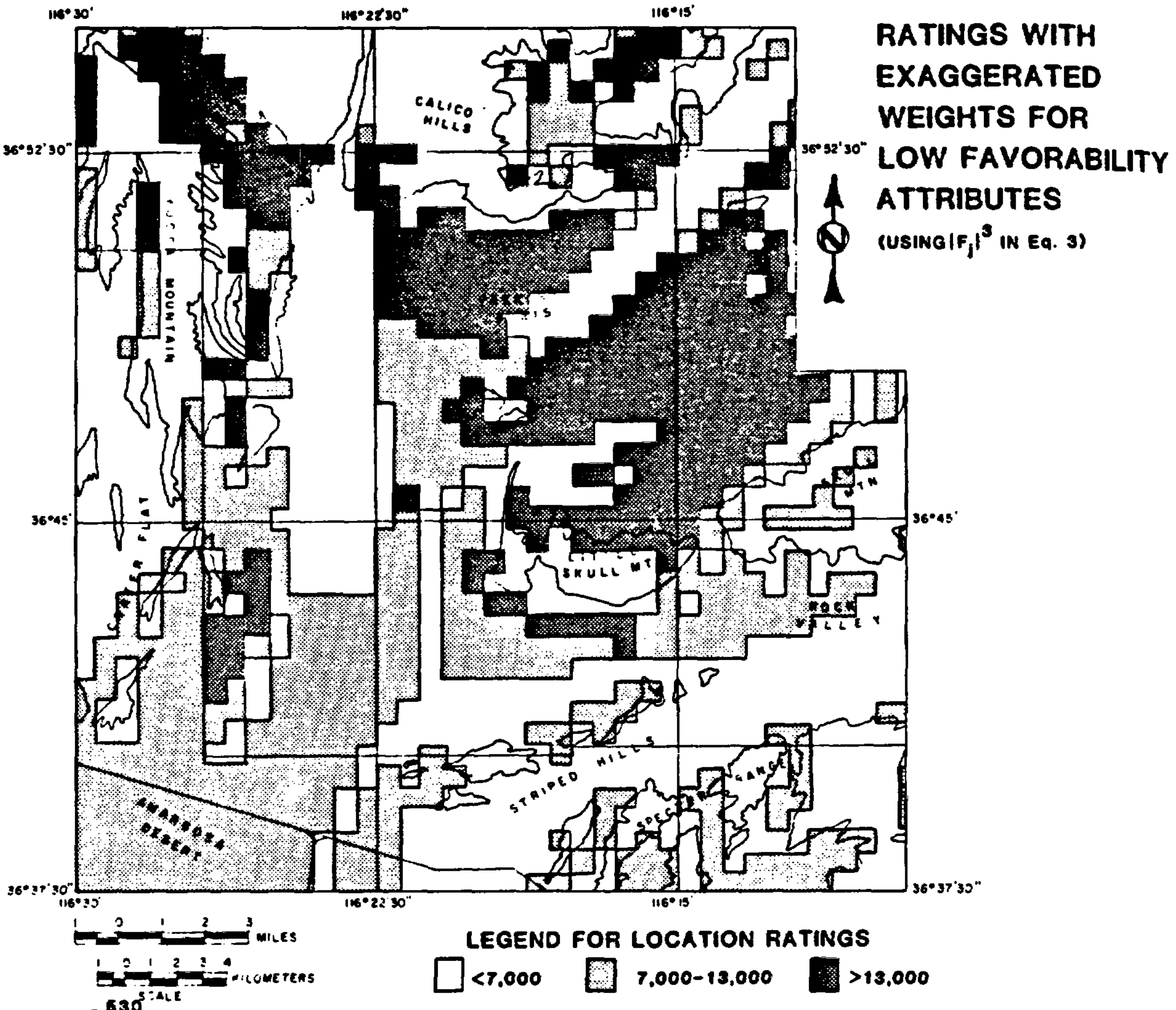
NOT APPLICABLE

Figure 35. Ratings Based Solely on Objectives for Near-Term Development of a Repository. See page C-15, Appendix C, for applied weights.

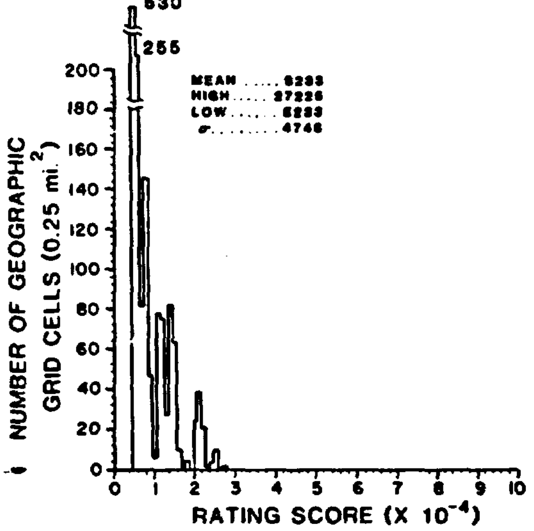
high on Figure 15 are characterized by at least one unfavorable attribute, presumed to be of minor importance. These locations are displayed in Figure 37, which is a map of the ratio of rating scores from Figure 15 to those from Figure 36. Higher ratios on Figure 37 (dark areas on the map, higher rating numbers on the host-rock lists) correspond to locations or host rocks which are most sensitive to exaggerated weights for low favorability attributes.

The map on Figure 36 indicates that northern Yucca Mountain, Calico Hills-Upper Topopah Wash, eastern Crater Flat, the area just west of Fortymile Canyon, a strip along northern Fortymile Wash, Skull Mountain, Rock Valley, the Specter Range and a strip from Mid-Valley to central Jackass Flats are all characterized by one or more potentially sensitive geographical attributes. These attributes depress rating scores most significantly only at northern Yucca Mountain, eastern Crater Flat, the west wall of Fortymile Canyon, and isolated spots throughout the rest of the screening area (Figure 37). Yucca Wash, northeastern Jackass Flats and central Jackass Flats, on the other hand, are least affected by exaggerated weights for low attribute favorabilities. The favorable location of overall ratings, including host-rock attributes, at Calico Hills-Upper Topopah Wash is only moderately affected by low favorabilities for geographical attributes (Figure 37).

Scanning Appendix B, pages B-1 to B-23, reveals that the only poorly rated geographical attributes (favorability of 1 or



(Based on Attributes 1-23 only.)

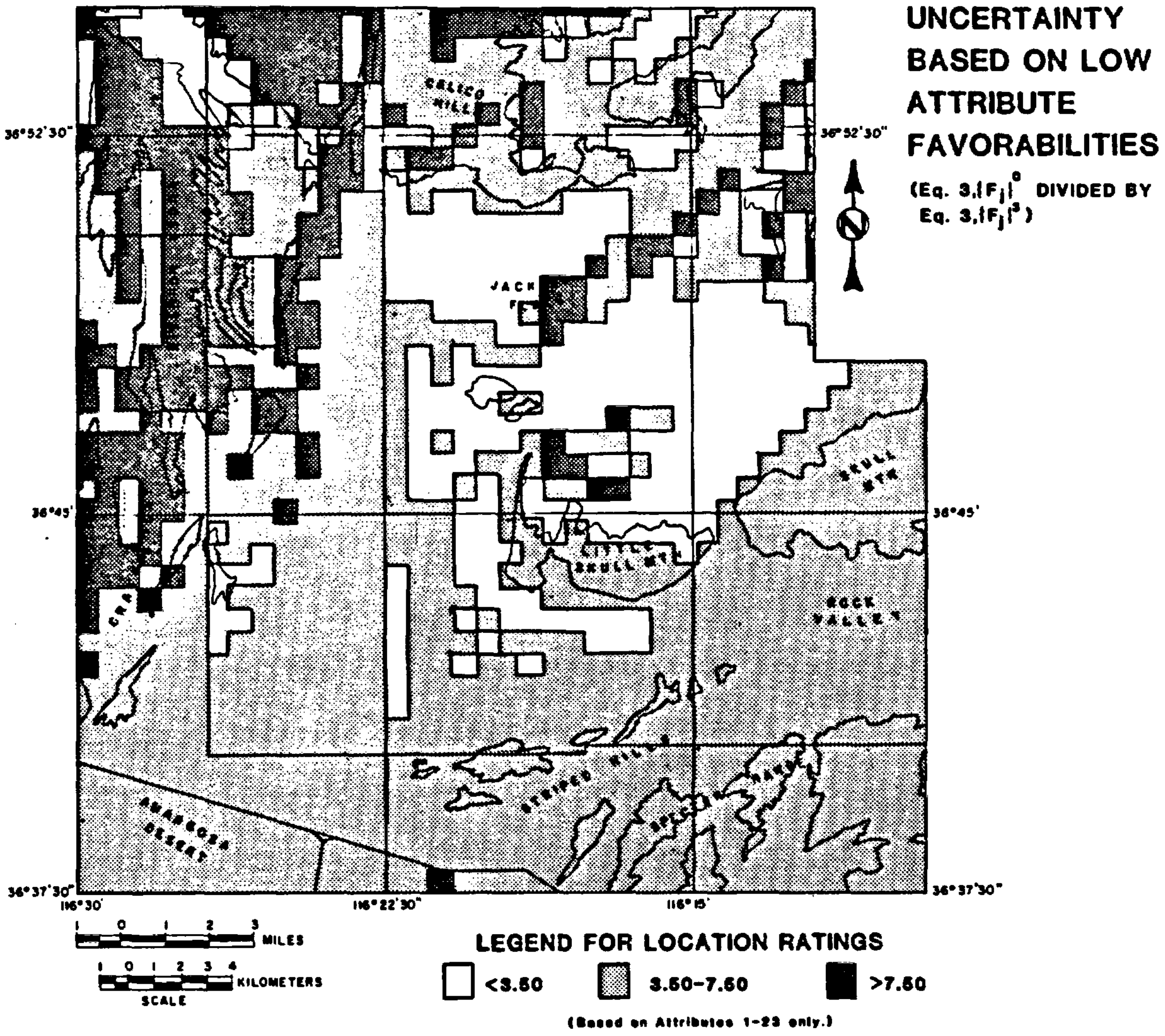


HOST ROCK RATINGS

AGE	ROCK TYPE	SATURATED		UNSATURATED	
		RATING	RANK	RATING	RANK
YOUNGER	Alluvium	26000	4	26000	4
	Basalt	29000	3	26000	4
	Non-welded Paintbrush Tuff	25000	5	26000	4
	Topopah Spring Tuff	11000	7	28000	3
	Calico Hills Tuff	5000	9	5000	7
	Crater Flat Tuff	50000	1	46000	1
	Granite	33000	2	31000	2
	Argillite	12000	6	11000	5
OLDER	Carbonate	8000	8	7000	6

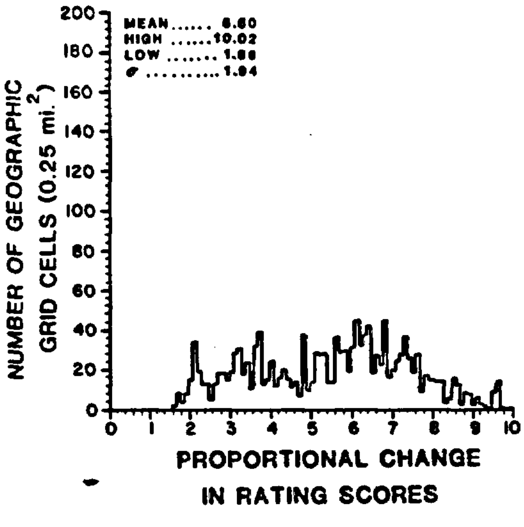
NOTE: Host rock ratings based solely on host rock attributes (numbers 24-31 for saturated list; for unsaturated list numbers 24-30 only). Ratings do not account for site dependent rock conditions such as in-situ stress, in-situ temperature, depth, local structures and others. Unsaturated ratings omit hydraulic transmissivity, attribute #31.

Figure 36. Ratings Based on Exaggerated Weights for Low Favorability Values of Attributes. See Table 6 for applied weights.



UNCERTAINTY BASED ON LOW ATTRIBUTE FAVORABILITIES

(Eq. 3,$\{F_j\}^0$ DIVIDED BY Eq. 3,$\{F_j\}^3$)



		SATURATED*		UNSATURATED*	
AGE	ROCK TYPE	RATING	RANK	RATING	RANK
YOUNGER	Alluvium	1.58	2	1.61	3
	Basalt	1.68	3	1.82	4
	Non-welded Paintbrush Tuff	2.00	4	1.60	2
	Topopah Spring Tuff	3.80	6	2.03	6
	Calico Hills Tuff	13.99	9	11.58	9
	Crater Flat Tuff	1.35	1	1.31	1
	Granite	2.30	5	2.02	5
	Argillite	6.90	8	6.23	7
OLDER	Carbonate	4.82	7	7.83	8

NOTE: Host rock ratings based solely on host rock attributes (numbers 24-31 for saturated list; for unsaturated list numbers 24-30 only). Ratings do not account for site dependent rock conditions such as in-situ stress, in-situ temperature, depth, local structures and others. Unsaturated ratings omit hydraulic transmissivity, attribute #31.

Figure 37. Ratio of Ratings of Overall Results (Figure 15) to Ratings from Figure 36

less) at northern Yucca Mountain are terrain ruggedness (page B-10), the proximity of the eastern portion of the location to the accessible environment (page B-14) and the land-use status of the southern portion (page B-22). At Calico Hills-Upper Topopah Wash the potentially sensitive attributes are faulting (pages B-2 and B-3), rock dips (page B-7), terrain ruggedness (pages B-10), potential mineral resources (page B-11), floral species (page B-16), and cultural resources (page B-20). For these two locations, issues associated with these attributes should be carefully assessed before accepting their favorable ratings as indicative of suitability for a repository.

For host rocks, high sensitivity to low attribute favorabilities is indicated for the Calico Hills Tuff and moderate sensitivity for argillite and carbonate (Figures 36 and 37). Inspection of attribute values on Table B-1 (page B-25) and associated favorability graphs (page B-26) clearly points to mineral stability and associated contraction upon heating as topics of concern for argillite and Calico Hills Tuff. Low compressive strength as a factor in mining may also be of concern for these two rock types which rate so highly for long-term safety. Hydraulic transmissivity of the Topopah Spring Tuff and carbonates also needs careful assessment before seriously considering these rock types for use as a repository host.

CHAPTER 4. SUMMARY OF RESULTS AND CONCLUSIONS

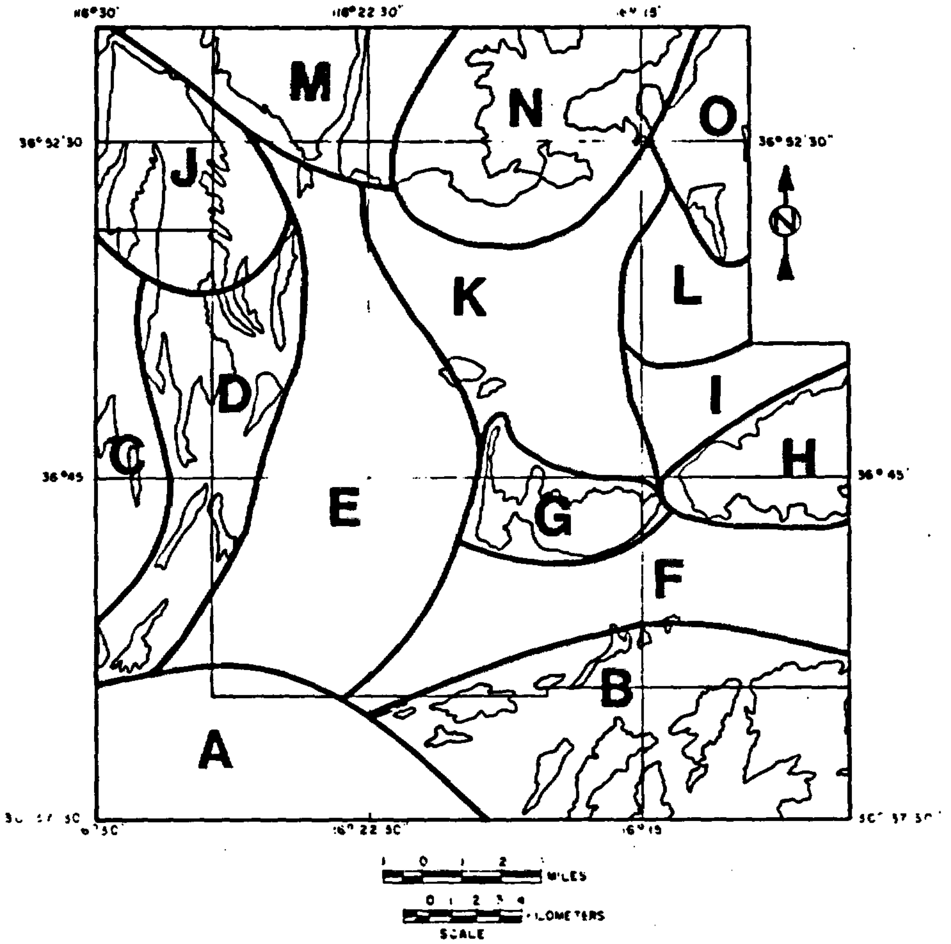
Summary of Analytical Results

The screening results shown in Chapter 3 are summarized in this chapter by comparing 15 alternative locations (Figure 38) and nine host rocks. The locations were selected with some discretion. Their boundaries generally correspond to areas where distinct clusters of grid cells rate similarly on most of the individual analyses presented in Chapter 3. The locations are thus defined primarily by the results of the screening analyses rather than by more arbitrary criteria established prior to the analyses. The boundaries are not rigidly defined. They are meant to be flexible and are shown only to provide an approximate guide as to where somewhat homogeneously rated locations occur.

The host-rock comparisons in this chapter are made only with the caveat that they are site-independent. Site-specific rock attributes such as in situ stress, in situ temperature, local fracture density, and local mineralogy were not evaluated. Such local attributes are being used in the horizon evaluation activity of the NNWSI, scheduled to select at the end of 1982 one or more stratigraphic horizons for later exploration and testing from the base of an exploratory shaft.

Location Comparisons

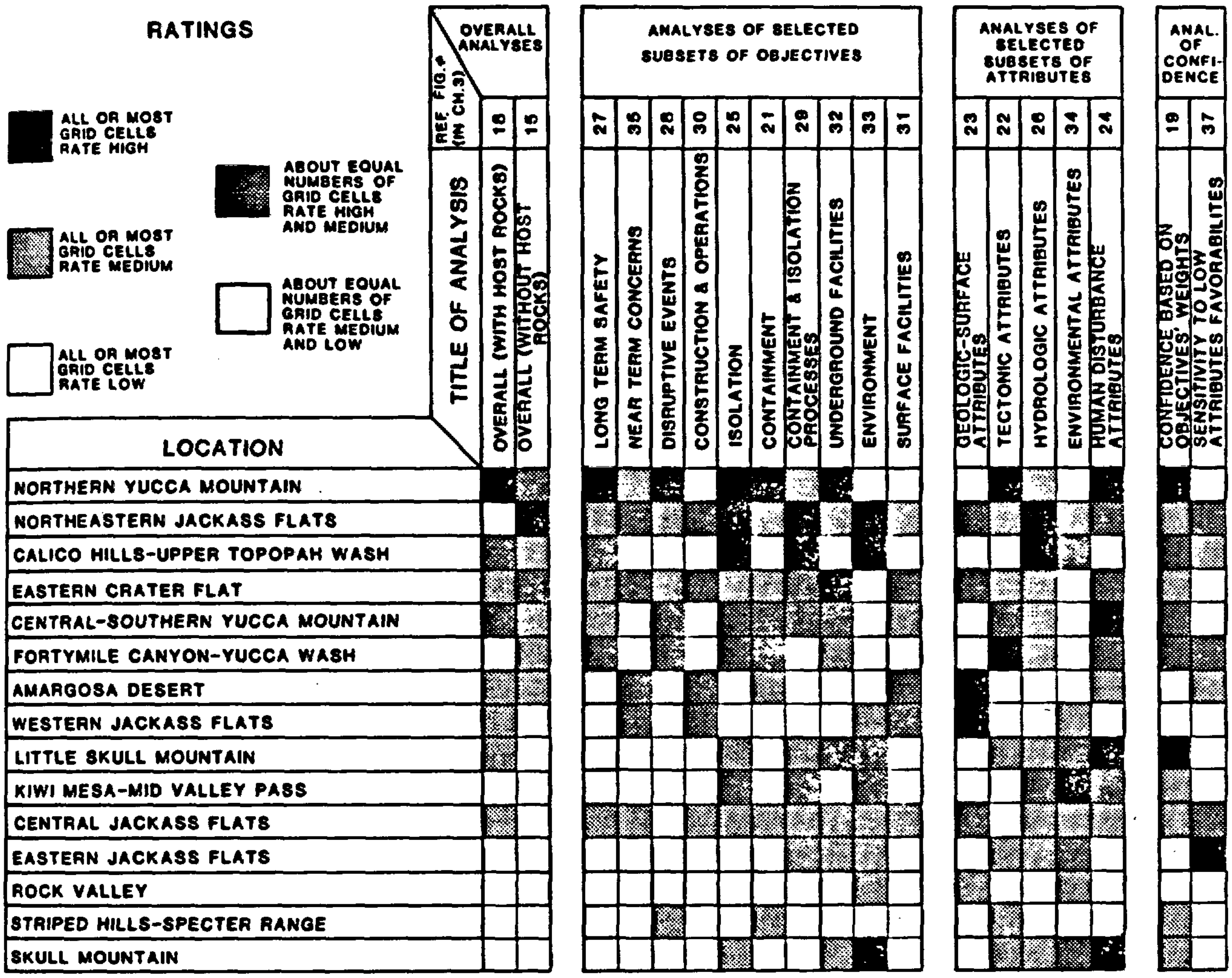
Table 9 shows how each of the 15 locations (Figure 38) rates with respect to 19 separate screening analyses (Figures



ALTERNATIVE LOCATIONS

A AMARGOSA DESERT
B STRIPED HILLS-SPECTER RANGE
C EASTERN CRATER FLAT
D CENTRAL-SOUTHERN YUCCA MOUNTAIN
E WESTERN JACKASS FLATS
F ROCK VALLEY
G LITTLE SKULL MOUNTAIN
H SKULL MOUNTAIN
I EASTERN JACKASS FLATS
J NORTHERN YUCCA MOUNTAIN
K CENTRAL JACKASS FLATS
L NORTHEASTERN JACKASS FLATS
M YUCCA WASH-FORTYMILE CANYON
N CALICO HILLS-UPPER TOPOPAH WASH
O KIWI MESA-MID VALLEY PASS

Figure 38. Approximate Boundaries of 15 Alternative Locations for Repositories in SW NTS and adjacent areas.



RATINGS

- ■ ALL OR MOST GRID CELLS RATE HIGH
- ▩ ABOUT EQUAL NUMBERS OF GRID CELLS RATE HIGH AND MEDIUM
- ▨ ALL OR MOST GRID CELLS RATE MEDIUM
- □ ABOUT EQUAL NUMBERS OF GRID CELLS RATE MEDIUM AND LOW
- □ ALL OR MOST GRID CELLS RATE LOW

	OVERALL ANALYSES		ANALYSES OF SELECTED SUBSETS OF OBJECTIVES										ANALYSES OF SELECTED SUBSETS OF ATTRIBUTES					ANAL. OF CONFI-DENCE	
REF. FIG.# (IN CH.3)	18	15	27	35	28	30	25	21	29	32	33	31	23	22	26	34	24	19	37
LOCATION / TITLE OF ANALYSIS	OVERALL (WITH HOST ROCKS)	OVERALL (WITHOUT HOST ROCKS)	LONG TERM SAFETY	NEAR TERM CONCERNS	DISRUPTIVE EVENTS	CONSTRUCTION & OPERATIONS	ISOLATION	CONTAINMENT	CONTAINMENT & ISOLATION PROCESSES	UNDERGROUND FACILITIES	ENVIRONMENT	SURFACE FACILITIES	GEOLOGIC-SURFACE ATTRIBUTES	TECTONIC ATTRIBUTES	HYDROLOGIC ATTRIBUTES	ENVIRONMENTAL ATTRIBUTES	HUMAN DISTURBANCE ATTRIBUTES	CONFIDENCE BASED ON OBJECTIVES' WEIGHTS	SENSITIVITY TO LOW ATTRIBUTES FAVORABILITES
NORTHERN YUCCA MOUNTAIN	■	▩	■	▨	▩	□	■	▩	▨	▩	□	□	□	■	▨	□	■	■	□
NORTHEASTERN JACKASS FLATS	□	■	▨	▩	▨	▩	▩	▨	▩	▨	▩	▨	▩	▨	■	▨	▩	▨	▩
CALICO HILLS-UPPER TOPOPAH WASH	▩	▨	▩	□	□	□	■	□	▩	□	■	□	□	□	■	▩	□	▩	▨
EASTERN CRATER FLAT	▨	▩	▨	▩	▨	▩	▨	▨	▩	▩	□	▩	▩	▨	▨	□	▩	▨	□
CENTRAL-SOUTHERN YUCCA MOUNTAIN	▩	▨	▨	□	▩	□	▩	▩	▩	▩	□	▩	□	▩	▨	□	■	▩	□
FORTYMILE CANYON-YUCCA WASH	□	▨	▩	□	▩	□	▩	▩	□	▩	□	□	□	■	▨	□	▩	▩	▩
AMARGOSA DESERT	▨	▨	□	▩	□	▩	□	▨	□	□	□	▩	■	□	□	□	▨	□	▨
WESTERN JACKASS FLATS	▨	□	□	▩	□	▩	□	□	□	□	▨	▩	■	□	□	▨	□	□	□
LITTLE SKULL MOUNTAIN	▨	□	□	□	□	□	▨	□	▨	▩	▩	□	□	▩	▨	▩	■	■	□
KIWI MESA-MID VALLEY PASS	□	□	□	□	□	□	▩	□	▨	□	▩	□	□	□	▩	▩	▩	▨	□
CENTRAL JACKASS FLATS	▨	□	▨	▨	□	▨	▨	▨	▨	▨	▨	▨	▩	□	▨	▨	▨	▨	▩
EASTERN JACKASS FLATS	□	□	□	□	□	□	□	□	▨	▨	▨	□	□	▩	▨	▩	□	□	■
ROCK VALLEY	□	□	□	□	□	□	□	□	□	□	▨	□	▨	□	□	▩	□	□	□
STRIPED HILLS-SPECTER RANGE	□	□	□	□	▨	□	□	▨	□	□	□	□	□	▨	□	□	□	▨	□
SKULL MOUNTAIN	□	□	□	□	□	□	▨	□	□	▨	■	□	□	▨	▨	▩	■	▨	□

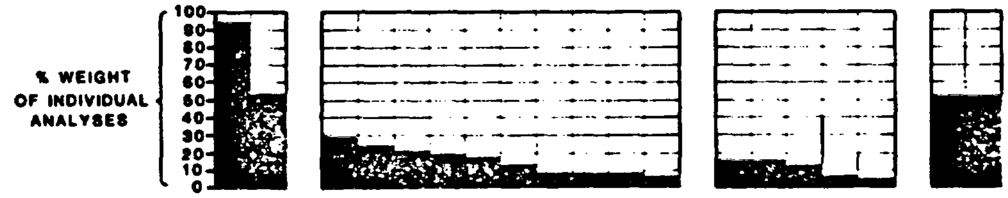


Table 9

Summary of Location Ratings

15, 18, 19, 21-35, and 37). Each location is assigned to one of five rating categories: high; high-and-medium; medium; medium-and-low; and low. These categories indicate which of the three rating levels shown on the maps in Chapter 3 are predominant at each of the locations. The "high" rating category on Table 9 is reserved for locations where all or most grid cells rate high on the maps. The "high-and-medium" category indicates that about equal numbers of grid cells rate both high and medium on the corresponding map. "Medium", "medium-and-low", and "low" categories are defined in the same manner.

The three rating levels which discriminate among grid cells on the maps in Chapter 3 are thus combined on Table 9 into five rating categories for alternative locations. The increase in the number of rating categories is necessary because the locations compared in Table 9 are composed of many grid cells, some of which have differing ratings on individual maps in Chapter 3.

The weight atrributed to each individual analysis is shown graphically at the bottom of Table 9 and listed in Table 10. The weights represent the proportional contribution of separate analyses to a weight of 100 percent* for the entire array of

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*Note the column labeled "Overall Analysis (with Host Rocks)" has a weight of 93.66 percent. Though this overall analysis accounts for the total weight assigned to all objectives and attributes used in screening, its weight is less than 100 percent because objectives 3.1.4, 3.2.6, 4.3.1, 4.3.2, and 4.4.1 (which together account for 6.34 percent of the total weight of 100 percent for attribute-objectives tree, Tables 4 and 6), have no pertinent attributes. Thus zero weight is attributed to each of these objectives and their combined weight is subtracted from the maximum possible weight of the overall analysis.

			LOCATION ANALYSES		HOST-ROCK ANALYSES			
					Saturated		Unsaturated	
Analysis Type	Reference in Text	Analysis Title	Weight (% of Total)	Rank	Weight (% of Total)	Rank	Weight (% of Total)	Rank
Overall	Figure 19	Overall(with host rock)	93.66	1	NA	NA	NA	NA
	Figure 17	Overall(without host rock)	52.42	2	41.24	1	26.77	1
Confidence	Figure 20	Confidence based on weights	52.42	2	41.24	1	26.77	1
	Figure 33	Sensitivity to low favorabilities	52.42	2	41.24	1	26.77	1
Objectives	Figure 24	Long-Term Safety	28.40	3	36.60	2	23.85	2
	Figure 31	Near-Term Concerns	24.01	4	4.64	5	2.93	5
	Figure 26	Disruptive Events	21.83	5	NA	NA	NA	NA
	Figure 27	Construction & Operations	17.50	6	4.64	5	2.93	5
	Figure 23	Isolation	17.05	7	16.95	4	12.79	3
	Figure 22	Containment	11.35	8	19.65	3	11.05	4
	Figure 25	Containment & Isolation Processes	6.58	9	36.60	2	23.85	2
	Figure 29	Underground Facilities	6.55	10	4.64	5	2.93	5
	Figure 30	Environment	6.51	11	NA	NA	NA	NA
	Figure 28	Surface Facilities	5.40	12	NA	NA	NA	NA
Attributes	Figure 36	Geologic-Surface Attributes	15.92	1-A	NA	NA	NA	NA
	Figure 35	Tectonic Attributes	15.37	2-A	NA	NA	NA	NA
	Table 6	Geochemical Attributes	NA	NA	14.64	1-A	14.64	1-A
	Table 6	Hydrologic Attributes(Host Rock)	NA	NA	14.47	2-A	NA	NA
	Table 6	Geomechanical Attributes	NA	NA	12.14	3-A	12.14	2-A
	Figure 34	Hydrologic Attributes (geographic)	12.00	3-A	NA	NA	NA	NA
	Figure 38	Environmental Attributes	5.47	4-A	NA	NA	NA	NA
	Figure 37	Human Disturbance Attributes	4.96	5-A	NA	NA	NA	NA

Table 10. Weights Attributed to Separate Screening Analyses. Ranks Based on Weights are Shown Separately for Analyses of Objectives (Including Overall and Confidence Analyses) and for Analyses of Attributes (Numbers with "A" Following)

attributes and objectives (Tables 4 and 6). Accordingly, the relative importance of individual analyses to the overall screening can be ascertained from the weights shown on Tables 9 and 10.

Table 9 groups the analyses from Chapter 3, first, according to their type (i.e., analyses of objectives, atrributes, and confidence) and, second, within each type, according to their weights. High to low weights are arranged from left to right, respectively, for each group of analyses. The locations on Table 9 are arranged from top to bottom according to the highest to the lowest rated, respectively. However, the order is only approximate. Some interpretation is required to determine whether a location with, for example, a few high ratings and many low ratings should be ranked above or below one with no high ratings but only a few low ratings.

Table 11 summarizes the number and total weight of high, high-and-medium, medium, medium-and-low, and low ratings for each location from the first 12 columns of Table 9. This provides a total hybrid weight* for each rating category and location. The analyses for which weights were summed are restricted to the first 12 columns of Table 9, i.e., overall analyses and analyses of objectives, to maintain the logic of the objectives tree in comparing alternative locations. The remaining columns of Table 9 can be scanned to glean, respectively, which groups of attributes contribute to the high or low ratings of each location and how much confidence can be placed in these ratings.

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*A total hybrid weight of 219.21 percent is associated with the first 12 columns in Table 9. This weight is greater than the total weight of 100 percent associated with the entire attribute-objectives matrix (Table 6). The term "hybrid" addresses the fact that some atrribute-objective intersections on Table 6 and their associated weights contribute to two or more of the 12 analyses summarized on Table 11 (see Appendix C for weights used for individual analyses).

	NUMBER AND SUMMED WEIGHTS OF INDIVIDUAL ANALYSES OF OBJECTIVES									
	High		High & Medium		Medium		Medium & Low		Low	
LOCATION	No.	Weight	No.	Weight	No.	Weight	No.	Weight	No.	Weight
Northern Yucca Mountain	6	178.79	1	52.42	2	30.59	3	29.41	0	-0-
Northeastern Jackass Flats	4	82.56	2	41.51	5	73.48	1	93.66	0	-0-
Calico Hills-Upper Topopah Wash	3	30.14	2	122.06	1	52.42	3	39.68	3	46.91
Eastern Crater Flat	1	6.55	5	105.91	5	172.24	0	-0-	1	6.51
Central-Southern Yucca Mountain	0	-0-	6	156.97	3	86.22	2	30.52	1	17.50
Fortymile Canyon-Yucca Wash	0	-0-	4	78.58	2	58.97	4	112.15	2	41.51
Amargosa Desert	0	-0-	3	46.91	3	157.38	4	73.83	2	13.09
Western Jackass Flats	0	-0-	3	46.91	2	100.17	2	74.25	5	69.88
Little Skull Mountain	0	-0-	2	13.06	3	117.29	3	63.71	4	97.15
Kiwi Mesa-Mid Valley Pass	0	-0-	3	30.14	0	-0-	5	120.50	4	140.57
Central Jackass Flats	0	-0-	0	-0-	10	216.96	2	74.25	0	-0-
Eastern Jackass Flats	0	-0-	0	-0-	3	19.64	9	271.57	0	-0-
Rock Valley	0	-0-	0	-0-	1	6.51	9	162.64	2	122.06
Striped Hills-Specter Range	0	-0-	0	-0-	2	33.13	3	52.03	7	206.05
Skull Mountain	1	6.51	0	-0-	2	23.60	2	33.13	7	227.97

Table 11 Rank of Locations (Top to Bottom) Based on the Number and Weights of High, High-and-Medium, Medium, Medium-and-Low, and Low Ratings for Analyses of Objectives

Table 11 indicates that northern Yucca Mountain and northeastern Jackass Flats are clearly the most highly rated locations, if host-rock atrributes are not considered. Especially for northern Yucca Mountain, a significant proportion of the total hybrid weight occurs in the highest rating category. Most of the remainder of the weight is attributed to the second highest category. Neither of these locations rates low for any of the 12 analyses considered in Table 11.

Northern Yucca Mountain and northeastern Jackass Flats rate high for somewhat different reasons. Northern Yucca Mountain is generally favorable for objectives and attributes which address long-term protection of humans from radionuclide contamination. Northeastern Jackass Flats, on the other hand, generally rates more highly than northern Yucca Mountain for near-term operational and environmental objectives.

In particular, high ratings at northern Yucca Mountain include those for long-term safety, isolation, containment, and low likelihood for disruptive events (Table 9). Supporting attributes which address tectonic stability and the potential for human intrusion are likewise rated highly. Moreover, only northern Yucca Mountain rates in the highest category for overall ratings which include host-rock attributes. However, generally lower ratings are obtained for near-term surface concerns, in particular for construction and operations of surface facilities and for environmental objectives. High confidence is obtained for this location based on the range of assumptions about the proper weights for various objectives. However, some sensitivity is indicated to potentially disqualifying attributes, particularly land use and, for the eastern part, proximity to the accessible environment.

Hydrological and terrain attributes are generally more favorable at northeastern Jackass Flats than northern Yucca

Mountain, reflecting associated higher ratings for, respectively, long-term containment, isolation processes, and near-term construction (Table 9). The only lower ratings at northeastern Jackass Flats are for the overall analysis which includes host-rock attributes. This points to a potential insurmountable flaw for this location; namely, the lack of a candidate host-rock. Interlayered tuffs and rhyolites are the inferred rock types underlying this location. Presumed complexity of these rocks was responsible for eliminating them from evaluation in this screening. In order for this location to be considered a viable alternative for repository siting, the containment, isolation, and mining qualities of these complex rocks will need to be carefully assessed.

The next most highly rated group of locations after northern Yucca Mountain and northeastern Jackass Flats include in order: Calico Hills-Upper Topopah Wash, eastern Crater Flat and central-to-southern Yucca Mountain. These locations rate less favorably than the top two, but all have significant weights assigned to high and high-to-medium ratings (Table 11). Accordingly, these locations thus also exhibit some relatively favorable conditions for repository siting. However, they all have low or low-to-medium ratings for a substantial portion of the total hybrid weight considered in Table 11. Therefore, potential drawbacks for siting a repository at these locations are indicated.

Calico Hills-Upper Topopah Wash exhibits high ratings for isolation and expected processes, and high-and-medium ratings for long-term safety (Table 9). These ratings are related to generally favorable hydrologic attributes, due in large part to the presence of low-permeability argillite. This rock type, the most highly rated in the screening area, is also highly sorptive. The occurrence of argillite and perhaps granite, the second-most highly rated rock type, beneath Calico Hills-Upper Topopah Wash is responsible for high-and-medium overall ratings when host-rock attributes are included. Thus, when host-rock attributes are included, this location rates second, behind northern Yucca Mountain, as the most favorable for repository siting (Table 9). Though environmental objectives are well satisfied at Calico Hills-Upper Topopah Wash, low ratings for construction of surface facilities result in generally unfavorable near-term concerns. This is due primarily to low ratings for surface geologic and terrain attributes (Table 9). Generally low ratings also occur for tectonic attributes at this location, a fact that is instrumental in depressing its favorability for containment and underground construction objectives.

For eastern Crater Flat, a lower proportion of the total hybrid weight is attributed to both high and low ratings than for Calico Hills-Upper Topopah Wash. As a result, most of the hybrid weight occurs in the medium rating category. This location rates most highly for near-term concerns including both surface and underground facilities and human disturbance attributes. Low ratings are expressed only for environmental objectives and attributes (Table 9).

Central-southern Yucca Mountain, on the other hand, rates most highly for tectonic attributes and associated objectives for containment, isolation, avoidance of disruptive events, and benign expected processes. However, it rates relatively low for environmental objectives and attributes and for near-term operational objectives.

The next lower ranked group of locations are from higher to lower rank: the area from Yucca Wash to Fortymile Canyon; the Amargosa Desert; western Jackass Flats; Little Skull Mountain; and the Kiwi Mesa-Mid Valley Pass area. For these locations no analyses rate high and only a few with low weights yield high-and-medium ratings (Table 11). Though most ratings are medium, significant weights are also associated with medium-and-low and low ratings.

Ranked below Kiwi Mesa-Mid Valley Pass are central Jackass Flats and eastern Jackass Flats. These locations are somewhat unusual in that they exhibit only two rating categories, medium and medium-to-low (Tables 9 and 11). For central Jackass Flats the overwhelming proportion of ratings are medium, whereas medium-to-low ratings dominate eastern Jackass Flats (Table 11).

The lowest ranked locations in the screening area are clearly Rock Valley, the Striped Hills-Specter Range, and Skull

Mountain (Table 11). Rock Valley is predominantly characterized by medium-to-low ratings and the last two locations are dominated by low ratings (Tables 9 and 11). All locations ranked below central-southern Yucca Mountain are not prime candidates for siting a repository based on this screening, therefore the reader is referred to Table 9 without further discussion to interpret which objectives and attributes contribute most to their ratings.

Host-Rock Comparisons

Tables 12 and 13 summarize the results of 10 separate analyses of the nine candidate host rocks. These tables were compiled in the same way as Tables 9 and 11, but for only those analyses from Chapter 3 which include host-rock attributes (Figures 15, 19, 21, 25, 27, 37 and Table 8). Major column headings in Table 12 and 13 distinguish saturated and unsaturated analyses of selected sets of objectives. Table 12 has additional columns for analyses of selected sets of host-rock attributes.

On Table 13, as on Table 11, only the weights attributed to the overall analysis and analyses of objectives are summed to obtain the hybrid weights. The total hybrid weight for Table 13 is 119.08 percent for saturated conditions and 77.39 percent for unsaturated conditions.* Only three rating categories are

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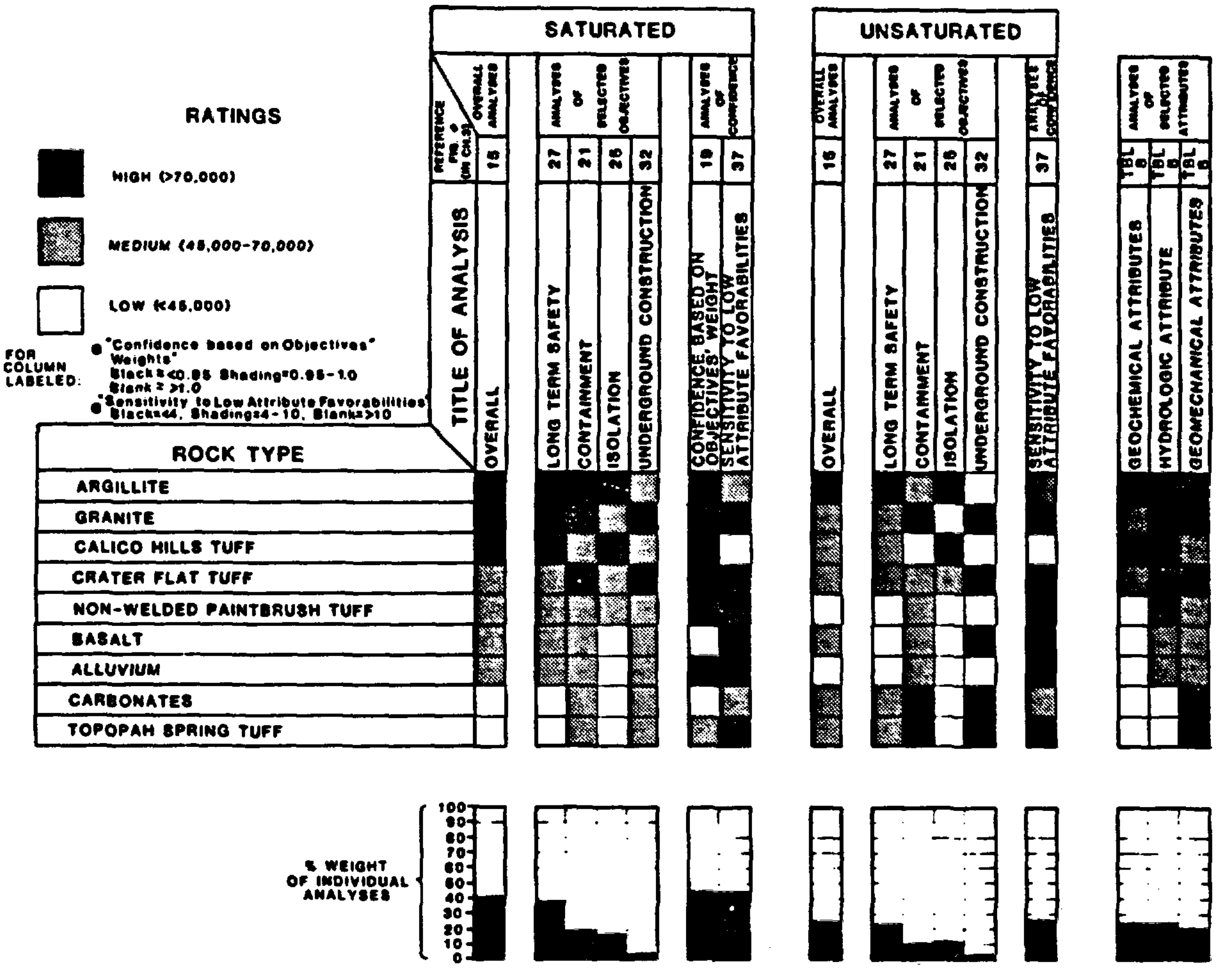
*The lower weight for unsaturated analyses reinforces the argument made in the footnote on page 69 that saturated ratings may approximate host-rock ratings better than unsaturated ratings; even for unsaturated conditions.



RATINGS

■ HIGH (>70,000)

▨ MEDIUM (45,000-70,000)

□ LOW (<45,000)

FOR COLUMN LABELED:
- "Confidence based on Objectives' Weights" Black ≤0.95 Shading=0.95-1.0 Blank ≥1.0
- "Sensitivity to Low Attribute Favorabilities" Black≤4, Shading=4-10, Blank≥10

TITLE OF ANALYSIS	SATURATED OVERALL ANALYSES OVERALL	 ANALYSES OF SELECTED OBJECTIVES LONG TERM SAFETY	 CONTAINMENT	 ISOLATION	 UNDERGROUND CONSTRUCTION	 ANALYSES OF CONFIDENCE CONFIDENCE BASED ON OBJECTIVES' WEIGHT	 SENSITIVITY TO LOW ATTRIBUTE FAVORABILITIES	UNSATURATED OVERALL ANALYSES OVERALL	 ANALYSES OF SELECTED OBJECTIVES LONG TERM SAFETY	 CONTAINMENT	 ISOLATION	 UNDERGROUND CONSTRUCTION	 ANALYSES OF CONFIDENCE SENSITIVITY TO LOW ATTRIBUTE FAVORABILITIES	 ANALYSES OF SELECTED ATTRIBUTES GEOCHEMICAL ATTRIBUTES	 HYDROLOGIC ATTRIBUTE	 GEOMECHANICAL ATTRIBUTES
REFERENCE FIG. # (IN CH.3)	15	27	21	25	32	19	37	16	27	21	25	32	37	TBL 8	TBL 8	TBL 8
ROCK TYPE																
ARGILLITE	■	■	■	■	▨	■	▨	■	■	▨	■	□	■	■	■	■
GRANITE	■	■	■	▨	■	■	■	▨	▨	■	□	■	■	▨	■	■
CALICO HILLS TUFF	■	■	▨	■	▨	■	□	▨	▨	□	■	□	□	■	■	▨
CRATER FLAT TUFF	▨	▨	■	▨	■	■	■	▨	▨	▨	▨	■	■	▨	■	■
NON-WELDED PAINTBRUSH TUFF	▨	▨	▨	▨	▨	■	■	□	□	▨	□	□	■	□	■	▨
BASALT	▨	▨	▨	□	▨	□	■	▨	□	▨	□	■	■	□	▨	▨
ALLUVIUM	▨	▨	▨	□	▨	■	■	□	□	▨	□	□	■	□	▨	▨
CARBONATES	□	□	▨	□	▨	□	▨	▨	▨	■	□	■	▨	□	□	■
TOPOPAH SPRING TUFF	□	□	▨	□	▨	▨	■	▨	▨	■	□	■	■	□	□	■

Table 12.

Summary of Host-Rock Ratings

used in Tables 12 and 13, compared to five categories in Tables 9 and 11. This is because only one rating number is assigned to each rock type for each analysis; therefore, combined high-and-medium and medium-and-low categories are not necessary.

	NUMBER AND WEIGHT OF INDIVIDUAL HOST ROCK RATING ANALYSES OF OBJECTIVES													
	SATURATED							UNSATURATED						
	High		Medium		Low		Saturated Rank	Unsaturated Rank	High		Medium		Low	
	No.	Weight	No.	Weight	No.	Weight			No.	Weight	No.	Weight	No.	Weight
Argillite	4	114.44	1	4.64	0	-0-	1	1	3	63.41	1	11.05	1	2.93
Granite	4	102.13	1	16.95	0	-0-	2	2	2	13.98	2	50.62	1	12.79
Calico Hills Tuff	3	94.79	2	24.29	0	-0-	3	4	1	12.79	2	50.62	2	13.98
Crater Flat Tuff	2	24.29	3	94.79	0	-0-	4	3	1	2.93	4	74.46	0	-0-
Non-Welded Paintbrush Tuff	0	-0-	5	119.08	0	-0-	5	6	0	-0-	1	11.05	4	66.34
Basalt	0	-0-	4	102.13	1	16.95	6	5	1	2.93	2	37.82	2	36.64
Alluvium	0	-0-	4	102.13	1	16.95	6	6	0	-0-	1	11.05	4	66.34
Carbonates	0	-0-	2	24.29	3	94.79	7	2	2	13.98	2	50.62	1	12.79
Topopah Spring Tuff	0	-0-	2	24.29	3	94.79	7	2	2	13.98	2	50.62	1	12.79

Table 13

Rank of Saturated and Unsaturated Host Rocks Based on the Number and Weight of High, Medium, and Low Ratings for Analyses of Objectives (Table 12, Columns 1-5, for Saturated Rocks, and Columns 8-12 for Unsaturated Rocks)

Saturated Rankings

Argillite, granite, and Calico Hills Tuff are clearly the most highly rated saturated rocks (Table 13). These rock types are all dominated by high ratings with only small weights expressed by medium ratings. They are also the only three rock types that rate high for the overall analysis of saturated conditions (Table 12). Argillite and granite rate high for all sets of objectives except underground construction (argillite) and isolation (granite), for which they rate medium. The Calico Hills Tuff rates high for all but two sets of objectives, containment and underground construction, for which it rates medium. The ratings of these rocks for objectives is reflected in their ratings for attributes. Argillite rates high for all attribute types: geomechanical; geochemical; and hydrologic. Granite rates high for geomechanical and hydrologic attributes but medium for geochemical attributes explaining, in part, its medium rating for isolation. On the other hand, medium ratings for geomechanical attributes of the Calico Hills Tuff associates with its medium rating for containment and underground construction; whereas high ratings for geochemical and hydrologic attributes associate with high ratings for long-term safety and isolation.

The next highest rated rock type, the Crater Flat Tuff, has low weight attributed to high ratings, and much weight to medium ratings. It rates high for containment and underground construction reflecting generally high ratings for hydrologic and geomechanical attributes (Table 8). Medium ratings for geochemical attributes contribute to its medium ratings for long-term safety and isolation objectives.

Following in decreasing order of favorability is the nonwelded Paintbrush Tuff with all weight assigned to medium ratings. Nonwelded Paintbrush Tuff rates medium for all analyses of objectives for saturated conditions and for all attributes exept geochemical for which it rates low.

Saturated basalt and alluvium rank next with the total weight distributed among medium and low ratings, medium ratings dominant. They both rate medium for all objectives except isolation, for which they rate low. This reflects low ratings for geochemical attributes and medium ratings for geomechanical and hydrologic attributes.

The Topopah Spring Tuff and carbonates reverse the weight distribution among medium and low ratings of alluvium and basalt and, as a result, rank lowest for saturated conditions. Carbonates and Topopah Spring Tuff both exhibit relatively poor geochemical and hydrologic attributes accounting for their low ratings for long-term safety and isolation objectives, as well as their overall low ratings.

Unsaturated Rankings:

The ranking of unsaturated rock types is significantly different than for saturated rocks. Though argillite and granite retain, respectively, their first and second place ratings, the Topopah Spring Tuff and carbonates join granite as the second highest rated rocks. These are followed in order by the Calico Hills Tuff and Crater Flat Tuff. Which of latter two rock types should be ranked third and which fourth depends on how one interprets the tradeoff between the higher weights for both high and low ratings of the Calico Hills Tuff and the higher weight of medium ratings for the Crater Flat Tuff. In descending rank for unsaturated conditions, the remaining rock types are: basalt, ranked fifth; and alluvium and nonwelded Paintbrush Tuff, ranked sixth or last.

Though carbonates and Topopah Spring Tuff rate equal for unsaturated conditions, it should be noted that the relatively impermeable, sorptive Calico Hills Tuff lies between the Topopah Spring Tuff and the water table, whereas no such barrier exists beneath the unsaturated carbonates. Other caveats for interpreting the rankings on Table 13 are that unsaturated granite, and saturated, nonwelded Paintbrush Tuff probably do not occur in the screening area at the depths considered (Figure 7). In addition, unsaturated Crater Flat Tuff may not be sufficiently thick (~ 100') except in the southwesternmost portion of the screening area. Also, at the possible expense of redundancy, the reader is reminded that the unsaturated ratings do not give any weight to hydraulic transmissivity (a measure of rock's permeability) and thus may exaggerate the importance of nonhydrological properties.

Conclusions

The analytical results presented in Chapter 3 and summarized in the previous section indicate that the screening area divides naturally into about three categories with respect to favorability for siting a repository. The first category is composed of locations generally favorable for repository siting. These three locations are, in the order of their relative favorability: northern Yucca Mountain, northeastern Jackass Flats, and Calico Hills-Upper Topopah Wash. They offer the lowest risks, based on the assumptions of this screening method, that fully characterized sites within them will ultimately prove unsuitable for a repository.

These three locations are distinguished by (1) whether or not they are underlain by a favorably rated rock type or types and (2) by how they rate when the host-rock attributes are not considered. Only northern Yucca Mountain rates high both for host-rock independent and host-rock attributes. Two highly rated rock types occur at appropriate depths and in sufficient thickness at northern Yucca Mountain (Figure 7). These are the saturated or unsaturated Calico Hills Tuff and the unsaturated Topopah Spring Tuff. Though only moderately rated, the saturated Crater Flat Tuff also occurs at this location.

Northeastern Jackass Flats rates high for host-rock independent attributes, though no rock type analyzed in this screening occurs beneath a sufficiently large portion (about 2000 acres) of this location. Therein lies its distinguishing characteristic. For northeastern Jackass Flats to be seriously considered as a possible candidate for site characterization, a preliminary assessment would be required of the expected performance of complex, interlayered tuffs and rhyolites as a repository host.

The third generally favorable location is in and around Calico Hills and Upper Topopah Wash. Though this location rates only moderate for host-rock independent attributes, it is underlain by argillite, the most highly rated rock type, and perhaps by granite, the second most highly rated rock type. Because high ratings are obtained only when host-rock attributes are considered, this location is distinguished as a third type of favorable location. The relative contribution of host-rock and geographical attributes to overall repository performance must be assessed more rigorously than done by this screening before Calico Hills-Upper Topopah Wash is targeted for full site characterization.

The second general category of locations rates intermediate and includes eastern Crater Flat, central-to-southern Yucca Mountain, Fortymile Canyon-Yucca Wash, the Amargosa Desert, western Jackass Flats, Little Skull Mountain, Kiwi Mesa-Mid Valley Pass, and central Jackass Flats. These locations generally rate moderate with respect to most objectives and attributes. They may or may not be viable alternatives to the three most favorble locations depending on the level of risk willing to be assumed with regard to obtaining a license for fully characterized sites.

The third and last category of locations is rated low in this screening. Locations in this category include eastern Jackass Flats, Rock Valley, the Striped Hills-Specter Range, and Skull Mountain. These locations appear to present more potential obstacles to obtaining a repository license than the locations which rate moderate and, especially, those that rate high.

The design of this screening method does not allow assessments of suitability with respect to licensing criteria for any of the locations. Therefore, the ranking of location presented in this Chapter is only relative. The rankings are not meant to imply that any of the locations are, in fact, suitable for a repository. Nor do they imply the least favorable one, in fact, is unsuitable. Such assessments will require performance modeling based on more detailed data than available for this screening. Therefore, this screening only points to those locations in the screening area which, based on the assumptions inherent to the method, seem to present the best chance of ultimately qualifying for repository development.

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APPENDIX A

CONTENTS

APPENDIX A. RESULTS OF WEIGHTING POLL FOR PERFORMANCE OBJECTIVES

Set A Participants:
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LEVEL 1 OBJECTIVES

PROVIDE SAFE, EFFECTIVE, ENVIRONMENTALLY SOUND DISPOSAL OF RADIOACTIVE WASTES

Participant Set A

	Individual Respondent's Weights (% of Overall Goal)								
Level 1 Objectives	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	Mean ± 1σ
1.0 Containment	41.5	22	21	52	26	30	25	30	30.94 ± 10.66
2.0 Isolation	11	32	21	31	43	40	55	40	34.13 ± 13.65
3.0 Construction & Operation	41.5	46	52	11	21	20	10	10	26.44 ± 17.37
4.0 Environment	6	0	6	6	10	10	10	20	8.5 ± 5.73

LEVEL 2 OBJECTIVES

1.0 PROVIDE RADIONUCLIDE CONTAINMENT

Participant Set A

	Individual Respondent's Weights (% of Containment Objectives)								
Level 2 Objectives	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	Mean ± 1σ
1.1 Processes	80	80	70	60	60	67	60	67	68.00 ± 8.33
1.2 Events	20	20	30	40	40	33	40	33	32.00 ± 8.33

2.0 PROVIDE RADIONUCLIDE ISOLATION

Participant Set A

	Individual Respondent's Weights (% of Isolation Objectives)								
Level 2 Objectives	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	Mean ± 1σ
2.1 Radionuclide Migration	60	80	70	50	50	67	73	67	64.63 ± 10.66
2.2 Changes to Pathways	40	20	30	50	50	33	27	33	35.38 ± 10.66

3.0 PROVIDE SAFE, COST EFFECTIVE CONSTRUCTION AND OPERATIONS

Participant Set A

	Individual Respondent's Weights (% of Construction Objectives)								
Level 2 Objectives	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	Mean ± 1σ
3.1 Surface Facilities	35	20	30	20	15	33	30	33	27.00 ± 7.52
3.2 Subsurface Facilities	35	60	40	20	50	50	40	50	43.13 ± 12.23
3.3 Transportation	30	20	30	60	35	17	30	17	29.88 ± 13.95

4.0 AVOID UNDUE ENVIRONMENTAL IMPACTS

Participant Set B

	Individual Respondent's Weights (% of Environmental Objectives)							
Level 2 Objectives	(1)	(2)	(3)	(4)	(5)	(6)	(7)	Mean ± 1σ
4.1 Biotic Systems	15	25	20	10	20	33	28	21.57 ± 7.81
4.2 Abiotic Systems	15	35	30	20	20	7	23	21.43 ± 9.25
4.3 Socioeconomic	30	20	5	40	25	13	5	19.71 ± 13.06
4.4 Institutional Issues	35	10	25	20	25	20	16	21.57 ± 7.89
4.5 Cultural Resources	5	10	20	10	10	27	28	15.71 ± 9.21

LEVEL 3 OBJECTIVES

1.1 MINIMIZE EFFECTS OF ONGOING PROCESSES ON CONTAINMENT

Participant Set A

	Individual Respondent's Weights (% of Containment-Process Objectives)								
Level 3 Objectives	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	Mean ± 1σ
1.1.1 Chemical Processes	80	80	80	50	50	67	67	67	67.63 ± 12.43
1.1.2 Mechanical Processes	20	20	20	50	50	33	33	33	32.38 ± 12.43

1.2 AVOID SEVERE EVENTS THAT DISRUPT CONTAINMENT

Participant Set A

	Individual Respondent's Weights (% of Containment-Event Objectives)								
Level 3 Objectives	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	Mean ± 1σ
1.2.1 Seismic	30	60	70	30	20	27	30	27	36.75 ± 17.94
1.2.2 Erosional	30	10	5	20	10	13	10	13	13.89 ± 7.77
1.2.3 Volcanic	30	20	20	30	30	20	10	7	20.88 ± 8.97
1.2.4 Human Intrusion	5	10	5	18	40	33	40	33	23.00 ± 15.21
1.2.5 Miscellaneous	5	0	0	2	0	7	10	20	5.50 ± 6.93

2.1 RETARD RADIONUCLIDE MIGRATION

Participant Set A

	Individual Respondent's Weights (% of Isolation-Migration Objectives)								
Level 3 Objectives	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	Mean ± 1σ
2.1.1 Groundwater Flow	30	40	30	70	25	30	50	40	39.38 ± 14.75
2.1.2 Nuclide Retardation	20	40	30	15	25	40	38	30	29.75 ± 9.36
2.1.3 Host Rock Thickness	50	20	30	10	25	20	7	20	22.75 ± 13.28
2.1.4 Volatile Pathways	0	0	10	5	25	10	5	10	8.13 ± 7.99

2.2 AVOID ADVERSE CHANGES TO NUCLIDE MIGRATION PATHWAYS

Participant Set A

	Individual Respondent's Weights (% of Isolation-Change Objectives)								
Level 3 Objectives	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	Mean ± 1σ
2.2.1 Tectonic	30	40	50	40	25	27	20	20	31.50 ± 10.80
2.2.2 Climatic	10	20	20	20	15	20	33	27	20.63 ± 6.97
2.2.3 Geomorphic	30	40	20	20	10	13	13	13	19.88 ± 10.33
2.2.4 Human Induced	30	0	10	18	50	33	27	33	25.13 ± 15.50
2.2.5 Miscellaneous	0	0	0	2	0	7	7	7	2.88 ± 3.48

3.1 PROVIDE SAFE, COST EFFECTIVE SURFACE FACILITIES

Participant Set A

	Individual Respondent's Weights (% of Surface Facility Objectives)								
Level 3 Objectives	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	Mean ± 1σ
3.1.1 Seismic Hazards	10	30	30	30	16	24	16	14	21.25 ± 8.06
3.1.2 Monitoring Costs	0	0	20	5	16	5	16	28	11.25 ± 10.47
3.1.3 Foundation Conditions	30	60	20	15	16	28	16	19	25.50 ± 14.90
3.1.4 Wind Hazards	0	10	10	10	16	10	16	10	10.25 ± 5.18
3.1.5 Flood Hazards	40	0	10	15	16	19	16	24	17.50 ± 11.45
3.1.6 Construction Resources	20	0	10	25	16	14	16	5	13.25 ± 8.15

3.2 PROVIDE SAFE, COST EFFECTIVE SUBSURFACE FACILITIES

Participant Set A

	Individual Respondent's Weights (% of Subsurface Facility Objectives)								
Level 3 Objectives	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	Mean ± 1σ
3.2.1 Seismic Hazards	30	10	10	20	10	13	10	20	15.38 ± 7.35
3.2.2 Flood Hazards	30	0	20	10	10	27	40	27	20.50 ± 13.07
3.2.3 Mining Conditions	0	40	20	20	50	33	20	33	27.00 ± 15.33
3.2.4 Host Rock Geometry	20	40	15	10	10	10	10	6	15.13 ± 10.89
3.2.5 Host Rock Homogeneity	20	10	15	10	10	10	10	7	11.50 ± 4.07
3.2.6 Waste Package Acceptance	0	0	20	30	10	7	10	7	10.50 ± 10.11

3.3 PROVIDE SAFE, COST EFFECTIVE TRANSPORTATION CORRIDORS

Participant Set A

	Individual Respondent's Weights (% of Transportation Objectives)								
Level 3 Objectives	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	Mean ± 1σ
3.3.1 Terrain	90	90	70	50	57	67	80	67	71.38 ± 14.50
3.3.2 Distance	10	10	30	50	43	33	20	33	28.63 ± 14.50

4.1 MINIMIZE EFFECTS ON BIOTIC SYSTEMS

No poll necessary; 100% of weight for objective 4.1 is assigned to one subobjective (4.1.1), Sensitive Species.

4.2 MINIMIZE EFFECTS ON ABIOTIC SYSTEMS

Participant Set B

	Individual Respondent's Weights (% of Abiotic System Objectives)							
Level 3 Objectives	(1)	(2)	(3)	(4)	(5)	(6)	(7)	Mean ± 1σ
4.2.1 Surface Features	40	10	25	20	30	17	10	21.71 ± 10.90
4.2.2 Water Quality	50	60	40	40	40	50	45	46.43 ± 7.48
4.2.3 Air Quality	10	30	35	40	30	33	45	31.86 ± 11.07

4.3 MINIMIZE ADVERSE SOCIOECONOMIC EFFECTS

Participant Set B

	Individual Respondent's Weights (% of Socioeconomic Objectives)							
Level 3 Objectives	(1)	(2)	(3)	(4)	(5)	(6)	(7)	Mean ± 1σ
4.3.1 Local Economics	60	55	10	30	30	50	50	40.71 ± 17.90
4.3.2 Lifestyles	40	5	80	35	60	33	45	42.57 ± 23.37
4.3.3 Private Land Use	0	40	10	35	10	17	5	16.71 ± 15.18

4.4 MINIMIZE EFFECTS OF INSTITUTIONAL ISSUES

Participant Set B

	Individual Respondent's Weights (% of Institutional Objectives)							
Level 3 Objectives	(1)	(2)	(3)	(4)	(5)	(6)	(7)	Mean ± 1σ
4.4.1 Permits	95	50	60	40	70	33	25	53.29 ± 24.03
4.4.2 Schedules	5	50	40	60	30	67	75	46.71 ± 24.03

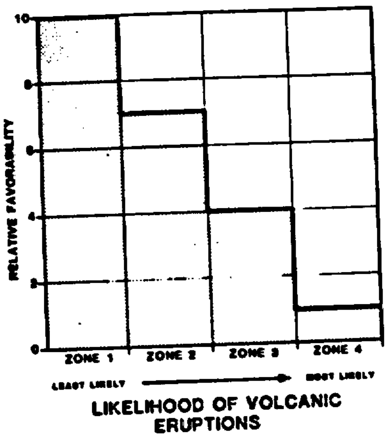
4.5 MINIMIZE EFFECTS ON CULTURAL RESOURCES

No poll necessary; 100% of weight for objective 4.5 is assigned to one subobjective (4.5.1), Archaeological and Historical Sites.

APPENDIX B

CONTENTS

ATTRIBUTE 1: VOLCANIC POTENTIAL



LEGEND

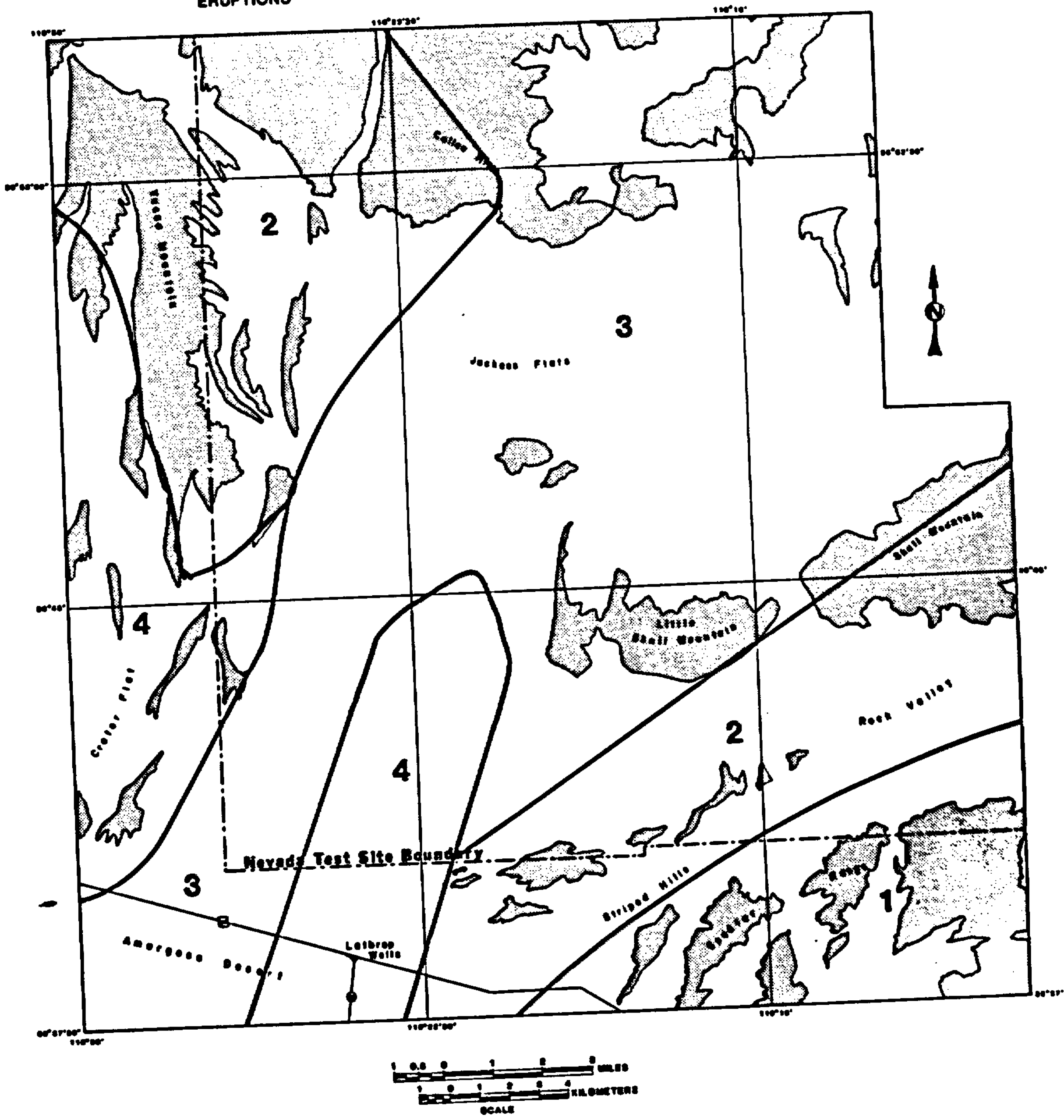
1 Lowest Potential

2

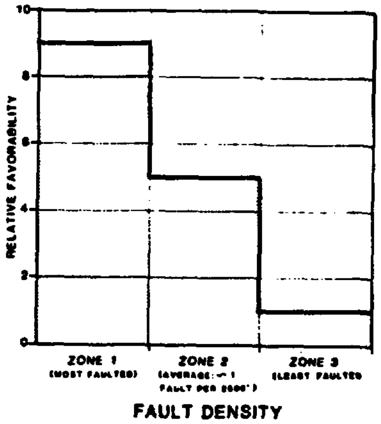
3

4 Highest Potential

NOTE: Within entire screening area the probability of basaltic volcanism is probably about 10^{-8} to 10^{-10} per year per square kilometer; probability of silicic volcanism is less (Crowe and Carr, 1980)



ATTRIBUTE 2: FAULT DENSITY



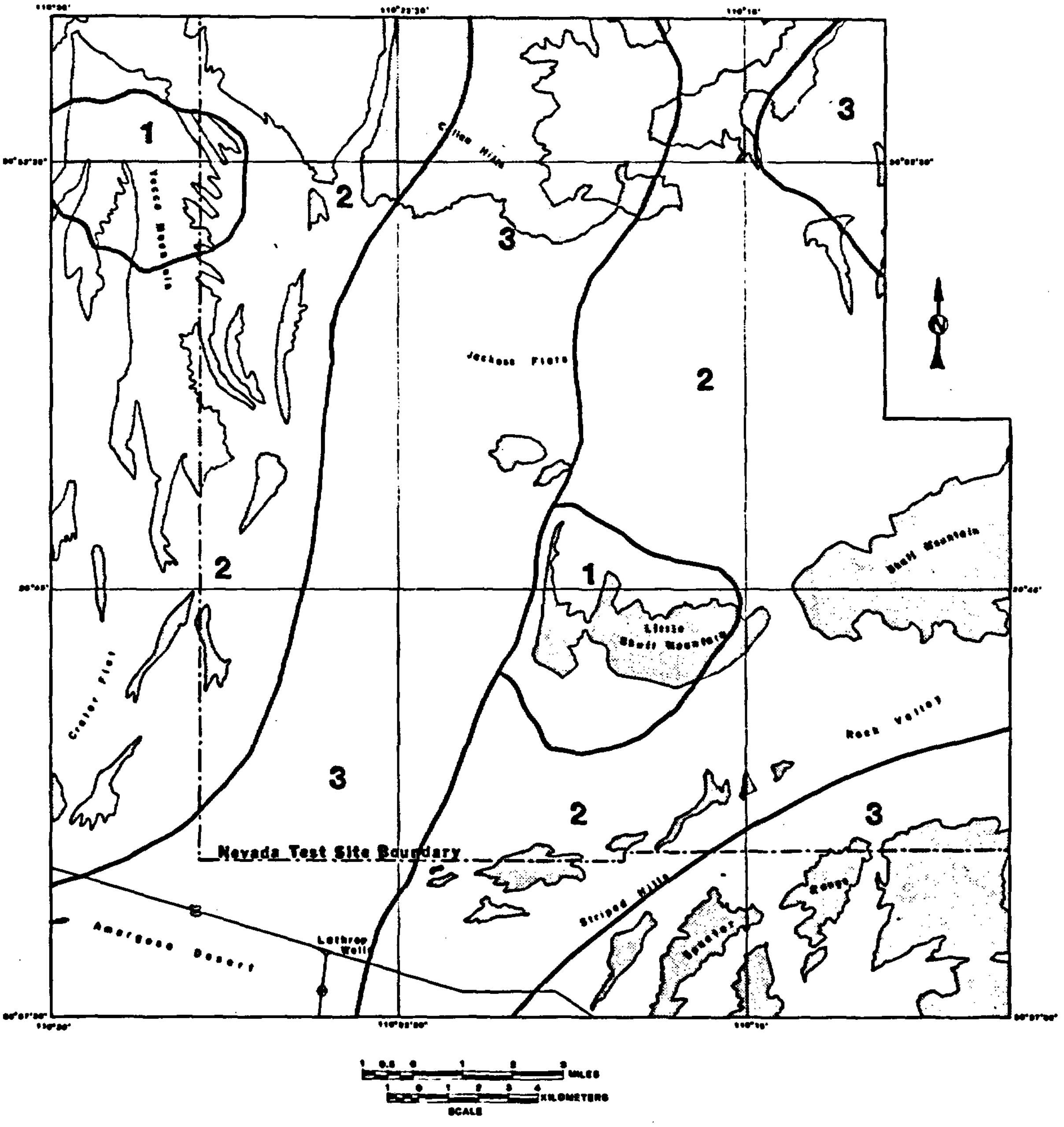
LEGEND

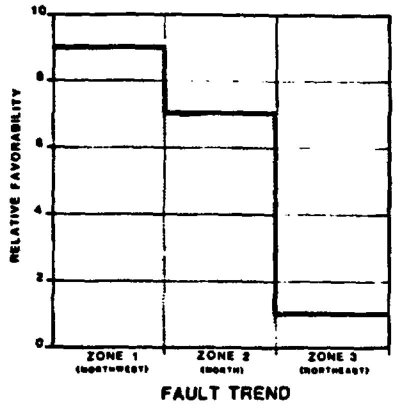
1 Least faulted

2 Average faulted (1 important fault about every 2,500')

3 Most faulted

NOTE: These units apply to near-surface rocks only and do not imply fault capability

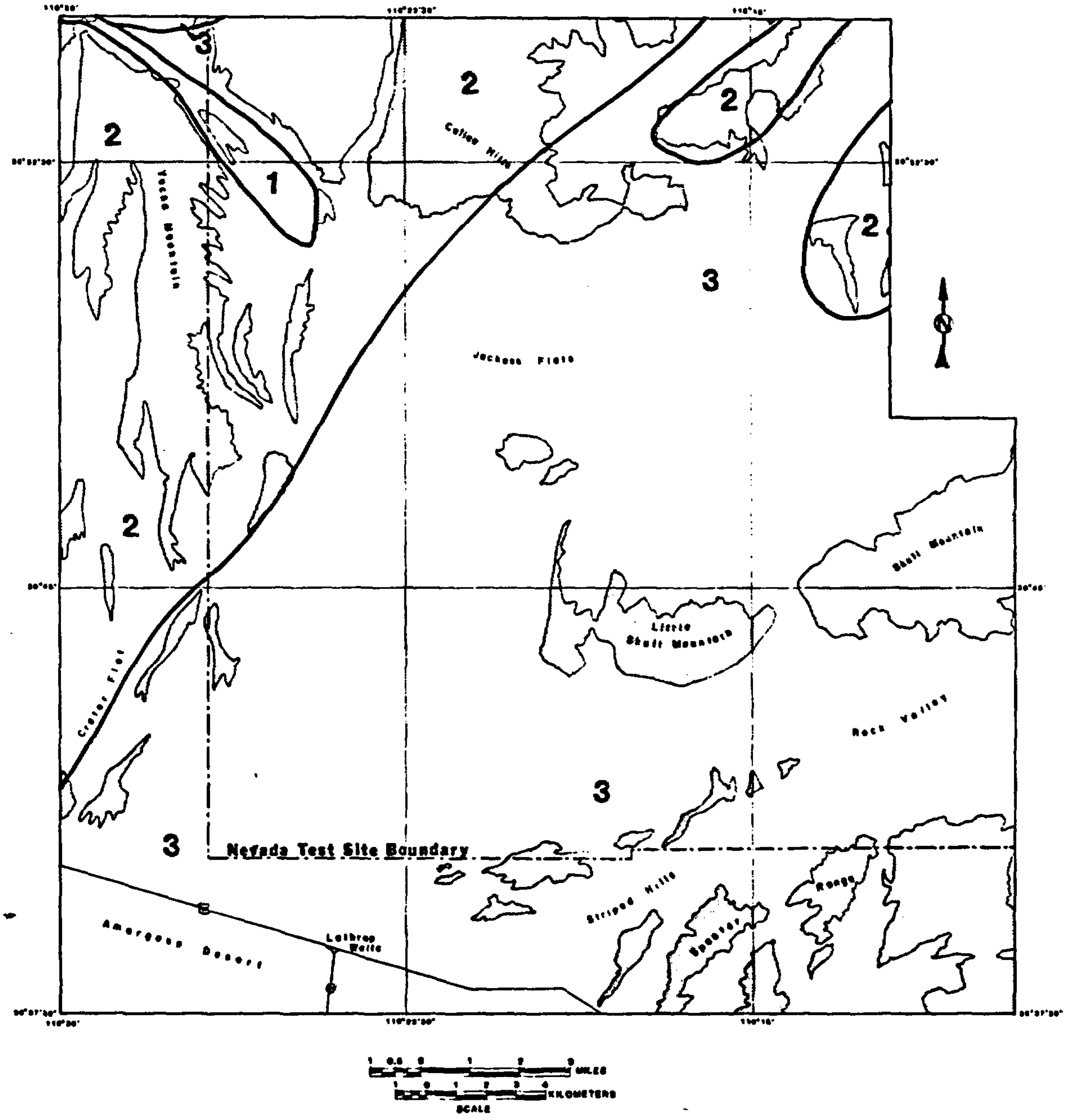




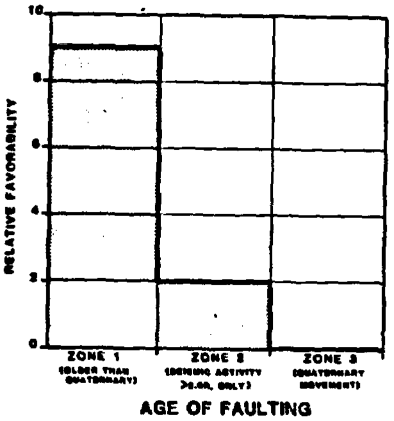
ATTRIBUTE 3: FAULT TREND

LEGEND

1	Northwest
2	North
3	Northeast and caldera ring-fracture zones



ATTRIBUTE 4: AGE OF FAULTING



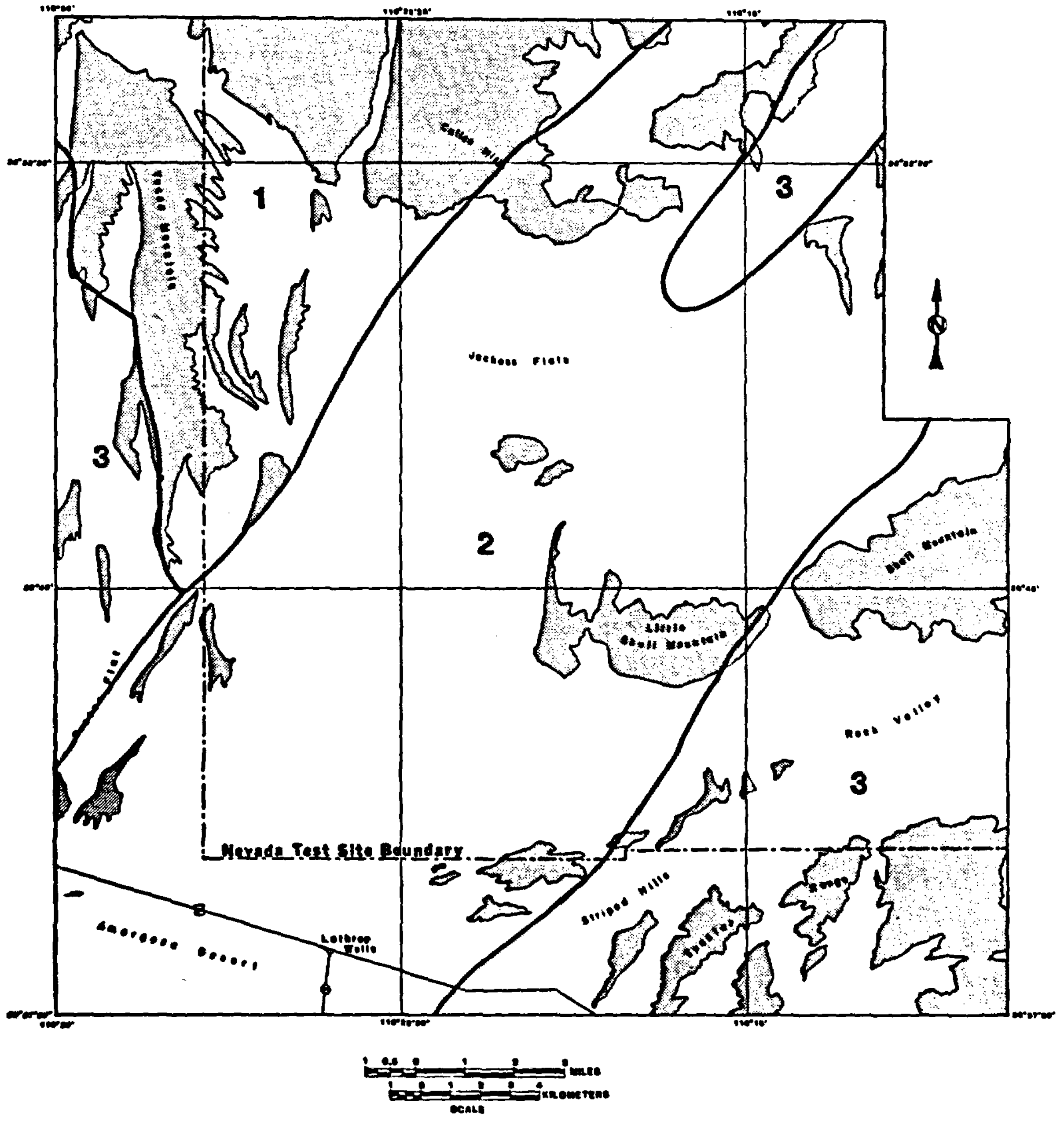
LEGEND

1 Older than Quaternary (>2 m.y.)

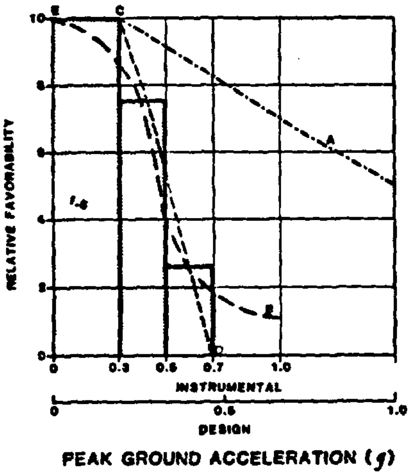
2 No evidence of Quaternary movement, but seismically active.*

3 Quaternary movement (geomorphic evidence)

* Magnitudes >2.0



B-5



ATTRIBUTE 5:
NATURAL SEISMIC ACCELERATIONS

See Ref. 11 for explanation of lines A, B, & D

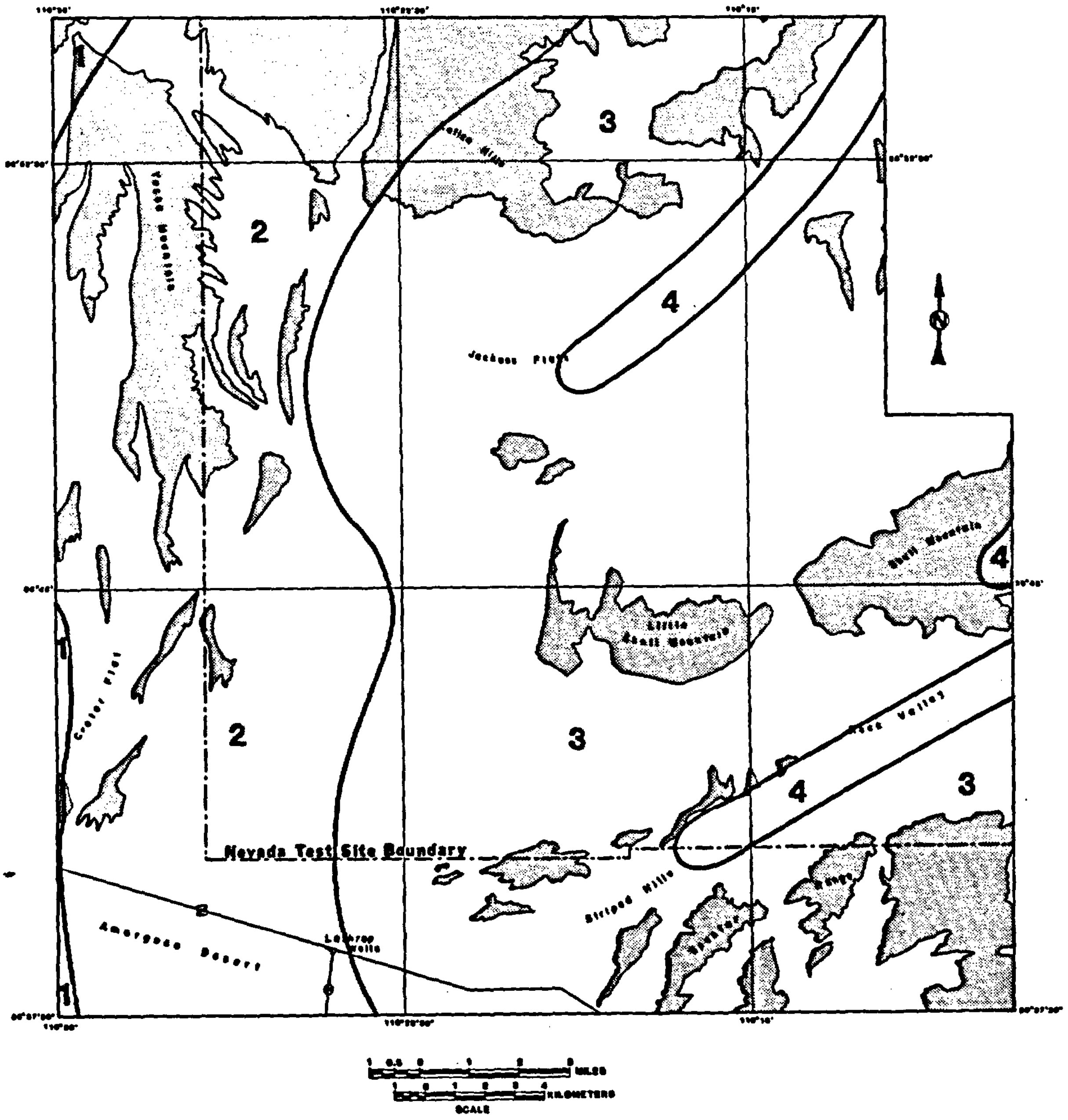
LEGEND

1 < 0.3g

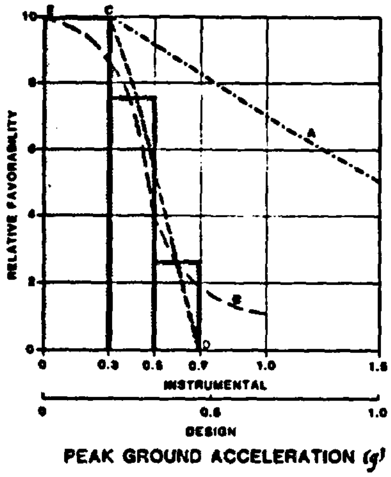
2 0.3g to 0.5g

3 0.5g to 0.7g

4 Approximates trace of active fault zone (approximately 0.7g)



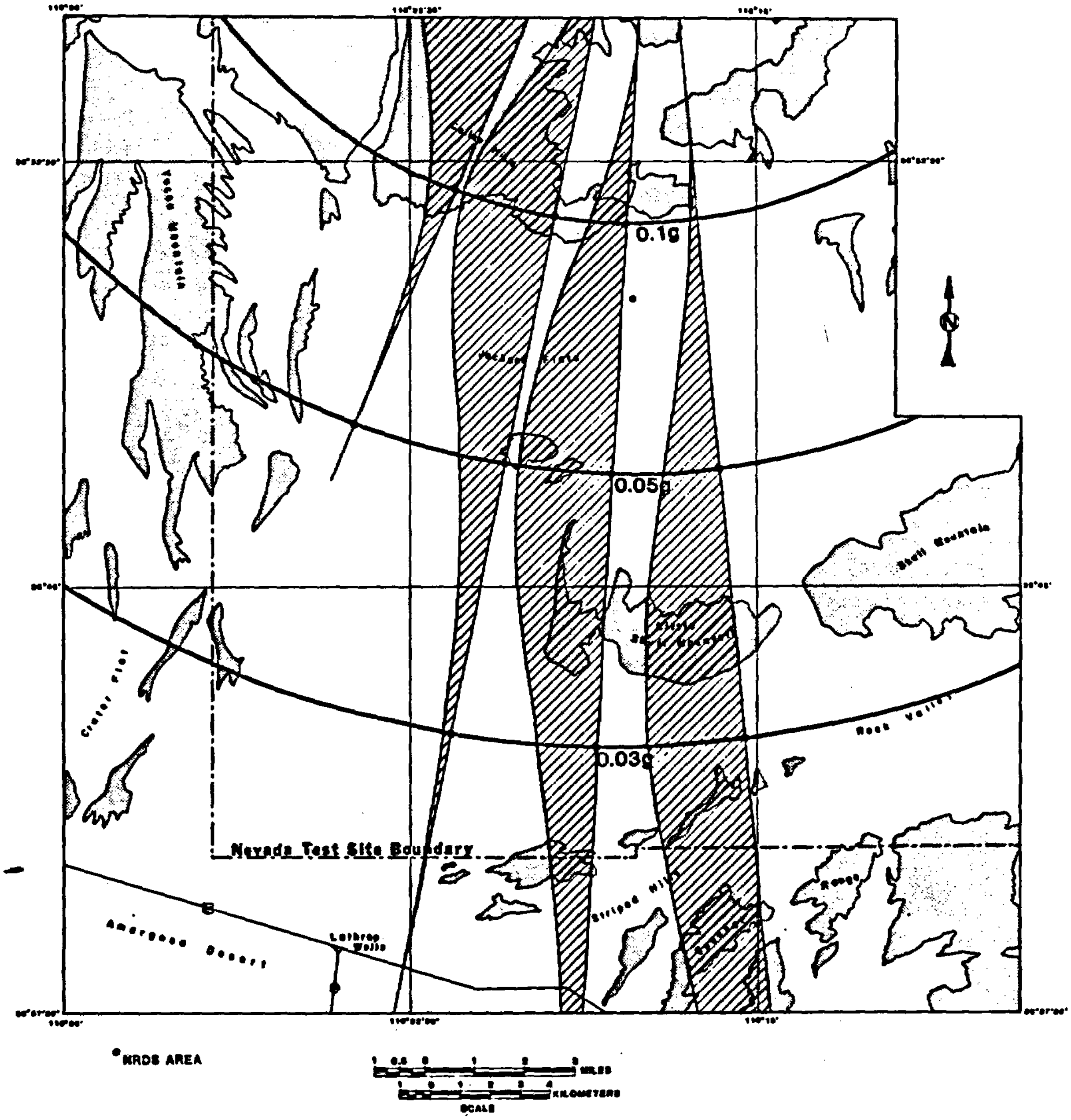
ATTRIBUTE 6: POTENTIAL PEAK VECTOR ACCELERATIONS FROM WEAPONS TESTING

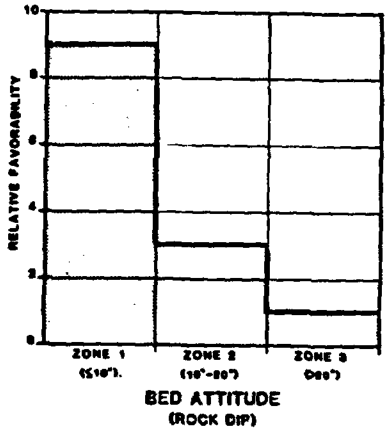


See Ref. 11 for explanation of lines A, B, & D

LEGEND

Mean peak vector accelaration values are displayed as arcs. Normal distributions about these mean values are displayed by the shaded areas.





ATTRIBUTE 7: BED ATTITUDE (ROCK DIP)

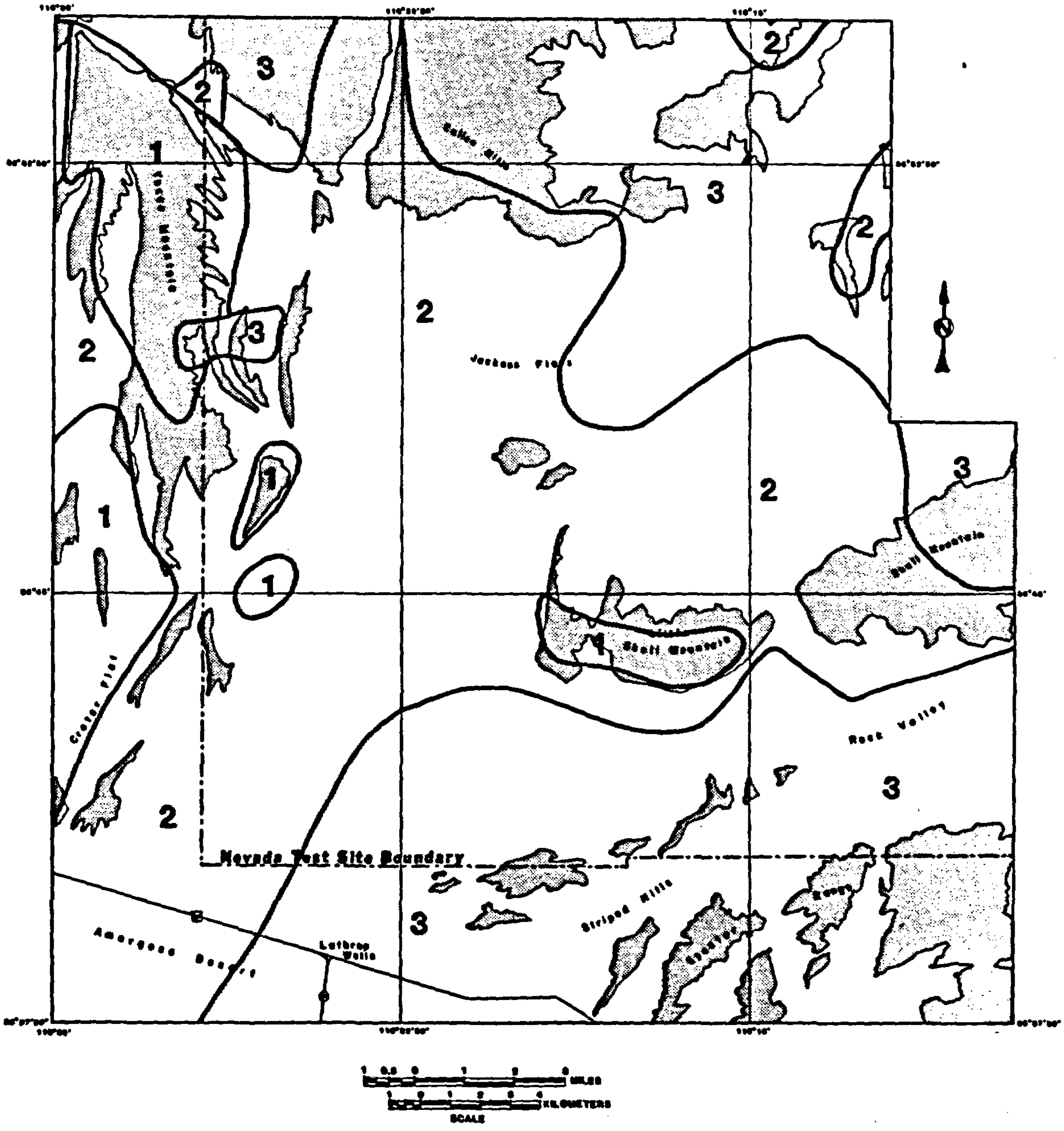
LEGEND

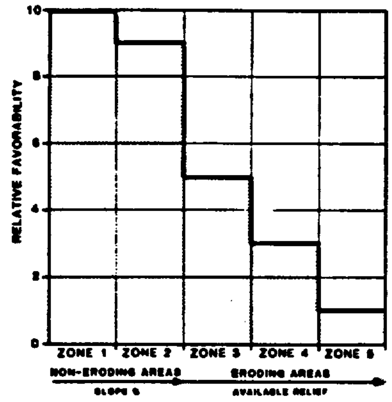
1 10° or less dips at the surface

2 10-20° dips at the surface

3 More than 20° dips at the surface

NOTE: In some areas such as Yucca Mountain, rock dips can be extrapolated to considerable depth; in other areas such as Timber Mountain and the Specter Range, surface dips should not be extrapolated to depths greater than 1000' or so.





POTENTIAL FOR DEEP EROSION

ATTRIBUTE 8: EROSION POTENTIAL

LEGEND

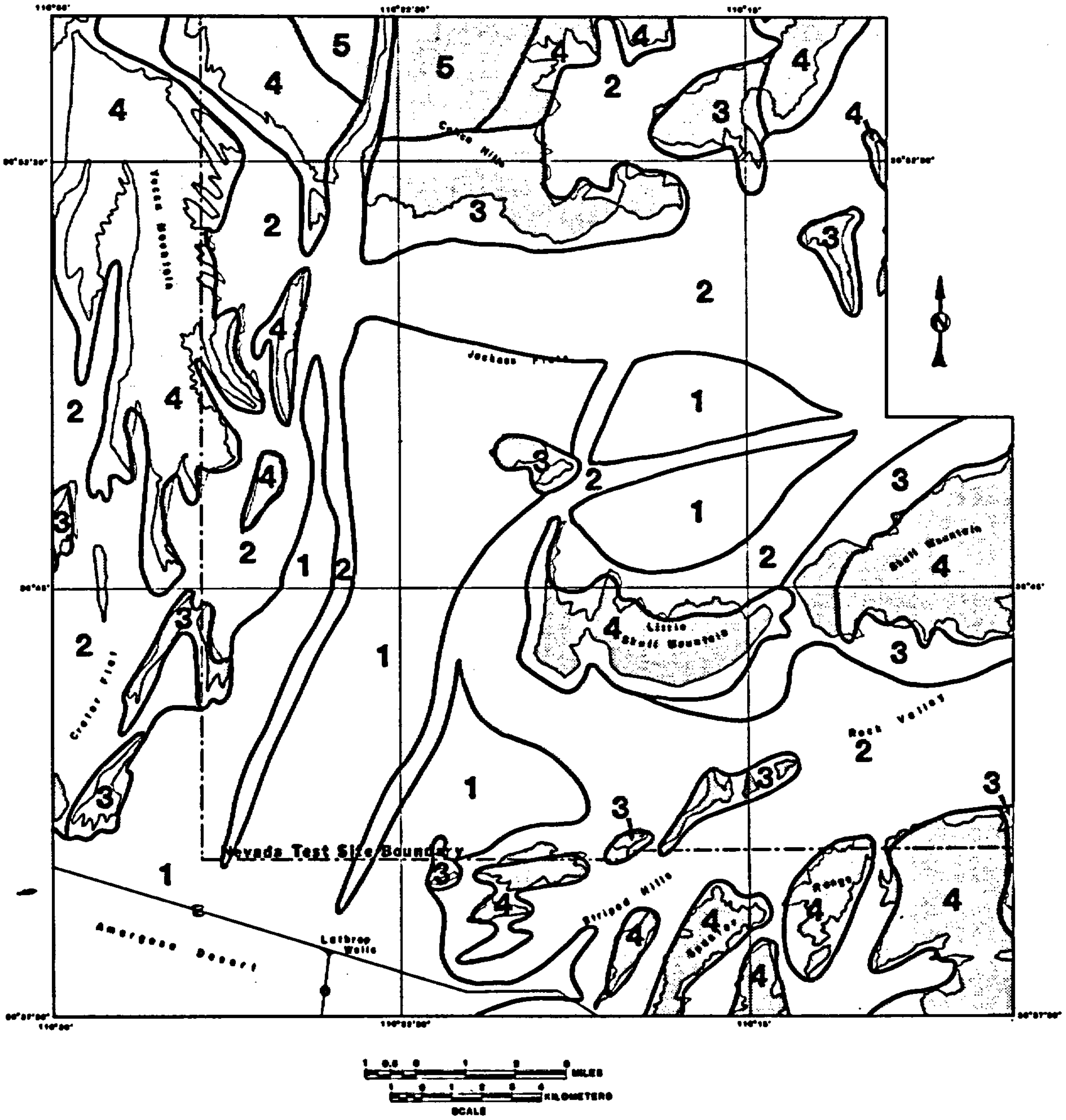
1 Currently non-eroding areas:
relatively low surface slopes (generally<2-3%).

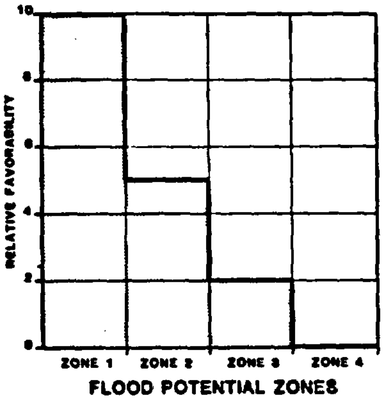
2 Currently non-eroding areas, including areas along major washes
relatively high surface slopes (generally>2-3%).

3 Currently eroding areas:
relatively low available relief (generally<500').

4 Currently eroding areas:
relatively moderate available relief (generally 500' to 2000').

5 Currently eroding areas:
relatively high available relief (generally >2000').

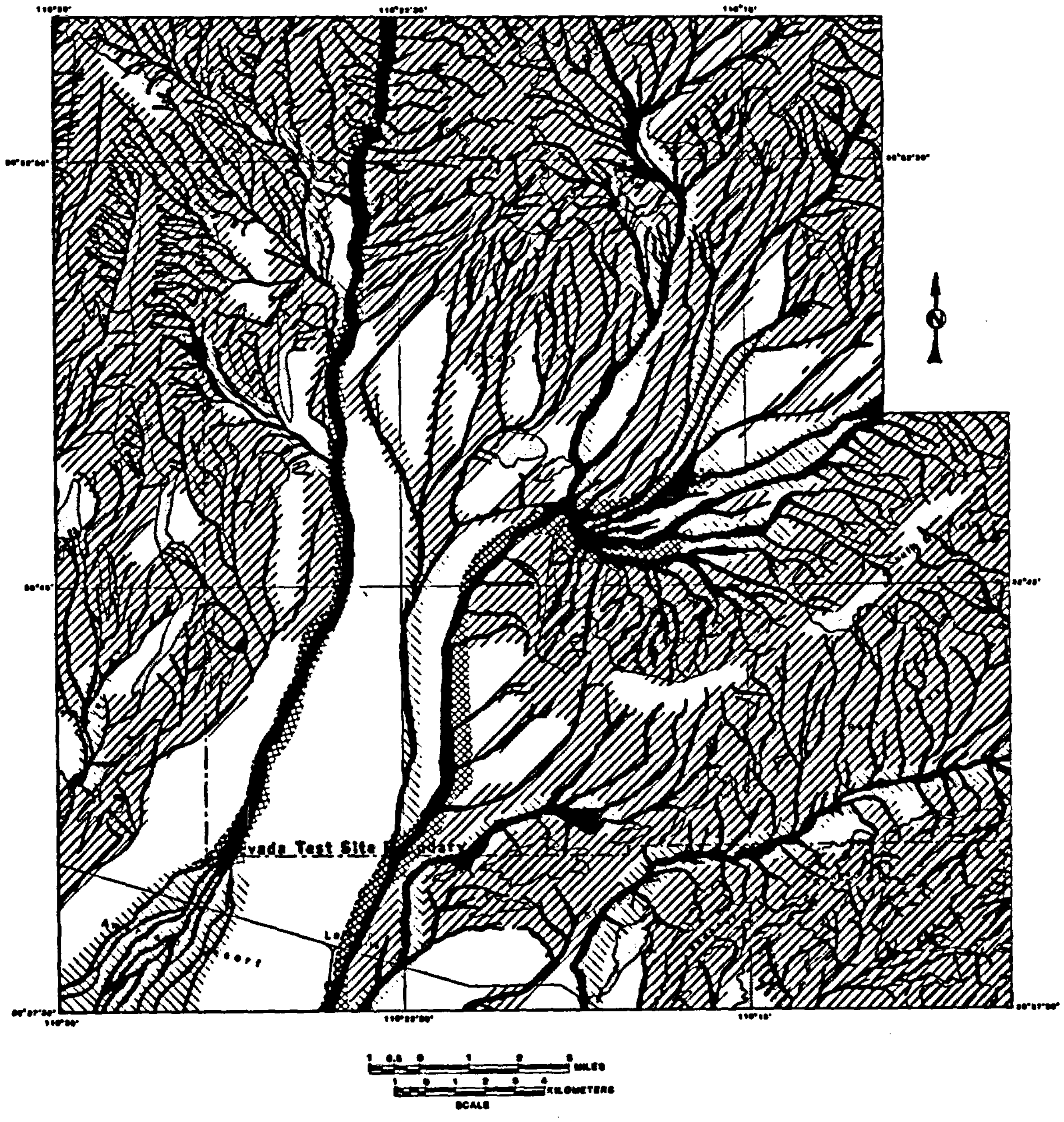




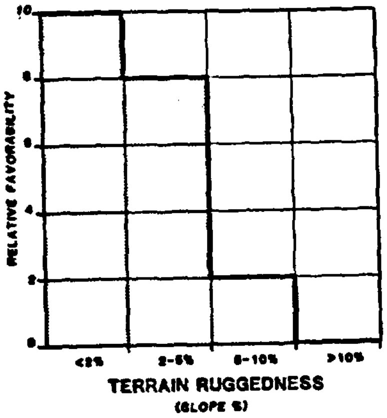
ATTRIBUTE 9: FLOOD POTENTIAL

LEGEND

- ↗ Actual floodways along drainage lines.
- ▭ ZONE 1. Areas essentially devoid of drainage channels; Very low potential for flooding.
- ▨ ZONE 2. Areas with closely spaced, small drainage channels; Flood potential limited to small proportion of the area.
- ▧ ZONE 3. Areas along major washes; likely to flood less frequently or less intensely than zone 4.
- ▩ ZONE 4. Areas along major washes; likely to flood *more frequently* or *more intensely* than zone 3.

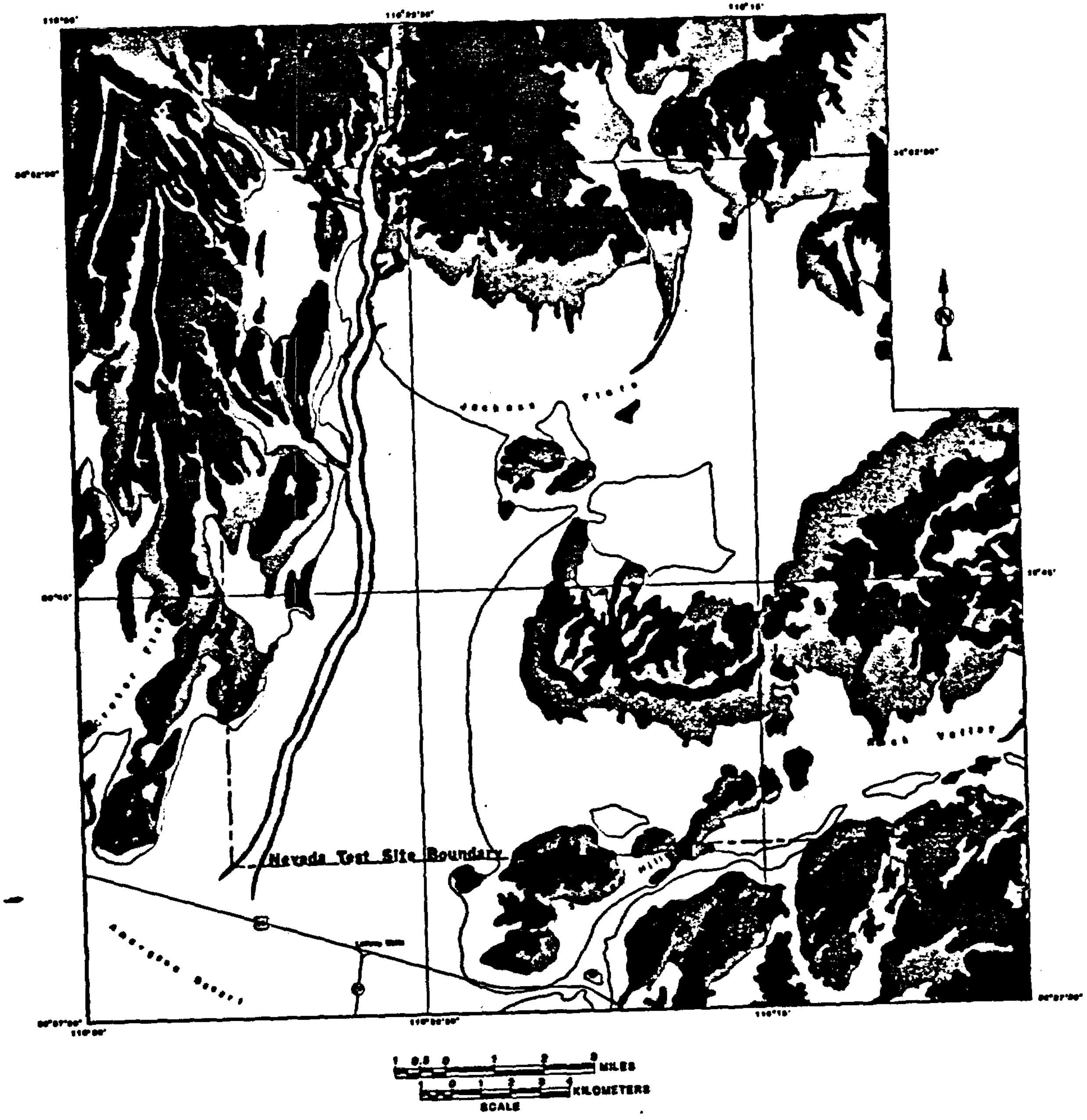


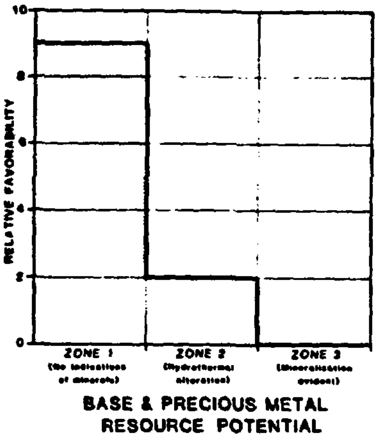
ATTRIBUTE 10: TERRAIN RUGGEDNESS



LEGEND

- ☐ Gentle slopes, generally <2%, generally undissected
- ☐ Gentle slopes, generally about 2-6%, some portions dissected by gullies
- ▨ Moderate Slopes, generally about 6-10%, many portions dissected by gullies
- ■ Steep, rugged slopes, generally >10%, almost totally composed of gullies or cliffs





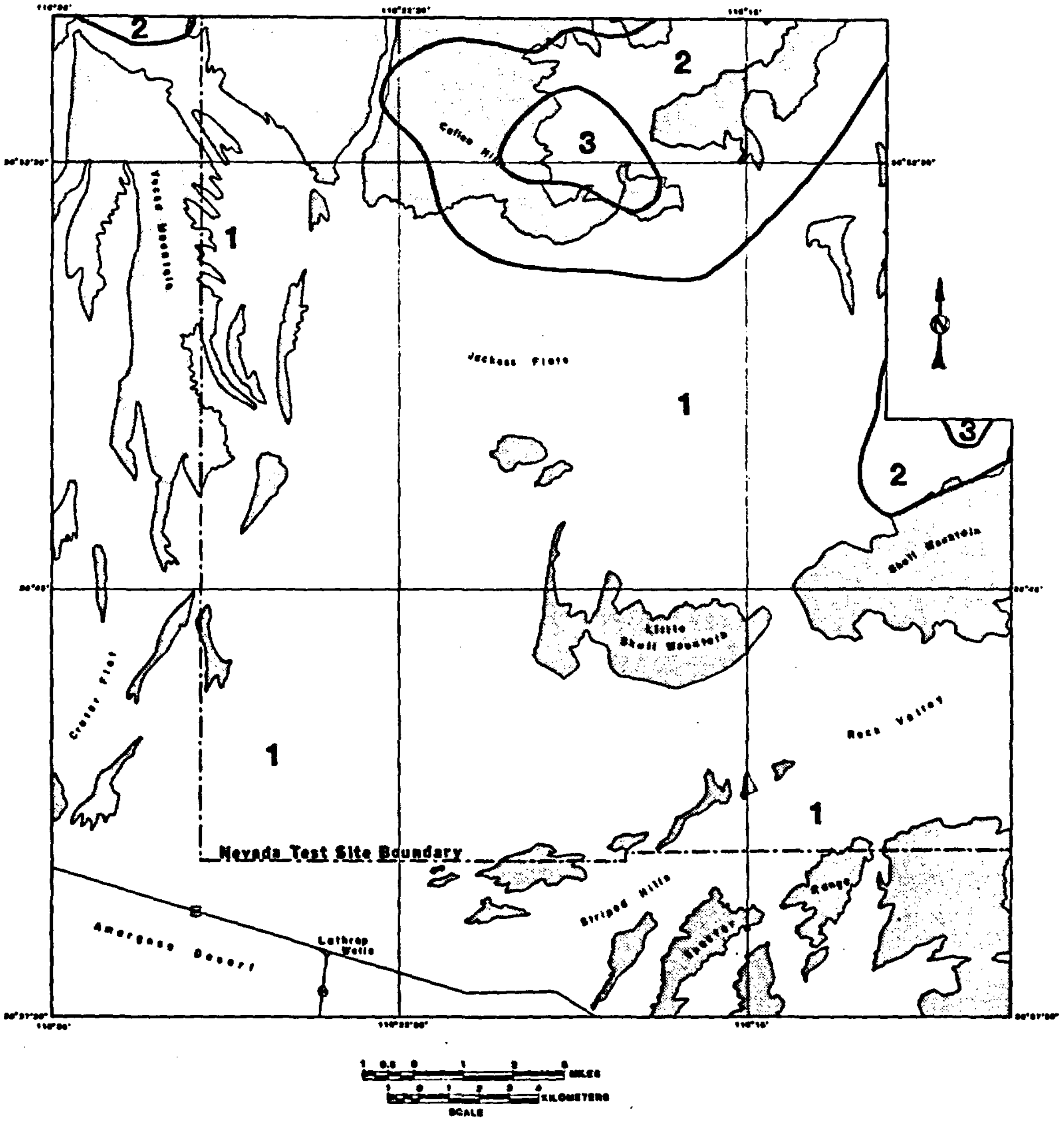
ATTRIBUTE 11:
BASE & PRECIOUS METAL RESOURCE POTENTIAL

LEGEND

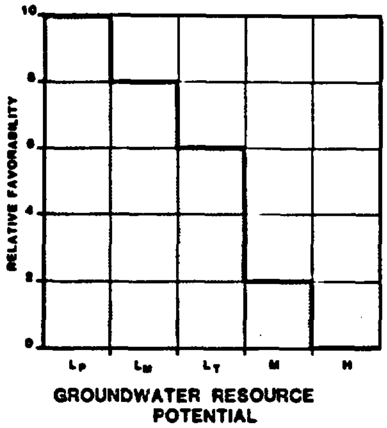
1 No mineralization evident.

2 Possibility of mineralization (hydrothermal alteration and/or minor prospecting).

3 Mineralization evident (mined or prospected extensively).



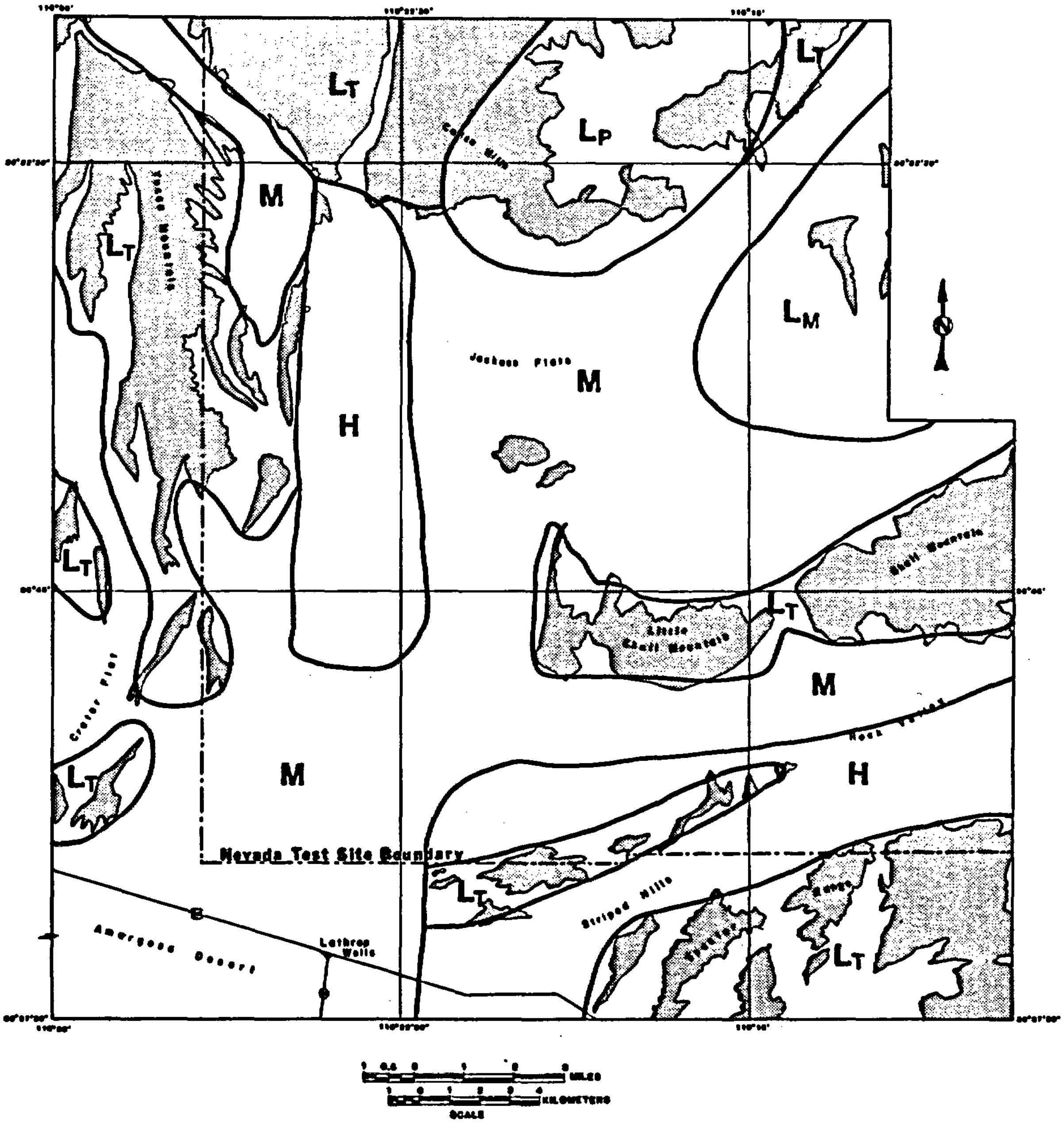
ATTRIBUTE 12: GROUNDWATER RESOURCE POTENTIAL

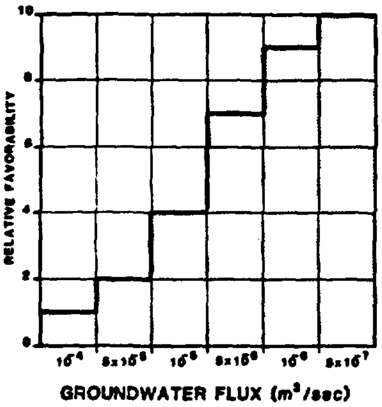


LEGEND

GROUNDWATER PRODUCTION POTENTIAL

H	High
M	Moderate
L_T	Low (due to topographic drilling constraints)
L_M	Low (due to mineralized water at potential production depths)
L_P	Low (due to low permeability at potential production depths)

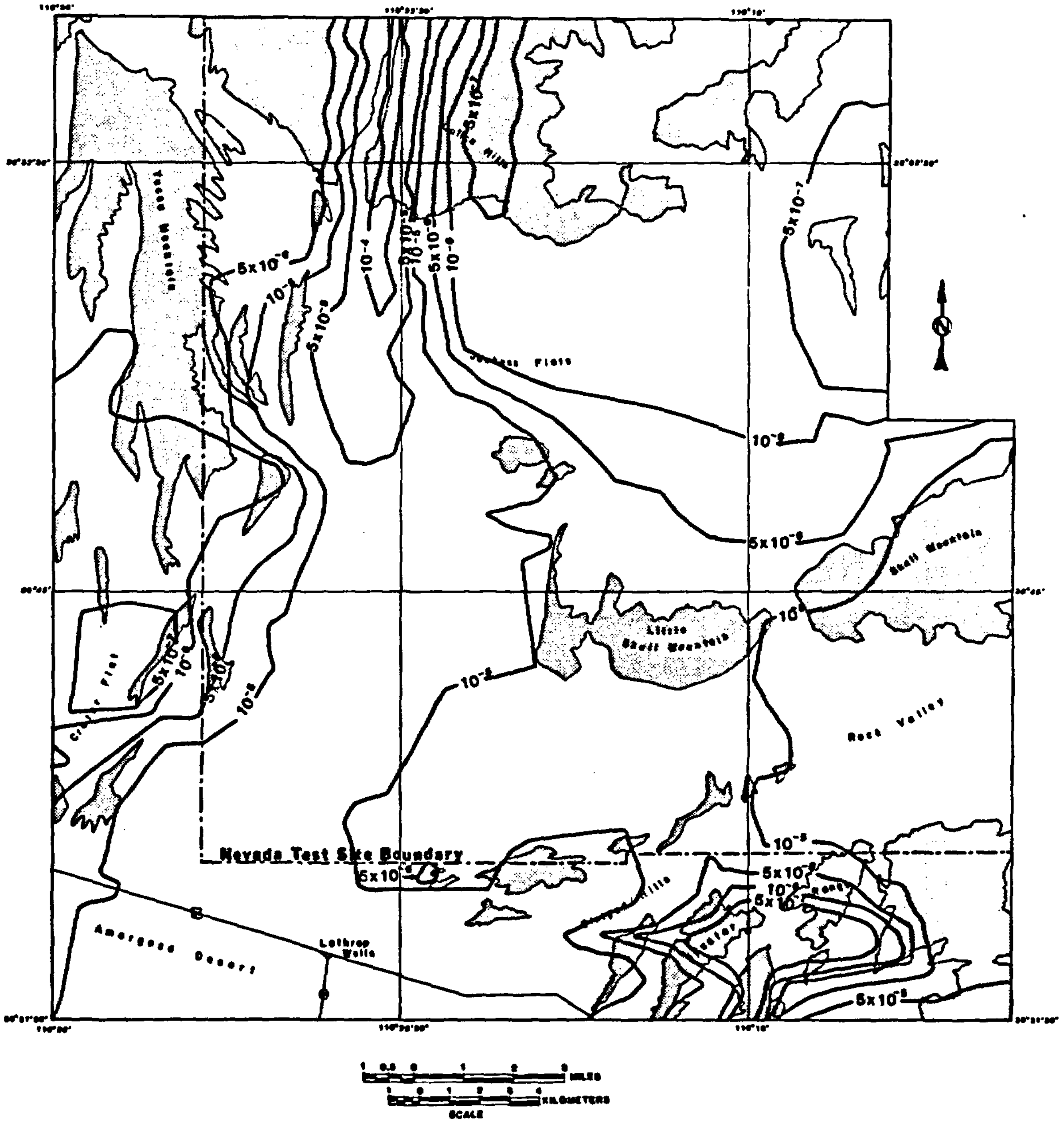


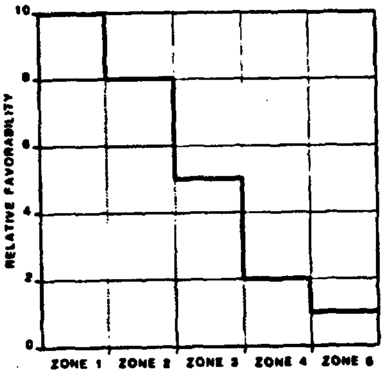


ATTRIBUTE 13: GROUNDWATER FLUX

LEGEND

- Contours expressed in m³/sec for a one meter wide strip extending down from the water table.
- Contour intervals are logrithmic by half orders of magnitude.





GROUNDWATER FLOW DIRECTION
& LENGTH

ATTRIBUTE 14:
GROUNDWATER FLOW DIRECTION

LEGEND

ZONE 1- Areas within and upgradient from low permeability regions.

ZONE 2- Areas within and upgradient from regions of mineralized groundwater.

ZONE 3- Areas relatively far upgradient from regions of potentially excellent groundwater resources.

ZONE 4- Areas upgradient and relatively close to regions of potentially excellent groundwater resources or within regions of moderately good groundwater resources.

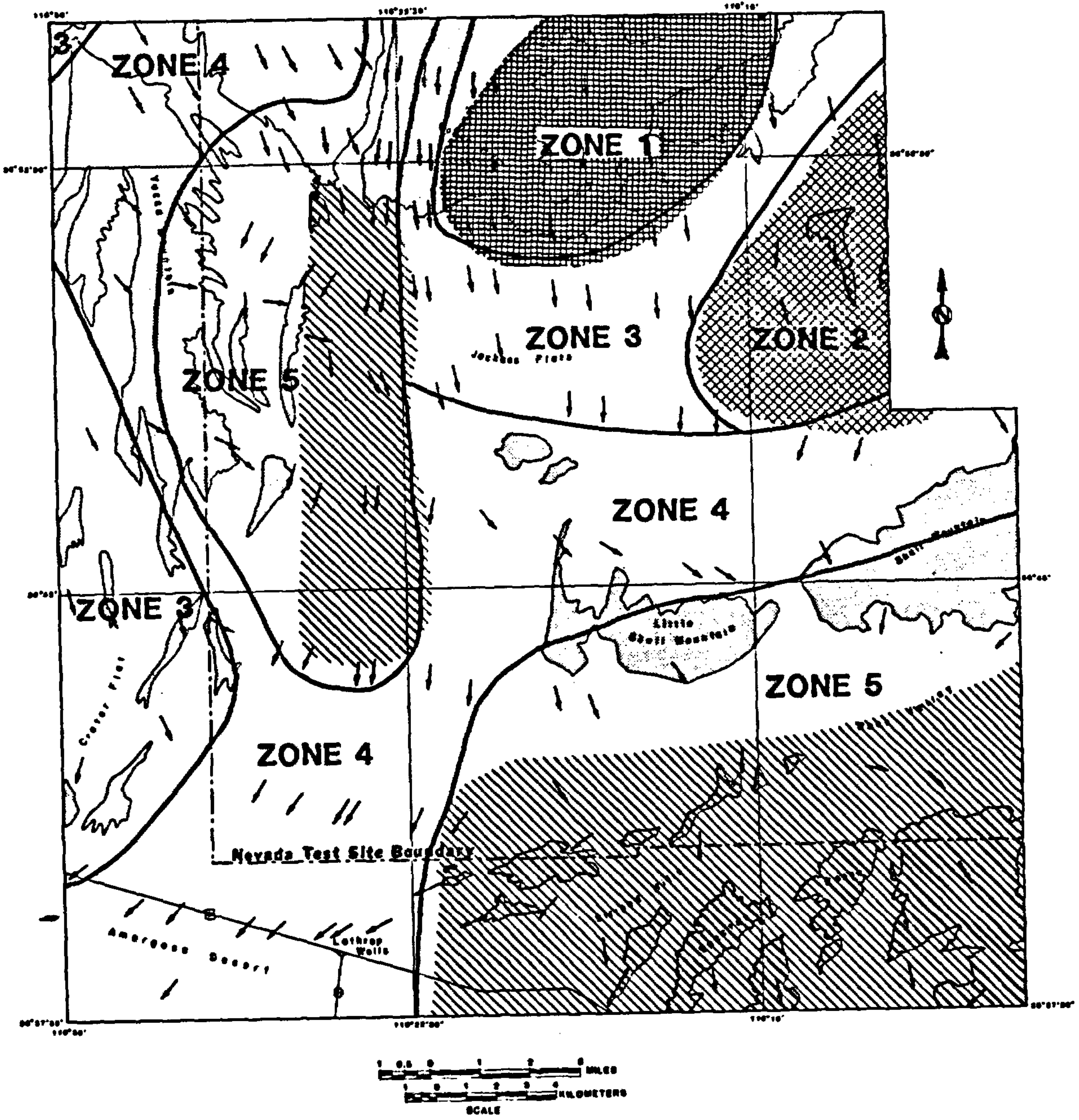
ZONE 5- Areas within or immediately upgradient from regions of potentially excellent groundwater resources.

▦ Regions of low permeability.

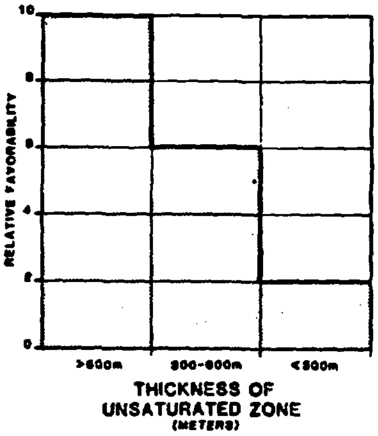
▨ Regions of potentially excellent groundwater resources.

▩ Regions of mineralized groundwater.

/// Calculated groundwater flow direction (from USGS regional model)

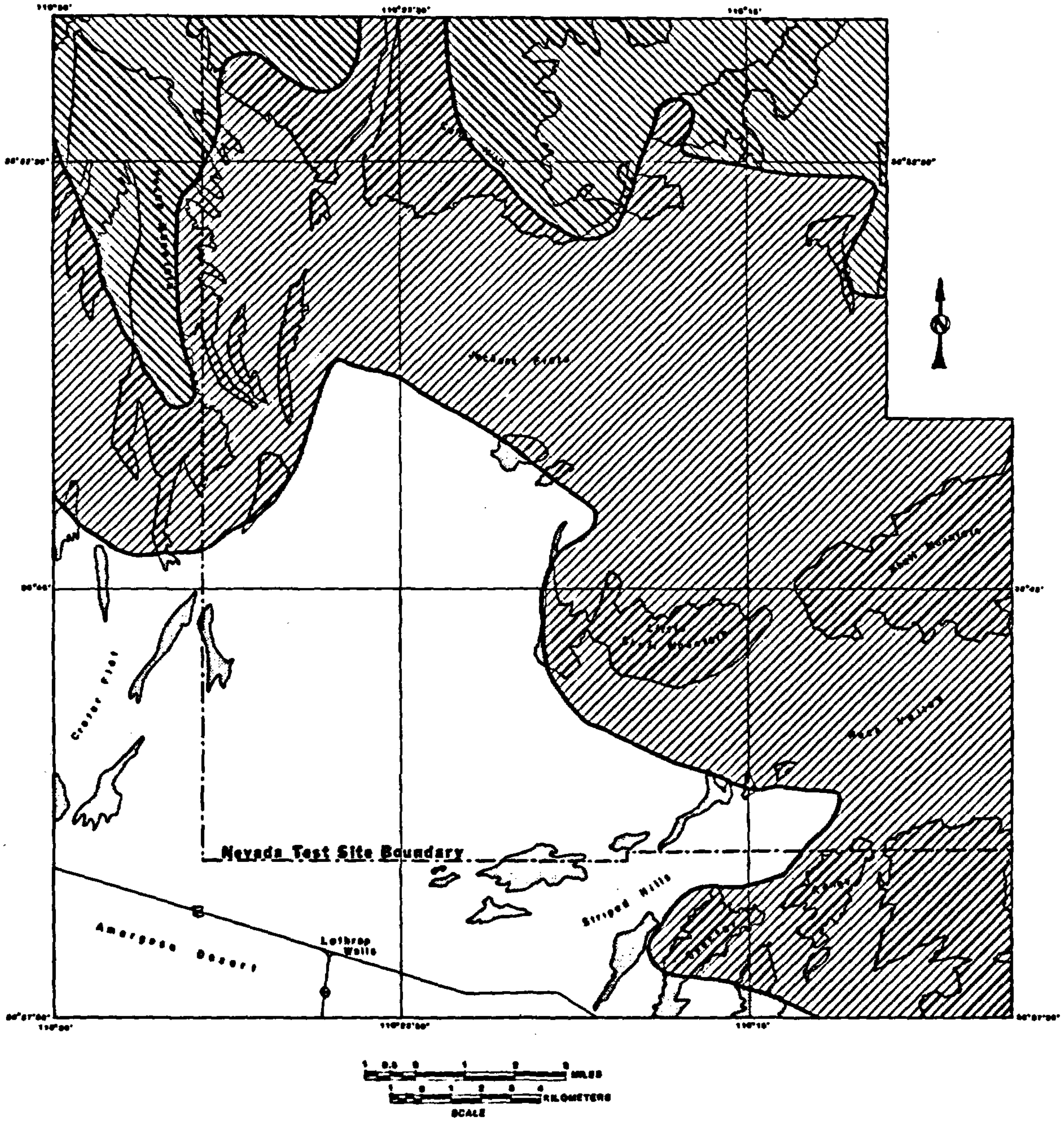


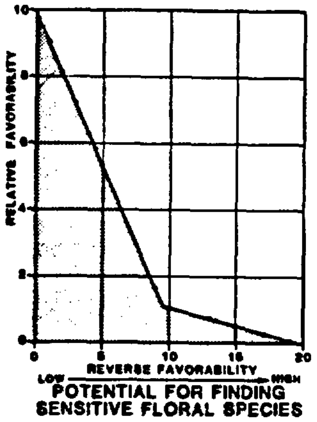
ATTRIBUTE 15:
THICKNESS OF UNSATURATED ZONE



LEGEND

- ▧ > 600 meters
- ▨ 300-600 meters
- ☐ < 300 meters

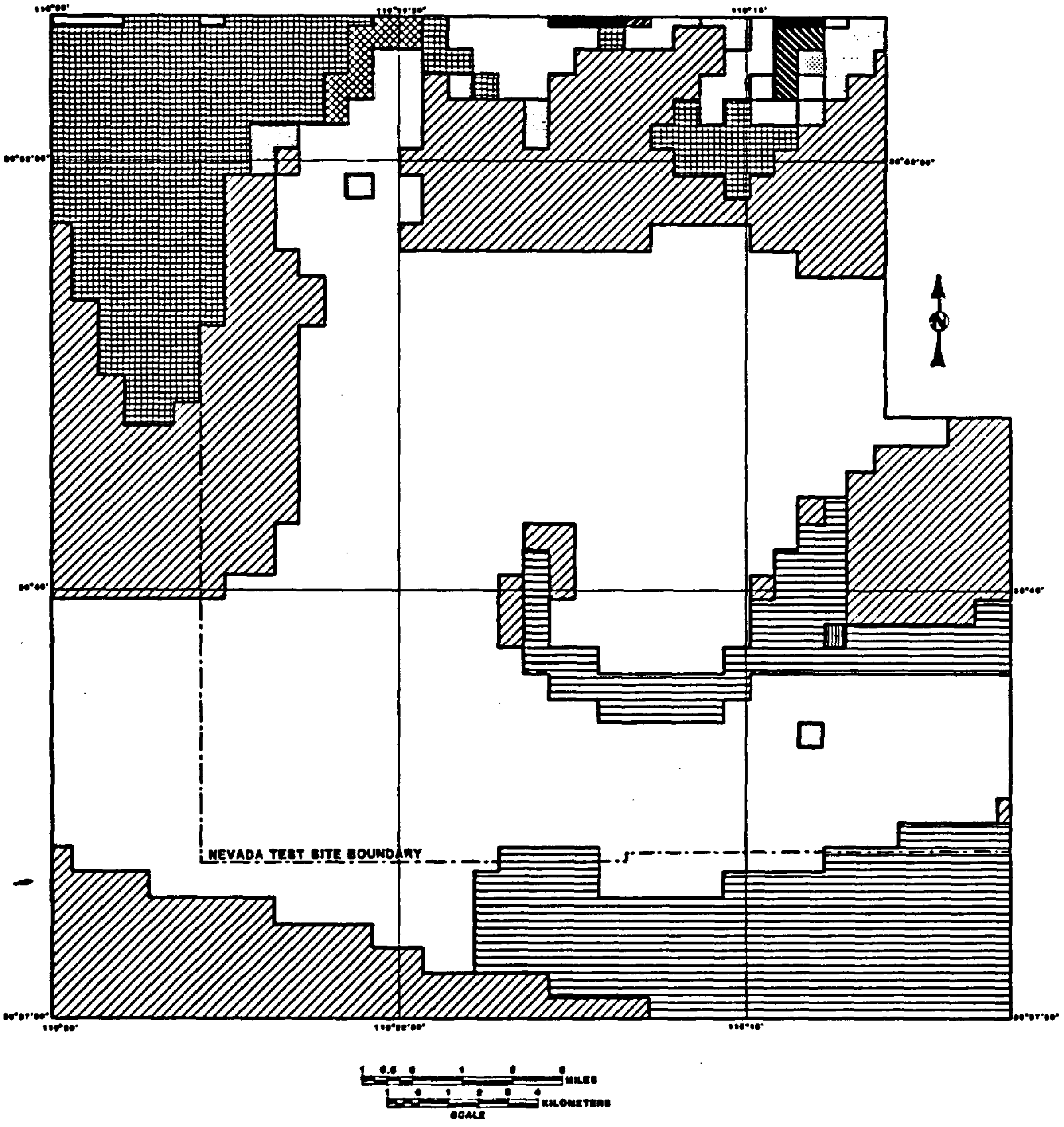




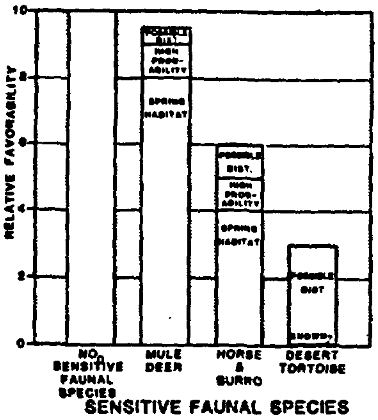
ATTRIBUTE 16: SENSITIVE FLORAL SPECIES

LEGEND

- ▨ 0 No sensitive floral species
- ☐ .5
- ☐ 1
- ▤ 2
- ▥ 3
- ▦ 4
- ▩ 4.5
- ▦ 9
- ☐ 13
- ▩ 13.5
- ☐ 16
- ▨ 17
- ▧ 18
- ■ 19.5 High possibility of locating sensitive floral species

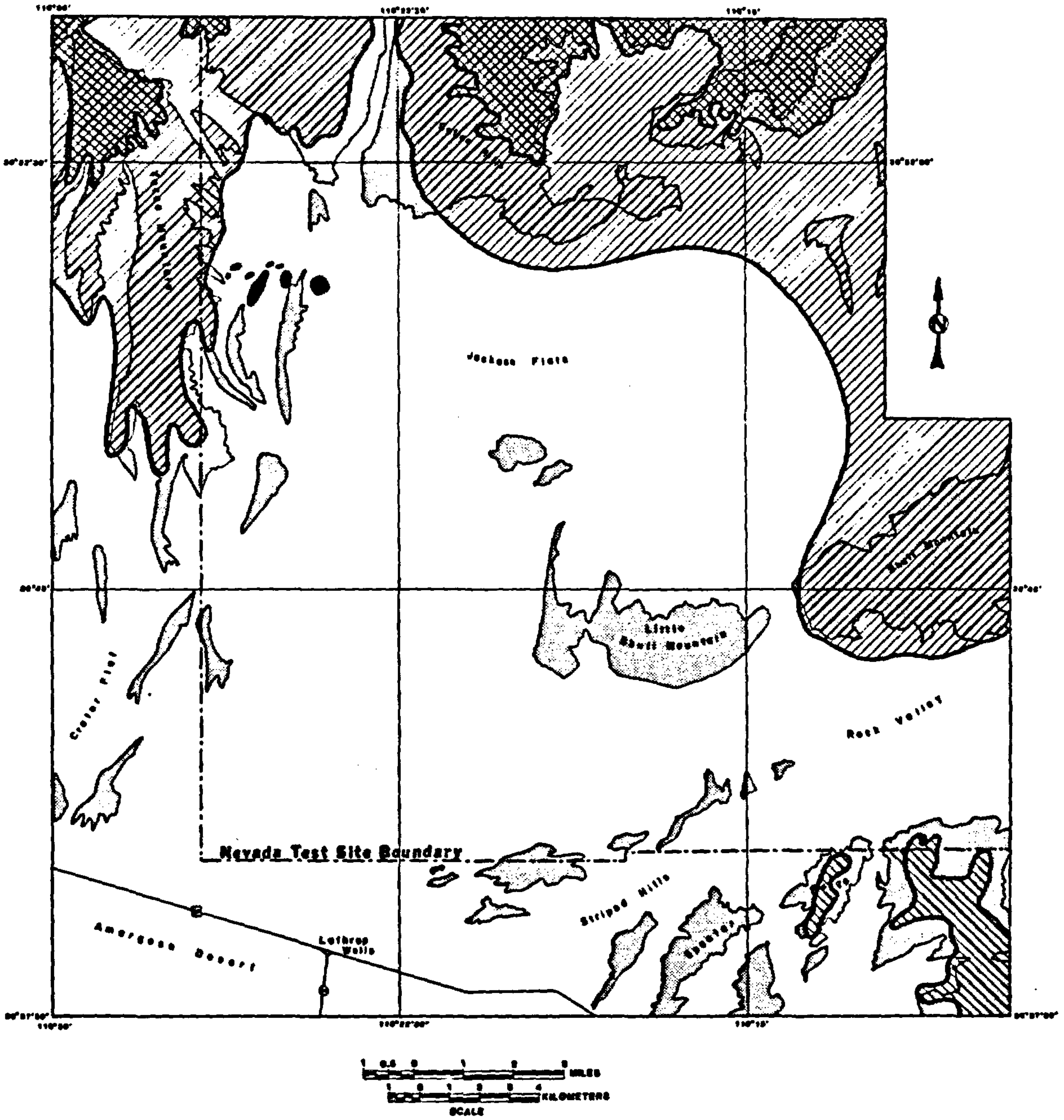


ATTRIBUTE 17
SENSITIVE FAUNAL SPECIES

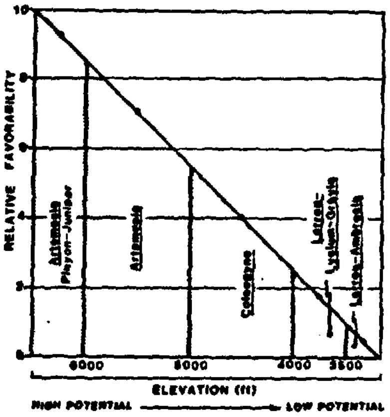


LEGEND

- ▧ No sensitive faunal species
- ▨ Possible distribution of *Equus caballus* (wild horses) and *Odocoileus hemionus* (mule deer)
- ▩ Highest probability for horses and mule deer
- ☐ Possible distribution of *Gopherus agassizii* (desert tortoise)
- ■ Known occurrence of desert tortoise



ATTRIBUTE 18: REVEGETATION POTENTIAL



REVEGETATION POTENTIAL

LEGEND

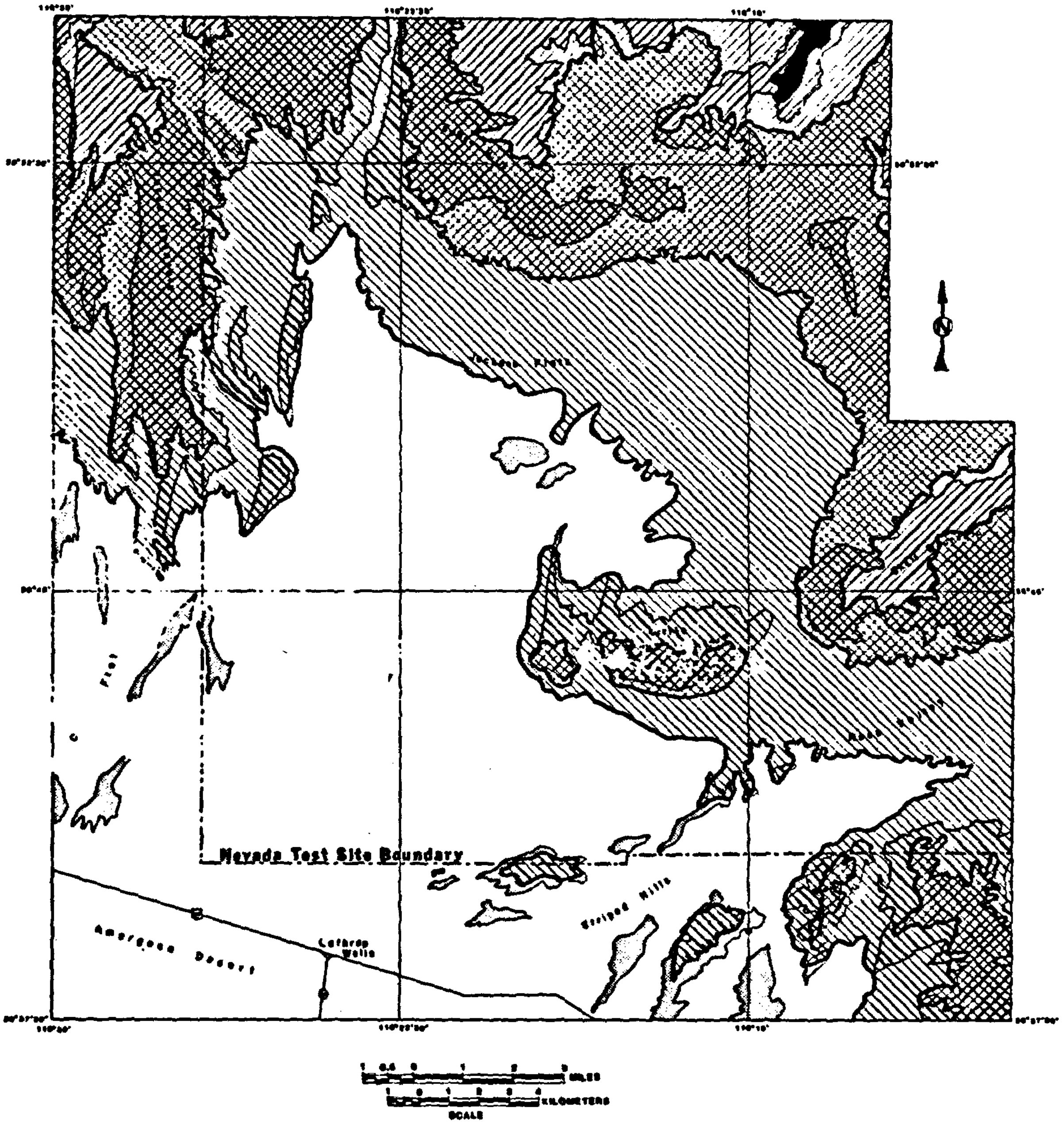
■ *Artemisia* - Pinyon - Juniper vegetation (above 6000')

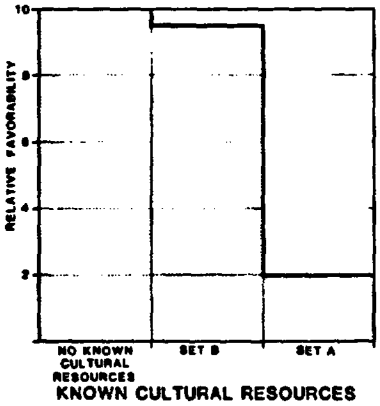
▨ *Artemisia* vegetation (5000'-6000')

▩ *Coleogyne* vegetation (4000'-5000')

▧ *Larrea* - *Lycium* - *Grayia* vegetation (3500'-4000')

☐ *Larrea* - *Ambrosia* vegetation (below 3500')





ATTRIBUTE 19: KNOWN CULTURAL RESOURCES

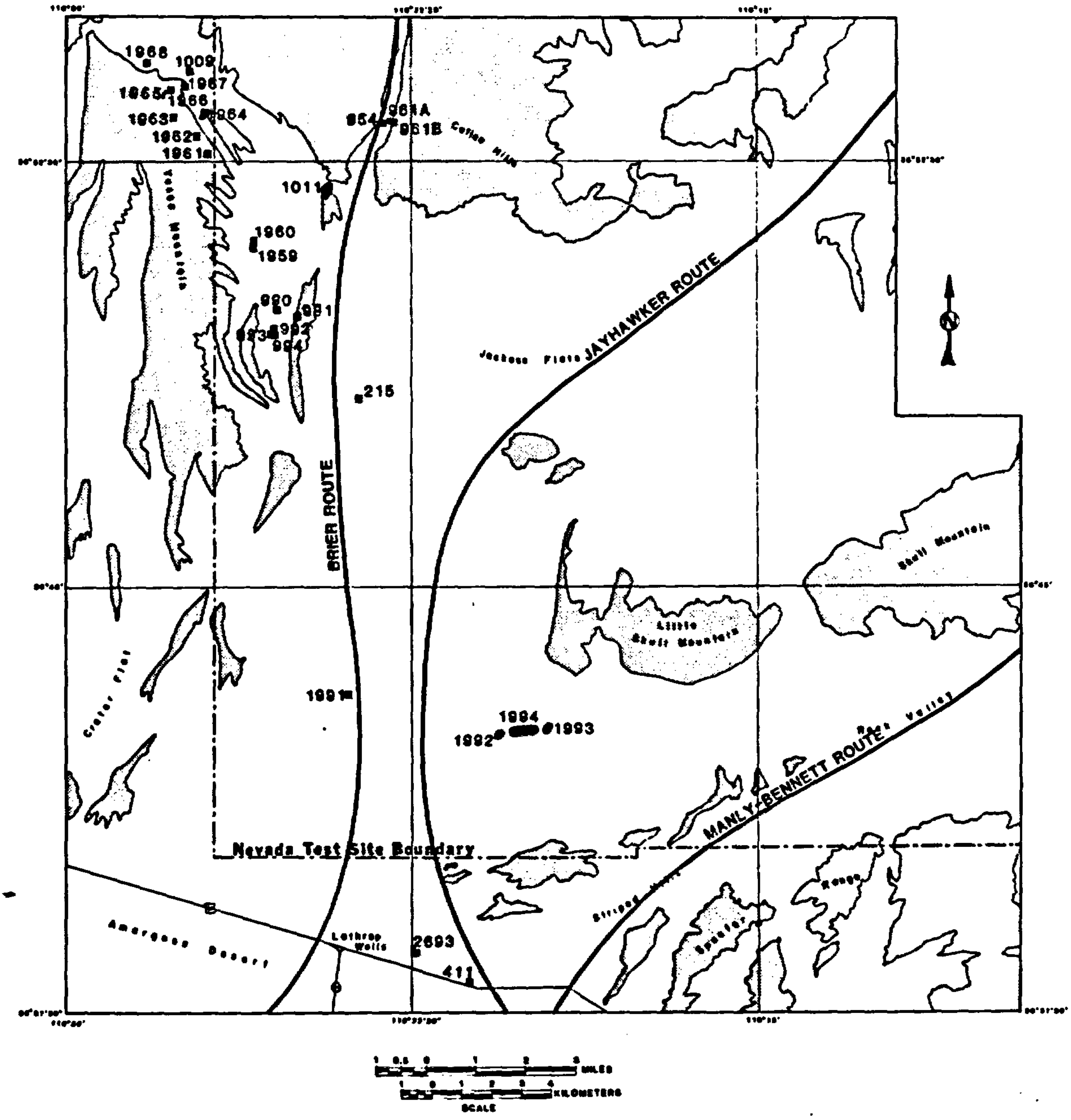
LEGEND

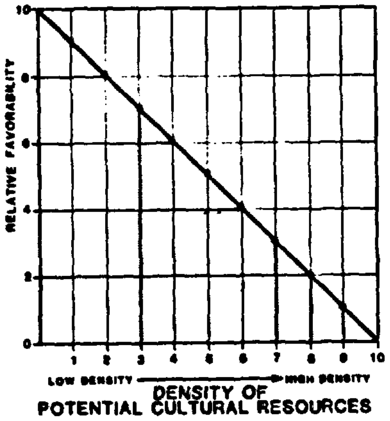
A Potentially eligible for listing in the national register of historic places

215
411
954
961A
961B
1009
1011
1960
1964
1967
1968

B Not eligible for listing in the national register

990
991
992
993
994
1959
1961
1962
1963
1965
1966
1991
1992
1993
1994
2693

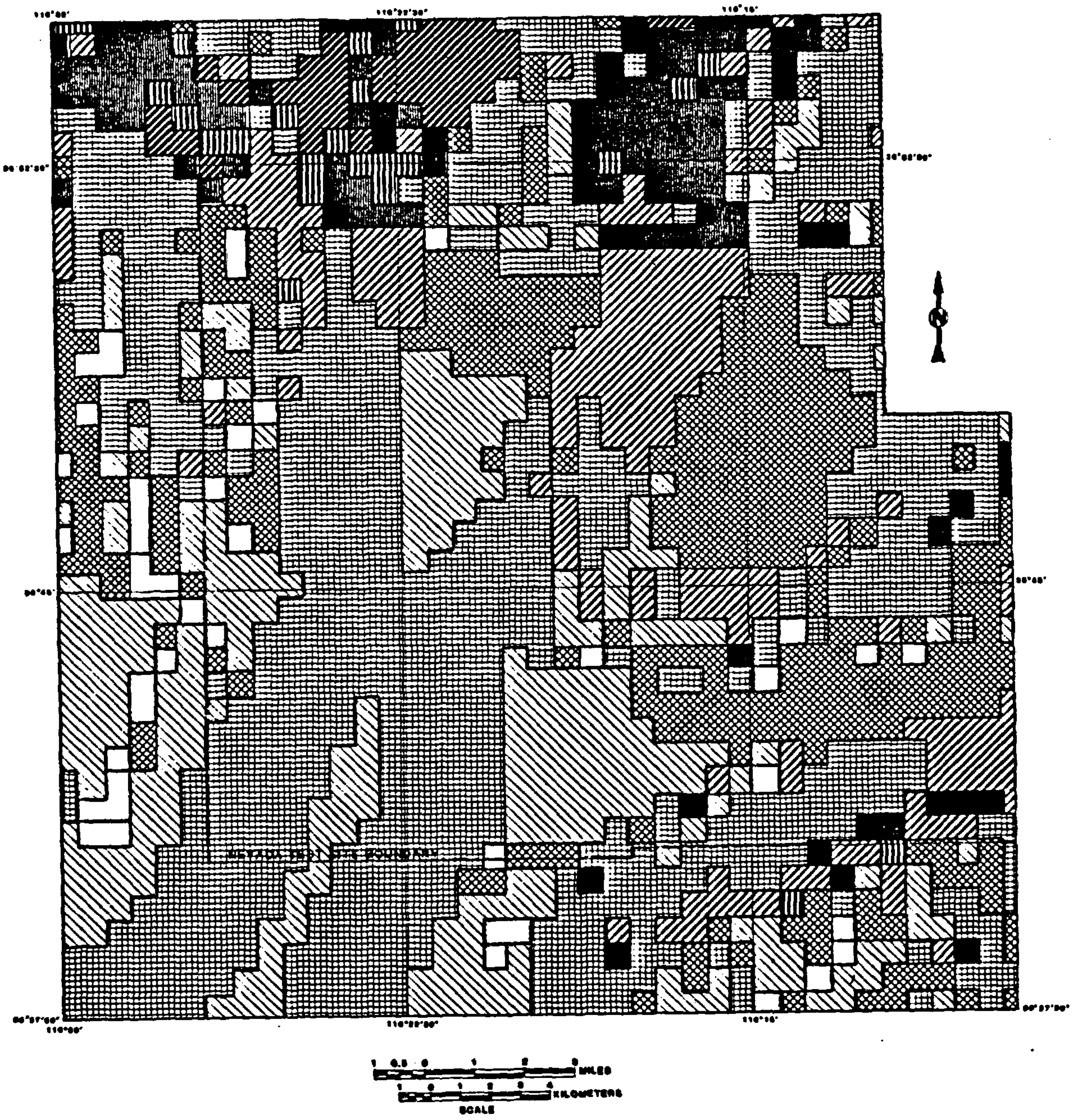




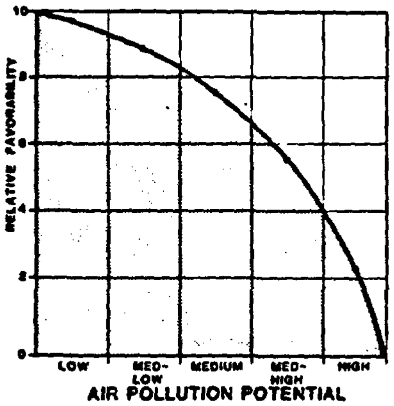
ATTRIBUTE 20: COMPOSITE POTENTIAL CULTURAL RESOURCES

LEGEND

- □ 1 Low density of cultural resources
- □ 2
- ▧ 3
- ▩ 4
- ▦ 5
- ▨ 6
- ■ 7
- ▥ 8
- ▨ 9
- ■ 10 High density of cultural resources



ATTRIBUTE 21: AIR POLLUTION POTENTIAL



LEGEND

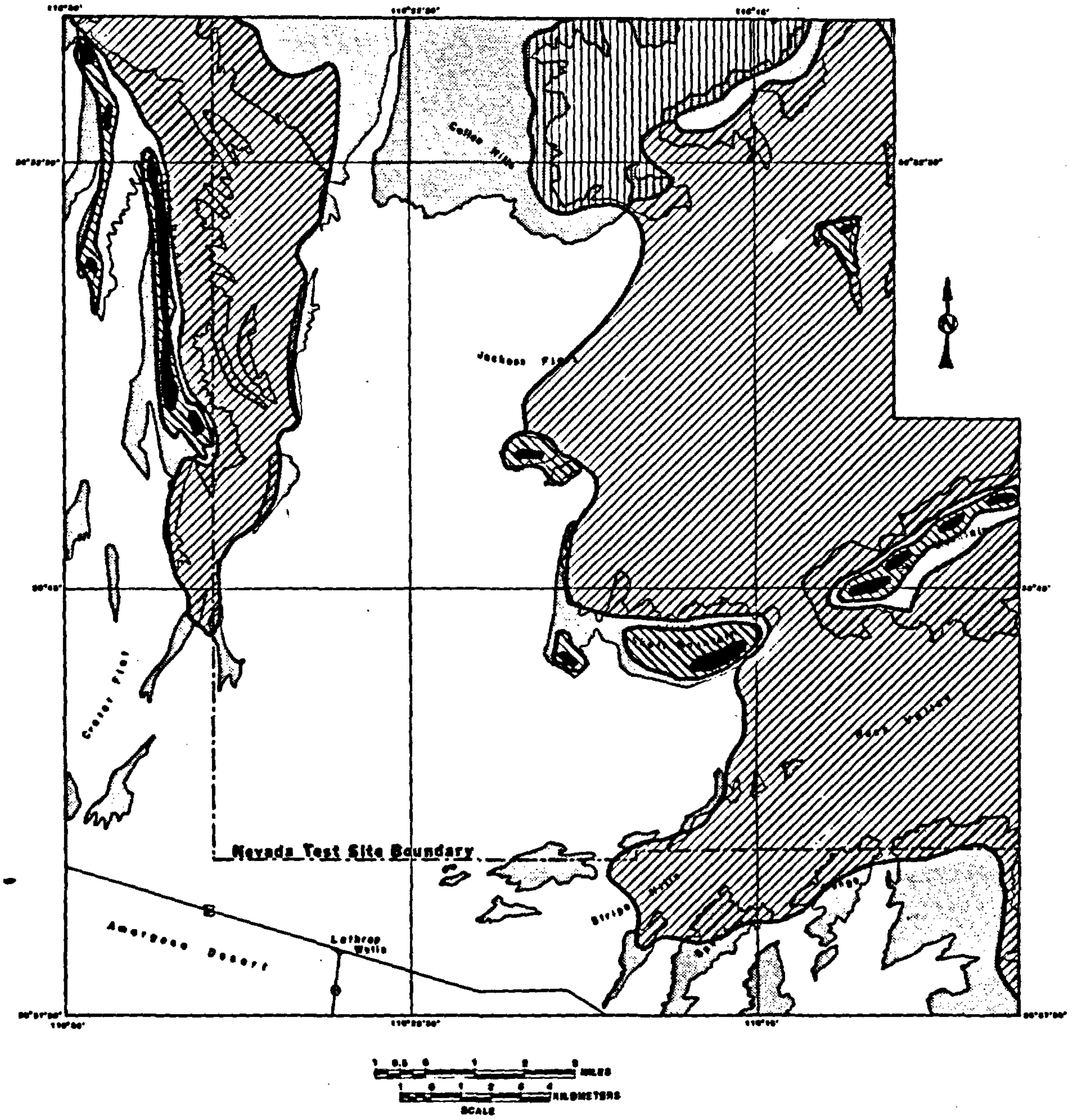
■ LOW

▧ MEDIUM LOW

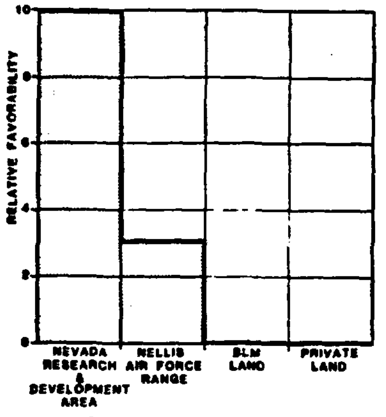
☐ MEDIUM

▨ MEDIUM HIGH

▥ HIGH

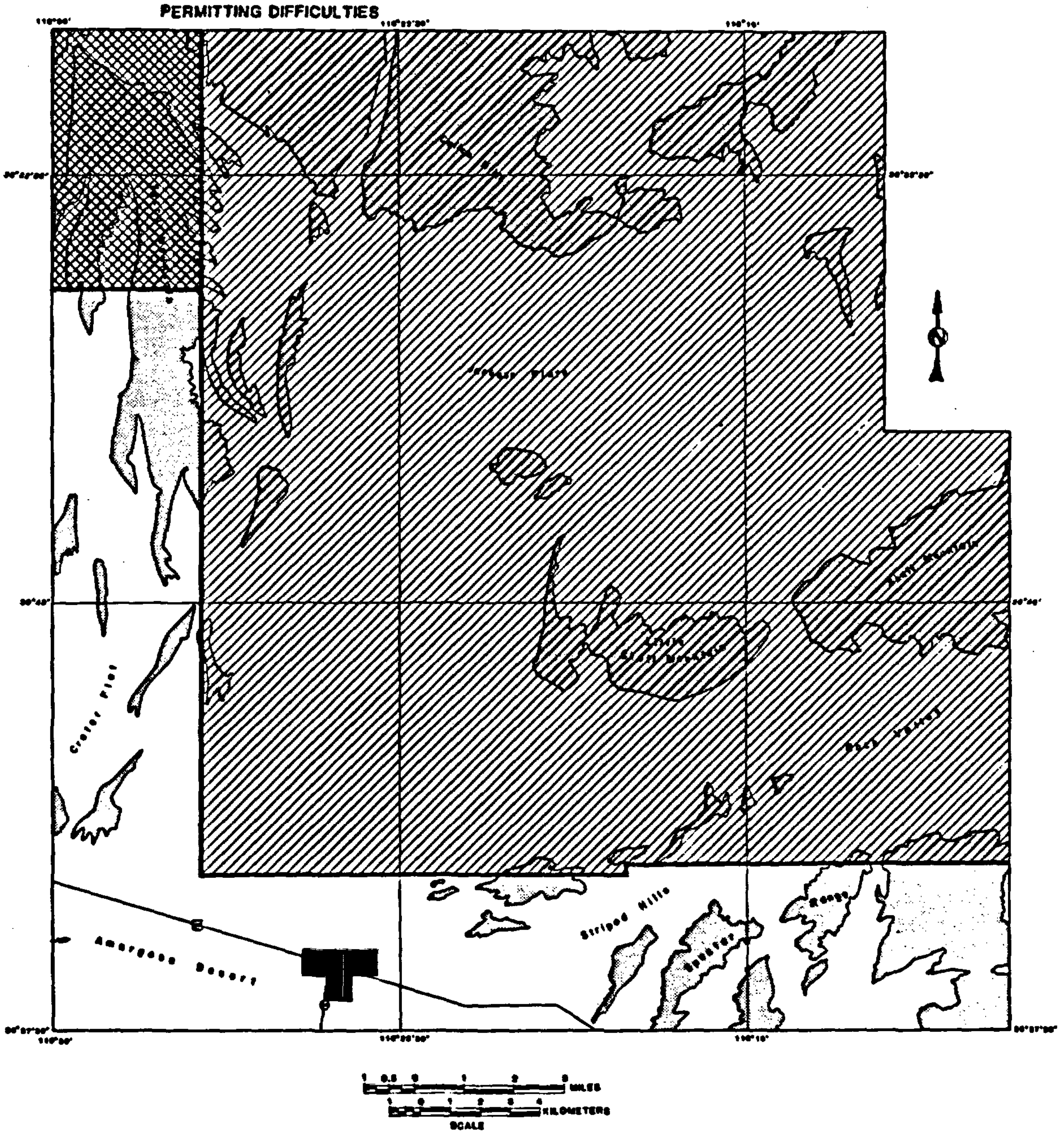


ATTRIBUTE 22: PERMITTING DIFFICULTIES

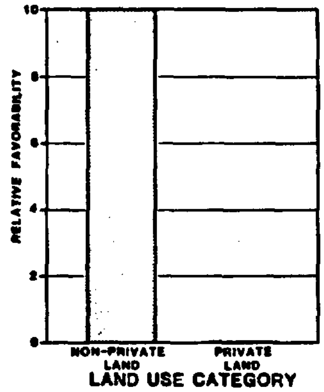


LEGEND

- ▨ Nevada Research and Development Area (NTS)
- ⊠ Nellis Air Force Range
- ▽ Bureau of Land Management Land
- ■ Private Land



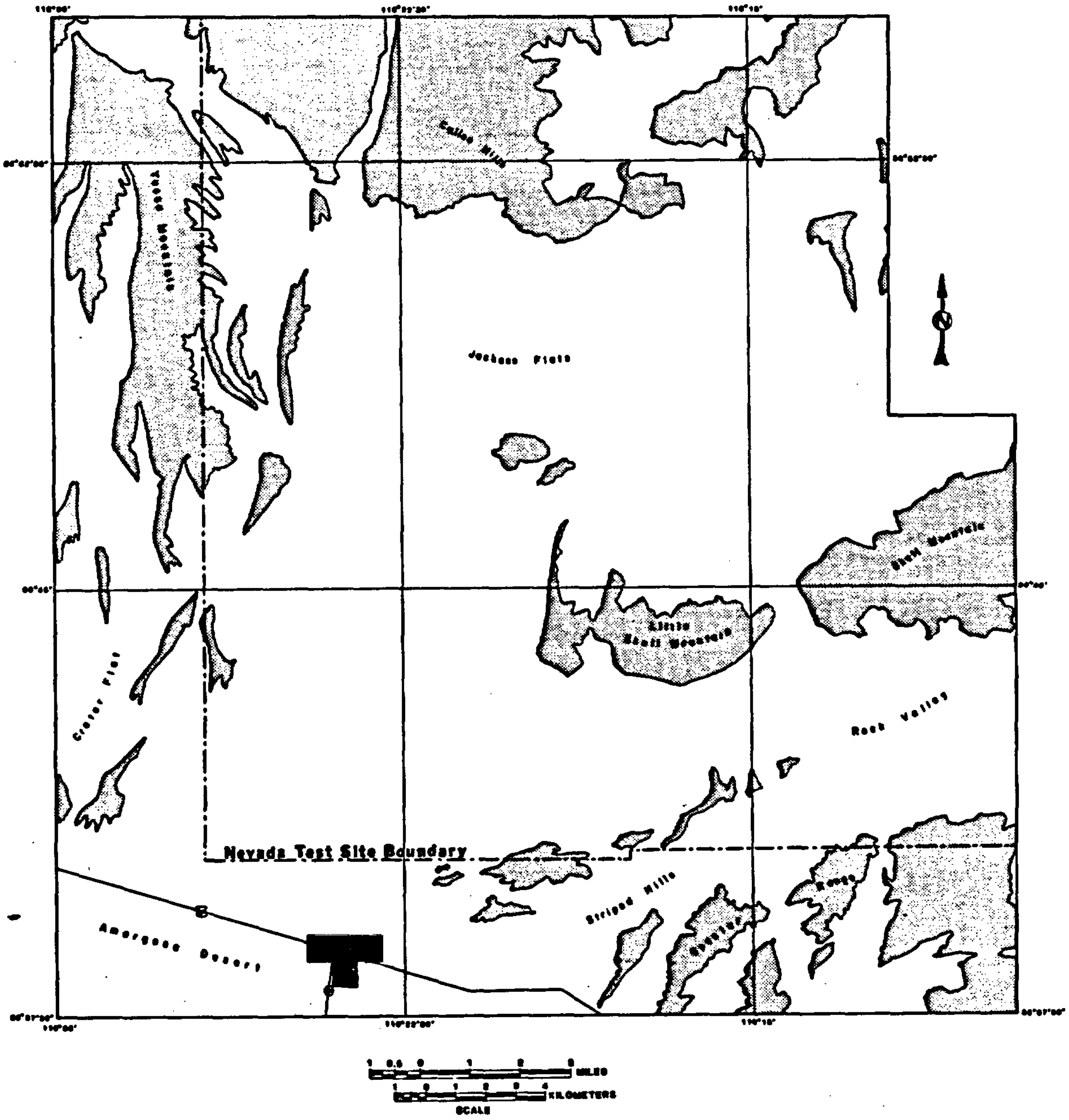
ATTRIBUTE 23: PRIVATE LAND USE

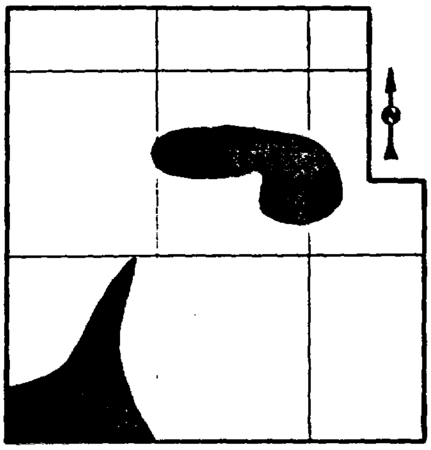


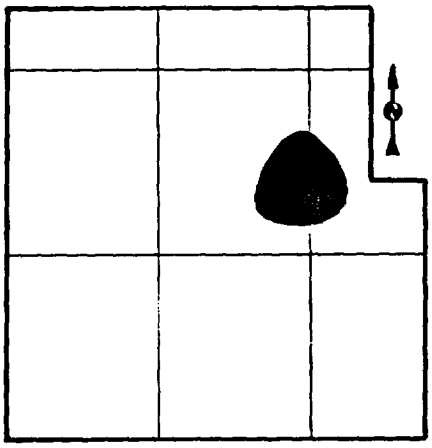
LEGEND

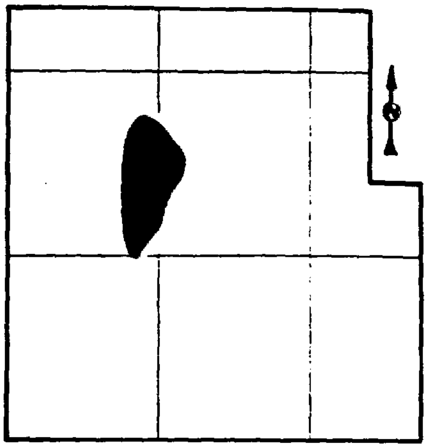
V Non-Private Land

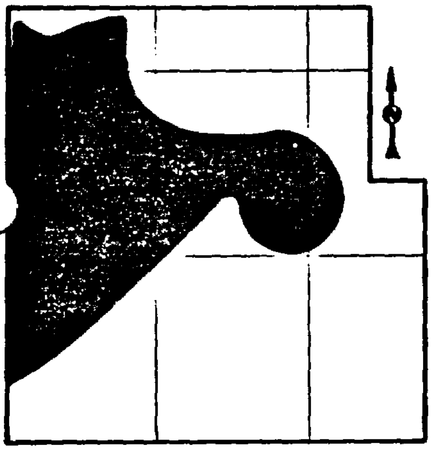
■ Private Land

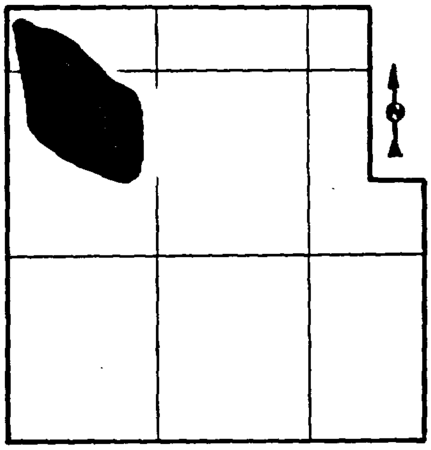


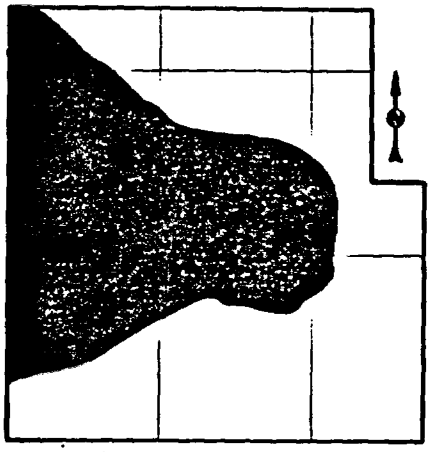

ALLUVIUM

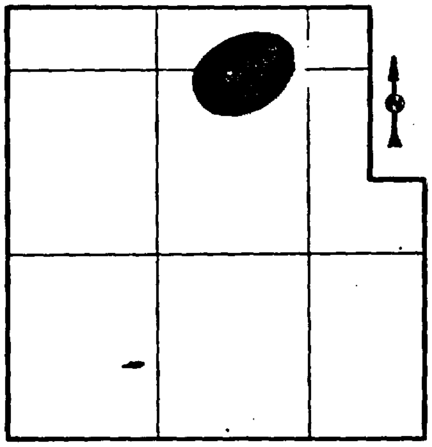

BASALT

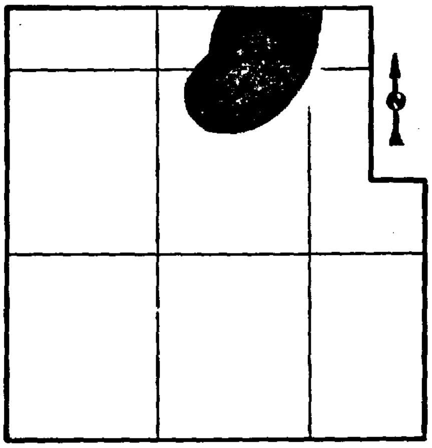

NON-WELDED TUFF (PAINTBRUSH)

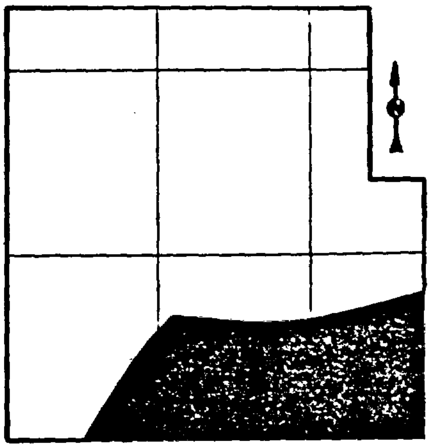

DENSELY WELDED TUFF (TOPOPAH SPRING)


NON-WELDED TUFF (CALICO HILLS)


MODERATELY WELDED TUFF (CRATER FLAT)

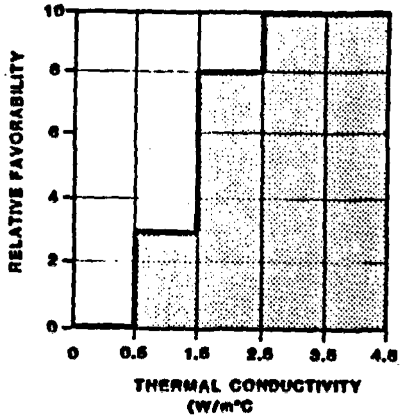

GRANITE

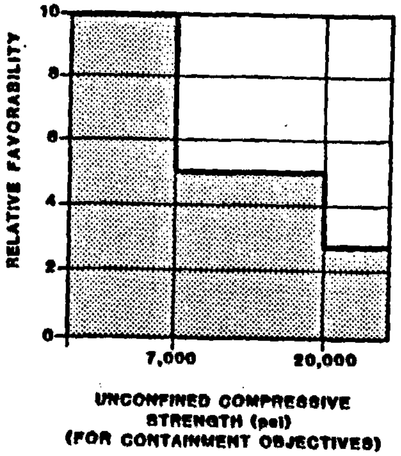

ARGILLITE

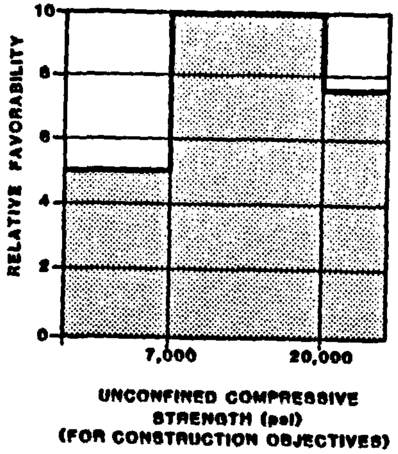

CARBONATES

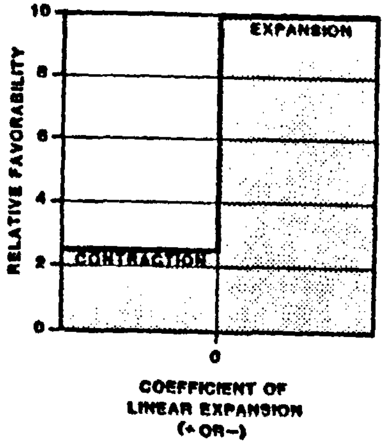
ROCK TYPES	ATTRIBUTES						
	24 THERMAL CONDUCTIVITY (W/m°K)	25/26 UNCONFINED COMPRESSIVE STRENGTH (psi)	27 EXPANSION-CONTRACTION BEHAVIOR	28 MINERAL STABILITY (RANK ORDER) *	29 STRATIGRAPHIC SETTING (WEIGHTED X 10^3)	30 HYDRAULIC RETARDATION (RANK ORDER) *	31 HYDRAULIC TRANSMISSIVITY (cm^2/sec)
ALLUVIUM	0.5-1.5	< 7000	CONTR	7	2000-4000	1	10^{-3}
BASALT	1.5-2.5	>20000	EXPAN	4	2000-4000	6	10^{-3}
NON-WELDED TUFF (PAINTBRUSH)	0.5-1.5	< 7000	CONTR	7	2000-4000	2	10^{-4}
DENSELY WELDED TUFF (TOPOPAH SPRING)	1.5-2.5	7000-20000	EXPAN	2	2000-4000	5	10^{-2}
NON-WELDED TUFF (CALICO HILLS)	0.5-1.5	< 7000	CONTR	9	10000-12000	1	10^{-5}
MOD. WELDED TUFF (CRATER FLAT et al)	1.5-2.5	7000-20000	EXPAN	5	4000-6000	3	10^{-4}
GRANITE	2.5-3.5	>20000	EXPAN	1	4000-6000	6	10^{-5}
ARGILLITE	1.5-2.5	< 7000	CONTR	8	>12000	6	10^{-5}
CARBONATES	3.5-4.5	7000-20000	EXPAN	1	<2000	7	10^{-2}

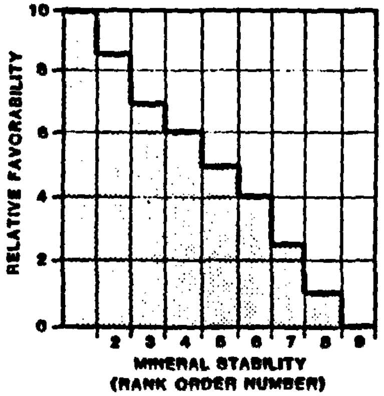
* RANK ORDERS BASED ON LIST OF ROCK TYPES ORIGINALLY CONSIDERED, THREE OCCURRING OUTSIDE OF SCREENING AREA BEFORE SCREENING AREA WAS DIMINISHED TO CURRENT BOUNDARIES

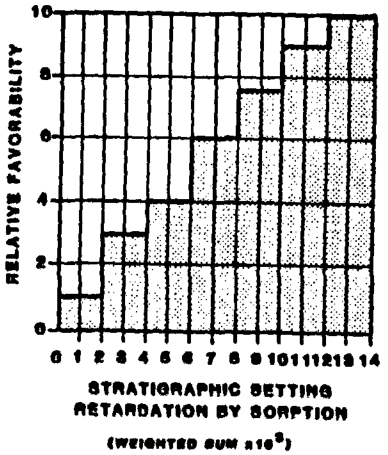

RELATIVE FAVORABILITY
0
2
4
6
8
10
0
0.5
1.5
2.5
3.5
4.5
THERMAL CONDUCTIVITY
(W/m°C

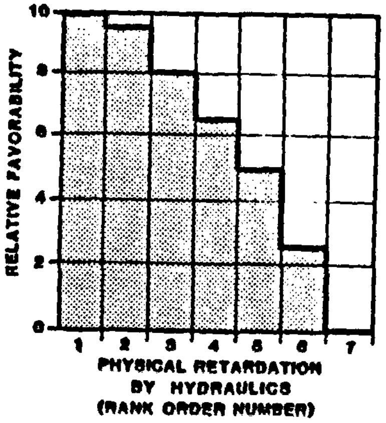

RELATIVE FAVORABILITY
0
2
4
6
8
10
7,000
20,000
UNCONFINED COMPRESSIVE
STRENGTH (psi)
(FOR CONTAINMENT OBJECTIVES)

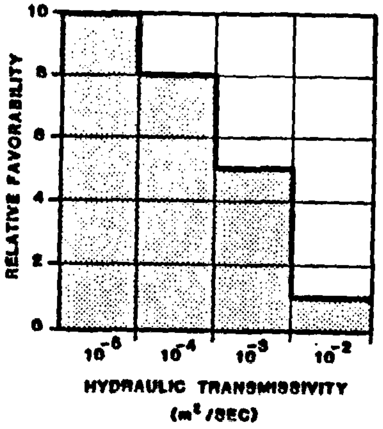

RELATIVE FAVORABILITY
0
2
4
6
8
10
7,000
20,000
UNCONFINED COMPRESSIVE
STRENGTH (psi)
(FOR CONSTRUCTION OBJECTIVES)


RELATIVE FAVORABILITY
0
2
4
6
8
10
EXPANSION
CONTRACTION
0
COEFFICIENT OF
LINEAR EXPANSION
(+ OR –)


RELATIVE FAVORABILITY
0
2
4
6
8
10
2
3
4
5
6
7
8
9
MINERAL STABILITY
(RANK ORDER NUMBER)


RELATIVE FAVORABILITY
0
2
4
6
8
10
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
STRATIGRAPHIC SETTING
RETARDATION BY SORPTION
(WEIGHTED SUM x10³)


RELATIVE FAVORABILITY
0
2
4
6
8
10
1
2
3
4
5
6
7
PHYSICAL RETARDATION
BY HYDRAULICS
(RANK ORDER NUMBER)


RELATIVE FAVORABILITY
0
2
4
6
8
10
10⁻⁵
10⁻⁴
10⁻³
10⁻²
HYDRAULIC TRANSMISSIVITY
(m²/SEC)

APPENDIX C

CONTENTS

APPENDIX C

CONTENTS

Weights for Analysis of:

CONTAINMENT OBJECTIVES

Clear–Weights used in analysis

Shading–Weights set to 0 for analysis

Figure 21 shows resulting location and host-rock ratings

OBJECTIVES
(WEIGHTS IN PARENTHESES)

ATTRIBUTES
(WEIGHTS AT MATRIX INTERSECTIONS)

		OVER-ALL GOAL	PROVIDE SAFE, EFFECTIVE & ENVIRONMENTALLY SOUND RADIOACTIVE WASTE DISPOSAL																																					
		LEVEL 1	1.0 PROVIDE CONTAINMENT (31%)							2.0 PROVIDE ISOLATION (54%)									3.0 PROVIDE SAFE COST EFFECTIVE CONSTRUCTION & OPERATIONS (9%)														4.0 PROVIDE ACCEPTABLE ENVIRONMENTAL IMPACTS (6%)									
		LEVEL 2	1.1 DISRUPTIVE PROCESSES (68%)		1.2 DISRUPTIVE EVENTS (32%)					2.1 RADIONUCLIDE MIGRATION (85%)				2.2 DISRUPTIVE EVENTS (15%)					3.1 SURFACE FACILITIES (37%)						3.2 SUBSURFACE FACILITIES (43%)						3.3 TRANSPORTATION SYSTEMS (20%)		4.1 BIOTIC SYS.(22%)	4.2 ABIOTIC SYSTEMS (21%)			4.3 SOCIOECONOMIC IMPACTS (20%)			4.4 INSTITUTIONAL IMPACTS (21%)		4.5 CULT. RES. (16%)
		LEVEL 3	1.1.1 CHEMICAL (68%)	1.1.2 MECHANICAL (32%)	1.2.1 SEISMIC (37%)	1.2.2 EROSIONAL (14%)	1.2.3 VOLCANIC (21%)	1.2.4 HUMAN INTRUSION (23%)	1.2.5 MISCELLANEOUS (5%)	2.1.1 GROUNDWATER FLOW (36%)	2.1.2 NUCLIDE RETARD. (30%)	2.1.3 HOST ROCK THICK. (29%)	2.1.4 VOLATILE MIGRATION (5%)	2.2.1 TECTONIC (31%)	2.2.2 CLIMATIC (31%)	2.2.3 GEOMORPHIC (20%)	2.2.4 HUMAN INDUCED (8%)	2.2.5 MISC. & COMPLEXITY (5%)	3.1.1 SEISMICITY (21%)	3.1.2 MONITORING PONT'S (12%)	3.1.3 FOUNDATION COND. (25%)	3.1.4 WIND LOADS (19%)	3.1.5 FLOODING (12%)	3.1.6 AVAIL. NAT. RES. (13%)	3.2.1 SEISMICITY (12%)	3.2.2 FLOODING (21%)	3.2.3 MINING COND (37%)	3.2.4 HOST ROCK GEOM. (10%)	3.2.5 HOST ROCK HOMOG. (12%)	3.2.6 WASTE PKG ACCEPT. (10%)	3.3.1 TERRAIN (71%)	3.3.2 EXISTING CORRIDOR (29%)	4.1.1 SENSITIVE SYS. (100%)	4.2.1 SURFACE GEOLOGY (25%)	4.2.2 WATER QUALITY (49%)	4.2.3 AIR QUALITY (26%)	4.3.1 LOCAL ECONOMICS (41%)	4.3.2 LIFE STYLES (42%)	4.3.3 LAND USE (17%)	4.4.1 STATE ISSUES (53%)	4.4.2 FEDERAL REGS. (47%)	4.5.1 ARCH. & HIST. SITES (100%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL			5		100							40																											
		2 FAULT DENSITY	5							5			10					50							10	10	20		50												
		3 FAULT TREND			5									10																											
		4 AGE OF FAULTING			30									10																											
		5 NATURAL SEISMIC POTENTIAL			60									40					90						85																
		6 WEAPONS SEISMIC POTENTIAL							100								10		10						5																
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)																30										100	40												
		8 EROSION POTENTIAL				100										80					10																				
		9 FLOOD POTENTIAL														10					20		100			5					30			50								
		10 TERRAIN RUGGEDNESS														10		20		70	70										70			50								
		11 BASE & PRECIOUS METAL RESOURCE POT						50									40												10												
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL						50									50																		100						
		13 GROUNDWATER FLUX	5							10	10															15															
		14 GROUNDWATER FLOW DIRECTION								30																10	10														
		15 THICKNESS OF UNSATURATED ZONE								5					100																										
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES																		5													40									
		17 SENSITIVE FAUNAL SPECIES																		7													50									
		18 REVEGETATION POTENTIAL																															10									
		19 KNOWN CULTURAL RESOURCES																		5																						30
		20 POTENTIAL CULTURAL RESOURCES																		10																						70
		21 AIR POLLUTION POTENTIAL																																		100						
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES																																							100	
		23 PRIVATE LAND USE																																					100			
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY	20	30																							10			20												
		25 COMPRESSIVE STRENGTH (CONTAINMENT)		40								70																													
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)																									40															
		27 EXPANSION-CONTRACTION		20																										40												
	GEOCHEMICAL	28 MINERAL STABILITY	10	10							10		5														10			40												
		29 STRATIGRAPHIC SETTING									70	30	30																													
		30 HYDRAULIC RETARDATION								10	10		15																													
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	60							40			40													60	10															

Weights for Analysis of:

TECTONIC ATTRIBUTES

Clear–Weights used in analysis

Shading–Weights set to 0 for analysis

Figure 22 shows resulting location ratings

OBJECTIVES

(WEIGHTS IN PARENTHESES)

ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)

OVERALL GOAL			PROVIDE SAFE, EFFECTIVE & ENVIRONMENTALLY SOUND RADIOACTIVE WASTE DISPOSAL																																						
LEVEL 1			1.0 PROVIDE CONTAINMENT (31%)							2.0 PROVIDE ISOLATION (34%)									3.0 PROVIDE SAFE COST EFFECTIVE CONSTRUCTION & OPERATIONS (26%)														4.0 PROVIDE ACCEPTABLE ENVIRONMENTAL IMPACTS (9%)									
LEVEL 2			1.1 DISRUPTIVE PROCESSES (68%)		1.2 DISRUPTIVE EVENTS (32%)					2.1 RADIONUCLIDE MIGRATION (65%)				2.2 DISRUPTIVE EVENTS (35%)					3.1 SURFACE FACILITIES (37%)						3.2 SUBSURFACE FACILITIES (43%)						3.3 TRANSPORTATION SYSTEMS (20%)		4.1 BIOTIC SYSTEMS (22%)	4.2 ABIOTIC SYSTEMS (21%)			4.3 SOCIOECONOMIC IMPACTS (20%)			4.4 INSTITUTIONAL IMPACTS (21%)		4.5 CULT. RES. (16%)
LEVEL 3			1.1.1 CHEMICAL (65%)	1.1.2 MECHANICAL (35%)	1.2.1 SEISMIC (37%)	1.2.2 EROSIONAL (14%)	1.2.3 VOLCANIC (21%)	1.2.4 HUMAN INTRUSION (25%)	1.2.5 MISCELLANEOUS (3%)	2.1.1 GROUNDWATER FLOW (40%)	2.1.2 NUCLIDE RETARD. (30%)	2.1.3 HOST ROCK THICK. (22%)	2.1.4 VOLATILE MIGRATION (8%)	2.2.1 TECTONIC (21%)	2.2.2 CLIMATIC (21%)	2.2.3 GEOMORPHIC (29%)	2.2.4 HUMAN INDUCED (8%)	2.2.5 MISC. & COMPLEXITY (21%)	3.1.1 SEISMICITY (21%)	3.1.2 MONITORING CONST'N (12%)	3.1.3 FOUNDATION COND. (26%)	3.1.4 WIND LOADS (10%)	3.1.5 FLOODING (16%)	3.1.6 AVAIL. NAT. RES. (15%)	3.2.1 SEISMICITY (16%)	3.2.2 FLOODING (21%)	3.2.3 MINING COND (27%)	3.2.4 HOST ROCK GEOL. (16%)	3.2.5 HOST ROCK HOMOG (12%)	3.2.6 WASTE PKG ACCEPT. (10%)	3.3.1 TERRAIN (71%)	3.3.2 EXISTING CORRIDOR (29%)	4.1.1 SENSITIVE SYS. (100%)	4.2.1 SURFACE GEOLOGY (33%)	4.2.2 WATER QUALITY (45%)	4.2.3 AIR QUALITY (22%)	4.3.1 LOCAL ECONOMIES (41%)	4.3.2 LIFE STYLES (42%)	4.3.3 LAND USE (17%)	4.4.1 STATE ISSUES (53%)	4.4.2 FEDERAL REGS. (47%)	4.5.1 ARCH. & HIST. SITES (100%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL			5		100							40																												
		2 FAULT DENSITY	5							5			10					50							10	10	20		50													
		3 FAULT TREND			5									10																												
		4 AGE OF FAULTING			30									10																												
		5 NATURAL SEISMIC POTENTIAL			60									40					90						85																	
		6 WEAPONS SEISMIC POTENTIAL							100								15		10						5																	
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)																30										100	40													
		8 EROSION POTENTIAL				100										80					10																					
		9 FLOOD POTENTIAL														10					70		100				5					30			50								
		10 TERRAIN RUGGEDNESS														10		20		75	20											70			50								
		11 BASE & PRECIOUS METAL RESOURCE POT						50									40												10													
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL						50									45																		100							
		13 GROUNDWATER FLUX	5							10	10															10																
		14 GROUNDWATER FLOW DIRECTION								30																10	10															
		15 THICKNESS OF UNSATURATED ZONE								5					100																											
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES																		3													45									
		17 SENSITIVE FAUNAL SPECIES																		7													45									
		18 REVEGETATION POTENTIAL																															10									
		19 KNOWN CULTURAL RESOURCES																		5																						30
		20 POTENTIAL CULTURAL RESOURCES																		10																						70
		21 AIR POLLUTION POTENTIAL																																		100						
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES																																							100	
		23 PRIVATE LAND USE																																				100			
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY	20	30																							10			20												
		25 COMPRESSIVE STRENGTH (CONTAINMENT)		40								20																														
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)																									40															
		27 EXPANSION-CONTRACTION		30																										40												
	GEOCHEMICAL	28 MINERAL STABILITY	10	10							10		5														10			40												
		29 STRATIGRAPHIC SETTING									70	80	30																													
		30 HYDRAULIC RETARDATION								10	10		15																													
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	60							40			40													65	10															

Weights for Analysis of:

SURFACE/GEOLOGICAL ATTRIBUTES

Clear-Weights used in analysis

Shading-Weights set to 0 for analysis

Figure 23 shows resulting location ratings

OBJECTIVES
(WEIGHTS IN PARENTHESES)

ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)		LEVEL 3	1.1.1 CHEMICAL (50%)	1.1.2 MECHANICAL (50%)	1.2.1 SEISMIC (37%)	1.2.2 EROSIONAL (14%)	1.2.3 VOLCANIC (21%)	1.2.4 HUMAN INTRUSION (23%)	1.2.5 MISCELLANEOUS (5%)	2.1.1 GROUNDWATER FLOW (39%)	2.1.2 NUCLIDE RETARD. (30%)	2.1.3 HOST ROCK THICK. (23%)	2.1.4 VOLATILE MIGRATION (8%)	2.2.1 TECTONIC (31%)	2.2.2 CLIMATIC (31%)	2.2.3 GEOMORPHIC (20%)	2.2.4 HUMAN INDUCED (9%)	2.2.5 MISC. & COMPLEXITY (9%)	3.1.1 SEISMICITY (31%)	3.1.2 MONITORING ROMT'S (12%)	3.1.3 FOUNDATION COND (26%)	3.1.4 WIND LOADS (10%)	3.1.5 FLOODING (10%)	3.1.6 AVAIL. NAT. RES. (11%)	3.2.1 SEISMICITY (15%)	3.2.2 FLOODING (8%)	3.2.3 MINING COND. (37%)	3.2.4 HOST ROCK GEOM (16%)	3.2.5 HOST ROCK HOMOG (12%)	3.2.6 WASTE PKG ACCEPT. (12%)	3.3.1 TERRAIN (71%)	3.3.2 EXISTING CORRIDOR (29%)	4.1.1 SENSITIVE SPS. (100%)	4.2.1 SURFACE GEOLOGY (22%)	4.2.2 WATER QUALITY (46%)	4.2.3 AIR QUALITY (32%)	4.3.1 LOCAL ECONOMIES (47%)	4.3.2 LIFE STYLES (42%)	4.3.3 LAND USE (11%)	4.4.1 STATE ISSUES (53%)	4.4.2 FEDERAL REGS. (47%)	4.5.1 ARCH. & HIST. SITES (100%)
OVER-ALL GOAL			PROVIDE SAFE, EFFECTIVE & ENVIRONMENTALLY SOUND RADIOACTIVE WASTE DISPOSAL																																								
LEVEL 1			1.0 PROVIDE CONTAINMENT (31%)							2.0 PROVIDE ISOLATION (34%)									3.0 PROVIDE SAFE COST EFFECTIVE CONSTRUCTION & OPERATIONS (26%)														4.0 PROVIDE ACCEPTABLE ENVIRONMENTAL IMPACTS (9%)									
LEVEL 2			1.1 DISRUPTIVE PROCESSES (68%)		1.2 DISRUPTIVE EVENTS (32%)					2.1 RADIONUCLIDE MIGRATION (65%)				2.2 DISRUPTIVE EVENTS (35%)					3.1 SURFACE FACILITIES (27%)						3.2 SUBSURFACE FACILITIES (43%)						3.3 TRANSPORTATION SYSTEMS (30%)		4.1 BIOTIC SYSTEMS (16%)	4.2 ABIOTIC SYSTEMS (21%)			4.3 SOCIOECONOMIC IMPACTS (10%)			4.4 INSTITUTIONAL IMPACTS (31%)		4.5 CULT. RES. (22%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL			5		100							40																												
GEOGRAPHICAL	TECTONIC/SEISMIC	2 FAULT DENSITY	5							5			10					50							10	10	20		50													
GEOGRAPHICAL	TECTONIC/SEISMIC	3 FAULT TREND			5									10																												
GEOGRAPHICAL	TECTONIC/SEISMIC	4 AGE OF FAULTING			50									10																												
GEOGRAPHICAL	TECTONIC/SEISMIC	5 NATURAL SEISMIC POTENTIAL			40									40					90						85																	
GEOGRAPHICAL	TECTONIC/SEISMIC	6 WEAPONS SEISMIC POTENTIAL							100								10		10						5																	
GEOGRAPHICAL	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)																30										100	40													
GEOGRAPHICAL	GEOLOGIC/SURFACE	8 EROSION POTENTIAL				100										80					10																					
GEOGRAPHICAL	GEOLOGIC/SURFACE	9 FLOOD POTENTIAL														10					20		100			5					30			50								
GEOGRAPHICAL	GEOLOGIC/SURFACE	10 TERRAIN RUGGEDNESS														10		20		70	70										70			50								
GEOGRAPHICAL	GEOLOGIC/SURFACE	11 BASE & PRECIOUS METAL RESOURCE POT						60									50												10													
GEOGRAPHICAL	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL						40									40																		100							
GEOGRAPHICAL	HYDROLOGICAL	13 GROUNDWATER FLUX	5							15	10															15																
GEOGRAPHICAL	HYDROLOGICAL	14 GROUNDWATER FLOW DIRECTION								20																10	10															
GEOGRAPHICAL	HYDROLOGICAL	15 THICKNESS OF UNSATURATED ZONE								5					100																											
GEOGRAPHICAL	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES																		3													40									
GEOGRAPHICAL	ENVIRONMENTAL	17 SENSITIVE FAUNAL SPECIES																		7													50									
GEOGRAPHICAL	ENVIRONMENTAL	18 REVEGETATION POTENTIAL																															10									
GEOGRAPHICAL	ENVIRONMENTAL	19 KNOWN CULTURAL RESOURCES																		5																						30
GEOGRAPHICAL	ENVIRONMENTAL	20 POTENTIAL CULTURAL RESOURCES																		15																						70
GEOGRAPHICAL	ENVIRONMENTAL	21 AIR POLLUTION POTENTIAL																																		100						
GEOGRAPHICAL	INSTITUTIONAL	22 PERMITTING DIFFICULTIES																																							100	
GEOGRAPHICAL	INSTITUTIONAL	23 PRIVATE LAND USE																																					100			
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY	30	30																							10			20												
HOST ROCK	GEOMECHANICAL	25 COMPRESSIVE STRENGTH (CONTAINMENT)		40								20																														
HOST ROCK	GEOMECHANICAL	26 COMPRESSIVE STRENGTH (CONSTRUCTION)																									40															
HOST ROCK	GEOMECHANICAL	27 EXPANSION-CONTRACTION		20																										40												
HOST ROCK	GEOCHEMICAL	28 MINERAL STABILITY	10	10							10		5														10			40												
HOST ROCK	GEOCHEMICAL	29 STRATIGRAPHIC SETTING									70	80	30																													
HOST ROCK	GEOCHEMICAL	30 HYDRAULIC RETARDATION								15	10		15																													
HOST ROCK	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	50							40			40													60	10															

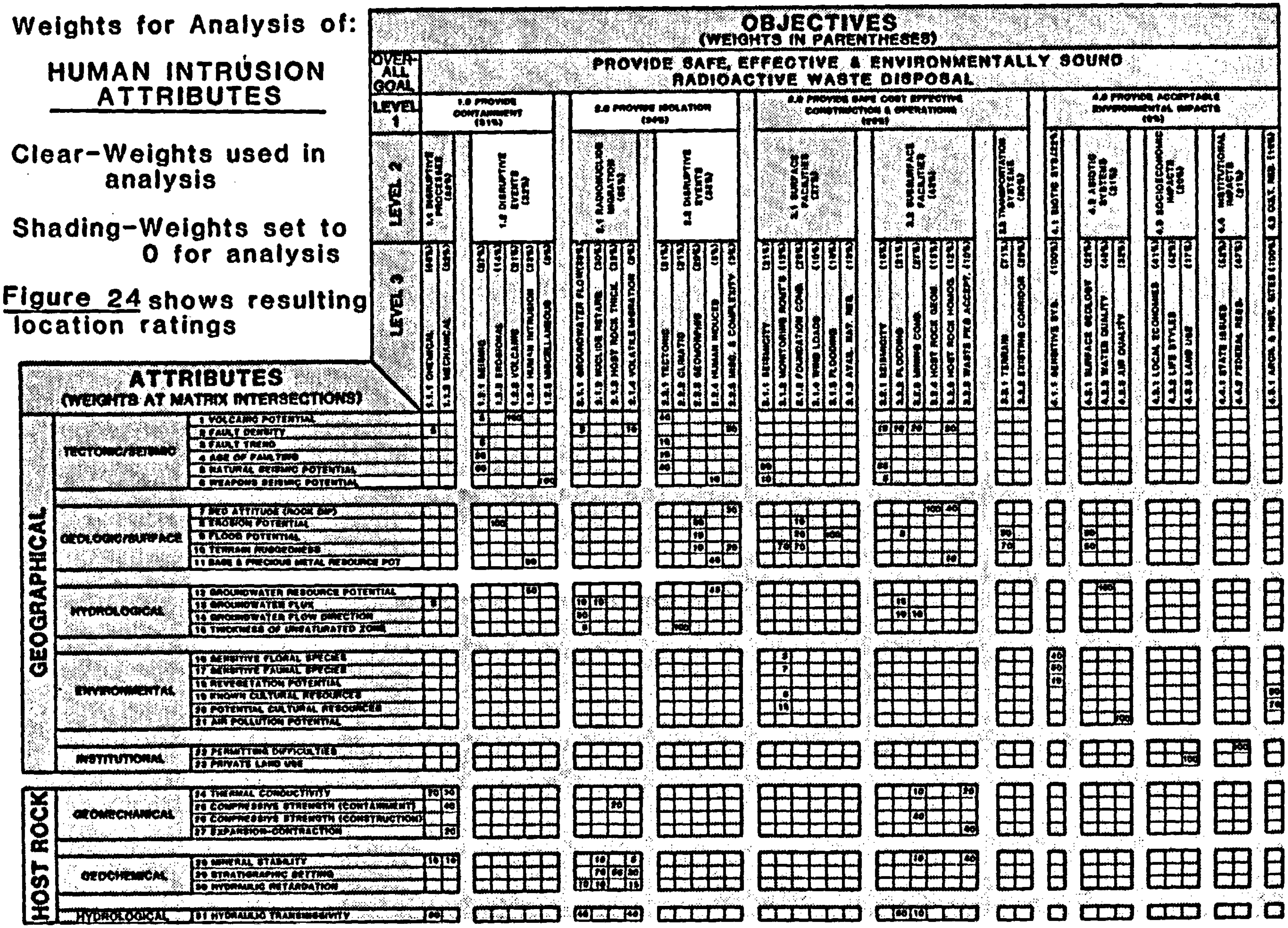
Weights for Analysis of:

HUMAN INTRUSION ATTRIBUTES

Clear–Weights used in analysis

Shading–Weights set to 0 for analysis

Figure 24 shows resulting location ratings



OBJECTIVES
(WEIGHTS IN PARENTHESES)

OVER-ALL GOAL: PROVIDE SAFE, EFFECTIVE & ENVIRONMENTALLY SOUND RADIOACTIVE WASTE DISPOSAL

LEVEL 1:
- 1.0 PROVIDE CONTAINMENT
  - 1.1 DISRUPTIVE PROCESSES: 1.1.1 CHEMICAL; 1.1.2 MECHANICAL
  - 1.2 DISRUPTIVE EVENTS: 1.2.1 SEISMIC; 1.2.2 EROSIONAL; 1.2.3 VOLCANIC; 1.2.4 HUMAN INTRUSION; 1.2.5 MISCELLANEOUS
- 2.0 PROVIDE ISOLATION
  - 2.1 RADIONUCLIDE MIGRATION: 2.1.1 GROUNDWATER FLOW; 2.1.2 NUCLIDE RETARD.; 2.1.3 HOST ROCK THICK.; 2.1.4 VOLATILE MIGRATION
  - 2.2 DISRUPTIVE EVENTS: 2.2.1 TECTONIC; 2.2.2 CLIMATIC; 2.2.3 GEOMORPHIC; 2.2.4 HUMAN INDUCED; 2.2.5 HYDG. & COMPLEXITY
- 3.0 PROVIDE SAFE COST EFFECTIVE CONSTRUCTION & OPERATIONS
  - 3.1 SURFACE FACILITIES: 3.1.1 SEISMICITY; 3.1.2 MONITORING ROUTES; 3.1.3 FOUNDATION COND.; 3.1.4 WIND LOADS; 3.1.5 FLOODING; 3.1.6 AVAIL. NAT. RES.
  - 3.2 SUBSURFACE FACILITIES: 3.2.1 SEISMICITY; 3.2.2 FLOODING; 3.2.3 MINING COND.; 3.2.4 HOST ROCK GEOM.; 3.2.5 HOST ROCK HOMOG.; 3.2.6 WASTE PKG ACCEPT.
  - 3.3 TRANSPORTATION SYSTEMS: 3.3.1 TERRAIN; 3.3.2 EXISTING CORRIDOR
- 4.0 PROVIDE ACCEPTABLE ENVIRONMENTAL IMPACTS
  - 4.1 BIOTIC SYSTEMS: 4.1.1 SENSITIVE SYS.
  - 4.2 ABIOTIC SYSTEMS: 4.2.1 SURFACE GEOLOGY; 4.2.2 WATER QUALITY; 4.2.3 AIR QUALITY
  - 4.3 SOCIOECONOMIC IMPACTS: 4.3.1 LOCAL ECONOMIES; 4.3.2 LIFE STYLES; 4.3.3 LAND USE
  - 4.4 INSTITUTIONAL IMPACTS: 4.4.1 STATE ISSUES; 4.4.2 FEDERAL REGS.
  - 4.5 CULT. RES.: 4.5.1 ARCH. & HIST. SITES

ATTRIBUTES
(WEIGHTS AT MATRIX INTERSECTIONS)

GEOGRAPHICAL
- TECTONIC/SEISMIC: 1 VOLCANIC POTENTIAL; 2 FAULT DENSITY; 3 FAULT TREND; 4 AGE OF FAULTING; 5 NATURAL SEISMIC POTENTIAL; 6 WEAPONS SEISMIC POTENTIAL
- GEOLOGIC/SURFACE: 7 BED ATTITUDE (ROCK DIP); 8 EROSION POTENTIAL; 9 FLOOD POTENTIAL; 10 TERRAIN RUGGEDNESS; 11 BASE & PRECIOUS METAL RESOURCE POT
- HYDROLOGICAL: 12 GROUNDWATER RESOURCE POTENTIAL; 13 GROUNDWATER FLUX; 14 GROUNDWATER FLOW DIRECTION; 15 THICKNESS OF UNSATURATED ZONE
- ENVIRONMENTAL: 16 SENSITIVE FLORAL SPECIES; 17 SENSITIVE FAUNAL SPECIES; 18 REVEGETATION POTENTIAL; 19 KNOWN CULTURAL RESOURCES; 20 POTENTIAL CULTURAL RESOURCES; 21 AIR POLLUTION POTENTIAL
- INSTITUTIONAL: 22 PERMITTING DIFFICULTIES; 23 PRIVATE LAND USE

HOST ROCK
- GEOMECHANICAL: 24 THERMAL CONDUCTIVITY; 25 COMPRESSIVE STRENGTH (CONTAINMENT); 26 COMPRESSIVE STRENGTH (CONSTRUCTION); 27 EXPANSION-CONTRACTION
- GEOCHEMICAL: 28 MINERAL STABILITY; 29 STRATIGRAPHIC SETTING; 30 HYDRAULIC RETARDATION
- HYDROLOGICAL: 31 HYDRAULIC TRANSMISSIVITY

Weights for Analysis of:

ISOLATION OBJECTIVES

Clear–Weights used in analysis

Shading–Weights set to 0 for analysis

Figure 25 shows resulting location and host-rock ratings

OBJECTIVES
(WEIGHTS IN PARENTHESES)

OVERALL GOAL: PROVIDE SAFE, EFFECTIVE & ENVIRONMENTALLY SOUND RADIOACTIVE WASTE DISPOSAL

ATTRIBUTES
(WEIGHTS AT MATRIX INTERSECTIONS)

		LEVEL 1	1.0 PROVIDE CONTAINMENT (31%)							2.0 PROVIDE ISOLATION (34%)								
		LEVEL 2	1.1 DISRUPTIVE PROCESSES (68%)		1.2 DISRUPTIVE EVENTS (32%)					2.1 RADIONUCLIDE MIGRATION (65%)				2.2 DISRUPTIVE EVENTS (35%)				
		LEVEL 3	1.1.1 CHEMICAL (68%)	1.1.2 MECHANICAL (32%)	1.2.1 SEISMIC (37%)	1.2.2 EROSIONAL (14%)	1.2.3 VOLCANIC (21%)	1.2.4 HUMAN INTRUSION (23%)	1.2.5 MISCELLANEOUS (5%)	2.1.1 GROUNDWATER FLOW (39%)	2.1.2 NUCLIDE RETARD. (30%)	2.1.3 HOST ROCK THICK. (25%)	2.1.4 VOLATILE MIGRATION (6%)	2.2.1 TECTONIC (31%)	2.2.2 CLIMATIC (31%)	2.2.3 GEOMORPHIC (30%)	2.2.4 HUMAN INDUCED (5%)	2.2.5 MISC. & COMPLEXITY (3%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL			5		100							40				
		2 FAULT DENSITY	6							6			10					80
		3 FAULT TREND			6									10				
		4 AGE OF FAULTING			30									10				
		5 NATURAL SEISMIC POTENTIAL			60									40				
		6 WEAPONS SEISMIC POTENTIAL							100								10	
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)																30
		8 EROSION POTENTIAL				100										80		
		9 FLOOD POTENTIAL														10		
		10 TERRAIN RUGGEDNESS														10		20
		11 BASE & PRECIOUS METAL RESOURCE POT						50									40	
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL						50									45	
		13 GROUNDWATER FLUX	6							10	10							
		14 GROUNDWATER FLOW DIRECTION								90								
		15 THICKNESS OF UNSATURATED ZONE								5					100			
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES																
		17 SENSITIVE FAUNAL SPECIES																
		18 REVEGETATION POTENTIAL																
		19 KNOWN CULTURAL RESOURCES																
		20 POTENTIAL CULTURAL RESOURCES																
		21 AIR POLLUTION POTENTIAL																
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES																
		23 PRIVATE LAND USE																
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY	20	30														
		25 COMPRESSIVE STRENGTH (CONTAINMENT)		40								20						
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)																
		27 EXPANSION-CONTRACTION		30														
	GEOCHEMICAL	28 MINERAL STABILITY	10	10							10		5					
		29 STRATIGRAPHIC SETTING									70	80	30					
		30 HYDRAULIC RETARDATION								10	10		15					
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	80							40			40					

		LEVEL 1	3.0 PROVIDE SAFE COST EFFECTIVE CONSTRUCTION & OPERATIONS (29%)													
		LEVEL 2	3.1 SURFACE FACILITIES (27%)						3.2 SUBSURFACE FACILITIES (43%)						3.3 TRANSPORTATION SYSTEMS (30%)	
		LEVEL 3	3.1.1 SEISMICITY (31%)	3.1.2 MONITORING ROAD'S (12%)	3.1.3 FOUNDATION COND. (26%)	3.1.4 WIND LOADS (10%)	3.1.5 FLOODING (10%)	3.1.6 AVAIL. NAT. RES. (11%)	3.2.1 SEISMICITY (11%)	3.2.2 FLOODING (21%)	3.2.3 MINING COND. (27%)	3.2.4 HOST ROCK GEOM. (16%)	3.2.5 HOST ROCK HOMOG. (15%)	3.2.6 WASTE PKG ACCEPT. (10%)	3.3.1 TERRAIN (71%)	3.3.2 EXISTING CORRIDOR (29%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL														
		2 FAULT DENSITY							10	10	20		60			
		3 FAULT TREND														
		4 AGE OF FAULTING														
		5 NATURAL SEISMIC POTENTIAL	90						55							
		6 WEAPONS SEISMIC POTENTIAL	10						5							
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)										100	40			
		8 EROSION POTENTIAL			15											
		9 FLOOD POTENTIAL			20		100			5					80	
		10 TERRAIN RUGGEDNESS		75	75										70	
		11 BASE & PRECIOUS METAL RESOURCE POT											10			
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL														
		13 GROUNDWATER FLUX								15						
		14 GROUNDWATER FLOW DIRECTION								10	10					
		15 THICKNESS OF UNSATURATED ZONE														
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES		3												
		17 SENSITIVE FAUNAL SPECIES		7												
		18 REVEGETATION POTENTIAL														
		19 KNOWN CULTURAL RESOURCES		5												
		20 POTENTIAL CULTURAL RESOURCES		10												
		21 AIR POLLUTION POTENTIAL														
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES														
		23 PRIVATE LAND USE														
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY									10			50		
		25 COMPRESSIVE STRENGTH (CONTAINMENT)														
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)									40					
		27 EXPANSION-CONTRACTION												60		
	GEOCHEMICAL	28 MINERAL STABILITY									10			40		
		29 STRATIGRAPHIC SETTING														
		30 HYDRAULIC RETARDATION														
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY								80	10					

		LEVEL 1	4.0 PROVIDE ACCEPTABLE ENVIRONMENTAL IMPACTS (6%)									
		LEVEL 2	4.1 BIOTIC SYS.(22%)	4.2 ABIOTIC SYSTEMS (31%)			4.3 SOCIOECONOMIC IMPACTS (20%)			4.4 INSTITUTIONAL IMPACTS (21%)		4.5 CULT. RES. (10%)
		LEVEL 3	4.1.1 SENSITIVE SYS. (100%)	4.2.1 SURFACE GEOLOGY (22%)	4.2.2 WATER QUALITY (46%)	4.2.3 AIR QUALITY (32%)	4.3.1 LOCAL ECONOMIES (41%)	4.3.2 LIFE STYLES (42%)	4.3.3 LAND USE (17%)	4.4.1 STATE ISSUES (53%)	4.4.2 FEDERAL REGS. (47%)	4.5.1 ARCH. & HIST. SITES (100%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL										
		2 FAULT DENSITY										
		3 FAULT TREND										
		4 AGE OF FAULTING										
		5 NATURAL SEISMIC POTENTIAL										
		6 WEAPONS SEISMIC POTENTIAL										
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)										
		8 EROSION POTENTIAL										
		9 FLOOD POTENTIAL		80								
		10 TERRAIN RUGGEDNESS		50								
		11 BASE & PRECIOUS METAL RESOURCE POT										
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL			100							
		13 GROUNDWATER FLUX										
		14 GROUNDWATER FLOW DIRECTION										
		15 THICKNESS OF UNSATURATED ZONE										
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES	40									
		17 SENSITIVE FAUNAL SPECIES	50									
		18 REVEGETATION POTENTIAL	10									
		19 KNOWN CULTURAL RESOURCES										30
		20 POTENTIAL CULTURAL RESOURCES										70
		21 AIR POLLUTION POTENTIAL				100						
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES									100	
		23 PRIVATE LAND USE							100			
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY										
		25 COMPRESSIVE STRENGTH (CONTAINMENT)										
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)										
		27 EXPANSION-CONTRACTION										
	GEOCHEMICAL	28 MINERAL STABILITY										
		29 STRATIGRAPHIC SETTING										
		30 HYDRAULIC RETARDATION										
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY										

Weights for Analysis of:

HYDROLOGIC ATTRIBUTES

Clear-Weights used in analysis

Shading-Weights set to 0 for analysis

Figure 26 shows resulting location ratings

OBJECTIVES
(WEIGHTS IN PARENTHESES)

OVERALL GOAL: PROVIDE SAFE, EFFECTIVE & ENVIRONMENTALLY SOUND RADIOACTIVE WASTE DISPOSAL

		LEVEL 1	1.0 PROVIDE CONTAINMENT (31%)						
		LEVEL 2	1.1 DISRUPTIVE PROCESSES (68%)		1.2 DISRUPTIVE EVENTS (32%)				
ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)		LEVEL 3	1.1.1 CHEMICAL (68%)	1.1.2 MECHANICAL (32%)	1.2.1 SEISMIC (37%)	1.2.2 EROSIONAL (14%)	1.2.3 VOLCANIC (21%)	1.2.4 HUMAN INTRUSION (23%)	1.2.5 MISCELLANEOUS (5%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL			5		100		
		2 FAULT DENSITY	5						
		3 FAULT TREND			5				
		4 AGE OF FAULTING			60				
		5 NATURAL SEISMIC POTENTIAL			30				
		6 WEAPONS SEISMIC POTENTIAL							100
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)							
		8 EROSION POTENTIAL				100			
		9 FLOOD POTENTIAL							
		10 TERRAIN RUGGEDNESS							
		11 BASE & PRECIOUS METAL RESOURCE POT						50	
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL						50	
		13 GROUNDWATER FLUX	5						
		14 GROUNDWATER FLOW DIRECTION							
		15 THICKNESS OF UNSATURATED ZONE							
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES							
		17 SENSITIVE FAUNAL SPECIES							
		18 REVEGETATION POTENTIAL							
		19 KNOWN CULTURAL RESOURCES							
		20 POTENTIAL CULTURAL RESOURCES							
		21 AIR POLLUTION POTENTIAL							
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES							
		23 PRIVATE LAND USE							
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY	20	30					
		25 COMPRESSIVE STRENGTH (CONTAINMENT)		40					
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)							
		27 EXPANSION-CONTRACTION		30					
	GEOCHEMICAL	28 MINERAL STABILITY	10	10					
		29 STRATIGRAPHIC SETTING							
		30 HYDRAULIC RETARDATION							
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	60						

		LEVEL 1	2.0 PROVIDE ISOLATION (40%)								
		LEVEL 2	2.1 RADIONUCLIDE MIGRATION (65%)				2.2 DISRUPTIVE EVENTS (35%)				
ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)		LEVEL 3	2.1.1 GROUNDWATER FLOW (38%)	2.1.2 NUCLIDE RETARD. (30%)	2.1.3 HOST ROCK THICK. (23%)	2.1.4 VOLATILE MIGRATION (8%)	2.2.1 TECTONIC (31%)	2.2.2 CLIMATIC (31%)	2.2.3 GEOMORPHIC (20%)	2.2.4 HUMAN INDUCED (6%)	2.2.5 UNC. & COMPLEXITY (8%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL					40				
		2 FAULT DENSITY	5			10					30
		3 FAULT TREND					10				
		4 AGE OF FAULTING					10				
		5 NATURAL SEISMIC POTENTIAL					40				
		6 WEAPONS SEISMIC POTENTIAL								10	
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)									30
		8 EROSION POTENTIAL							60		
		9 FLOOD POTENTIAL							10		
		10 TERRAIN RUGGEDNESS							10		50
		11 BASE & PRECIOUS METAL RESOURCE POT								40	
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL								45	
		13 GROUNDWATER FLUX	10	10							
		14 GROUNDWATER FLOW DIRECTION	30								
		15 THICKNESS OF UNSATURATED ZONE	5					100			
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES									
		17 SENSITIVE FAUNAL SPECIES									
		18 REVEGETATION POTENTIAL									
		19 KNOWN CULTURAL RESOURCES									
		20 POTENTIAL CULTURAL RESOURCES									
		21 AIR POLLUTION POTENTIAL									
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES									
		23 PRIVATE LAND USE									
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY									
		25 COMPRESSIVE STRENGTH (CONTAINMENT)			20						
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)									
		27 EXPANSION-CONTRACTION									
	GEOCHEMICAL	28 MINERAL STABILITY		10		5					
		29 STRATIGRAPHIC SETTING		70	80	20					
		30 HYDRAULIC RETARDATION	10	10		15					
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	40			40					

		LEVEL 1	3.0 PROVIDE SAFE COST EFFECTIVE CONSTRUCTION & OPERATIONS (20%)													
		LEVEL 2	3.1 SURFACE FACILITIES (37%)						3.2 SUBSURFACE FACILITIES (43%)						3.3 TRANSPORTATION SYSTEMS (20%)	
ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)		LEVEL 3	3.1.1 SEISMICITY (31%)	3.1.2 MONITORING ROUTS (12%)	3.1.3 FOUNDATION COND. (26%)	3.1.4 WIND LOADS (10%)	3.1.5 FLOODING (10%)	3.1.6 AVAIL. NAT. RES. (11%)	3.2.1 SEISMICITY (13%)	3.2.2 FLOODING (21%)	3.2.3 MINING COND (27%)	3.2.4 HOST ROCK GEOM. (13%)	3.2.5 HOST ROCK HOMOG. (11%)	3.2.6 WASTE PKG ACCEPT. (16%)	3.3.1 TERRAIN (71%)	3.3.2 EXISTING CORRIDORS (29%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL														
		2 FAULT DENSITY							10	15	20		60			
		3 FAULT TREND														
		4 AGE OF FAULTING														
		5 NATURAL SEISMIC POTENTIAL	90						95							
		6 WEAPONS SEISMIC POTENTIAL	10						5							
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)										100	40			
		8 EROSION POTENTIAL			15											
		9 FLOOD POTENTIAL			15		100			5					30	
		10 TERRAIN RUGGEDNESS		75	70										70	
		11 BASE & PRECIOUS METAL RESOURCE POT											10			
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL														
		13 GROUNDWATER FLUX								15						
		14 GROUNDWATER FLOW DIRECTION								10	10					
		15 THICKNESS OF UNSATURATED ZONE														
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES		3												
		17 SENSITIVE FAUNAL SPECIES		7												
		18 REVEGETATION POTENTIAL														
		19 KNOWN CULTURAL RESOURCES		8												
		20 POTENTIAL CULTURAL RESOURCES		12												
		21 AIR POLLUTION POTENTIAL														
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES														
		23 PRIVATE LAND USE														
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY									10			20		
		25 COMPRESSIVE STRENGTH (CONTAINMENT)														
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)									40					
		27 EXPANSION-CONTRACTION												60		
	GEOCHEMICAL	28 MINERAL STABILITY									10			40		
		29 STRATIGRAPHIC SETTING														
		30 HYDRAULIC RETARDATION														
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY								60	10					

		LEVEL 1	4.0 PROVIDE ACCEPTABLE ENVIRONMENTAL IMPACTS (9%)									
		LEVEL 2	4.1 BIOTIC SYS. (27%)	4.2 ABIOTIC SYSTEMS (31%)			4.3 SOCIOECONOMIC IMPACTS (20%)			4.4 INSTITUTIONAL IMPACTS (21%)		4.5 CULT. RES. (1%)
ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)		LEVEL 3	4.1.1 SENSITIVE SYS. (100%)	4.2.1 SURFACE GEOLOGY (33%)	4.2.2 WATER QUALITY (46%)	4.2.3 AIR QUALITY (20%)	4.3.1 LOCAL ECONOMIES (41%)	4.3.2 LIFE STYLES (42%)	4.3.3 LAND USE (17%)	4.4.1 STATE ISSUES (53%)	4.4.2 FEDERAL REGS. (47%)	4.5.1 ARCH. & HIST. SITES (100%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL										
		2 FAULT DENSITY										
		3 FAULT TREND										
		4 AGE OF FAULTING										
		5 NATURAL SEISMIC POTENTIAL										
		6 WEAPONS SEISMIC POTENTIAL										
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)										
		8 EROSION POTENTIAL										
		9 FLOOD POTENTIAL		30								
		10 TERRAIN RUGGEDNESS		50								
		11 BASE & PRECIOUS METAL RESOURCE POT										
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL			100							
		13 GROUNDWATER FLUX										
		14 GROUNDWATER FLOW DIRECTION										
		15 THICKNESS OF UNSATURATED ZONE										
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES	40									
		17 SENSITIVE FAUNAL SPECIES	50									
		18 REVEGETATION POTENTIAL	10									
		19 KNOWN CULTURAL RESOURCES										30
		20 POTENTIAL CULTURAL RESOURCES										70
		21 AIR POLLUTION POTENTIAL				100						
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES									100	
		23 PRIVATE LAND USE							100			
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY										
		25 COMPRESSIVE STRENGTH (CONTAINMENT)										
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)										
		27 EXPANSION-CONTRACTION										
	GEOCHEMICAL	28 MINERAL STABILITY										
		29 STRATIGRAPHIC SETTING										
		30 HYDRAULIC RETARDATION										
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY										

Weights for Analysis of:

LONG-TERM SAFETY OBJECTIVES

Clear-Weights used in analysis

Shading-Weights set to 0 for analysis

Figure 27 shows resulting location and host-rock ratings

OBJECTIVES
(WEIGHTS IN PARENTHESES)

OVERALL GOAL: PROVIDE SAFE, EFFECTIVE & ENVIRONMENTALLY SOUND RADIOACTIVE WASTE DISPOSAL

ATTRIBUTES
(WEIGHTS AT MATRIX INTERSECTIONS)

LEVEL 1: 1.0 PROVIDE CONTAINMENT (31%)

			1.1 DISRUPTIVE PROCESSES (68%)		1.2 DISRUPTIVE EVENTS (32%)				
			1.1.1 CHEMICAL (68%)	1.1.2 MECHANICAL (32%)	1.2.1 SEISMIC (37%)	1.2.2 EROSIONAL (14%)	1.2.3 VOLCANIC (21%)	1.2.4 HUMAN INTRUSION (23%)	1.2.5 MISCELLANEOUS (5%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL			5		100		
		2 FAULT DENSITY	5						
		3 FAULT TREND			5				
		4 AGE OF FAULTING			30				
		5 NATURAL SEISMIC POTENTIAL			60				
		6 WEAPONS SEISMIC POTENTIAL							100
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)							
		8 EROSION POTENTIAL				100			
		9 FLOOD POTENTIAL							
		10 TERRAIN RUGGEDNESS							
		11 BASE & PRECIOUS METAL RESOURCE POT						50	
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL						50	
		13 GROUNDWATER FLUX	5						
		14 GROUNDWATER FLOW DIRECTION							
		15 THICKNESS OF UNSATURATED ZONE							
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES							
		17 SENSITIVE FAUNAL SPECIES							
		18 REVEGETATION POTENTIAL							
		19 KNOWN CULTURAL RESOURCES							
		20 POTENTIAL CULTURAL RESOURCES							
		21 AIR POLLUTION POTENTIAL							
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES							
		23 PRIVATE LAND USE							
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY	20	30					
		25 COMPRESSIVE STRENGTH (CONTAINMENT)		40					
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)							
		27 EXPANSION-CONTRACTION		20					
	GEOCHEMICAL	28 MINERAL STABILITY	10	10					
		29 STRATIGRAPHIC SETTING							
		30 HYDRAULIC RETARDATION							
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	60						

LEVEL 1: 2.0 PROVIDE ISOLATION (54%)

			2.1 RADIONUCLIDE MIGRATION (65%)				2.2 DISRUPTIVE EVENTS (35%)				
			2.1.1 GROUNDWATER FLOW (35%)	2.1.2 NUCLIDE RETARD. (30%)	2.1.3 HOST ROCK THICK. (23%)	2.1.4 VOLATILE MIGRATION (12%)	2.2.1 TECTONIC (31%)	2.2.2 CLIMATIC (31%)	2.2.3 GEOMORPHIC (20%)	2.2.4 HUMAN INDUCED (15%)	2.2.5 MISC. & COMPLEXITY (3%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL					40				
		2 FAULT DENSITY	5			10					50
		3 FAULT TREND					10				
		4 AGE OF FAULTING					10				
		5 NATURAL SEISMIC POTENTIAL					40				
		6 WEAPONS SEISMIC POTENTIAL								10	
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)									30
		8 EROSION POTENTIAL							80		
		9 FLOOD POTENTIAL							10		
		10 TERRAIN RUGGEDNESS							10		20
		11 BASE & PRECIOUS METAL RESOURCE POT								40	
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL								50	
		13 GROUNDWATER FLUX	10	10							
		14 GROUNDWATER FLOW DIRECTION	30								
		15 THICKNESS OF UNSATURATED ZONE	5					100			
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES									
		17 SENSITIVE FAUNAL SPECIES									
		18 REVEGETATION POTENTIAL									
		19 KNOWN CULTURAL RESOURCES									
		20 POTENTIAL CULTURAL RESOURCES									
		21 AIR POLLUTION POTENTIAL									
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES									
		23 PRIVATE LAND USE									
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY									
		25 COMPRESSIVE STRENGTH (CONTAINMENT)			20						
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)									
		27 EXPANSION-CONTRACTION									
	GEOCHEMICAL	28 MINERAL STABILITY		10		5					
		29 STRATIGRAPHIC SETTING		70	80	30					
		30 HYDRAULIC RETARDATION	10	10		15					
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	40			40					

LEVEL 1: 3.0 PROVIDE SAFE COST EFFECTIVE CONSTRUCTION & OPERATIONS (10%)

			3.1 SURFACE FACILITIES (27%)						3.2 SUBSURFACE FACILITIES (43%)						3.3 TRANSPORTATION SYSTEMS (30%)	
			3.1.1 SEISMICITY (31%)	3.1.2 MONITORING ROUTE'S (12%)	3.1.3 FOUNDATION COND. (28%)	3.1.4 WIND LOADS (10%)	3.1.5 FLOODING (10%)	3.1.6 AVAIL. MAT. RES. (10%)	3.2.1 SEISMICITY (10%)	3.2.2 FLOODING (31%)	3.2.3 MINING COND (27%)	3.2.4 HOST ROCK GEOM. (10%)	3.2.5 HOST ROCK HOMOG. (12%)	3.2.6 WASTE PKG ACCEPT. (10%)	3.3.1 TERRAIN (71%)	3.3.2 EXISTING CORRIDOR (29%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL														
		2 FAULT DENSITY							10	10	20		50			
		3 FAULT TREND														
		4 AGE OF FAULTING														
		5 NATURAL SEISMIC POTENTIAL	90						85							
		6 WEAPONS SEISMIC POTENTIAL	10						5							
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)										100	40			
		8 EROSION POTENTIAL			10											
		9 FLOOD POTENTIAL			20		100			5					30	
		10 TERRAIN RUGGEDNESS		70	70										70	
		11 BASE & PRECIOUS METAL RESOURCE POT											10			
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL														
		13 GROUNDWATER FLUX								15						
		14 GROUNDWATER FLOW DIRECTION								10	10					
		15 THICKNESS OF UNSATURATED ZONE														
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES		5												
		17 SENSITIVE FAUNAL SPECIES		7												
		18 REVEGETATION POTENTIAL														
		19 KNOWN CULTURAL RESOURCES		5												
		20 POTENTIAL CULTURAL RESOURCES		15												
		21 AIR POLLUTION POTENTIAL														
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES														
		23 PRIVATE LAND USE														
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY									10			20		
		25 COMPRESSIVE STRENGTH (CONTAINMENT)														
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)									40					
		27 EXPANSION-CONTRACTION												40		
	GEOCHEMICAL	28 MINERAL STABILITY									10			40		
		29 STRATIGRAPHIC SETTING														
		30 HYDRAULIC RETARDATION														
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY								60	10					

LEVEL 1: 4.0 PROVIDE ACCEPTABLE ENVIRONMENTAL IMPACTS (5%)

			4.1 BIOTIC SYS. (22%)	4.2 ABIOTIC SYSTEMS (21%)			4.3 SOCIOECONOMIC IMPACTS (26%)			4.4 INSTITUTIONAL IMPACTS (21%)		4.5 CULT. RES. (10%)
			4.1.1 SENSITIVE SYS. (100%)	4.2.1 SURFACE GEOLOGY (32%)	4.2.2 WATER QUALITY (48%)	4.2.3 AIR QUALITY (20%)	4.3.1 LOCAL ECONOMIC (41%)	4.3.2 LIFE STYLES (42%)	4.3.3 LAND USE (17%)	4.4.1 STATE ISSUES (53%)	4.4.2 FEDERAL REGS. (47%)	4.5.1 ARCH. & HIST. SITES (100%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL										
		2 FAULT DENSITY										
		3 FAULT TREND										
		4 AGE OF FAULTING										
		5 NATURAL SEISMIC POTENTIAL										
		6 WEAPONS SEISMIC POTENTIAL										
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)										
		8 EROSION POTENTIAL										
		9 FLOOD POTENTIAL		30								
		10 TERRAIN RUGGEDNESS		70								
		11 BASE & PRECIOUS METAL RESOURCE POT										
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL			100							
		13 GROUNDWATER FLUX										
		14 GROUNDWATER FLOW DIRECTION										
		15 THICKNESS OF UNSATURATED ZONE										
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES	40									
		17 SENSITIVE FAUNAL SPECIES	50									
		18 REVEGETATION POTENTIAL	10									
		19 KNOWN CULTURAL RESOURCES										30
		20 POTENTIAL CULTURAL RESOURCES										70
		21 AIR POLLUTION POTENTIAL				100						
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES									100	
		23 PRIVATE LAND USE							100			
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY										
		25 COMPRESSIVE STRENGTH (CONTAINMENT)										
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)										
		27 EXPANSION-CONTRACTION										
	GEOCHEMICAL	28 MINERAL STABILITY										
		29 STRATIGRAPHIC SETTING										
		30 HYDRAULIC RETARDATION										
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY										

Weights for Analysis of:

DISRUPTIVE EVENT OBJECTIVES

Clear-Weights used in analysis

Shading-Weights set to 0 for analysis

Figure 28 shows resulting location ratings

OBJECTIVES (WEIGHTS IN PARENTHESES)

OVER-ALL GOAL			PROVIDE SAFE, EFFECTIVE & ENVIRONMENTALLY SOUND RADIOACTIVE WASTE DISPOSAL																																						
LEVEL 1			1.0 PROVIDE CONTAINMENT (31%)							2.0 PROVIDE ISOLATION (34%)									3.0 PROVIDE SAFE COST EFFECTIVE CONSTRUCTION & OPERATIONS (26%)														4.0 PROVIDE ACCEPTABLE ENVIRONMENTAL IMPACTS (9%)									
LEVEL 2			1.1 DISRUPTIVE PROCESSES (68%)		1.2 DISRUPTIVE EVENTS (32%)					2.1 RADIONUCLIDE MIGRATION (65%)				2.2 DISRUPTIVE EVENTS (35%)					3.1 SURFACE FACILITIES (27%)						3.2 SUBSURFACE FACILITIES (43%)						3.3 TRANSPORTATION SYSTEMS (30%)		4.1 BIOTIC SYS. (23%)	4.2 ABIOTIC SYSTEMS (21%)			4.3 SOCIOECONOMIC IMPACTS (20%)			4.4 INSTITUTIONAL IMPACTS (21%)		4.5 CULT. RES. (15%)
LEVEL 3			1.1.1 CHEMICAL (68%)	1.1.2 MECHANICAL (32%)	1.2.1 SEISMIC (37%)	1.2.2 EROSIONAL (14%)	1.2.3 VOLCANIC (21%)	1.2.4 HUMAN INTRUSION (23%)	1.2.5 MISCELLANEOUS (5%)	2.1.1 GROUNDWATER FLOW (34%)	2.1.2 NUCLIDE RETARD. (30%)	2.1.3 HOST ROCK THICK. (28%)	2.1.4 VOLATILE MIGRATION (8%)	2.2.1 TECTONIC (31%)	2.2.2 CLIMATIC (31%)	2.2.3 GEOMORPHIC (30%)	2.2.4 HUMAN INDUCED (5%)	2.2.5 MISC. & COMPLEXITY (3%)	3.1.1 SEISMICITY (21%)	3.1.2 MONITORING REQT'S (12%)	3.1.3 FOUNDATION COND (28%)	3.1.4 WIND LOADS (10%)	3.1.5 FLOODING (14%)	3.1.6 AVAIL. NAT. RES. (15%)	3.2.1 SEISMICITY (15%)	3.2.2 FLOODING (21%)	3.2.3 MINING COND. (27%)	3.2.4 HOST ROCK GEOM (15%)	3.2.5 HOST ROCK HOMOG. (12%)	3.2.6 WASTE PKG ACCEPT. (10%)	3.3.1 TERRAIN (71%)	3.3.2 EXISTING CORRIDOR (29%)	4.1.1 SENSITIVE SYS. (100%)	4.2.1 SURFACE GEOLOGY (32%)	4.2.2 WATER QUALITY (46%)	4.2.3 AIR QUALITY (22%)	4.3.1 LOCAL ECONOMIES (41%)	4.3.2 LIFE STYLES (42%)	4.3.3 LAND USE (17%)	4.4.1 STATE ISSUES (33%)	4.4.2 FEDERAL REGS. (67%)	4.5.1 ARCH. & HIST. SITES (100%)
ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)																																										
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL			5		100							40																											
		2 FAULT DENSITY	5							5			10					80							10	10	20		50													
		3 FAULT TREND			5									10																											
		4 AGE OF FAULTING			30									10																											
		5 NATURAL SEISMIC POTENTIAL			60									40					90						85																	
		6 WEAPONS SEISMIC POTENTIAL							100								10		10						5																	
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)																30										100	40													
		8 EROSION POTENTIAL				100										80					10																					
		9 FLOOD POTENTIAL														10					20		100			5					30			50								
		10 TERRAIN RUGGEDNESS														10		20		70	70										70			50								
		11 BASE & PRECIOUS METAL RESOURCE POT						60									40												10													
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL						50									45																		100							
		13 GROUNDWATER FLUX	5							10	10															10																
		14 GROUNDWATER FLOW DIRECTION								80																10	10															
		15 THICKNESS OF UNSATURATED ZONE								5					100																										
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES																		3												60									
		17 SENSITIVE FAUNAL SPECIES																		7												30									
		18 REVEGETATION POTENTIAL																														10									
		19 KNOWN CULTURAL RESOURCES																		5																					30
		20 POTENTIAL CULTURAL RESOURCES																		15																					70
		21 AIR POLLUTION POTENTIAL																																	100						
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES																																						100	
		23 PRIVATE LAND USE																																				100			
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY	20	30																							10			20												
		25 COMPRESSIVE STRENGTH (CONTAINMENT)		40								20																													
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)																									40															
		27 EXPANSION-CONTRACTION		20																										40												
	GEOCHEMICAL	28 MINERAL STABILITY	10	10							10		5														10			40												
		29 STRATIGRAPHIC SETTING									70	80	30																												
		30 HYDRAULIC RETARDATION								15	10		15																												
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	60							40			40														60	10														

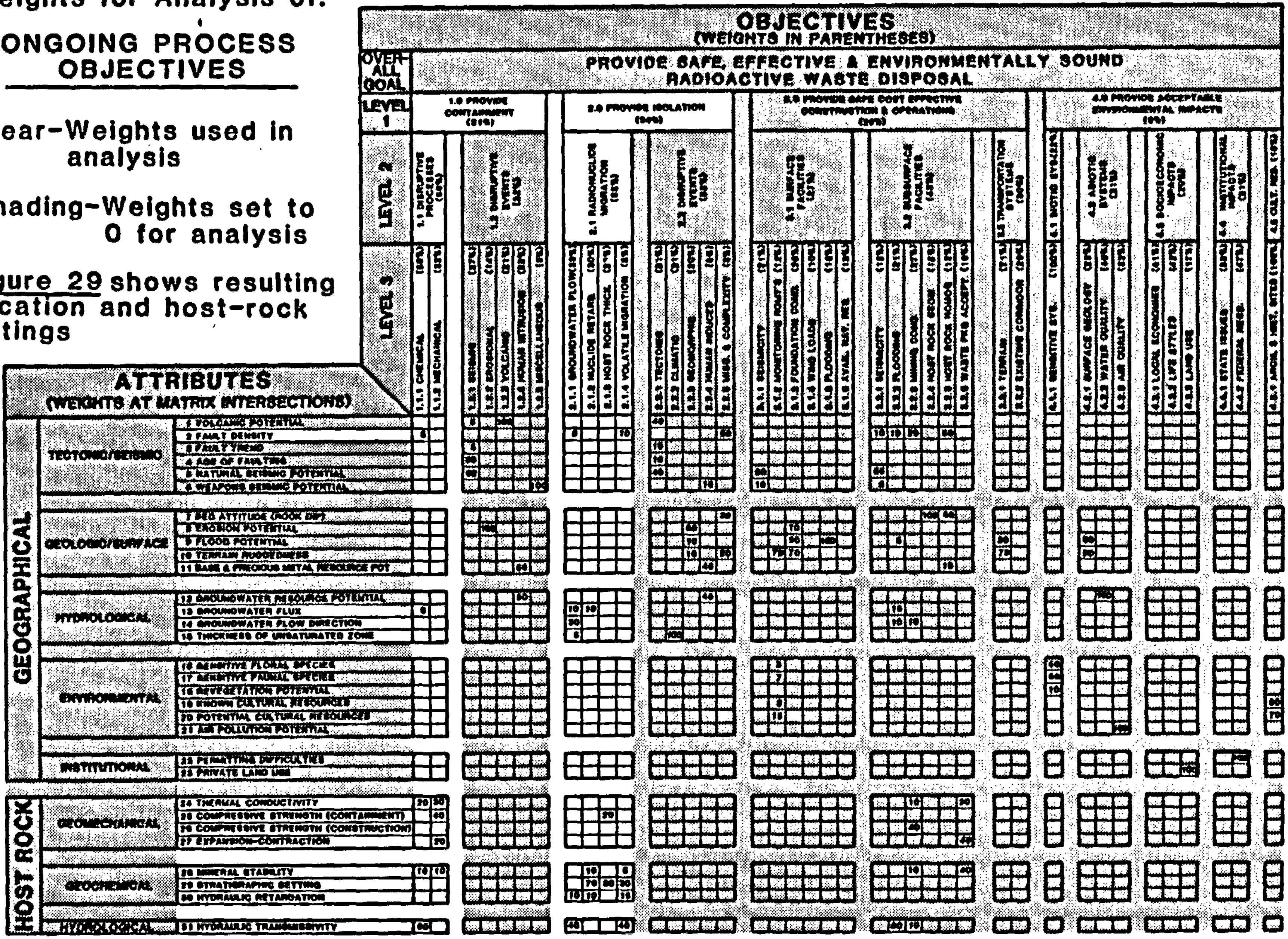
Weights for Analysis of:

ONGOING PROCESS OBJECTIVES

Clear–Weights used in analysis

Shading–Weights set to 0 for analysis

Figure 29 shows resulting location and host-rock ratings



OBJECTIVES
(WEIGHTS IN PARENTHESES)

OVER-ALL GOAL: PROVIDE SAFE, EFFECTIVE & ENVIRONMENTALLY SOUND RADIOACTIVE WASTE DISPOSAL

LEVEL 1: 1.0 PROVIDE CONTAINMENT; 2.0 PROVIDE ISOLATION; 3.0 PROVIDE SAFE COST EFFECTIVE CONSTRUCTION & OPERATIONS; 4.0 PROVIDE ACCEPTABLE ENVIRONMENTAL IMPACTS

LEVEL 2: 1.1 DISRUPTIVE PROCESSES; 1.2 DISRUPTIVE EVENTS; 2.1 RADIONUCLIDE MIGRATION; 2.2 DISRUPTIVE EVENTS; 3.1 SURFACE FACILITIES; 3.2 SUBSURFACE FACILITIES; 3.3 TRANSPORTATION SYSTEMS; 4.1 BIOTIC SYSTEMS; 4.2 ABIOTIC SYSTEMS; 4.3 SOCIOECONOMIC IMPACTS; 4.4 INSTITUTIONAL IMPACTS; 4.5 CULT. RES.

LEVEL 3: 1.1.1 CHEMICAL; 1.1.2 MECHANICAL; 1.2.1 SEISMIC; 1.2.2 EROSIONAL; 1.2.3 VOLCANIC; 1.2.4 HUMAN INTRUSION; 1.2.5 MISCELLANEOUS; 2.1.1 GROUNDWATER FLOW; 2.1.2 NUCLIDE RETARD.; 2.1.3 HOST ROCK THICK.; 2.1.4 VOLATILE MIGRATION; 2.2.1 TECTONIC; 2.2.2 CLIMATIC; 2.2.3 GEOMORPHIC; 2.2.4 HUMAN INDUCED; 2.2.5 MISS. & COMPLEXITY; 3.1.1 SEISMICITY; 3.1.2 MONITORING ROUTS; 3.1.3 FOUNDATION COND.; 3.1.4 WIND LOADS; 3.1.5 FLOODING; 3.1.6 AVAIL. NAT. RES.; 3.2.1 SEISMICITY; 3.2.2 FLOODING; 3.2.3 MINING COND.; 3.2.4 HOST ROCK GEOM.; 3.2.5 HOST ROCK HOMOG.; 3.2.6 WASTE PKG ACCEPT.; 3.3.1 TERRAIN; 3.3.2 EXISTING CORRIDOR; 4.1.1 SENSITIVE SYS.; 4.2.1 SURFACE GEOLOGY; 4.2.2 WATER QUALITY; 4.2.3 AIR QUALITY; 4.3.1 LOCAL ECONOMIES; 4.3.2 LIFE STYLES; 4.3.3 LAND USE; 4.4.1 STATE ISSUES; 4.4.2 FEDERAL REGS.; 4.5.1 ARCH. & HIST. SITES

ATTRIBUTES
(WEIGHTS AT MATRIX INTERSECTIONS)

GEOGRAPHICAL

TECTONIC/SEISMIC
1 VOLCANIC POTENTIAL
2 FAULT DENSITY
3 FAULT TREND
4 AGE OF FAULTING
5 NATURAL SEISMIC POTENTIAL
6 WEAPONS SEISMIC POTENTIAL

GEOLOGIC/SURFACE
7 BED ATTITUDE (ROCK DIP)
8 EROSION POTENTIAL
9 FLOOD POTENTIAL
10 TERRAIN RUGGEDNESS
11 BASE & PRECIOUS METAL RESOURCE POT

HYDROLOGICAL
12 GROUNDWATER RESOURCE POTENTIAL
13 GROUNDWATER FLUX
14 GROUNDWATER FLOW DIRECTION
15 THICKNESS OF UNSATURATED ZONE

ENVIRONMENTAL
16 SENSITIVE FLORAL SPECIES
17 SENSITIVE FAUNAL SPECIES
18 REVEGETATION POTENTIAL
19 KNOWN CULTURAL RESOURCES
20 POTENTIAL CULTURAL RESOURCES
21 AIR POLLUTION POTENTIAL

INSTITUTIONAL
22 PERMITTING DIFFICULTIES
23 PRIVATE LAND USE

HOST ROCK

GEOMECHANICAL
24 THERMAL CONDUCTIVITY
25 COMPRESSIVE STRENGTH (CONTAINMENT)
26 COMPRESSIVE STRENGTH (CONSTRUCTION)
27 EXPANSION–CONTRACTION

GEOCHEMICAL
28 MINERAL STABILITY
29 STRATIGRAPHIC SETTING
30 HYDRAULIC RETARDATION

HYDROLOGICAL
31 HYDRAULIC TRANSMISSIVITY

Weights for Analysis of:

CONST. & OPER. OBJECTIVES

Clear–Weights used in analysis

Shading–Weights set to 0 for analysis

Figure 30 shows resulting location and host-rock ratings

OBJECTIVES
(WEIGHTS IN PARENTHESES)

OVERALL GOAL: PROVIDE SAFE, EFFECTIVE & ENVIRONMENTALLY SOUND RADIOACTIVE WASTE DISPOSAL

LEVEL 1			1.0 PROVIDE CONTAINMENT (51%)						
LEVEL 2			1.1 DISRUPTIVE PROCESSES (63%)		1.2 DISRUPTIVE EVENTS (37%)				
LEVEL 3			1.1.1 CHEMICAL (68%)	1.1.2 MECHANICAL (32%)	1.2.1 SEISMIC (37%)	1.2.2 EROSIONAL (14%)	1.2.3 VOLCANIC (21%)	1.2.4 HUMAN INTRUSION (23%)	1.2.5 MISCELLANEOUS (5%)
ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)									
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL			5		100		
		2 FAULT DENSITY	5						
		3 FAULT TREND			5				
		4 AGE OF FAULTING			30				
		5 NATURAL SEISMIC POTENTIAL			60				
		6 WEAPONS SEISMIC POTENTIAL							100
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)							
		8 EROSION POTENTIAL				100			
		9 FLOOD POTENTIAL							
		10 TERRAIN RUGGEDNESS							
		11 BASE & PRECIOUS METAL RESOURCE POT						60	
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL						40	
		13 GROUNDWATER FLUX	5						
		14 GROUNDWATER FLOW DIRECTION							
		15 THICKNESS OF UNSATURATED ZONE							
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES							
		17 SENSITIVE FAUNAL SPECIES							
		18 REVEGETATION POTENTIAL							
		19 KNOWN CULTURAL RESOURCES							
		20 POTENTIAL CULTURAL RESOURCES							
		21 AIR POLLUTION POTENTIAL							
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES							
		23 PRIVATE LAND USE							
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY	20	30					
		25 COMPRESSIVE STRENGTH (CONTAINMENT)		40					
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)							
		27 EXPANSION-CONTRACTION		20					
	GEOCHEMICAL	28 MINERAL STABILITY	10	10					
		29 STRATIGRAPHIC SETTING							
		30 HYDRAULIC RETARDATION							
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	60						

LEVEL 1			2.0 PROVIDE ISOLATION (24%)								
LEVEL 2			2.1 RADIONUCLIDE MIGRATION (65%)				2.2 DISRUPTIVE EVENTS (35%)				
LEVEL 3			2.1.1 GROUNDWATER FLOWTIME (39%)	2.1.2 NUCLIDE RETARD. (30%)	2.1.3 HOST ROCK THICK. (22%)	2.1.4 VOLATILE MIGRATION (9%)	2.2.1 TECTONIC (31%)	2.2.2 CLIMATIC (21%)	2.2.3 GEOMORPHIC (30%)	2.2.4 HUMAN INDUCED (8%)	2.2.5 MISC. & COMPLEXITY (5%)
ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)											
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL					40				
		2 FAULT DENSITY	5			10					50
		3 FAULT TREND					10				
		4 AGE OF FAULTING					10				
		5 NATURAL SEISMIC POTENTIAL					40				
		6 WEAPONS SEISMIC POTENTIAL								10	
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)									30
		8 EROSION POTENTIAL							80		
		9 FLOOD POTENTIAL							10		
		10 TERRAIN RUGGEDNESS							10		20
		11 BASE & PRECIOUS METAL RESOURCE POT								45	
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL								45	
		13 GROUNDWATER FLUX	10	10							
		14 GROUNDWATER FLOW DIRECTION	80								
		15 THICKNESS OF UNSATURATED ZONE	5					100			
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES									
		17 SENSITIVE FAUNAL SPECIES									
		18 REVEGETATION POTENTIAL									
		19 KNOWN CULTURAL RESOURCES									
		20 POTENTIAL CULTURAL RESOURCES									
		21 AIR POLLUTION POTENTIAL									
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES									
		23 PRIVATE LAND USE									
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY									
		25 COMPRESSIVE STRENGTH (CONTAINMENT)			20						
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)									
		27 EXPANSION-CONTRACTION									
	GEOCHEMICAL	28 MINERAL STABILITY		10		5					
		29 STRATIGRAPHIC SETTING		70	80	30					
		30 HYDRAULIC RETARDATION	10	10		10					
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	40			40					

LEVEL 1			3.0 PROVIDE SAFE COST EFFECTIVE CONSTRUCTION & OPERATIONS (20%)													
LEVEL 2			3.1 SURFACE FACILITIES (27%)						3.2 SUBSURFACE FACILITIES (43%)						3.3 TRANSPORTATION SYSTEMS (30%)	
LEVEL 3			3.1.1 SEISMICITY (21%)	3.1.2 MONITORING RQMT'S (12%)	3.1.3 FOUNDATION COND (28%)	3.1.4 WIND LOADS (10%)	3.1.5 FLOODING (18%)	3.1.6 AVAIL. NAT RES. (11%)	3.2.1 SEISMICITY (16%)	3.2.2 FLOODING (19%)	3.2.3 MINING COND (27%)	3.2.4 HOST ROCK GEOM (16%)	3.2.5 HOST ROCK HOMOG (12%)	3.2.6 WASTE PKG ACCEPT. (10%)	3.3.1 TERRAIN (71%)	3.3.2 EXISTING CORRIDOR (29%)
ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)																
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL														
		2 FAULT DENSITY							10	10	30		50			
		3 FAULT TREND														
		4 AGE OF FAULTING														
		5 NATURAL SEISMIC POTENTIAL	90						85							
		6 WEAPONS SEISMIC POTENTIAL	10						5							
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)										100	40			
		8 EROSION POTENTIAL			10											
		9 FLOOD POTENTIAL			20		100			5					30	
		10 TERRAIN RUGGEDNESS		70	70										70	
		11 BASE & PRECIOUS METAL RESOURCE POT											10			
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL														
		13 GROUNDWATER FLUX								15						
		14 GROUNDWATER FLOW DIRECTION								10	10					
		15 THICKNESS OF UNSATURATED ZONE														
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES		3												
		17 SENSITIVE FAUNAL SPECIES		7												
		18 REVEGETATION POTENTIAL														
		19 KNOWN CULTURAL RESOURCES		5												
		20 POTENTIAL CULTURAL RESOURCES		15												
		21 AIR POLLUTION POTENTIAL														
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES														
		23 PRIVATE LAND USE														
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY									10			20		
		25 COMPRESSIVE STRENGTH (CONTAINMENT)														
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)									60					
		27 EXPANSION-CONTRACTION												40		
	GEOCHEMICAL	28 MINERAL STABILITY									10			40		
		29 STRATIGRAPHIC SETTING														
		30 HYDRAULIC RETARDATION														
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY								60	10					

LEVEL 1			4.0 PROVIDE ACCEPTABLE ENVIRONMENTAL IMPACTS (5%)										
LEVEL 2			4.1 BIOTIC SYS (22%)	4.2 ABIOTIC SYSTEMS (21%)			4.3 SOCIOECONOMIC IMPACTS (20%)			4.4 INSTITUTIONAL IMPACTS (21%)		4.5 CULT. RES (15%)
LEVEL 3			4.1.1 SENSITIVE SYS. (100%)	4.2.1 SURFACE GEOLOGY (22%)	4.2.2 WATER QUALITY (45%)	4.2.3 AIR QUALITY (33%)	4.3.1 LOCAL ECONOMIES (41%)	4.3.2 LIFE STYLES (42%)	4.3.3 LAND USE (17%)	4.4.1 STATE ISSUES (53%)	4.4.2 FEDERAL RESP. (47%)	4.5.1 ARCH. & HIST. SITES (100%)
ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)												
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL										
		2 FAULT DENSITY										
		3 FAULT TREND										
		4 AGE OF FAULTING										
		5 NATURAL SEISMIC POTENTIAL										
		6 WEAPONS SEISMIC POTENTIAL										
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)										
		8 EROSION POTENTIAL										
		9 FLOOD POTENTIAL		50								
		10 TERRAIN RUGGEDNESS		50								
		11 BASE & PRECIOUS METAL RESOURCE POT										
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL			100							
		13 GROUNDWATER FLUX										
		14 GROUNDWATER FLOW DIRECTION										
		15 THICKNESS OF UNSATURATED ZONE										
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES	40									
		17 SENSITIVE FAUNAL SPECIES	50									
		18 REVEGETATION POTENTIAL	10									
		19 KNOWN CULTURAL RESOURCES										30
		20 POTENTIAL CULTURAL RESOURCES										70
		21 AIR POLLUTION POTENTIAL				100						
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES									100	
		23 PRIVATE LAND USE							100			
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY										
		25 COMPRESSIVE STRENGTH (CONTAINMENT)										
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)										
		27 EXPANSION-CONTRACTION										
	GEOCHEMICAL	28 MINERAL STABILITY										
		29 STRATIGRAPHIC SETTING										
		30 HYDRAULIC RETARDATION										
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY										

Weights for Analysis of:

SURFACE FAC. OBJECTIVES

Clear-Weights used in analysis

Shading-Weights set to 0 for analysis

Figure 31 shows resulting location ratings

OBJECTIVES
(WEIGHTS IN PARENTHESES)

OVERALL GOAL: PROVIDE SAFE, EFFECTIVE & ENVIRONMENTALLY SOUND RADIOACTIVE WASTE DISPOSAL

ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)

			LEVEL 1: 1.0 PROVIDE CONTAINMENT (31%)						
		LEVEL 2	1.1 DISRUPTIVE PROCESSES (45%)		1.2 DISRUPTIVE EVENTS (55%)				
		LEVEL 3	1.1.1 CHEMICAL (50%)	1.1.2 MECHANICAL (50%)	1.2.1 SEISMIC (37%)	1.2.2 EROSIONAL (14%)	1.2.3 VOLCANIC (21%)	1.2.4 HUMAN INTRUSION (27%)	1.2.5 MISCELLANEOUS (1%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL			5		100		
		2 FAULT DENSITY	5						
		3 FAULT TREND			5				
		4 AGE OF FAULTING			30				
		5 NATURAL SEISMIC POTENTIAL			60				
		6 WEAPONS SEISMIC POTENTIAL							100
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)							
		8 EROSION POTENTIAL				100			
		9 FLOOD POTENTIAL							
		10 TERRAIN RUGGEDNESS							
		11 BASE & PRECIOUS METAL RESOURCE POT						50	
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL						50	
		13 GROUNDWATER FLUX	5						
		14 GROUNDWATER FLOW DIRECTION							
		15 THICKNESS OF UNSATURATED ZONE							
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES							
		17 SENSITIVE FAUNAL SPECIES							
		18 REVEGETATION POTENTIAL							
		19 KNOWN CULTURAL RESOURCES							
		20 POTENTIAL CULTURAL RESOURCES							
		21 AIR POLLUTION POTENTIAL							
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES							
		23 PRIVATE LAND USE							
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY	30	30					
		25 COMPRESSIVE STRENGTH (CONTAINMENT)		40					
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)							
		27 EXPANSION-CONTRACTION		20					
	GEOCHEMICAL	28 MINERAL STABILITY	10	10					
		29 STRATIGRAPHIC SETTING							
		30 HYDRAULIC RETARDATION							
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	50						

			LEVEL 1: 2.0 PROVIDE ISOLATION (24%)								
		LEVEL 2	2.1 RADIONUCLIDE MIGRATION (67%)				2.2 DISRUPTIVE EVENTS (33%)				
		LEVEL 3	2.1.1 GROUNDWATER FLOWS (35%)	2.1.2 NUCLIDE RETARD. (30%)	2.1.3 HOST ROCK THICK. (25%)	2.1.4 VOLATILE MIGRATION (10%)	2.2.1 TECTONIC (31%)	2.2.2 CLIMATIC (21%)	2.2.3 GEOMORPHIC (20%)	2.2.4 HUMAN INDUCED (5%)	2.2.5 MISC. & COMPLEXITY (23%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL					40				
		2 FAULT DENSITY	5			10					30
		3 FAULT TREND					10				
		4 AGE OF FAULTING					10				
		5 NATURAL SEISMIC POTENTIAL					40				
		6 WEAPONS SEISMIC POTENTIAL								10	
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)									50
		8 EROSION POTENTIAL							80		
		9 FLOOD POTENTIAL							10		
		10 TERRAIN RUGGEDNESS							10		20
		11 BASE & PRECIOUS METAL RESOURCE POT								40	
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL								40	
		13 GROUNDWATER FLUX	10	10							
		14 GROUNDWATER FLOW DIRECTION	30								
		15 THICKNESS OF UNSATURATED ZONE	5					100			
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES									
		17 SENSITIVE FAUNAL SPECIES									
		18 REVEGETATION POTENTIAL									
		19 KNOWN CULTURAL RESOURCES									
		20 POTENTIAL CULTURAL RESOURCES									
		21 AIR POLLUTION POTENTIAL									
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES									
		23 PRIVATE LAND USE									
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY									
		25 COMPRESSIVE STRENGTH (CONTAINMENT)			20						
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)									
		27 EXPANSION-CONTRACTION									
	GEOCHEMICAL	28 MINERAL STABILITY		10		5					
		29 STRATIGRAPHIC SETTING		70	80	30					
		30 HYDRAULIC RETARDATION	10	10		15					
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	45			40					

			LEVEL 1: 3.0 PROVIDE SAFE COST EFFECTIVE CONSTRUCTION & OPERATIONS (39%)													
		LEVEL 2	3.1 SURFACE FACILITIES (37%)						3.2 SUBSURFACE FACILITIES (43%)						3.3 TRANSPORTATION SYSTEMS (20%)	
		LEVEL 3	3.1.1 SEISMICITY (21%)	3.1.2 MONITORING RQMT'S (12%)	3.1.3 FOUNDATION COND. (26%)	3.1.4 WIND LOADS (10%)	3.1.5 FLOODING (18%)	3.1.6 AVAIL. NAT. RES. (13%)	3.2.1 SEISMICITY (12%)	3.2.2 FLOODING (8%)	3.2.3 MINING COND. (37%)	3.2.4 HOST ROCK GEOM (18%)	3.2.5 HOST ROCK HOMOG (12%)	3.2.6 WASTE PKG ACCEPT. (10%)	3.3.1 TERRAIN (71%)	3.3.2 EXISTING CORRIDOR (29%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL														
		2 FAULT DENSITY							10	10	20		50			
		3 FAULT TREND														
		4 AGE OF FAULTING														
		5 NATURAL SEISMIC POTENTIAL	90						85							
		6 WEAPONS SEISMIC POTENTIAL	10						5							
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)										100	40			
		8 EROSION POTENTIAL			10											
		9 FLOOD POTENTIAL			20		100			5					30	
		10 TERRAIN RUGGEDNESS		70	70										70	
		11 BASE & PRECIOUS METAL RESOURCE POT											10			
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL														
		13 GROUNDWATER FLUX								15						
		14 GROUNDWATER FLOW DIRECTION								10	10					
		15 THICKNESS OF UNSATURATED ZONE														
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES		3												
		17 SENSITIVE FAUNAL SPECIES		7												
		18 REVEGETATION POTENTIAL														
		19 KNOWN CULTURAL RESOURCES		5												
		20 POTENTIAL CULTURAL RESOURCES		10												
		21 AIR POLLUTION POTENTIAL														
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES														
		23 PRIVATE LAND USE														
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY									15			10		
		25 COMPRESSIVE STRENGTH (CONTAINMENT)														
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)									40					
		27 EXPANSION-CONTRACTION												40		
	GEOCHEMICAL	28 MINERAL STABILITY									10			50		
		29 STRATIGRAPHIC SETTING														
		30 HYDRAULIC RETARDATION														
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY								60	10					

			LEVEL 1: 4.0 PROVIDE ACCEPTABLE ENVIRONMENTAL IMPACTS (6%)									
		LEVEL 2	4.1 BIOTIC SYS (22%)	4.2 ABIOTIC SYSTEMS (21%)			4.3 SOCIOECONOMIC IMPACTS (20%)			4.4 INSTITUTIONAL IMPACTS (21%)		4.5 CULT. RES (16%)
		LEVEL 3	4.1.1 SENSITIVE SYS. (100%)	4.2.1 SURFACE GEOLOGY (22%)	4.2.2 WATER QUALITY (46%)	4.2.3 AIR QUALITY (32%)	4.3.1 LOCAL ECONOMIES (41%)	4.3.2 LIFE STYLES (42%)	4.3.3 LAND USE (17%)	4.4.1 STATE ISSUES (53%)	4.4.2 FEDERAL REGS. (47%)	4.5.1 ARCH. & HIST. SITES (100%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL										
		2 FAULT DENSITY										
		3 FAULT TREND										
		4 AGE OF FAULTING										
		5 NATURAL SEISMIC POTENTIAL										
		6 WEAPONS SEISMIC POTENTIAL										
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)										
		8 EROSION POTENTIAL										
		9 FLOOD POTENTIAL		60								
		10 TERRAIN RUGGEDNESS		40								
		11 BASE & PRECIOUS METAL RESOURCE POT										
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL			100							
		13 GROUNDWATER FLUX										
		14 GROUNDWATER FLOW DIRECTION										
		15 THICKNESS OF UNSATURATED ZONE										
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES	40									
		17 SENSITIVE FAUNAL SPECIES	50									
		18 REVEGETATION POTENTIAL	10									
		19 KNOWN CULTURAL RESOURCES										30
		20 POTENTIAL CULTURAL RESOURCES										70
		21 AIR POLLUTION POTENTIAL				100						
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES									100	
		23 PRIVATE LAND USE							100			
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY										
		25 COMPRESSIVE STRENGTH (CONTAINMENT)										
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)										
		27 EXPANSION-CONTRACTION										
	GEOCHEMICAL	28 MINERAL STABILITY										
		29 STRATIGRAPHIC SETTING										
		30 HYDRAULIC RETARDATION										
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY										

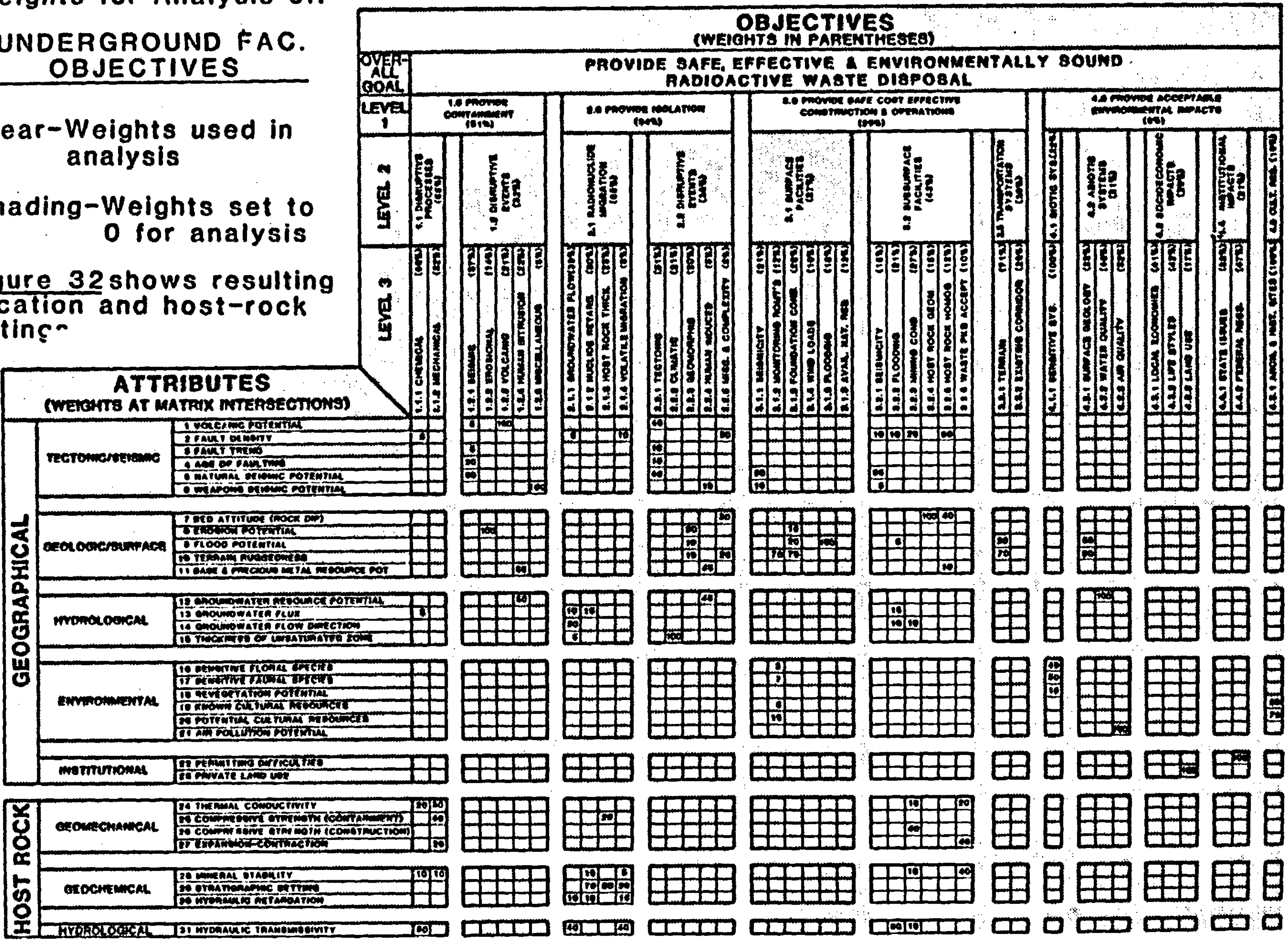
Weights for Analysis of:

UNDERGROUND FAC. OBJECTIVES

Clear–Weights used in analysis

Shading–Weights set to 0 for analysis

Figure 32 shows resulting location and host-rock rating~



OBJECTIVES
(WEIGHTS IN PARENTHESES)

OVER-ALL GOAL: PROVIDE SAFE, EFFECTIVE & ENVIRONMENTALLY SOUND RADIOACTIVE WASTE DISPOSAL

LEVEL 1 / LEVEL 2 / LEVEL 3

1.0 PROVIDE CONTAINMENT (51%)
- 1.1 DISRUPTIVE PROCESSES ([illegible])
  - 1.1.1 CHEMICAL ([illegible])
  - 1.1.2 MECHANICAL ([illegible])
- 1.2 DISRUPTIVE EVENTS ([illegible])
  - 1.2.1 SEISMIC ([illegible])
  - 1.2.2 EROSIONAL ([illegible])
  - 1.2.3 VOLCANIC ([illegible])
  - 1.2.4 HUMAN INTRUSION ([illegible])
  - 1.2.5 MISCELLANEOUS ([illegible])

2.0 PROVIDE ISOLATION ([illegible])
- 2.1 RADIONUCLIDE MIGRATION ([illegible])
  - 2.1.1 GROUNDWATER FLOW ([illegible])
  - 2.1.2 NUCLIDE RETARD. ([illegible])
  - 2.1.3 HOST ROCK THICK. ([illegible])
  - 2.1.4 VOLATILE MIGRATION ([illegible])
- 2.2 DISRUPTIVE EVENTS ([illegible])
  - 2.2.1 TECTONIC ([illegible])
  - 2.2.2 CLIMATIC ([illegible])
  - 2.2.3 GEOMORPHIC ([illegible])
  - 2.2.4 HUMAN INDUCED ([illegible])
  - 2.2.5 UNCE. & COMPLEXITY ([illegible])

3.0 PROVIDE SAFE COST EFFECTIVE CONSTRUCTION & OPERATIONS ([illegible])
- 3.1 SURFACE FACILITIES ([illegible])
  - 3.1.1 SEISMICITY ([illegible])
  - 3.1.2 MONITORING ROUTE'S ([illegible])
  - 3.1.3 FOUNDATION COND. ([illegible])
  - 3.1.4 WIND LOADS ([illegible])
  - 3.1.5 FLOODING ([illegible])
  - 3.1.6 AVAIL. NAT. RES. ([illegible])
- 3.2 SUBSURFACE FACILITIES ([illegible])
  - 3.2.1 SEISMICITY ([illegible])
  - 3.2.2 FLOODING ([illegible])
  - 3.2.3 MINING COND ([illegible])
  - 3.2.4 HOST ROCK GEOM ([illegible])
  - 3.2.5 HOST ROCK HOMOG ([illegible])
  - 3.2.6 WASTE PKG ACCEPT ([illegible])
- 3.3 TRANSPORTATION SYSTEMS ([illegible])
  - 3.3.1 TERRAIN ([illegible])
  - 3.3.2 EXISTING CORRIDOR ([illegible])

4.0 PROVIDE ACCEPTABLE ENVIRONMENTAL IMPACTS ([illegible])
- 4.1 BIOTIC SYS. ([illegible])
  - 4.1.1 SENSITIVE SYS. ([illegible])
- 4.2 ABIOTIC SYSTEMS ([illegible])
  - 4.2.1 SURFACE GEOLOGY ([illegible])
  - 4.2.2 WATER QUALITY ([illegible])
  - 4.2.3 AIR QUALITY ([illegible])
- 4.3 SOCIOECONOMIC IMPACTS ([illegible])
  - 4.3.1 LOCAL ECONOMICS ([illegible])
  - 4.3.2 LIFE STYLES ([illegible])
  - 4.3.3 LAND USE ([illegible])
- 4.4 INSTITUTIONAL IMPACTS ([illegible])
  - 4.4.1 STATE ISSUES ([illegible])
  - 4.4.2 FEDERAL REGS. ([illegible])
- 4.5 CULT. RES. ([illegible])
  - 4.5.1 ARCH. & HIST. SITES ([illegible])

ATTRIBUTES
(WEIGHTS AT MATRIX INTERSECTIONS)

GEOGRAPHICAL
- TECTONIC/SEISMIC
  - 1 VOLCANIC POTENTIAL
  - 2 FAULT DENSITY
  - 3 FAULT TREND
  - 4 AGE OF FAULTING
  - 5 NATURAL SEISMIC POTENTIAL
  - 6 WEAPONS SEISMIC POTENTIAL
- GEOLOGIC/SURFACE
  - 7 BED ATTITUDE (ROCK DIP)
  - 8 EROSION POTENTIAL
  - 9 FLOOD POTENTIAL
  - 10 TERRAIN RUGGEDNESS
  - 11 BASE & PRECIOUS METAL RESOURCE POT
- HYDROLOGICAL
  - 12 GROUNDWATER RESOURCE POTENTIAL
  - 13 GROUNDWATER FLUX
  - 14 GROUNDWATER FLOW DIRECTION
  - 15 THICKNESS OF UNSATURATED ZONE
- ENVIRONMENTAL
  - 16 SENSITIVE FLORAL SPECIES
  - 17 SENSITIVE FAUNAL SPECIES
  - 18 REVEGETATION POTENTIAL
  - 19 KNOWN CULTURAL RESOURCES
  - 20 POTENTIAL CULTURAL RESOURCES
  - 21 AIR POLLUTION POTENTIAL
- INSTITUTIONAL
  - 22 PERMITTING DIFFICULTIES
  - 23 PRIVATE LAND USE

HOST ROCK
- GEOMECHANICAL
  - 24 THERMAL CONDUCTIVITY
  - 25 COMPRESSIVE STRENGTH (CONTAINMENT)
  - 26 COMPRESSIVE STRENGTH (CONSTRUCTION)
  - 27 EXPANSION-CONTRACTION
- GEOCHEMICAL
  - 28 MINERAL STABILITY
  - 29 STRATIGRAPHIC SETTING
  - 30 HYDRAULIC RETARDATION
- HYDROLOGICAL
  - 31 HYDRAULIC TRANSMISSIVITY

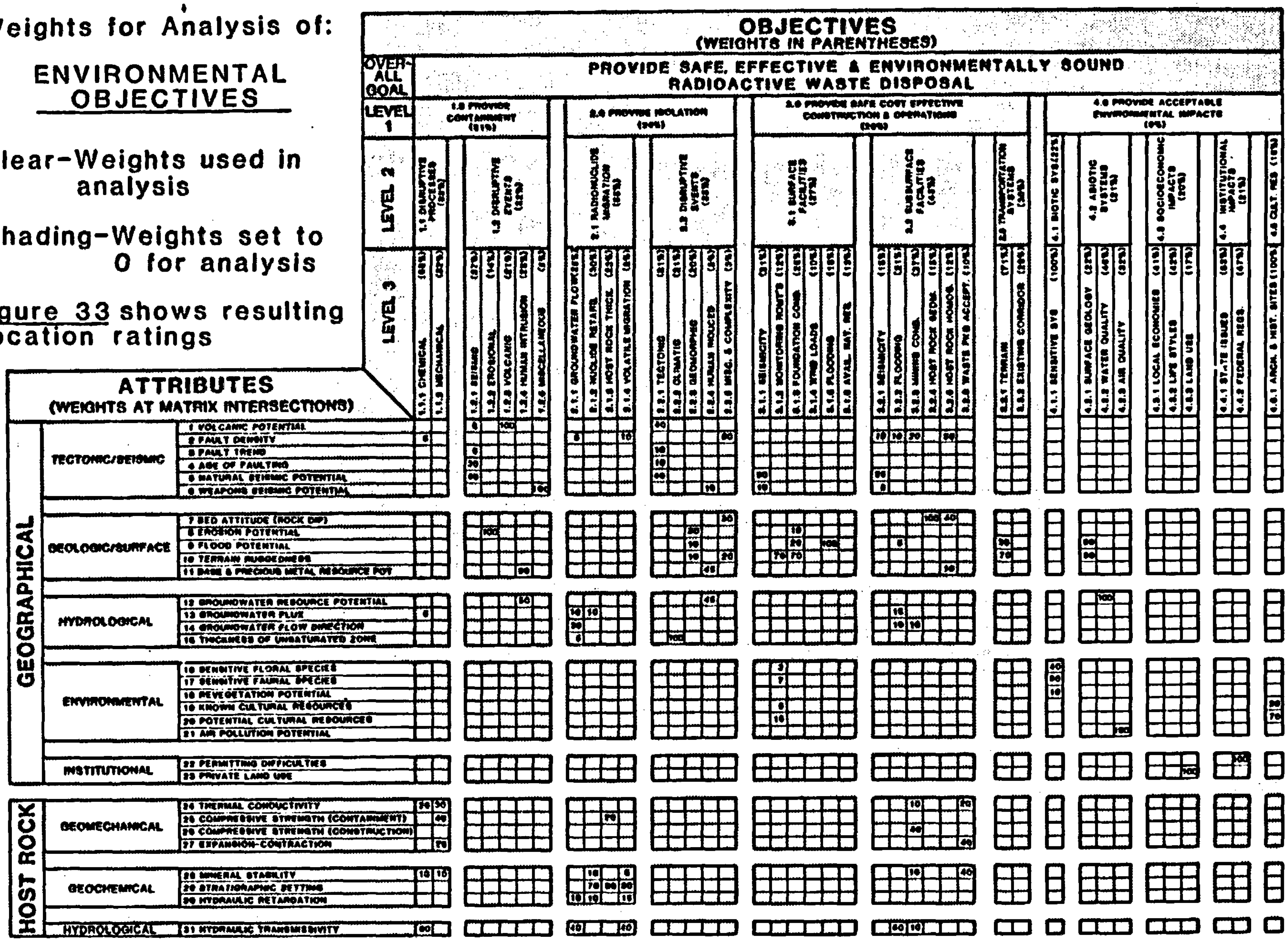
Weights for Analysis of:

ENVIRONMENTAL OBJECTIVES

Clear-Weights used in analysis

Shading-Weights set to 0 for analysis

Figure 33 shows resulting location ratings



Weights for Analysis of:

ENVIRONMENTAL ATTRIBUTES

Clear-Weights used in analysis

Shading-Weights set to 0 for analysis

Figure 34 shows resulting location ratings

OBJECTIVES (WEIGHTS IN PARENTHESES)

OVERALL GOAL: PROVIDE SAFE, EFFECTIVE & ENVIRONMENTALLY SOUND RADIOACTIVE WASTE DISPOSAL

ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)

	LEVEL 1	1.0 PROVIDE CONTAINMENT (31%)						
	LEVEL 2	1.1 DISRUPTIVE PROCESSES ([illegible])		1.2 DISRUPTIVE EVENTS ([illegible])				
	LEVEL 3	1.1.1 CHEMICAL (50%)	1.1.2 MECHANICAL (50%)	1.2.1 SEISMIC (37%)	1.2.2 EROSIONAL (14%)	1.2.3 VOLCANIC (31%)	1.2.4 HUMAN INTRUSION (12%)	1.2.5 MISCELLANEOUS (6%)
GEOGRAPHICAL – TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL			5		100		
	2 FAULT DENSITY	5						
	3 FAULT TREND			5				
	4 AGE OF FAULTING			30				
	5 NATURAL SEISMIC POTENTIAL			60				
	6 WEAPONS SEISMIC POTENTIAL							100
GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)							
	8 EROSION POTENTIAL				100			
	9 FLOOD POTENTIAL							
	10 TERRAIN RUGGEDNESS							
	11 BASE & PRECIOUS METAL RESOURCE POT						50	
HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL						50	
	13 GROUNDWATER FLUX	5						
	14 GROUNDWATER FLOW DIRECTION							
	15 THICKNESS OF UNSATURATED ZONE							
ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES							
	17 SENSITIVE FAUNAL SPECIES							
	18 REVEGETATION POTENTIAL							
	19 KNOWN CULTURAL RESOURCES							
	20 POTENTIAL CULTURAL RESOURCES							
	21 AIR POLLUTION POTENTIAL							
INSTITUTIONAL	22 PERMITTING DIFFICULTIES							
	23 PRIVATE LAND USE							
HOST ROCK – GEOMECHANICAL	24 THERMAL CONDUCTIVITY	20	30					
	25 COMPRESSIVE STRENGTH (CONTAINMENT)		40					
	26 COMPRESSIVE STRENGTH (CONSTRUCTION)							
	27 EXPANSION-CONTRACTION		20					
GEOCHEMICAL	28 MINERAL STABILITY	10	10					
	29 STRATIGRAPHIC SETTING							
	30 HYDRAULIC RETARDATION							
HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	60						

	LEVEL 1	2.0 PROVIDE ISOLATION (40%)								
	LEVEL 2	2.1 RADIONUCLIDE MIGRATION (65%)				2.2 DISRUPTIVE EVENTS (35%)				
	LEVEL 3	2.1.1 GROUNDWATER FLOW (35%)	2.1.2 NUCLIDE RETARD. (30%)	2.1.3 HOST ROCK THICK. (27%)	2.1.4 VOLATILE MIGRATION (8%)	2.2.1 TECTONIC (31%)	2.2.2 CLIMATIC (31%)	2.2.3 GEOMORPHIC (20%)	2.2.4 HUMAN INDUCED (8%)	2.2.5 MISC. & COMPLEXITY (10%)
GEOGRAPHICAL – TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL					40				
	2 FAULT DENSITY	5			10					50
	3 FAULT TREND					10				
	4 AGE OF FAULTING					10				
	5 NATURAL SEISMIC POTENTIAL					40				
	6 WEAPONS SEISMIC POTENTIAL								10	
GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)									30
	8 EROSION POTENTIAL							80		
	9 FLOOD POTENTIAL							10		
	10 TERRAIN RUGGEDNESS							10		20
	11 BASE & PRECIOUS METAL RESOURCE POT								50	
HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL								40	
	13 GROUNDWATER FLUX	15	10							
	14 GROUNDWATER FLOW DIRECTION	25								
	15 THICKNESS OF UNSATURATED ZONE	5					100			
ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES									
	17 SENSITIVE FAUNAL SPECIES									
	18 REVEGETATION POTENTIAL									
	19 KNOWN CULTURAL RESOURCES									
	20 POTENTIAL CULTURAL RESOURCES									
	21 AIR POLLUTION POTENTIAL									
INSTITUTIONAL	22 PERMITTING DIFFICULTIES									
	23 PRIVATE LAND USE									
HOST ROCK – GEOMECHANICAL	24 THERMAL CONDUCTIVITY									
	25 COMPRESSIVE STRENGTH (CONTAINMENT)			20						
	26 COMPRESSIVE STRENGTH (CONSTRUCTION)									
	27 EXPANSION-CONTRACTION									
GEOCHEMICAL	28 MINERAL STABILITY		10		5					
	29 STRATIGRAPHIC SETTING		70	80	30					
	30 HYDRAULIC RETARDATION	10	10		15					
HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	40			40					

	LEVEL 1	3.0 PROVIDE SAFE COST EFFECTIVE CONSTRUCTION & OPERATIONS (20%)													
	LEVEL 2	3.1 SURFACE FACILITIES (37%)						3.2 SUBSURFACE FACILITIES (43%)						3.3 TRANSPORTATION SYSTEMS (20%)	
	LEVEL 3	3.1.1 SEISMICITY (31%)	3.1.2 MONITORING ROUT'S (12%)	3.1.3 FOUNDATION COND. (26%)	3.1.4 WIND LOADS (10%)	3.1.5 FLOODING (10%)	3.1.6 AVAIL. NAT. RES. (11%)	3.2.1 SEISMICITY (15%)	3.2.2 FLOODING (21%)	3.2.3 MINING COND. (27%)	3.2.4 HOST ROCK GEOM. (15%)	3.2.5 HOST ROCK HOMOG. (12%)	3.2.6 WASTE PKG ACCEPT. (10%)	3.3.1 TERRAIN (71%)	3.3.2 EXISTING CORRIDOR (29%)
GEOGRAPHICAL – TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL														
	2 FAULT DENSITY							10	10	20		50			
	3 FAULT TREND														
	4 AGE OF FAULTING														
	5 NATURAL SEISMIC POTENTIAL	90						85							
	6 WEAPONS SEISMIC POTENTIAL	10						5							
GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)										100	40			
	8 EROSION POTENTIAL			10											
	9 FLOOD POTENTIAL			20		100			5					30	
	10 TERRAIN RUGGEDNESS		70	70										70	
	11 BASE & PRECIOUS METAL RESOURCE POT											10			
HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL														
	13 GROUNDWATER FLUX								15						
	14 GROUNDWATER FLOW DIRECTION								70	10					
	15 THICKNESS OF UNSATURATED ZONE														
ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES		3												
	17 SENSITIVE FAUNAL SPECIES		7												
	18 REVEGETATION POTENTIAL														
	19 KNOWN CULTURAL RESOURCES		5												
	20 POTENTIAL CULTURAL RESOURCES		10												
	21 AIR POLLUTION POTENTIAL														
INSTITUTIONAL	22 PERMITTING DIFFICULTIES														
	23 PRIVATE LAND USE														
HOST ROCK – GEOMECHANICAL	24 THERMAL CONDUCTIVITY									10			20		
	25 COMPRESSIVE STRENGTH (CONTAINMENT)														
	26 COMPRESSIVE STRENGTH (CONSTRUCTION)									40					
	27 EXPANSION-CONTRACTION												60		
GEOCHEMICAL	28 MINERAL STABILITY									10			40		
	29 STRATIGRAPHIC SETTING														
	30 HYDRAULIC RETARDATION														
HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY								50	10					

	LEVEL 1	4.0 PROVIDE ACCEPTABLE ENVIRONMENTAL IMPACTS (9%)									
	LEVEL 2	4.1 BIOTIC SYS. (22%)	4.2 ABIOTIC SYSTEMS (21%)			4.3 SOCIOECONOMIC IMPACTS (20%)			4.4 INSTITUTIONAL IMPACTS (21%)		4.5 CULT. RES. (16%)
	LEVEL 3	4.1.1 SENSITIVE SYS. (100%)	4.2.1 SURFACE GEOLOGY (22%)	4.2.2 WATER QUALITY (46%)	4.2.3 AIR QUALITY (32%)	4.3.1 LOCAL ECONOMIES (41%)	4.3.2 LIFE STYLES (42%)	4.3.3 LAND USE (17%)	4.4.1 STATE ISSUES (53%)	4.4.2 FEDERAL REGS. (47%)	4.5.1 ARCH. & HIST. SITES (100%)
GEOGRAPHICAL – TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL										
	2 FAULT DENSITY										
	3 FAULT TREND										
	4 AGE OF FAULTING										
	5 NATURAL SEISMIC POTENTIAL										
	6 WEAPONS SEISMIC POTENTIAL										
GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)										
	8 EROSION POTENTIAL										
	9 FLOOD POTENTIAL		40								
	10 TERRAIN RUGGEDNESS		60								
	11 BASE & PRECIOUS METAL RESOURCE POT										
HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL			100							
	13 GROUNDWATER FLUX										
	14 GROUNDWATER FLOW DIRECTION										
	15 THICKNESS OF UNSATURATED ZONE										
ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES	40									
	17 SENSITIVE FAUNAL SPECIES	50									
	18 REVEGETATION POTENTIAL	10									
	19 KNOWN CULTURAL RESOURCES										30
	20 POTENTIAL CULTURAL RESOURCES										70
	21 AIR POLLUTION POTENTIAL				100						
INSTITUTIONAL	22 PERMITTING DIFFICULTIES									100	
	23 PRIVATE LAND USE							100			
HOST ROCK – GEOMECHANICAL	24 THERMAL CONDUCTIVITY										
	25 COMPRESSIVE STRENGTH (CONTAINMENT)										
	26 COMPRESSIVE STRENGTH (CONSTRUCTION)										
	27 EXPANSION-CONTRACTION										
GEOCHEMICAL	28 MINERAL STABILITY										
	29 STRATIGRAPHIC SETTING										
	30 HYDRAULIC RETARDATION										
HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY										

Weights for Analysis of:

NEAR-TERM OBJECTIVES

Clear-Weights used in analysis

Shading-Weights set to 0 for analysis

Figure 35 shows resulting location and host-rock ratings

OBJECTIVES
(WEIGHTS IN PARENTHESES)

OVERALL GOAL: PROVIDE SAFE, EFFECTIVE & ENVIRONMENTALLY SOUND RADIOACTIVE WASTE DISPOSAL

		LEVEL 1	1.0 PROVIDE CONTAINMENT (31%)						
		LEVEL 2	1.1 DISRUPTIVE PROCESSES (50%)		1.2 DISRUPTIVE EVENTS (50%)				
ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)		LEVEL 3	1.1.1 CHEMICAL (50%)	1.1.2 MECHANICAL (50%)	1.2.1 SEISMIC (27%)	1.2.2 EROSIONAL (14%)	1.2.3 VOLCANIC (31%)	1.2.4 HUMAN INTRUSION (22%)	1.2.5 MISCELLANEOUS (6%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL			5		100		
		2 FAULT DENSITY	5						
		3 FAULT TREND			5				
		4 AGE OF FAULTING			30				
		5 NATURAL SEISMIC POTENTIAL			60				
		6 WEAPONS SEISMIC POTENTIAL							100
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)							
		8 EROSION POTENTIAL				100			
		9 FLOOD POTENTIAL							
		10 TERRAIN RUGGEDNESS							
		11 BASE & PRECIOUS METAL RESOURCE POT						50	
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL						50	
		13 GROUNDWATER FLUX	5						
		14 GROUNDWATER FLOW DIRECTION							
		15 THICKNESS OF UNSATURATED ZONE							
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES							
		17 SENSITIVE FAUNAL SPECIES							
		18 REVEGETATION POTENTIAL							
		19 KNOWN CULTURAL RESOURCES							
		20 POTENTIAL CULTURAL RESOURCES							
		21 AIR POLLUTION POTENTIAL							
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES							
		23 PRIVATE LAND USE							
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY	30	30					
		25 COMPRESSIVE STRENGTH (CONTAINMENT)		40					
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)							
		27 EXPANSION-CONTRACTION		20					
	GEOCHEMICAL	28 MINERAL STABILITY	10	10					
		29 STRATIGRAPHIC SETTING							
		30 HYDRAULIC RETARDATION							
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	50						

		LEVEL 1	2.0 PROVIDE ISOLATION ([illegible])								
		LEVEL 2	2.1 RADIONUCLIDE MIGRATION (65%)				2.2 DISRUPTIVE EVENTS (35%)				
ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)		LEVEL 3	2.1.1 GROUNDWATER FLOW (38%)	2.1.2 NUCLIDE RETARD. (30%)	2.1.3 HOST ROCK THICK. (13%)	2.1.4 VOLATILE MIGRATION (8%)	2.2.1 TECTONIC (31%)	2.2.2 CLIMATIC (21%)	2.2.3 GEOMORPHIC (20%)	2.2.4 HUMAN INDUCED (8%)	2.2.5 MISC. & COMPLEXITY (19%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL					40				
		2 FAULT DENSITY	5			10					50
		3 FAULT TREND					10				
		4 AGE OF FAULTING					10				
		5 NATURAL SEISMIC POTENTIAL					40				
		6 WEAPONS SEISMIC POTENTIAL								10	
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)									30
		8 EROSION POTENTIAL							80		
		9 FLOOD POTENTIAL							10		
		10 TERRAIN RUGGEDNESS							10		20
		11 BASE & PRECIOUS METAL RESOURCE POT								45	
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL								45	
		13 GROUNDWATER FLUX	10	10							
		14 GROUNDWATER FLOW DIRECTION	30								
		15 THICKNESS OF UNSATURATED ZONE	5					100			
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES									
		17 SENSITIVE FAUNAL SPECIES									
		18 REVEGETATION POTENTIAL									
		19 KNOWN CULTURAL RESOURCES									
		20 POTENTIAL CULTURAL RESOURCES									
		21 AIR POLLUTION POTENTIAL									
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES									
		23 PRIVATE LAND USE									
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY									
		25 COMPRESSIVE STRENGTH (CONTAINMENT)			20						
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)									
		27 EXPANSION-CONTRACTION									
	GEOCHEMICAL	28 MINERAL STABILITY		10		5					
		29 STRATIGRAPHIC SETTING		70	80	30					
		30 HYDRAULIC RETARDATION	10	10		15					
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	40			40					

		LEVEL 1	3.0 PROVIDE SAFE COST EFFECTIVE CONSTRUCTION & OPERATIONS ([illegible])													
		LEVEL 2	3.1 SURFACE FACILITIES (37%)						3.2 SUBSURFACE FACILITIES (45%)						3.3 TRANSPORTATION SYSTEMS (30%)	
ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)		LEVEL 3	3.1.1 SEISMICITY (21%)	3.1.2 MONITORING RQMT'S (12%)	3.1.3 FOUNDATION COND. (28%)	3.1.4 WIND LOADS (10%)	3.1.5 FLOODING (18%)	3.1.6 AVAIL. NAT. RES. (11%)	3.2.1 SEISMICITY (15%)	3.2.2 FLOODING (21%)	3.2.3 MINING COND (27%)	3.2.4 HOST ROCK GEOM. (16%)	3.2.5 HOST ROCK HOMOG (12%)	3.2.6 WASTE PKG ACCEPT (10%)	3.3.1 TERRAIN (71%)	3.3.2 EXISTING CORRIDOR (29%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL														
		2 FAULT DENSITY							10	10	20		50			
		3 FAULT TREND														
		4 AGE OF FAULTING														
		5 NATURAL SEISMIC POTENTIAL	90						85							
		6 WEAPONS SEISMIC POTENTIAL	10						5							
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)										100	40			
		8 EROSION POTENTIAL			10											
		9 FLOOD POTENTIAL			20		100			5					30	
		10 TERRAIN RUGGEDNESS		70	70										70	
		11 BASE & PRECIOUS METAL RESOURCE POT											10			
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL														
		13 GROUNDWATER FLUX								15						
		14 GROUNDWATER FLOW DIRECTION								10	10					
		15 THICKNESS OF UNSATURATED ZONE														
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES		2												
		17 SENSITIVE FAUNAL SPECIES		7												
		18 REVEGETATION POTENTIAL														
		19 KNOWN CULTURAL RESOURCES		6												
		20 POTENTIAL CULTURAL RESOURCES		15												
		21 AIR POLLUTION POTENTIAL														
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES														
		23 PRIVATE LAND USE														
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY									10			20		
		25 COMPRESSIVE STRENGTH (CONTAINMENT)														
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)									40					
		27 EXPANSION-CONTRACTION												40		
	GEOCHEMICAL	28 MINERAL STABILITY									10			40		
		29 STRATIGRAPHIC SETTING														
		30 HYDRAULIC RETARDATION														
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY								60	10					

		LEVEL 1	4.0 PROVIDE ACCEPTABLE ENVIRONMENTAL IMPACTS (9%)									
		LEVEL 2	4.1 BIOTIC SYSTEMS (22%)	4.2 ABIOTIC SYSTEMS (31%)			4.3 SOCIOECONOMIC IMPACTS (20%)			4.4 INSTITUTIONAL IMPACTS (21%)		4.5 CULT. RES (15%)
ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)		LEVEL 3	4.1.1 SENSITIVE SYS. (100%)	4.2.1 SURFACE GEOLOGY (22%)	4.2.2 WATER QUALITY (46%)	4.2.3 AIR QUALITY (32%)	4.3.1 LOCAL ECONOMIES (41%)	4.3.2 LIFE STYLES (42%)	4.3.3 LAND USE (17%)	4.4.1 STATE ISSUES (53%)	4.4.2 FEDERAL REGS. (47%)	4.5.1 ARCH. & HIST. SITES (100%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL										
		2 FAULT DENSITY										
		3 FAULT TREND										
		4 AGE OF FAULTING										
		5 NATURAL SEISMIC POTENTIAL										
		6 WEAPONS SEISMIC POTENTIAL										
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)										
		8 EROSION POTENTIAL										
		9 FLOOD POTENTIAL		50								
		10 TERRAIN RUGGEDNESS		50								
		11 BASE & PRECIOUS METAL RESOURCE POT										
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL			100							
		13 GROUNDWATER FLUX										
		14 GROUNDWATER FLOW DIRECTION										
		15 THICKNESS OF UNSATURATED ZONE										
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES	40									
		17 SENSITIVE FAUNAL SPECIES	50									
		18 REVEGETATION POTENTIAL	10									
		19 KNOWN CULTURAL RESOURCES										30
		20 POTENTIAL CULTURAL RESOURCES										70
		21 AIR POLLUTION POTENTIAL				100						
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES									100	
		23 PRIVATE LAND USE							100			
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY										
		25 COMPRESSIVE STRENGTH (CONTAINMENT)										
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)										
		27 EXPANSION-CONTRACTION										
	GEOCHEMICAL	28 MINERAL STABILITY										
		29 STRATIGRAPHIC SETTING										
		30 HYDRAULIC RETARDATION										
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY										

Weights for Analysis of:

GEOMECHANICAL ATTRIBUTES

Clear–Weights used in analysis

Shading–Weights set to 0 for analysis

Table 8 shows resulting host-rock ratings

OBJECTIVES
(WEIGHTS IN PARENTHESES)

OVERALL GOAL: PROVIDE SAFE, EFFECTIVE & ENVIRONMENTALLY SOUND RADIOACTIVE WASTE DISPOSAL

ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)

		LEVEL 3	1.1.1 CHEMICAL (68%)	1.1.2 MECHANICAL (32%)	1.2.1 SEISMIC (37%)	1.2.2 EROSIONAL (14%)	1.2.3 VOLCANIC (16%)	1.2.4 HUMAN INTRUSION (28%)	1.2.5 [illegible] (5%)
		LEVEL 1	1.0 PROVIDE CONTAINMENT (31%)						
		LEVEL 2	1.1 DISRUPTIVE PROCESSES (68%)		1.2 DISRUPTIVE EVENTS (32%)				
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL			5		100		
		2 FAULT DENSITY	5						
		3 FAULT TREND			5				
		4 AGE OF FAULTING			30				
		5 NATURAL SEISMIC POTENTIAL			60				
		6 WEAPONS SEISMIC POTENTIAL							100
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)							
		8 EROSION POTENTIAL				100			
		9 FLOOD POTENTIAL							
		10 TERRAIN RUGGEDNESS							
		11 BASE & PRECIOUS METAL RESOURCE POT						60	
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL						50	
		13 GROUNDWATER FLUX	5						
		14 GROUNDWATER FLOW DIRECTION							
		15 THICKNESS OF UNSATURATED ZONE							
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES							
		17 SENSITIVE FAUNAL SPECIES							
		18 REVEGETATION POTENTIAL							
		19 KNOWN CULTURAL RESOURCES							
		20 POTENTIAL CULTURAL RESOURCES							
		21 AIR POLLUTION POTENTIAL							
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES							
		23 PRIVATE LAND USE							
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY	20	30					
		25 COMPRESSIVE STRENGTH (CONTAINMENT)		40					
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)							
		27 EXPANSION-CONTRACTION		20					
	GEOCHEMICAL	28 MINERAL STABILITY	10	10					
		29 STRATIGRAPHIC SETTING							
		30 HYDRAULIC RETARDATION							
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	60						

		LEVEL 3	2.1.1 GROUND [illegible] FLOW (3[illegible]%)	2.1.2 NUCLIDE RETARD. (30%)	2.1.3 HOST ROCK THICK. (23%)	2.1.4 VOLATILE MIGRATION (3%)	2.2.1 TECTONIC (31%)	2.2.2 CLIMATIC (31%)	2.2.3 GEOMORPHIC (20%)	2.2.4 HUMAN INDUCED (8%)	2.2.5 MISC. & COMPLEXITY (3%)
		LEVEL 1	2.0 PROVIDE ISOLATION (34%)								
		LEVEL 2	2.1 RADIONUCLIDE MIGRATION (65%)				2.2 DISRUPTIVE EVENTS (35%)				
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL					40				
		2 FAULT DENSITY	5			10					50
		3 FAULT TREND					10				
		4 AGE OF FAULTING					10				
		5 NATURAL SEISMIC POTENTIAL					40				
		6 WEAPONS SEISMIC POTENTIAL								10	
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)									30
		8 EROSION POTENTIAL							30		
		9 FLOOD POTENTIAL							10		
		10 TERRAIN RUGGEDNESS							15		20
		11 BASE & PRECIOUS METAL RESOURCE POT								45	
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL								45	
		13 GROUNDWATER FLUX	10	10							
		14 GROUNDWATER FLOW DIRECTION	20								
		15 THICKNESS OF UNSATURATED ZONE	5					100			
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES									
		17 SENSITIVE FAUNAL SPECIES									
		18 REVEGETATION POTENTIAL									
		19 KNOWN CULTURAL RESOURCES									
		20 POTENTIAL CULTURAL RESOURCES									
		21 AIR POLLUTION POTENTIAL									
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES									
		23 PRIVATE LAND USE									
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY									
		25 COMPRESSIVE STRENGTH (CONTAINMENT)			20						
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)									
		27 EXPANSION-CONTRACTION									
	GEOCHEMICAL	28 MINERAL STABILITY		10		5					
		29 STRATIGRAPHIC SETTING		70	80	20					
		30 HYDRAULIC RETARDATION	10	10		15					
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	40			40					

		LEVEL 3	3.1.1 SEISMICITY (21%)	3.1.2 MONITORING ROUTS (12%)	3.1.3 FOUNDATION COND. (25%)	3.1.4 WIND LOADS (10%)	3.1.5 FLOODING (10%)	3.1.6 AVAIL. NAT. RES. (12%)	3.2.1 SEISMICITY (18%)	3.2.2 FLOODING (31%)	3.2.3 MINING COND (27%)	3.2.4 HOST ROCK GEOL (18%)	3.2.5 HOST ROCK HOMOG. (12%)	3.2.6 WASTE PKG ACCEPT (10%)	3.3.1 TERRAIN (71%)	3.3.2 EXISTING CORRIDOR (29%)
		LEVEL 1	3.0 PROVIDE SAFE COST EFFECTIVE CONSTRUCTION & OPERATIONS (30%)													
		LEVEL 2	3.1 SURFACE FACILITIES (27%)						3.2 SUBSURFACE FACILITIES (43%)						3.3 TRANSPORTATION SYSTEMS (30%)	
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL														
		2 FAULT DENSITY							10	10	70		50			
		3 FAULT TREND														
		4 AGE OF FAULTING														
		5 NATURAL SEISMIC POTENTIAL	90						85							
		6 WEAPONS SEISMIC POTENTIAL	10						5							
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)										100	40			
		8 EROSION POTENTIAL			10											
		9 FLOOD POTENTIAL			20		100			5					30	
		10 TERRAIN RUGGEDNESS		70	70										70	
		11 BASE & PRECIOUS METAL RESOURCE POT											10			
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL														
		13 GROUNDWATER FLUX								15						
		14 GROUNDWATER FLOW DIRECTION								10	10					
		15 THICKNESS OF UNSATURATED ZONE														
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES		3												
		17 SENSITIVE FAUNAL SPECIES		7												
		18 REVEGETATION POTENTIAL														
		19 KNOWN CULTURAL RESOURCES		8												
		20 POTENTIAL CULTURAL RESOURCES		15												
		21 AIR POLLUTION POTENTIAL														
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES														
		23 PRIVATE LAND USE														
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY									10			20		
		25 COMPRESSIVE STRENGTH (CONTAINMENT)														
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)									40					
		27 EXPANSION-CONTRACTION												40		
	GEOCHEMICAL	28 MINERAL STABILITY									10			40		
		29 STRATIGRAPHIC SETTING														
		30 HYDRAULIC RETARDATION														
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY								45	10					

		LEVEL 3	4.1.1 SENSITIVE SYS. (100%)	4.2.1 SURFACE GEOLOGY (33%)	4.2.2 WATER QUALITY (46%)	4.2.3 AIR QUALITY (21%)	4.3.1 LOCAL ECONOMIES (41%)	4.3.2 LIFE STYLES (42%)	4.3.3 LAND USE (17%)	4.4.1 STATE ISSUES (53%)	4.4.2 FEDERAL REGS. (47%)	4.5.1 ARCH. & HIST. SITES (100%)
		LEVEL 1	4.0 PROVIDE ACCEPTABLE ENVIRONMENTAL IMPACTS (5%)									
		LEVEL 2	4.1 BIOTIC SYS (22%)	4.2 ABIOTIC SYSTEMS (31%)			4.3 SOCIOECONOMIC IMPACTS (26%)			4.4 INSTITUTIONAL IMPACTS (31%)		4.5 CULT. RES. (10%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL										
		2 FAULT DENSITY										
		3 FAULT TREND										
		4 AGE OF FAULTING										
		5 NATURAL SEISMIC POTENTIAL										
		6 WEAPONS SEISMIC POTENTIAL										
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)										
		8 EROSION POTENTIAL										
		9 FLOOD POTENTIAL		50								
		10 TERRAIN RUGGEDNESS		50								
		11 BASE & PRECIOUS METAL RESOURCE POT										
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL			100							
		13 GROUNDWATER FLUX										
		14 GROUNDWATER FLOW DIRECTION										
		15 THICKNESS OF UNSATURATED ZONE										
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES	40									
		17 SENSITIVE FAUNAL SPECIES	50									
		18 REVEGETATION POTENTIAL	15									
		19 KNOWN CULTURAL RESOURCES										30
		20 POTENTIAL CULTURAL RESOURCES										70
		21 AIR POLLUTION POTENTIAL				100						
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES									100	
		23 PRIVATE LAND USE							100			
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY										
		25 COMPRESSIVE STRENGTH (CONTAINMENT)										
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)										
		27 EXPANSION-CONTRACTION										
	GEOCHEMICAL	28 MINERAL STABILITY										
		29 STRATIGRAPHIC SETTING										
		30 HYDRAULIC RETARDATION										
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY										

Weights for Analysis of:

GEOCHEMICAL ATTRIBUTES

Clear-Weights used in analysis

Shading-Weights set to 0 for analysis

Table 8 shows resulting host-rock ratings

ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)			OBJECTIVES (WEIGHTS IN PARENTHESES)															
		OVERALL GOAL	PROVIDE SAFE, EFFECTIVE & ENVIRONMENTALLY SOUND RADIOACTIVE WASTE DISPOSAL															
		LEVEL 1	1.0 PROVIDE CONTAINMENT (31%)							2.0 PROVIDE ISOLATION (34%)								
		LEVEL 2	1.1 DISRUPTIVE PROCESSES (68%)		1.2 DISRUPTIVE EVENTS (32%)					2.1 RADIONUCLIDE MIGRATION (66%)				2.2 DISRUPTIVE EVENTS (34%)				
		LEVEL 3	1.1.1 CHEMICAL (68%)	1.1.2 MECHANICAL (32%)	1.2.1 SEISMIC (37%)	1.2.2 EROSIONAL (14%)	1.2.3 VOLCANIC (21%)	1.2.4 HUMAN INTRUSION (25%)	1.2.5 MISCELLANEOUS (3%)	2.1.1 GROUNDWATER FLOW (38%)	2.1.2 NUCLIDE RETARD (30%)	2.1.3 HOST ROCK THICK (25%)	2.1.4 VOLATILE MIGRATION (6%)	2.2.1 TECTONIC (31%)	2.2.2 CLIMATIC (31%)	2.2.3 GEOMORPHIC (20%)	2.2.4 HUMAN INDUCED (8%)	2.2.5 MISC. & COMPLEXITY (9%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL			5		100							40				
		2 FAULT DENSITY	5							5			10					50
		3 FAULT TREND			5									10				
		4 AGE OF FAULTING			30									10				
		5 NATURAL SEISMIC POTENTIAL			60									40				
		6 WEAPONS SEISMIC POTENTIAL							100								10	
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)																20
		8 EROSION POTENTIAL				100										85		
		9 FLOOD POTENTIAL														10		
		10 TERRAIN RUGGEDNESS														5		25
		11 BASE & PRECIOUS METAL RESOURCE POT						50									45	
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL						50									45	
		13 GROUNDWATER FLUX	5							10	10							
		14 GROUNDWATER FLOW DIRECTION								30								
		15 THICKNESS OF UNSATURATED ZONE								5					100			
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES																
		17 SENSITIVE FAUNAL SPECIES																
		18 REVEGETATION POTENTIAL																
		19 KNOWN CULTURAL RESOURCES																
		20 POTENTIAL CULTURAL RESOURCES																
		21 AIR POLLUTION POTENTIAL																
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES																
		23 PRIVATE LAND USE																
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY	20	30														
		25 COMPRESSIVE STRENGTH (CONTAINMENT)		40								20						
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)																
		27 EXPANSION-CONTRACTION		20														
	GEOCHEMICAL	28 MINERAL STABILITY	10	10							10		5					
		29 STRATIGRAPHIC SETTING									70	80	30					
		30 HYDRAULIC RETARDATION								10	10		10					
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY	60							40			40					

ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)			OBJECTIVES (WEIGHTS IN PARENTHESES)													
		OVERALL GOAL	PROVIDE SAFE, EFFECTIVE & ENVIRONMENTALLY SOUND RADIOACTIVE WASTE DISPOSAL													
		LEVEL 1	3.0 PROVIDE SAFE COST EFFECTIVE CONSTRUCTION & OPERATIONS (20%)													
		LEVEL 2	3.1 SURFACE FACILITIES (37%)						3.2 SUBSURFACE FACILITIES (43%)						3.3 TRANSPORTATION SYSTEMS (20%)	
		LEVEL 3	3.1.1 SEISMICITY (31%)	3.1.2 MONITORING ROMT'S (11%)	3.1.3 FOUNDATION COND (26%)	3.1.4 WIND LOADS (10%)	3.1.5 FLOODING (10%)	3.1.6 AVAIL. NAT. RES. (13%)	3.2.1 SEISMICITY (15%)	3.2.2 FLOODING (15%)	3.2.3 MINING COND (37%)	3.2.4 HOST ROCK GEOM. (16%)	3.2.5 HOST ROCK HOMOG. (12%)	3.2.6 WASTE PKG ACCEPT (10%)	3.3.1 TERRAIN (71%)	3.3.2 EXISTING CORRIDOR (29%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL														
		2 FAULT DENSITY							10	10	20		50			
		3 FAULT TREND														
		4 AGE OF FAULTING														
		5 NATURAL SEISMIC POTENTIAL	90						85							
		6 WEAPONS SEISMIC POTENTIAL	10						5							
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)										100	40			
		8 EROSION POTENTIAL			10											
		9 FLOOD POTENTIAL			20		100			5					30	
		10 TERRAIN RUGGEDNESS		70	70										70	
		11 BASE & PRECIOUS METAL RESOURCE POT											10			
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL														
		13 GROUNDWATER FLUX								15						
		14 GROUNDWATER FLOW DIRECTION								10	10					
		15 THICKNESS OF UNSATURATED ZONE														
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES		3												
		17 SENSITIVE FAUNAL SPECIES		7												
		18 REVEGETATION POTENTIAL														
		19 KNOWN CULTURAL RESOURCES		5												
		20 POTENTIAL CULTURAL RESOURCES		15												
		21 AIR POLLUTION POTENTIAL														
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES														
		23 PRIVATE LAND USE														
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY									15			20		
		25 COMPRESSIVE STRENGTH (CONTAINMENT)														
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)									40					
		27 EXPANSION-CONTRACTION												40		
	GEOCHEMICAL	28 MINERAL STABILITY									10			40		
		29 STRATIGRAPHIC SETTING														
		30 HYDRAULIC RETARDATION														
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY								60	10					

ATTRIBUTES (WEIGHTS AT MATRIX INTERSECTIONS)			OBJECTIVES (WEIGHTS IN PARENTHESES)									
		OVERALL GOAL	PROVIDE SAFE, EFFECTIVE & ENVIRONMENTALLY SOUND RADIOACTIVE WASTE DISPOSAL									
		LEVEL 1	4.0 PROVIDE ACCEPTABLE ENVIRONMENTAL IMPACTS (15%)									
		LEVEL 2	4.1 BIOTIC SYS.(22%)	4.2 ABIOTIC SYSTEMS (21%)			4.3 SOCIOECONOMIC IMPACTS (26%)			4.4 INSTITUTIONAL IMPACTS (21%)		4.5 CULT. RES. (10%)
		LEVEL 3	4.1.1 SENSITIVE SYS. (100%)	4.2.1 SURFACE GEOLOGY (22%)	4.2.2 WATER QUALITY (46%)	4.2.3 AIR QUALITY (32%)	4.3.1 LOCAL ECONOMIES (41%)	4.3.2 LIFE STYLES (42%)	4.3.3 LAND USE (17%)	4.4.1 STATE ISSUES (53%)	4.4.2 FEDERAL REGS. (47%)	4.5.1 ARCH. & HIST. SITES (100%)
GEOGRAPHICAL	TECTONIC/SEISMIC	1 VOLCANIC POTENTIAL										
		2 FAULT DENSITY										
		3 FAULT TREND										
		4 AGE OF FAULTING										
		5 NATURAL SEISMIC POTENTIAL										
		6 WEAPONS SEISMIC POTENTIAL										
	GEOLOGIC/SURFACE	7 BED ATTITUDE (ROCK DIP)										
		8 EROSION POTENTIAL										
		9 FLOOD POTENTIAL		50								
		10 TERRAIN RUGGEDNESS		50								
		11 BASE & PRECIOUS METAL RESOURCE POT										
	HYDROLOGICAL	12 GROUNDWATER RESOURCE POTENTIAL			100							
		13 GROUNDWATER FLUX										
		14 GROUNDWATER FLOW DIRECTION										
		15 THICKNESS OF UNSATURATED ZONE										
	ENVIRONMENTAL	16 SENSITIVE FLORAL SPECIES	40									
		17 SENSITIVE FAUNAL SPECIES	50									
		18 REVEGETATION POTENTIAL	10									
		19 KNOWN CULTURAL RESOURCES										30
		20 POTENTIAL CULTURAL RESOURCES										70
		21 AIR POLLUTION POTENTIAL				100						
	INSTITUTIONAL	22 PERMITTING DIFFICULTIES									100	
		23 PRIVATE LAND USE							100			
HOST ROCK	GEOMECHANICAL	24 THERMAL CONDUCTIVITY										
		25 COMPRESSIVE STRENGTH (CONTAINMENT)										
		26 COMPRESSIVE STRENGTH (CONSTRUCTION)										
		27 EXPANSION-CONTRACTION										
	GEOCHEMICAL	28 MINERAL STABILITY										
		29 STRATIGRAPHIC SETTING										
		30 HYDRAULIC RETARDATION										
	HYDROLOGICAL	31 HYDRAULIC TRANSMISSIVITY										