NNA.870831.0129

NNWSI PROJECT

USGS SCIENTIFIC INVESTIGATION PLAN

DISTRIBUTION AND CHARACTERISTICS OF PAST EROSION

Effective Date _____

Principal Investigator K. Fox	7-31-87 Date	Investigator J. W. Whitney	8/25/87 Date
Technical Reviewer E. Helley	8-26-87 Date	(Optional)Technical Reviewer	Date
Quality Assurance Manager J. Willmon	8/28/87 Date	Chief, Branch of NNWSI for L. Hayes	8/28/87 Date
WMPO Technical	Date	WMPO Quality Assurance	Date

SAIC/T&MSS

AUG 31 1987

CCF RECEIVED

9076200/343
9303110201 930224
PDR WASTE
WM-11 PDR

TABLE OF CONTENTS

Page

1.0 INTRODUCTION 5

1.1 Purpose and Scope 5
1.2 Application of Results 6

2.0 RATIONALE FOR THE STUDY 13

2.1 General Approach 13
2.2 Quality Assurance Levels 13
2.3 Other Applicable Information 16
2.4 Program Interfaces 17

3.0 DESCRIPTION OF ACTIVITIES 18

3.1 Development of a Geomorphic Map of Yucca Mountain 18
3.1.1 Introduction 18
3.1.2 Supporting Activities 18
3.1.3 Equipment 18
3.1.4 Methods, Procedures, and Quality Assurance 18
3.2 Analysis of the Downcutting History of Fortymile Wash and its Tributaries 21
3.2.1 Introduction 21
3.2.2 Supporting Activities 22
3.2.3 Equipment 22
3.2.4 Methods, Procedures, and Quality Assurance 22
3.3 Analysis of Hillslope Erosion 24
3.3.1 Introduction 24
3.3.2 Supporting Activities 25
3.3.3 Equipment 25
3.3.4 Methods, Procedures, and Quality Assurance 25

4.0 SCHEDULE AND MILESTONES 27

REFERENCE LIST 30

APPENDIX A - QUALITY ASSURANCE LEVEL ASSIGNMENTS 33

9076200/344

LIST OF FIGURES

Figure	Title	Page
1-1	Relationship of Distribution and Characteristics of Past Erosion to the NNWSI Work Breakdown Structure	8
2-1	Geology Work Breakdown Structure Indicating Placement of the Distribution and Characteristics of Past Erosion Study	14
2-2	Work Breakdown Structure for Distribution and Characteristics of Past Erosion	[illegible]
4-1	Summary Logic Network for Distribution and Characteristics of Past Erosion	28

9076200/345

LIST OF TABLES

Table	Title	Page
1-1	Study Location Within the Issues Hierarchy	9
1-2	Information Needs which Use the Study Results in Performance, Design and Characterization Assessment Analyses	10
3-1	Methods and Technical Procedures for Development of a Geomorphic Map of Yucca Mountain	20
3-2	Methods and Technical Procedures for Analysis of the Downcutting History of Fortymile Wash and Its Tributaries	23
3-3	Methods and Technical Procedures for Analysis of Hillslope Erosion	26
4-1	List of Reports Identified for the Distribution and Characteristics of Past Erosion	29

9076200/346

1.0 INTRODUCTION

1.1 Purpose and Scope

The objectives of this study are (1) to identify the erosional processes that have been operating in the Yucca Mountain area during the Quaternary, (2) to identify the specific locations of past erosion, and (3) to quantify the rates of the different erosional processes and assess their relative importance.

Geomorphic processes in the southern Great Basin and northern Mojave Desert are governed largely by climate, existing topography, tectonic activity, and the spatial and temporal relations between these determinants. Late Cenozoic extensional tectonism and a predominantly semiarid-to-arid climate have combined to produce a structurally dominated landscape of high relief with narrow, rugged uplands separated by broad, gently sloping lowland basins. Within this landscape, erosion and erosional processes are mostly concentrated in the high, steep, and relatively wetter uplands, whereas, deposition and depositional processes are generally concentrated in the low, gently sloping, and relatively drier lowlands. The intervening piedmonts serve primarily as surfaces of transport between the eroding uplands and aggrading basins.

Desert geomorphic processes acting in conjunction with extensional tectonism have molded the present topography of the Yucca Mountain area, and these processes continue to modify the landscape. Future tectonism, climatic change, and (or) complex threshold-related changes could alter the intensity and distribution of these processes, thereby changing present patterns and rates of erosion and deposition. Such changes would in turn affect topography and surface drainage and could affect ground-water recharge, and subsurface water flow. However, available data suggest that the region surrounding Yucca Mountain has been geomorphically stable during much of the middle and late Quaternary, and that rates of erosion are likely to remain generally low during the next 10,000 years.

The predominantly semiarid to arid climates of the past and present have preserved the landscape of the region surrounding Yucca Mountain. Weathering in arid environments proceeds more slowly than in more humid environments, and rock debris on most mountain bedrock slopes appears to be only slightly weathered. Surface-water flow is intermittent and flashy, typically occurring in response to small, intense storms of brief duration. Because of a lack of perennial streams, long distance sediment transport is also intermittent and relatively slow. Indeed, sediment storage between upland slopes and basin floor is manifested in a variety of constructional landforms, including colluvial wedges, talus cones, alluviated valley floors, stream terraces, and alluvial fans. The late and middle Pleistocene ages of many of these landforms (as indicated by soil development, rock-varnish development, and radiometric dating) attest to the slow and discontinuous nature of sediment transport throughout the region. Limited surface water and sparse vegetation enhance eolian processes which act to further slow the overall progress of upland degradation. Fine particles deflated from basin floors are returned to upland areas as sand sheets, thin blankets of desert loess (eolian silt) that commonly veneer piedmont surfaces and hillslopes, and as sand ramps and dunes that locally bury lower hillslopes.

9076200/347

Three kinds of data will be obtained to characterize past distribution of erosion and average erosion rates. First, the areal distribution of hillslope and alluvial deposits and surfaces of different ages will be shown on a geomorphic map of Yucca Mountain. The map will show how modern erosion has only slightly affected an essentially Pleistocene landscape. Second, local stream incision rates will be calculated by dating incised stream terraces and sand ramps by U-trend, U-series, and cation ratio (rock varnish) dating methods. Third, hillslope erosion rates will be calculated by measuring the volume of debris eroded from the hillslopes in relation to rock-varnish-dated hillslope surfaces and deposits. Hillslope degradation rates will be shown to be very low; preliminary rock-varnish ages of up to 100,000 years old have been calculated for some hillslope deposits on Yucca Mountain. Site-specific average erosion rates will demonstrate that if the climate and tectonic environment of Yucca Mountain are not significantly altered during the post-closure period, then the repository is in no danger of being breached by erosion.

Activities planned for this study include (1) distribution and characteristics of past erosion, (2) analysis of the downcutting history of Fortymile Wash and its tributaries, and (3) analysis of hillslope erosion. Preparation of a geomorphic map for Yucca Mountain will permit the delineation of erosionally active and stable areas, and the correlation of the various surficial deposits with the geomorphic processes of their origin. Investigation of the downcutting history of Fortymile Wash will yield ages of stream terraces, depths of stream incision, stream gradients, and lithologies of stream gravels. An analysis of hillslope erosion will result in a determination of hillslope erosion rates, and the genesis of hillslope deposits.

Assessment of the characteristics and distribution of past erosion will involve characterization of the following parameters: (1) locations of areas of active erosion; (2) locations of geomorphically stable areas; (3) distribution of deposits originating from different geomorphic processes; (4) ages of stream terraces; (5) depths of stream incision; (6) stream gradients; (7) lithologic composition of stream gravels; (8) rock-varnish ages of hillslope deposits and surfaces; (9) textural and sedimentary characteristics of hillslope deposits; and (10) approximate volume of material eroded from hillslopes during the Quaternary.

1.2 Application of Results

Geomorphic processes in the southern Great Basin and northern Mojave Desert are determined largely by climate (Climatology, WBS 1.2.3.3.7), existing topography (Topographic Analysis, WBS 1.2.3.2.1.2), and tectonic activity (Tectonics and Volcanism, WBS 1.2.3.2.3.1), and by the spatial and temporal relations between these determinants. Desert geomorphic processes acting in conjunction with extensional tectonism have molded the present topography of the Yucca Mountain area, and these processes continue to modify the landscape. Future tectonism, climatic change, and (or) complex threshold-related changes could alter the intensity and distribution of these processes, thereby changing present patterns and rates of erosion and deposition. Such changes would in turn affect topography, surface drainage (Streamflow, WBS 1.2.3.3.1),

9076200/348

ground-water recharge (Regional Hydrology, WBS 1.2.3.3.3.4), and subsurface water flow (Saturated Zone Hydrology, WBS 1.2.3.3.3 and Unsaturated Zone Hydrology, WBS 1.2.3.3.4). The flow of information associated with this study is schematically represented in Figure 1-1.

Average late Tertiary and Quaternary erosion rates for local areas of the southern Great Basin and northern Mojave Desert can be inferred from height differences between active and relic basalt-capped erosion surfaces. Site-specific data is needed at Yucca Mountain to calculate accurate long-term average erosion rates. These site-specific average erosion rates will demonstrate that if the climate (Climatology, WBS 1.2.3.3.7) and tectonic (Tectonic and Volcanism, WBS 1.2.3.2.3.1) environment of Yucca Mountain are not significantly altered during the post-closure period, then the repository is in no danger of being breached by erosion.

The application of these results will be used to address a specific information need of NNWSI-Project issues hierarchy. The specific information need satisfied, in part, by these results is 1.17.1 Present Locations and Rates of Surface Erosion. This information need supports the resolution of Issue 1.17 concerning the description of future erosional processes and rates necessary for design and performance assessment analysis. The study location within the issues hierarchy, illustrated in Table 1-1, summarizes the relationship to other elements delineated in the SCP and the logic of the information need and issue resolution. The performance, design, and characterization information needs that will use the information developed by this investigation are listed in Table 1-2.

9076200/349

Figure 1-1. Relationship of Distribution and Characteristics of Past Erosion to the NNWSI Work Breakdown Structure.

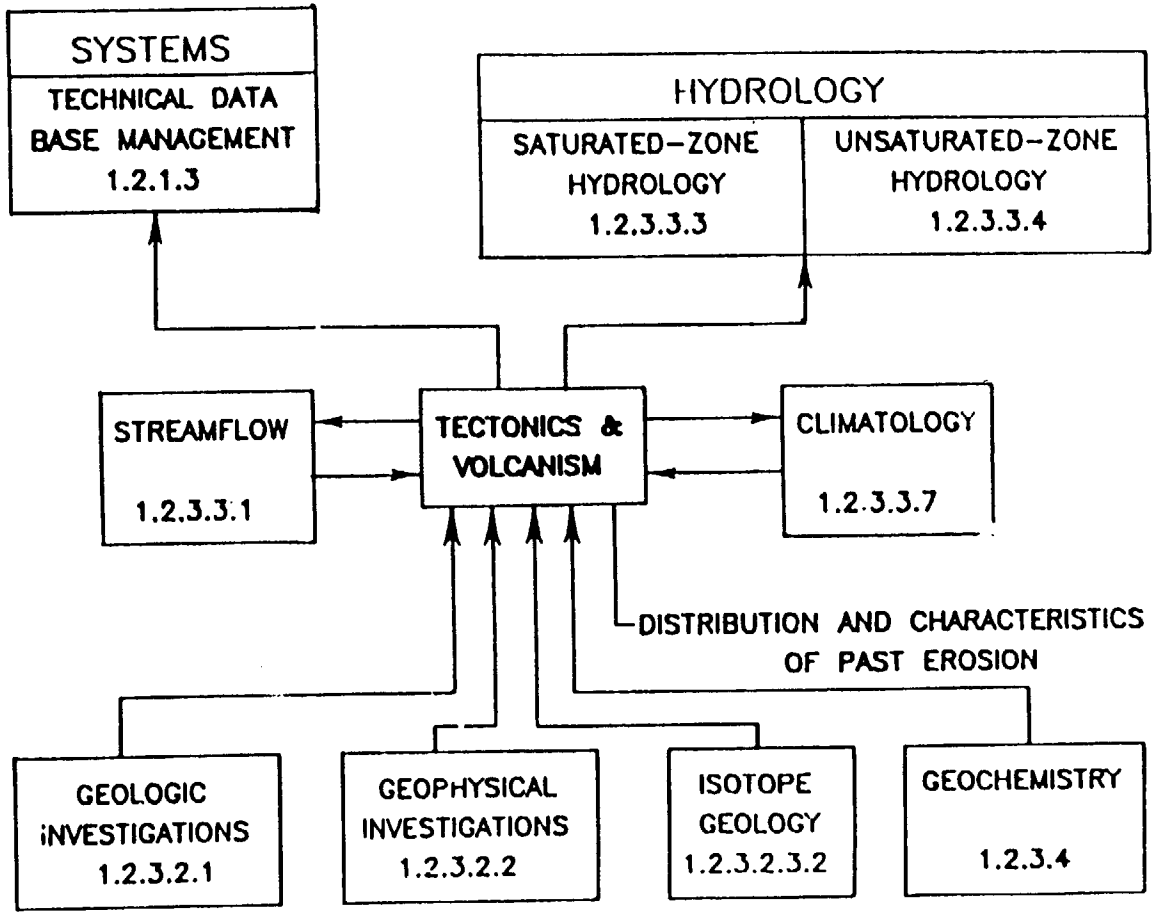


Table 1-1. Study Location Within the Issues Hierarchy. (February, 1987)

Issue 1.17 - Do the data collected in order to describe the future erosional processes and rates provide the information required by the design and performance issues?

Information Need 1.17.1 - Present Locations and Rates of Erosion

Study 1.17.1.1 - Distribution and Characteristics of Present and Past Erosion

Activity 1.17.1.1.1 - Development of a Geomorphic Map of Yucca Mountain

Activity 1.17.1.1.2 - Analysis of the Downcutting History of Fortymile Wash and Its Tributaries

Information Need 1.17.2 - Potential Effects of Future Climatic Conditions on Locations and Rates of Erosion

Information Need 1.17.3 - Potential Effects of Tectonic Activity on Locations and Rates of Erosion

Information Need 1.17.4 - Potential Effects of Erosion on Hydrologic Characteristics

6200/351

Table 1-2. Information Needs which Use the Study Results in Performance, Design, and Characterization Assessment Analyses. (February, 1987)

Performance Information Needs

1.1.1 Site information needed to calculate the releases of radionuclides to the accessible environment.

1.1.3 Calculational models for predicting releases to the accessible environment attending realizations of the anticipated and unanticipated release-scenario classes.

1.4.4 Estimates of the rates and mechanisms of containment barrier degradation in the repository environment for anticipated and unanticipated processes and events.

1.6.1 Site information and design concepts needed to identify the fastest path of likely radionuclide travel and to calculate the ground-water travel time along that path.

1.6.3 Identification of the paths of likely radionuclide travel from the disturbed zone to the accessible environment, and identification of the fastest path.

1.6.4 Determination of the pre-waste-emplacement ground-water travel time along the fastest path of likely radionuclide travel from the disturbed zone to the accessible environment.

1.7.2 Determination that the subsurface conditions encountered and the changes in those conditions during construction and waste emplacement operations are within the limits assumed in the licensing review [10CFR60.43(b), 60.74, 60.140(a)(1) and 60.141(b)].

1.8.1 Determination if the favorable conditions present at the site, together with the engineered barrier system, are sufficient to provide reasonable assurance that the performance objectives relating to isolation of waste will be met.

1.9.1 Evaluations to support higher level findings for each of the disqualifying conditions.

1.9.2 Evaluations to support higher level findings for each of the technical guidelines.

1.9.3 Evaluations to support the higher level finding for the system guideline.

2.1.1 Site and design data required to support retrieval.

2.2.1 Site and design information needed to assess preclosure radiological safety.

9078200/352

Table 1-2. (cont.) Information Needs which Use the Study Results in Performance, Design, and Characterization Assessment Analyses. (February, 1987)

2.5.1 Evaluations to support higher level findings for each of the disqualifying conditions.

2.5.2 Evaluations to support higher level findings for each of the qualifying conditions of the technical guidelines.

2.5.3 Evaluations to support higher level findings for each of the qualifying conditions of the system guideline.

2.7.1 Site information needed for design.

2.10.1 Meteorological conditions in the vicinity of the site.

2.10.4 Potential extreme weather phenomena and their recurrence intervals.

Design Information Needs

1.11.1 Site characterization information needed for design.

1.12.1 Site, waste package, and underground facility information needed for design of seals and their placement methods.

Characterization Information Needs

1.16.1 Nature and rates of change in climatic conditions to predict future climates.

1.16.2 Potential effects of future climatic conditions on hydrologic characteristics.

1.17.2 Potential effects of future climatic conditions on locations and rates of erosion.

1.17.3 Potential effects of tectonic activity on locations and rates of erosion.

1.17.4 Potential effects of erosion on hydrologic characteristics.

1.17.5 Potential effects of erosion on geochemical characteristics.

1.17.6 Potential effects of erosion on rock characteristics.

2076200/353

Table 1-2. (cont.) Information Needs which Use the Study Results in Performance, Design, and Characterization Assessment Analyses. (February, 1987)

1.19.1 Rates and magnitudes of potential igneous activity.

1.19.2 Nature and rates of tectonic processes, including faulting, folding, uplift and subsidence, and seismic activity.

4.6.2 Soil and bedrock properties of potential locations of surface facilities.

4.8.1 Flood recurrence intervals and levels at potential locations of surface facilities.

76200/354

2.0 RATIONALE FOR THE STUDY

2.1 General Approach

A description of present locations and rates of surface erosion can be prepared by integrating information obtained from two principal areas of study. These include (1) characterization of regional surface water, and (2) past erosion studies.

This Scientific Investigation Plan describes activities associated with the distribution and characterization of past erosion, conducted under Geology WBS 1.2.3.2, according to the structure presented in Figure 2-1. The study of present-day erosion is described in SIP-3310G-01, Characterization of Regional Surface Water.

The following three activities are planned for this study and included in this Scientific Investigation Plan: (1) development of a geomorphic map of Yucca Mountain; (2) analysis of the downcutting history of Fortymile Wash and its tributaries; and (3) analysis of hillslope erosion. The structure for this study is presented in Figure 2-2.

Maps are included within this Scientific Investigation Plan as illustrations for planning purposes; specific sampling sites shown on these maps and discussed in the text may be modified in the future without formal revision of this document.

2.2 Quality Assurance Levels

One requirement for participation in the NNWSI Project is that a Quality Assurance Program Plan (QAPP) will be prepared to describe how the participant will satisfy the quality assurance requirements of the project and to recognize the importance of both radiological and non-radiological health and safety related activities. The QAPP brings together an assimilation of Quality Assurance Management Procedures (QMP) that are in compliance with the NNWSI Project QA Plan, NVO-196-17. The Plan includes preliminary organizational and explanatory elements followed by the procedures for its implementation.

The USGS QA Program identifies the systems, structures, components, and activities to be covered by the USGS QA Program Plan. It also identifies the major organizations participating in the project and the designated functions of these organizations. The USGS QA Program Plan provides control over activities that affect the quality of the identified structures, systems, and components to an extent consistent with their importance to safety. The activities that affect quality are accomplished under suitably controlled conditions. Controlled conditions include the use of appropriate equipment; suitable environmental conditions for accomplishing the activity; and assurance that all prerequisites for the given activity have been satisfied. The USGS QA Program also takes into account the need for controls, processes, test equipment, instruments and skills to attain the required quality, and the need for verification of quality by inspection, test, and (or) peer review. The

76200/355

Figure 2-1. Geology Work Breakdown Structure Indicating Placement of the Distribution and Characteristics of Past Erosion Study.

TECTONICS AND VOLCANISM WBS

USGS–NNWSI PROJECT

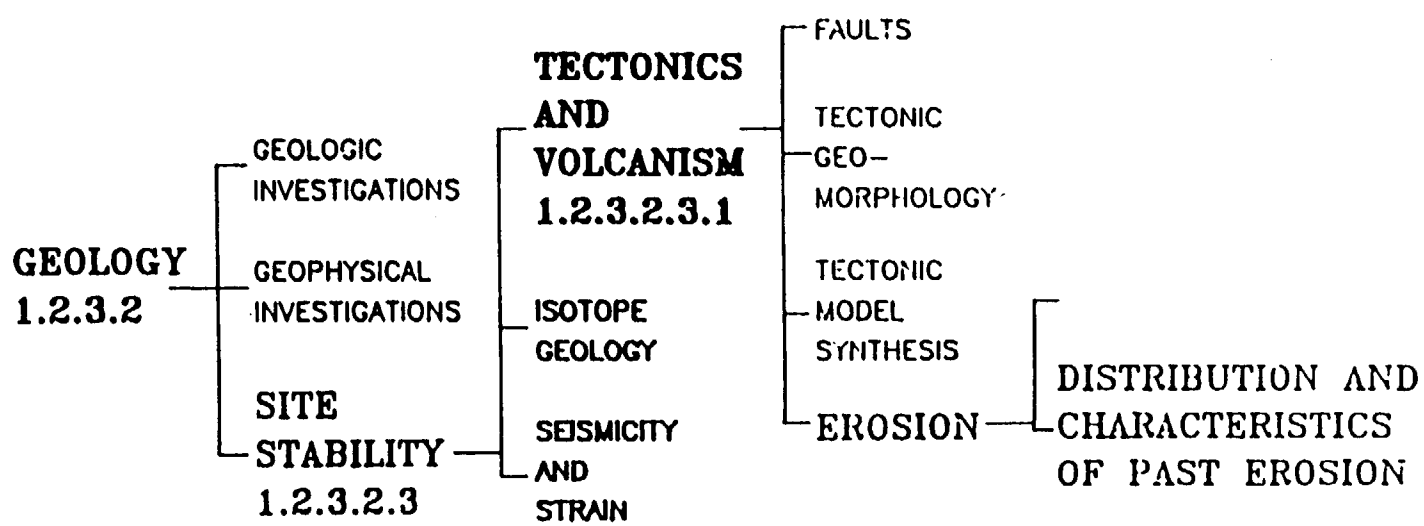
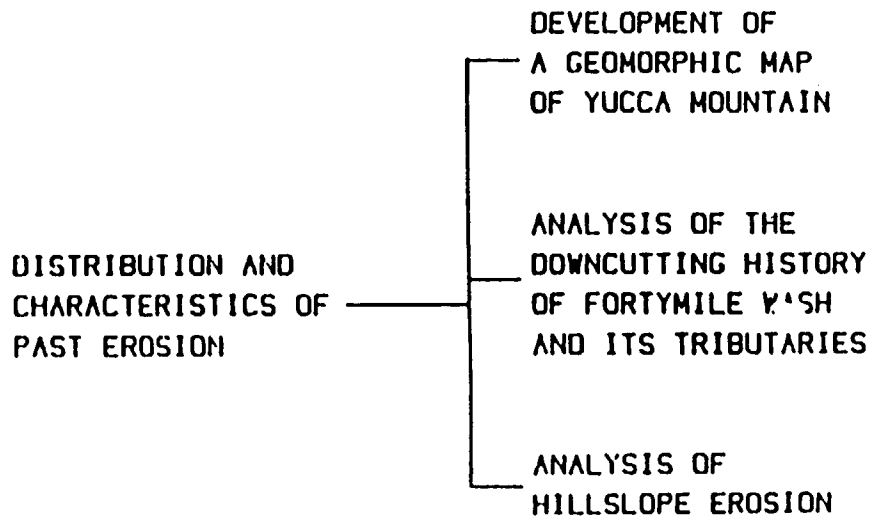


Figure 2-2. Work Breakdown Structure for Distribution and Characteristics of Past Erosion.

SCIENTIFIC INVESTIGATION PLAN

WORK BREAKDOWN STRUCTURE



USGS QA Program provides for indoctrination and as necessary, training of personnel performing activities that affect quality to assure that suitable proficiency is achieved and maintained. The Waste Management Project Office (WMPO) regularly assesses the status and adequacy of the QAPPs of the U.S. Geological Survey and Support Contractors by means of surveillance and audit activities. The USGS and Support Contractors' management shall assess the adequacy and implementation of their QA Program Plans on an annual basis.

The provisions of a QAPP and its implementing documents apply to all nuclear-waste management activities performed by USGS participants and by contractors to the USGS who do not have a qualifying QAPP. It is the responsibility of the Assistant Director for Engineering Geology of the USGS, or his delegate, to assure compliance of the USGS with the requirements of this QAPP. The Chief, Branch of NNWSI, shall be responsible for enforcing and assuring the preparation and implementation of the Quality Assurance Program. The Manager of the Quality Assurance Office is responsible for preparation of the QAPP and its associated Quality Management Procedures and for tracking and verifying their implementation. The participating investigators are assigned responsibility for preparation of their technical procedures and for becoming familiar with and implementing appropriate parts of the QAPP under the guidance of the Quality Assurance Office. All support contractors and suppliers shall be responsible for compliance with pertinent sections of this QAPP.

In conformance with the NNWSI QA Plan (NVO-196-17) as specified in NNWSI-USGS-QMP-3.02, the USGS uses a graded approach to quality assurance based on the differences between items and activities that affect radiological health and safety and those that do not. This approach assigns QA requirements at a level consistent with the activity's or item's potential impact and (or) importance in terms of radiological health and safety, non-radiological health and safety, the Nuclear Regulatory Commission (NRC) licensing process, costs, and schedules. The requirements shall be:

For Level I & II - Compliance with all 18 Criteria of 10CFR50, Appendix B, as described in NQA-1 and incorporated in the USGS QA Manual is required unless omission of a specific criteria is noted and thoroughly justified according to Para. 6.3.6 of QMP-3.02; and

For Level III - Requirements for existing good scientific practice shall apply.

2.3 Other Applicable Information

The reference list at the end of this plan provides a tabulation of technical reports and publications that are used as a basis of existing information pertinent to the objectives of this study. Reports and publications of work sponsored by the NNWSI Project are listed, including those produced by the USGS and and other project participants. Data, samples, interpretations, and conclusions pertinent to the stratigraphy of the Yucca Mountain Site area are described in these documents.

Data compiled or produced throughout this study, which will be used for site characterization will be input to or obtained from the NNWSI Project data base in accordance with WMPO procedures.

9076200358

Data or data interpretation developed prior to August 1980, the implementation date of the NNWSI Quality Assurance Plan, will be handled according to procedures outlined in the USGS Quality Assurance Plan, NNWSI-USGS QMP-17.02 (Acceptance of Data Not Developed Under the NNWSI QA Plan). QMP-17.02 is not intended to cover data or data interpretations that were generated by the NNWSI participants after August 1980. Data or data interpretations developed after August 1980 will be handled according to procedures outlined in NNWSI-USGS QMP-3.04 (Technical Review of NNWSI-USGS Publications). Data or data interpretations generated after August 1980 where the NNWSI QA Plan was not implemented shall be processed in accordance with NNWSI-USGS QMP-15.01 (Control of Nonconforming Items).

2.4 Program Interfaces

This study supports the effort to investigate erosion in the Yucca Mountain region; Tectonics and Volcanism, WBS 1.2.3.2.3.1. To save time and effort, geomorphic maps are constructed from much of the effort conducted to develop surficial deposit maps; Climatology, WBS 1.2.3.3.7. Ages of stream terraces, Isotope Geology, WBS 1.2.3.2.3.2; help to refine average incision rates used to calculate future erosion rates contributing to an evaluation of the paleoenvironmental history; Climatology, WBS 1.2.3.3.7. Stream gradient data supplements streamflow studies conducted under Streamflow, WBS 1.2.3.3.1.

Several geologic tasks provide supporting evidence to aid the evaluation of erosion. Rock varnish dates are calibrated using K-Ar dated volcanic rocks; Geochemistry, WBS 1.2.3.4. U-trend methods; Isotope Geology, WBS 1.2.3.3.1; provide dates for alluvial deposits. Drillhole; Site Geology, WBS 1.2.3.2.1.1; and geophysical; Geophysical Investigations, WBS 1.2.3.2.2; data are examined to determine if Fortymile wash is situated along a fault or fault zone.

Data base management for site characterization activities is coordinated through the NNWSI-Project data bases developed under Technical Data Base Management, WBS 1.2.1.3. Sample management is coordinated through the NNWSI-Project sample management facility.

9076200/359

3.0 DESCRIPTION OF ACTIVITIES

3.1 Development of a Geomorphic Map of Yucca Mountain

3.1.1 Introduction

The objectives of this activity are (1) to determine the areal distribution of active erosional areas and geomorphically stable areas, and (2) to determine the spatial distribution of the different types of geomorphic processes and associated deposits.

The distribution of landforms and areas of present and past erosion at Yucca Mountain will be shown on a geomorphic map of the area. The map will clearly show the limited areas of modern erosion, and the large stable areas that are mainly unaffected by modern erosion. Accurate distribution of areas of modern erosion is important for calculation of present and future erosion rates.

The geomorphic map is expected to be a derivative map of the surficial deposits map. The surficial deposits map will show the types and ages of surficial deposits on the landscape. The geomorphic map will show landforms and the types of past and present geomorphic processes that are chiefly responsible for the deposition (and in some cases the removal) of these deposits. Age of deposits can be used to infer the relative stability or instability of the deposit or landform. In order to save time and duplication of effort, the geomorphic map will be constructed from much of the aerial photograph interpretation and field checking of deposits and map unit contacts that will be done for the surficial deposits map. Dating of surficial deposits, with the exception of the detailed study of hillslope deposits, will also be accomplished in the surficial deposits map activity and in the eolian history activity. Anticipated field work will be limited to examination of areas that are not studied in detail by other erosion and paleoenvironmental activities. The geomorphic interpretation of the surficial deposits will be primarily based upon the interpretations of origins from other paleoenvironmental studies of Yucca Mountain and reported in the synthesis of the Quaternary history of Yucca Mountain.

3.1.2 Supporting Activities

3.1.3 Equipment

Equipment required to conduct this activity is identified in the technical procedures. No additional major equipment is required for this activity. Maintenance and repair of existing equipment, however, may be necessary.

3.1.4 Methods, Procedures, and Quality Assurance

Specific investigative methods used in the development of a geomorphic map study are listed in Table 3-1. Identified in the table are supporting technical procedures used to assure the quality and traceability of the activity and data collection; the applicable QALA numbers; and software requirements.

9076200/360

Approved procedures are identified with a USGS number, title, and effective date. Procedures that require preparation before this plan is implemented are identified as being needed. Work shall not proceed on these activities until the applicable technical procedures have been prepared, reviewed, and approved in accordance with NNWSI-USGS-QMP-5.01. Appendix A of this plan contains completed Quality Assurance Level Assignments (QALA) for each method identified including criteria exception justifications for each method identified.

9076200/361

Table 3-1. Methods and Technical Procedures for Development of a Geomorphic Map of Yucca Mountain

Method	Technical Procedure Number (NWM-USGS-)	Technical Procedure Title	Technical Procedure Date	QA Level Assignment Sheet (QALAS) Number (NNWSI-QALA-)	Software Reference
Preparation of a geomorphic map of Yucca Mountain from the surficial deposits map	GP-01, R0	Geologic Mapping *and derivative, interpretive maps*	to be revised	3231G-10-01	

3.2 Analysis of the Downcutting History of Fortymile Wash and Its Tributaries

3.2.1 Introduction

The objectives of this activity are (1) to determine stream incision rates on Fortymile Wash and selected tributaries; and (2) to determine the causes of major downcutting episodes on Fortymile Wash.

Fortymile Wash is a major geomorphic feature situated about 3 kilometers (1.9 miles) east of the proposed repository. The wash flows south out of the Timber Mountain caldera drainage basin, about 680 square kilometers (261 square miles) in size, and is incised between 20 and 25 meters (66 and 82 feet) into Quaternary deposits along its course east of Yucca Mountain (Swadley et al, 1984). Dune, Sever, and Yucca Washes are incised from 2 to 25 meters (6 and 82 feet) into Quaternary deposits as measured from topographic maps. The washes and their tributaries are incised as much as 100 meters (328 feet) into bedrock dip slopes and along fault and fracture zones on the east side of Yucca Mountain.

Rates of stream incision are greater than surface degradation rates, and the downcutting of the Fortymile Canyon represents the highest localized erosion rate at Yucca Mountain. The average rate of stream incision below the main stream terrace is about 8.5 centimeters (3.3 inches) per 1,000 years (Swadley et al, 1984). However, the age of the stream terrace is based not on a direct radiometric age, but on correlation to isotopically dated deposits with similar soil development. In this study, all major stream terraces on Fortymile Wash will be dated by either U-trend, rock varnish (cation ratios), or radiocarbon methods. By dating all terraces, average incision rates can be refined for specific intervals of downcutting between episodes of valley aggradation and subsequent terrace formation. Terraces on Fortymile Wash tributaries will be dated in an effort to refine the youngest episodes of valley aggradation and incision. These site-specific incision rates will be used to calculate future erosion rates near the repository. This information will also be valuable for interpreting the paleoenvironmental history of Yucca Mountain.

Another aspect of this activity is to determine the cause or causes for the downcutting of Fortymile Canyon, because this canyon is unusually deep when compared to other canyons in Great Basin piedmonts and basins. Structural control of the canyon has been suggested (but not proven) because major faults bounding Yucca Mountain also have a north-south orientation. Stream capture has also been suggested as a mechanism partly responsible for accelerated stream incision, but this hypothesis is also unproven. To identify contributing factors to this unique geomorphic feature, former stream gradients will be reconstructed from stream terrace profiles, and stream gravel lithologies will be examined to identify any changes in upper basin source areas. These two investigations will help in deciding whether or not stream capture was a major factor in the formation of Fortymile Wash. Also, all relevant subsurface information, both drillhole and geophysical data, will be examined to decide whether or not Fortymile Wash is situated along a fault or fault zone.

9076200/363

3.2.2 Supporting Activities

3.2.3 Equipment

Equipment required to conduct this activity is identified in the technical procedures. No additional major equipment is required for this activity. Maintenance and repair of existing equipment, however, may be necessary.

3.2.4 Methods, Procedures, and Quality Assurance

Specific investigative methods used in the analysis of the downcutting history of Fortymile Wash and its tributaries study are listed in Table 3-2. Identified in the table are supporting technical procedures used to assure the quality and traceability of the activity and data collection; the applicable QALA numbers; and software requirements.

Approved procedures are identified with a USGS number, title, and effective date. Procedures that require preparation before this plan is implemented are identified as being needed. Work shall not proceed on these activities until the applicable technical procedures have been prepared, reviewed, and approved in accordance with NNWSI-USGS-QMP-5.01. Appendix A of this plan contains completed Quality Assurance Level Assignments (QALA) for each method identified including criteria exception justifications for each method identified.

9076200/364

Table 3-2. Methods and Technical Procedures for Analysis of the Downcutting History of Fortymile Wash and Its Tributaries

Method	Technical Procedure: Number (NWM-USGS-)	Technical Procedure: Title	Technical Procedure: Date	QA Level Assignment Sheet (QALAS) Number (NNWSI-QALA-)	Software Reference
Dating of major terraces on Fortymile Wash	GCP-02, R0	Labeling, Identification, and Control of Geochronology Samples	04/30/81	3231G-10-02	
	GCP-04, R0	Uranium-Trend Dating	06/15/81		
	GCP-03, R0	Uranium-Series Dating	06/15/81		
	Needed	Cation Ratio (desert varnish) Dating *			
	Needed	Radiocarbon Dating			
Generation of stream gradients	Needed	Generation of Stream Gradients		3231G-10-03	
Identification of gravel lithologies	GP-03,R0	Stratigraphic Studies	03/01/83	3231G-10-04	
Examination of lithologic logs of previously drilled boreholes	GP-02, R0	Subsurface Investigations	03/01/83	3231G-10-05	

* Responsibility applies to LANL and is referenced here as an interface, if USGS assumes responsibility for method, the technical procedures will be developed.

3.3 Analysis of Hillslope Erosion

3.3.1 Introduction

The objectives of this activity are (1) to calculate Quaternary rates of hillslope erosion on Yucca Mountain in bedrock and surficial deposits, and (2) to determine genesis and rates of movement of hillslope deposits.

Degradation of upland areas in the Yucca Mountain region is relatively slow, with average downwasting rates over the last 1 to 5 million years probably between 0.5 to 2.0 centimeters (0.2 to 0.8 inches) per 1,000 years on lower hillslopes and proximal piedmont areas and less than 0.5 centimeters (0.2 inches) per 1,000 years in middle and distal piedmont areas (Dohrenwend et al, 1984; Dohrenwend, 1986).

The main objective in this activity is to obtain site-specific data on upland erosion from the Yucca Mountain area. These data will be used to calculate average Quaternary erosion rates on hillslopes, which are among the most actively eroding landscape units in the site vicinity except for Fortymile Wash. Site-specific erosion rates calculated from hillslopes and adjacent piedmont surfaces will be the most accurate and applicable erosion rates pertaining to the proposed repository. These will be the rates that will be adjusted in the postclosure period on the basis of postulated future tectonic activity and future climates.

The calculation of site-specific erosion rates will be possible because of the development of a new dating technique for analysis of rock varnish. Rock varnish (sometimes called desert varnish) is nearly ubiquitous in semiarid and arid regions. It is a thin coat of ferromanganese oxides, clay minerals, and biologic material accreted on rocks in a variety of environmental settings. Varnished deposits and surfaces can be dated because several mobile cations in the varnish are depleted with time. The ratio of mobile to immobile cations (K+Ca/Ti) decreases with time, providing a relative age sequence for varnishes in a given area. Absolute age estimates of varnishes in the Yucca Mountain area can be determined because a cation-leaching curve is calibrated by cation ratios from K-Ar-dated volcanic rocks in Crater Flat and by U-trend-dated alluvial deposits near Yucca Mountain. Maximum incision parallel to the dated hillslope deposits and bedrock surfaces will be measured, and where possible, volumes of sediment stripped from the hillslope will be calculated by a computer-assisted photogrammetric mapping system. Erosion rates for surficial deposits and bedrock will be different because of the greater competence and slow weathering rates of the volcanic tuffs. Erosion rates for both bedrock and surficial deposits will be used to estimate future erosion rates during the postclosure period.

The origin of the hillslope deposits has not been explained, so part of this activity will focus on investigating the genesis and history of these deposits. An understanding of their genesis and history is important to both the erosional history and to the paleoenvironmental history of Yucca Mountain. The texture of these deposits will be determined by grain size analysis, and sedimentary structures of the deposits will be described where the deposits have been exposed by erosion or shallow excavations.

9076200366

Detailed dating of these deposits will make it possible to describe whether hillslope erosion has been more or less continuous throughout the Quaternary, or whether there have been climatically controlled episodes of accelerated hillslope erosion.

It is anticipated that these erosion rate studies will indicate that the proposed repository is situated in an environment having unusually low Quaternary erosion rates, and that future erosion rates will not pose a hazard to the repository.

3.3.2 Supporting Activities

3.3.3 Equipment

Equipment required to conduct this activity is identified in the technical procedures. No additional major equipment is required for this activity. Maintenance and repair of existing equipment, however, may be necessary.

3.3.4 Methods, Procedures, and Quality Assurance

Specific investigative methods used in the analysis of hillslope erosion studies are listed in Table 3-3. Identified in the table are supporting technical procedures used to assure the quality and traceability of the activity and data collection; the applicable QALA numbers; and software requirements.

Approved procedures are identified with a USGS number, title, and effective date. Procedures that require preparation before this plan is implemented are identified as being needed. Work shall not proceed on these activities until the applicable technical procedures have been prepared, reviewed, and approved in accordance with NNWSI-USGS-QMP-5.01. Appendix A of this plan contains completed Quality Assurance Level Assignments (QALA) for each method identified including criteria exception justifications for each method identified.

9076200/367

Table 3-3. Methods and Technical Procedures for Analysis of Hillslope Erosion

Method	Technical Procedure Number (NWM-USGS-)	Technical Procedure Title	Technical Procedure Date	QA Level Assignment Sheet (QALAS) Number (NNWSI-QALA-)	Software Reference
Rock varnish dating of hillslope deposits	Needed	Cation-Ratio (desert varnish) Dating *		3231G-10-06	TBD
Measurement of hillslope erosion	Needed	Measurement of Hillslope Erosion		3231G-10-07	TBD
Laboratory analysis of hillslope deposits	Needed	Sediment Size Analysis		3231G-10-08	

* Responsibility applies to LANL and is referenced here as an interface, if USGS assumes responsibility for method, the technical procedures will be developed.

4.0 SCHEDULE AND MILESTONES

The field investigations of this study will commence following approval of the technical procedures. An essential component of the quality assurance level assignments includes the identification of technical procedures required of all QA Level 1 activities. Preparation of these procedures constitutes a prerequisite for initiating this study. The schedule presented in Figure 4-1 summarizes a sequence of events associated with the preparation of the technical procedures and the activities for this study. These diagrams are referenced to the start of a fiscal year but are dependent on completion of technical procedures.

A list of reports resulting from this study is included in Table 4-1.

076200/369

Figure 4-1. Summary Logic Network for Distribution and Characteristics of Past Erosion.

DISTRIBUTION & CHARACTERISTICS OF PAST EROSION

DATE: 3-12-87

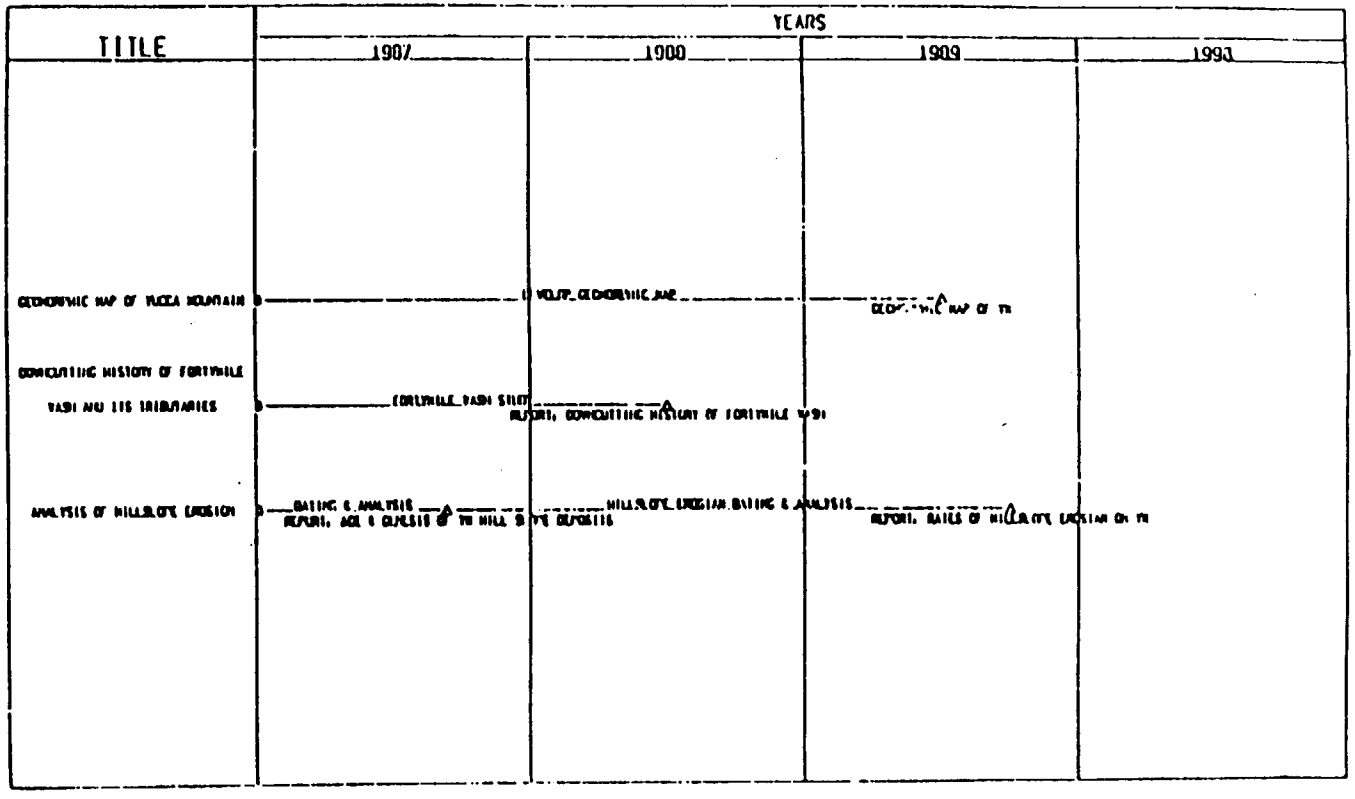


Table 4-1. List of Reports Identified for the Distribution and Characteristics of Past Erosion.

Node	Description
TBD	Map: Geomorphic Map of Yucca Mountain, 1:24,000
TBD	Report: Downcutting History of Fortymile Wash
TBD	Report: Age and Genesis of Yucca Mountain Hillslope Deposits
TBD	Report: Rates of Hillslope Erosion on Yucca Mountain

9076200/371

REFERENCES

Bull, W. B., 1984. "Tectonic Geomorphology," Journal of Geological Education, Vol. 32, pp. 310-324.

Bull, W. B., and McFadden, L. D., 1977. "Tectonic Geomorphology North and South of the Garlock Fault, California," Geomorphology in Arid Regions, Proceedings of the 8th Binghampton Symposium in Geomorphology Held at the State University of New York at Binghampton, September 23-24, 1977, D. O. Doehring (ed.), pp. 115-138.

Christensen, R. C., and Spahr, N. E., 1980. Flood Potential of Topopah Wash and Tributaries, Eastern Part of Jackass Flats, Nevada Test Site, Southern Nevada, U.S. Geological Survey Open-File Report 80-963, 22 p.

Dohrenwend, J. C., 1985. "Patterns and Processes of Middle and Late Quaternary Dissection in the Tecopa Basin, California," Quaternary Lakes of the Eastern Mojave Desert, California, G. R. Hale (ed.), Friends of the Pleistocene, Pacific Cell 1985 Annual Meeting Guidebook, pp. 113-144.

Dohrenwend, J. C., 1987. Morphometric Comparison of Tectonically Defined Areas within Mojave Desert and Southern Great Basin, U.S. Geological Survey Open-File Report 87-83, 34 p.

Dohrenwend, J. C., Wells, S. G., Turrin, B. D., and McFadden, L. D., 1984. "Rates and Trends of Late Cenozoic Landscape Degradation in the Area of the Cima Volcanic Field, Mojave Desert, California," Surficial Geology of the Eastern Mojave Desert, California, J. C. Dohrenwend (ed.), Geological Society of America 1984 Annual Meeting Guidebook, pp. 101-115.

Dohrenwend, J. C., Turrin, B. D., Diggles, M. F., 1985. "Topographic Distribution of Dated Basaltic Lava Flows in the Reveille Range, Nye County, Nevada: Implications for Late Cenozoic Erosion of Upland Areas in the Great Basin (abs.)," Geological Society of America, Abstracts with Programs, Vol. 17, pp. 351.

Glancy, P. A., and Harmsen, Lynn, 1975. A Hydrologic Assessment of the September 14, 1974, Flood in Eldorado Canyon, Nevada, U.S. Geological Survey Professional Paper 930, 28 p.

Hoover, D. L., Swadley, W C, and Gordon, A. J., 1981. Correlation Characteristics of Surficial Deposits with a Description of Surficial Stratigraphy in the Nevada Test Site Region, U.S. Geological Survey Open-File Report 81-512, 27 p.

Marchand, D E., 1971. "Rates and Modes of Denudation, White Mountains, Eastern California," American Journal of Science, Vol. 270, pp. 109-135.

McFadden, L. D., Wells, S. G., and Dohrenwend, J. C., 1985. "The Influence of Eolian Flux Rates and Climatic Change in the Development of Stone Pavements and Associated Soils in the Cima Volcanic Field, Mojave Desert, California [abs.]," Geological Society of America, Abstracts and Programs, Vol. 17, 368 p.

9076200/372

Peterson, F. F., 1981. Landforms of the Basin and Range Province Defined for Soil Survey. Technical Bulletin 28, Nevada Agricultural Experiment Station, University of Nevada, Reno, 52 p.

Reheis, M. C., 1986. Preliminary Study of Quaternary Faulting on the East Side of Bare Mountain, Nye County, Nevada. U.S. Geological Survey Open-File Report 86-576, 14 p.

Rosholt, J. N., Bush, C. A., Carr, W. J., Hoover, D. L., Swadley, W C, and Dooley, J. R. Jr., 1985. Uranium-Trend Dating of Quaternary Deposits in the Nevada Test Site Area, Nevada and California. U.S. Geological Survey Open-File Report 85-540, 37 p.

Scott, R. B., and Bonk, J., 1984. Preliminary Geologic Map of Yucca Mountain, Nye County, Nevada, with Geologic Sections. U.S. Geological Survey Open-File Report 84-494, xx p.

Spaulding, W. G., 1985. Vegetation and Climates of the Last 45,000 Years, Vicinity of the Nevada Test Site, Nevada. U.S. Geological Survey Professional Paper 1329, 83 p.

Squires, R. R., and Young, R. L., 1984. Flood Potential of Fortymile Wash and Its Principal Southwestern Tributaries, Nevada Test Site, Southern Nevada. U.S. Water-Resource Investigations Report 83-4001, 33p.

Swadley, W C, 1983. Map Showing Surficial Geology of the Lathrop Wells Quadrangle, Nye County, Nevada. U.S. Geological Survey Miscellaneous Investigations Map I-1361, scale 1:48,000.

Swadley, W C, Hoover, D. L., and Rosholt, J. N., 1984. Preliminary Report on Late Cenozoic Faulting and Stratigraphy in the Vicinity of Yucca Mountain, Nye County, Nevada. U.S. Geological Survey Open-File Report 84-788, 42 p.

Szabo, B. J., Carr, W. J., and Gottschall, W. C., 1981. Uranium-Thorium Dating of Quaternary Carbonate Accumulations in the Nevada Test Site Region, Southern Nevada. U.S. Geological Survey Open-File Report 81-119, 35 p.

Tayor, E. M., 1986. Impact of Time and Climate on Quaternary Soils in the Yucca Mountain Area of the Nevada Test Site. M.S. thesis, University of Colorado, Boulder, Colorado.

Wells, S. G., McFadden, L.D., Dohrenwend, J. C., Bullard, T. F., Feiberg, B. F., Ford, R. L., Grimm, J. P., Miller, J. R., Orbock, S. M., and Pickle, J. D., 1985. "Late Quaternary Geomorphic History of the Silver Lake Area: An Example of the Influence of Climatic Changes on Desert Piedmont Evolution in the Eastern Mojave Desert of California." Quaternary Lakes of the Eastern Mohave Desert, California, Friends of the Pleistocene, Pacific Cell, 1985 Meeting, Field Trip Guidebook, G. R. Hale (ed.), pp. 82-100.

9076200/373

Wells, S. G., Dohrenwend, J. C., McFadden, L. D., Turrin, B. D., and Mahrer, K. D., 1985. "Late Cenozoic Landscape Evolution on Lava Flow Surfaces of the Cima Volcanic Field, Mojave Desert, California," Geological Society of America Bulletin, Vol. 96, No. 12, pp. 1518-1529.

Whitney, J. W., Swadley, W C, and Shroba, R. R., 1985. "Middle Quaternary Sand Ramps in the Southern Great Basin, California and Nevada", Geological Society of America, Abstracts with Programs, Vol. 17, p. 750.

Whitney, J. W., Shroba, R. R., Simonds, F. W., and Harding, S. T., 1986. "Recurrent Quaternary Movement on the Windy Wash Fault, Nye County, Nevada", Geological Society of America, Abstracts with Programs, Vol. 18, p.787.

9076200/374

Appendix A - Quality Assurance Level Assignments (QALA)

9076200/375

NNWSI - USGS QUALITY LEVELS ASSIGNMENT SHEET (QALAS) NNWSI-QALA-3231G-10-01, R0

Activity - Development of a Geomorphic Map of Tucca Mountain Page 1 of 1

Method - Preparation of a geomorphic map of Tucca Mountain from the surficial deposits map

Method/Item Breakdown	QA Level	NQA-1 Criteria Requirements*	Justification of Level & QA Criteria Exceptions
Preparation of a geomorphic map of Tucca Mountain from the surficial deposits map	I	1,2,3,4,5,6,7,8, 10,12,13,15,16, 17,18	Meets step No. 2 of the QA Level Checklist wherein this item is a step in providing site characterization data that has a significant impact on the data base that supports the final repository design and assessment of the repository performance. Criteria excluded: 9 - not a special process; 11 - no tests or research involved; 14 - not part of USGS QA Program.

*LEGEND OF 18 QA CRITERIA of NQA-1

1 ORGANIZATION	7 CONTROL OF PURCHASED MAT'L, EQUIPMENT, SERVICES	13 HANDLING, STORAGE & SHIPPING
2 QA PROGRAM	8 ID & CONTROL OF MATERIALS, PARTS & SAMPLES	14 INSPECTION, TEST, & OP. STATUS
3 DESIGN & SITE INVESTIGATION CONTROL	9 CONTROL OF SPECIAL PROCESSES	15 CONTROL OF NONCONFORMING ITEMS
4 PROCUREMENT DOCUMENT CONTROL	10 INSPECTION (SURVEILLANCE)	16 CORRECTIVE ACTION
5 INSTRUCTIONS, PROCEDURES & DRAWINGS	11 TEST & EXPERIMENT/RESEARCH CONTROL	17 QA RECORDS
6 DOCUMENT CONTROL	12 CONTROL OF MEASURING & TEST EQUIPMENT	18 AUDITS

APPROVALS

John W Whitney	8/25/87	J R Willmon	8/28/87	A H Handy	8/28/87
Originator (J. Whitney)	Date	Quality Assurance Manager (J. R. Willmon)	Date	Chief, Branch of NNWSI (A. H. Handy, for L. R. Hayes)	Date
NNPO Quality Assurance	Date	NNPO Technical	Date	Effective Date	

9 7 7 6 0 2 5 2

NNWSI - USGS QUALITY LEVELS ASSIGNMENT SHEET (QALAS)

Activity - Analysis of the Downcutting History of Fortymile Wash and Its Tributaries

Method - Dating of major terraces on Fortymile Wash

Method/Item Breakdown	QA Level	NQA-1 Criteria Requirements*	Justification of Level & QA Criteria Exceptions
Cation ratio (LANL) radiocarbon, U-series, and U-trend dating of soils	I	1,2,3,4,5,6,7,8, 10,12,13,15,16, 17,18	Meets step No. 2 of the QA Level Checklist wherein the item provides data to be used in site characterization. Criteria excluded: 9 - not a special process; 11 - no tests or research involved; 14 - not part of USGS QA Program.

*LEGEND OF 18 QA CRITERIA of NQA-1

1 ORGANIZATION	7 CONTROL OF PURCHASED MAT'L, EQUIPMENT, SERVICES	13 HANDLING, STORAGE & SHIPPING
2 QA PROGRAM	8 ID & CONTROL OF MATERIALS, PARTS & SAMPLES	14 INSPECTION, TEST, & OP. STATUS
3 DESIGN & SITE INVESTIGATION CONTROL	9 CONTROL OF SPECIAL PROCESSES	15 CONTROL OF NONCONFORMING ITEMS
4 PROCUREMENT DOCUMENT CONTROL	10 INSPECTION (SURVEILLANCE)	16 CORRECTIVE ACTION
5 INSTRUCTIONS, PROCEDURES & DRAWINGS	11 TEST & EXPERIMENT/RESEARCH CONTROL	17 QA RECORDS
6 DOCUMENT CONTROL	12 CONTROL OF MEASURING & TEST EQUIPMENT	18 AUDITS

APPROVALS

J. W. Whitney	8/27/87	J. R. Ullman	8/28/87	A. H. Handy	8/28/87
Originator (J. Whitney)	Date	Quality Assurance Manager (J. R. Ullman)	Date	Chief, Branch of NNWSI (A. H. Handy, for L. R. Hayes)	Date
NNPO Quality Assurance	Date	NNPO Technical	Date	Effective Date	

1 1 7 5 2 0 2 7 7

NNWSI - USGS QUALITY LEVELS ASSIGNMENT SHEET (QALAS)

NNWSI-QALA-3231G-10-03, R0

Activity - Analysis of the Downcutting History of Fortymile Wash and Its Tributaries

Method - Generation of stream gradients

Method/Item Breakdown	QA Level	NQA-1 Criteria Requirements*	Justification of Level & QA Criteria Exceptions
Generation of stream gradients	I	1,2,3,4,5,6,7,8, 10,12,13,15,16, 17, 18	Meets step No. 5 of the QA Level Checklist wherein this item can impact the entire activity and other related Level I activities if not performed correctly. Criteria excluded: 9 - not a special process; 11 - no tests or research involved; 14 - not part of USGS QA Program.

*LEGEND OF 18 QA CRITERIA of NQA-1

1 ORGANIZATION
2 QA PROGRAM
3 DESIGN & SITE INVESTIGATION CONTROL
4 PROCUREMENT DOCUMENT CONTROL
5 INSTRUCTIONS, PROCEDURES & DRAWINGS
6 DOCUMENT CONTROL
7 CONTROL OF PURCHASED MAT'L, EQUIPMENT, SERVICES
8 ID & CONTROL OF MATERIALS, PARTS & SAMPLES
9 CONTROL OF SPECIAL PROCESSES
10 INSPECTION (SURVEILLANCE)
11 TEST & EXPERIMENT/RESEARCH CONTROL
12 CONTROL OF MEASURING & TEST EQUIPMENT
13 HANDLING, STORAGE & SHIPPING
14 INSPECTION, TEST, & OP. STATUS
15 CONTROL OF NONCONFORMING ITEMS
16 CORRECTIVE ACTION
17 QA RECORDS
18 AUDITS

APPROVALS

J. W. Whitney	8/25/87	J. R. Willmon	8/26/87	A. N. Handy	8/28/87
Originator (J. Whitney)	Date	Quality Assurance Manager (J. R. Willmon)	Date	Chief, Branch of NNWSI (A. N. Handy, for L. R. Hayes)	Date
NNPO Quality Assurance	Date	NNPO Technical	Date	Effective Date	

9 7 1 0 0 2 7 5 1 1

NNWSI · USGS QUALITY LEVELS ASSIGNMENT SHEET (QALAS)

Activity · Analysis of the Downcutting History of Fortymile Wash and Its Tributaries

Method · Identification of gravel lithologies

Method/Item Breakdown	QA Level	NQA-1 Criteria Requirements*	Justification of Level & QA Criteria Exceptions
Identification of gravel lithologies	I	1,2,3,4,5,6,7,8, 10,12,13,15,16, 17,18	Meets step No. 2 of the QA Level Checklist wherein the item provides data to be used in site characterization. Criteria excluded: 9 · not a special process; 11 · no tests or research involved; 14 · not part of USGS QA Program.

*LEGEND OF 18 QA CRITERIA of NQA-1

1 ORGANIZATION	7 CONTROL OF PURCHASED MAT'L, EQUIPMENT, SERVICES	13 HANDLING, STORAGE & SHIPPING
2 QA PROGRAM	8 ID & CONTROL OF MATERIALS, PARTS & SAMPLES	14 INSPECTION, TEST, & OP. STATUS
3 DESIGN & SITE INVESTIGATION CONTROL	9 CONTROL OF SPECIAL PROCESSES	15 CONTROL OF NONCONFORMING ITEMS
4 PROCUREMENT DOCUMENT CONTROL	10 INSPECTION (SURVEILLANCE)	16 CORRECTIVE ACTION
5 INSTRUCTIONS, PROCEDURES & DRAWINGS	11 TEST & EXPERIMENT/RESEARCH CONTRC.	17 QA RECORDS
6 DOCUMENT CONTROL	12 CONTROL OF MEASURING & TEST EQUIPMENT	18 AUDITS

APPROVALS

J. W. Whitney	8-25-87	J. R. Willmon	8/26/87	A. H. Handy	8/26/87
Originator (J. Whitney)	Date	Quality Assurance Manager (J. R. Willmon)	Date	Chief, Branch of NNWSI (A. H. Handy, for L. R. Hayes)	Date
NNPO Quality Assurance	Date	NNPO Technical	Date	Effective Date	

0 2 7 6 9

NNWSI · USGS QUALITY LEVELS ASSIGNMENT SHEET (QALAS)

NNWSI-QALA-3231G-10-05, R0

Activity · Analysis of the Downcutting History of Fortymile Wash and Its Tributaries

Method · Examination of lithologic logs of previously drilled boreholes

Method/Item Breakdown	QA Level	NQA-1 Criteria Requirements*	Justification of Level & QA Criteria Exceptions
Examination of lithologic logs of previously drilled boreholes	I	1,2,3,4,5,6,7,8, 10,12,13,15,16, 17,18	Meets step No. 5 of the QA Level Checklist wherein this item can impact the entire activity and other related Level I activities if not performed correctly. Criteria excluded: 9 · not a special process; 11 · no tests or research involved; 14 · not part of USGS QA Program.

*LEGEND OF 18 QA CRITERIA of NQA-1

1 ORGANIZATION
2 QA PROGRAM
3 DESIGN & SITE INVESTIGATION CONTROL
4 PROCUREMENT DOCUMENT CONTROL
5 INSTRUCTIONS, PROCEDURES & DRAWINGS
6 DOCUMENT CONTROL
7 CONTROL OF PURCHASED MAT'L, EQUIPMENT, SERVICES
8 ID & CONTROL OF MATERIALS, PARTS & SAMPLES
9 CONTROL OF SPECIAL PROCESSES
10 INSPECTION (SURVEILLANCE)
11 TEST & EXPERIMENT/RESEARCH CONTROL
12 CONTROL OF MEASURING & TEST EQUIPMENT
13 HANDLING, STORAGE & SHIPPING
14 INSPECTION, TEST, & OP. STATUS
15 CONTROL OF NONCONFORMING ITEMS
16 CORRECTIVE ACTION
17 QA RECORDS
18 AUDITS

APPROVALS

Originator (J. Whitney)	8-15-87 Date	Quality Assurance Manager (J. R. Willmon)	8/24/87 Date	Chief, Branch of NNWSI (A. H. Handy, for L. R. Hayes)	8/25/87 Date
NNPO Quality Assurance	Date	NNPO Technical	Date	Effective Date	

NNWSI · USGS QUALITY LEVELS ASSIGNMENT SHEET (QALAS)

NNWSI QALA-3231G-10 06, 80

Activity · Analysis of Hillslope Erosion

Page 1 of 1

Method · Rock varnish dating of hillslope deposits

Method/Item Breakdown	QA Level	NQA-1 Criteria Requirements*	Justification of Level & QA Criteria Exceptions
Cation ratio	I	1,2,3,4,5,6,7,8, 10,12,13,15,16, 17,18	Meets step No. 2 of the QA Level Checklist wherein the item provides data to be used in site characterization. Criteria excluded: 9 · not a special process; 11 · no tests or research involved; 14 · not part of USGS QA Program.

*LEGEND OF 18 QA CRITERIA of NQA-1

1 ORGANIZATION	7 CONTROL OF PURCHASED MAT'L, EQUIPMENT, SERVICES	13 HANDLING, STORAGE & SHIPPING
2 QA PROGRAM	8 ID & CONTROL OF MATERIALS, PARTS & SAMPLES	14 INSPECTION, TEST, & OP. STATUS
3 DESIGN & SITE INVESTIGATION CONTROL	9 CONTROL OF SPECIAL PROCESSES	15 CONTROL OF NONCONFORMING ITEMS
4 PROCUREMENT DOCUMENT CONTROL	10 INSPECTION (SURVEILLANCE)	16 CORRECTIVE ACTION
5 INSTRUCTIONS, PROCEDURES & DRAWINGS	11 TEST & EXPERIMENT/RESEARCH CONTROL	17 QA RECORDS
6 DOCUMENT CONTROL	12 CONTROL OF MEASURING & TEST EQUIPMENT	18 AUDITS

APPROVALS

John W Whitney	8-25-87	J R Willmon	8/26/87	A H Handy	8/28/87
Originator (J. Whitney)	Date	Quality Assurance Manager (J. R. Willmon)	Date	Chief, Branch of NNWSI (A. H. Handy, for L. R. Hayes)	Date
NNPO Quality Assurance	Date	NNPO Technical	Date	Effective Date	

2 i 7 6 2 0 7 8 1

NNWSI - USGS QUALITY LEVELS ASSIGNMENT SHEET (QALAS)

NNWSI-QALA-3231G-10-07, R0

Activity - Analysis of Hillslope Erosion

Page 1 of 1

Method - Measurement of hillslope erosion

Method/Item Breakdown	QA Level	NQA-1 Criteria Requirements*	Justification of Level & QA Criteria Exceptions
Measurement of hillslope erosion	1	1,2,3,4,5,6,7,8, 10,12,13,15,16, 17,18	Meets step No. 2 of the QA Level Checklist wherein the item provides data to be used in site characterization. Criteria excluded: 9 - not a special process; 11 - no tests or research involved; 14 - not part of USGS QA Program.

*LEGEND OF 18 QA CRITERIA of NQA-1

1 ORGANIZATION
2 QA PROGRAM
3 DESIGN & SITE INVESTIGATION CONTROL
4 PROCUREMENT DOCUMENT CONTROL
5 INSTRUCTIONS, PROCEDURES & DRAWINGS
6 DOCUMENT CONTROL
7 CONTROL OF PURCHASED MAT'L, EQUIPMENT, SERVICES
8 ID & CONTROL OF MATERIALS, PARTS & SAMPLES
9 CONTROL OF SPECIAL PROCESSES
10 INSPECTION (SURVEILLANCE)
11 TEST & EXPERIMENT/RESEARCH CONTROL
12 CONTROL OF MEASURING & TEST EQUIPMENT
13 HANDLING, STORAGE & SHIPPING
14 INSPECTION, TEST, & OP. STATUS
15 CONTROL OF NONCONFORMING ITEMS
16 CORRECTIVE ACTION
17 QA RECORDS
18 AUDITS

APPROVALS

John W Whitney	3-25-87	J R Willmon	3/26/87	A N Handy	8/28/87
Originator (J. Whitney)	Date	Quality Assurance Manager (J. R. Willmon)	Date	Chief, Branch of NNWSI (A. N. Handy, for L. R. Hayes)	Date
NNPO Quality Assurance	Date	NNPO Technical	Date	Effective Date	

0 7 3 2 0 7 5 2

NNWSI · USGS QUALITY LEVELS ASSIGNMENT SHEET (QALAS)
Activity · Analysis of Hillslope Erosion
Method · Laboratory analysis of hillslope deposits

Method/Item Breakdown	QA Level	NQA-1 Criteria Requirements*	Justification of Level & QA Criteria Exceptions
Laboratory analysis of hillslope deposits	I	1,2,3,4,5,6,7,8, 10,12,13,15,16, 17,18	Meets step No. 2 of the QA Level Checklist wherein this item is a step in providing site characterization data that has a significant impact on the data base that supports the final repository design and assessment of the repository performance. Criteria excluded: 9 · not a special process; 11 · no tests or research involved; 14 · not part of USGS QA Program.

*LEGEND OF 18 QA CRITERIA of NQA-1

1 ORGANIZATION
2 QA PROGRAM
3 DESIGN & SITE INVESTIGATION CONTROL
4 PROCUREMENT DOCUMENT CONTROL
5 INSTRUCTIONS, PROCEDURES & DRAWINGS
6 DOCUMENT CONTROL
7 CONTROL OF PURCHASED MAT'L, EQUIPMENT, SERVICES
8 ID & CONTROL OF MATERIALS, PARTS & SAMPLES
9 CONTROL OF SPECIAL PROCESSES
10 INSPECTION (SURVEILLANCE)
11 TEST & EXPERIMENT/RESEARCH CONTROL
12 CONTROL OF MEASURING & TEST EQUIPMENT
13 HANDLING, STORAGE & SHIPPING
14 INSPECTION, TEST, & OP. STATUS
15 CONTROL OF NONCONFORMING ITEMS
16 CORRECTIVE ACTION
17 QA RECORDS
18 AUDITS

APPROVALS

J. W. Whitney	8-25-87	J. R. Willman	8/25/87	A. H. Handy	8/28/87
Originator (J. Whitney)	Date	Quality Assurance Manager (J. R. Willman)	Date	Chief, Branch of NNWSI (A. H. Handy, for L. R. Hayes)	Date
NNPO Quality Assurance	Date	NNPO Technical	Date	Effective Date	

2 1 7 4 0 0 7 3 3