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Civilian Radioactive Waste Management System
Management & Operating Contractor

Data Qualification Report: Precipitation and Surface Geology Data for Use on the Yucca Mountain Project

TDR-NBS-GS-000022, REV. 00

November 2000

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Prepared by:

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Charles Wilson, Chairperson — 11/29/00 Date

for Stephen Alcorn
Stephen Alcorn, Technical Representative — 11/30/00 Date

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EXECUTIVE SUMMARY

This Data Qualification Report uses technical assessment and corroborating data methods according to Attachment 2 of AP-SIII.2Q, Rev. 00, Interim Change Notice (ICN) 3, *Qualification of Unqualified Data and the Documentation of Rationale for Accepted Data*, to qualify precipitation and surface geology data from four unqualified Data Tracking Numbers (DTNs) for use on the Yucca Mountain Site Characterization Project (YMP). This report was prepared in accordance with Data Qualification Plan DQP-NBS-GS-000001, Rev. 00. The data considered in this report were collected under the direction of the U.S. Geological Survey (USGS) and used in the Analysis Model Report (AMR) U0010, *Simulation of Net Infiltration for Modern and Potential Future Climates*, ANL-NBS-HS-000032 (Hevesi et al. 2000).

The Data Qualification Team found that the only information used from the first DTN, GS960108312111.001, was a precipitation volume/station elevation regression equation. This equation defined a method that was adopted for use in the AMR. This method is not data and its use does not require qualification.

The second DTN, GS000208312111.003, contains precipitation data collected by the USGS at Yucca Mountain. These data are unqualified because they were collected before the USGS Quality Assurance Program Plan (QAPP) was approved in 1989. Most of the data were collected following a written procedure that was later approved without revision for use under the USGS QAPP. The unqualified precipitation data were corroborated through a comparison with accepted data from two nearby weather stations. The positive corroborative results and the procedural continuity from the unqualified to the qualified data collection periods support the adequacy of the unqualified precipitation data for generalized uses.

The final DTNs, MO0003COV00095.000 and GS930283117461.001, are digitized and hard copy versions, respectively, of a geologic map by Scott and Bonk (1984) prepared before the USGS QAPP was approved. A hard copy of the map was corroborated by comparing it with two other surface geologic maps. The levels of detail were reviewed and portions of the maps were superimposed to identify differences in contact locations. Geologic cross-sections accompanying the map were compared with corroborating cross-sections. In almost all instances, equivalent geologic contact locations varied from essentially coincident (up to about 50 feet deviation) to several hundred feet. This is reasonable and not unexpected, considering that the maps and sections were developed at different times, by different geologists, for different purposes, and by different methods. The largest differences generally reflected the different purposes of the maps (for example, depicting shallow alluvium versus bedrock). Examples of the largest differences are documented in Section 3.3 of this report to help prospective users determine the appropriateness of the information for specific applications. Given the variability that may be expected among geologic maps, but more importantly the consistency exhibited with the corroborating data, the Data Qualification Team considers the Scott and Bonk map and cross-sections to be suitable sources of geologic information.

Based on a preponderance of evidence, the Data Qualification Team has concluded that the data considered in this report are qualified for generalized uses and can be appropriately used in a wide variety of applications, so long as consideration is given to accuracy, precision, and representativeness of the data for an intended use in a technical product.

CONTENTS

ACRONYMS AND ABBREVIATIONS

ACC	Accession Number
AFR	Audit Finding Report
AMR	Analysis Model Report
DOE	U.S. Department of Energy
DTN	Data Tracking Number
EPA	U.S. Environmental Protection Agency
HP	Hydrologic Procedure
ICN	Interim Change Notice
M&O	Management and Operations
NCR	Nonconformance Report
NOAA	National Oceanographic and Atmospheric Administration
NRC	U.S. Nuclear Regulatory Commission
NTS	Nevada Test Site
OFR	Open File Report
QAPP	Quality Assurance Program Plan
TDMS	Technical Data Management System
TIC	Technical Information Center
USGS	U.S. Geological Survey
WRIR	Water Resources Investigations Report
YMP	Yucca Mountain Site Characterization Project

1. INTRODUCTION

1.1 PURPOSE

The unqualified data addressed in this qualification report have been cited in an Analysis Model Report (AMR) to support the Site Recommendation in determining the suitability of Yucca Mountain as a repository for high-level radioactive waste. The unqualified data include precipitation volumes and surface geology maps The precipitation data consist of daily precipitation volumes measured at Yucca Mountain. The surface geology data include identification of the types and surface expressions of geologic units and associated structural features such as faults. These data were directly used in AMR U0010, *Simulation of Net Infiltration for Modern and Potential Future Climates*, ANL-NBS-HS-000032 (Hevesi et al. 2000), to estimate net infiltration into Yucca Mountain. This report evaluates the unqualified data within the context of supporting studies of this type for the Yucca Mountain Site Characterization Project (YMP).

The purpose of this report is to identify data that can be cited as qualified for use in technical products to support the YMP Site Recommendation and that may also be used to support the License Application. The qualified data may either be retained in the original Data Tracking Number (DTN) or placed in new DTNs generated as a result of the evaluation. The appropriateness and limitations (if any) of the data with respect to intended use are addressed in this report. In accordance with Attachment 1 of procedure AP-3.15Q, Rev. 02, *Managing Technical Product Inputs*, it has been determined that the unqualified precipitation and surface geology data are not used in the direct calculation of Principal Factors for postclosure safety or disruptive events. References to tables, figures, and sections from Hevesi et al. (2000) are based on Rev. 00 of that document.

1.2 SCOPE

This report evaluates data identified in Data Qualification Plan DQP-NBS-GS-000001, Rev. 00. The plan identifies three DTNs containing unqualified precipitation and surface geology data collected by the U.S. Geological Survey (USGS) and cited in USGS literature. The surface geology data source cited in the aforementioned AMR was a digitized version of a USGS geologic map. One additional unqualified DTN, the original published version of the geologic map, was identified in the progress of this work. That map and its accompanying geologic cross-sections were included in this qualification activity. The data in these DTNs are evaluated for qualification in this report using the methods and criteria described in the qualification plan. Other precipitation and geologic mapping data are also available and are used for corroboration.

The following unqualified DTNs are addressed in this report.

DTN	Short Title
GS960108312111.001	*Geostatistical Model for Estimating Precipitation and Recharge in the Yucca Mountain Region, Nevada – California.* (Hevesi and Flint 1996)
GS000208312111.003	*Precipitation Data for July 17, 1987 through May 2, 1989 from Weather Stations 1 and 3, Yucca Mountain, Nevada.* (Flint 2000)
MO0003COV00095.000	*Coverage: SCOTBONS; Digital Version of the 1993 USGS 1:12,000 Geologic Map of Yucca Mountain by Scott and Bonk.* (Brickey 2000)
GS930283117461.001	*Preliminary Geologic Map of Yucca Mountain, Nye County, Nevada, with Geologic Sections* (Scott and Bonk 1984)

The DTNs are populated by specific data sets in the Technical Data Management System (TDMS) and maps within USGS reports. The unqualified geologic map in DTN GS930283117461.001 was published as a USGS Open File Report (OFR) and the geostatistical model in DTN GS960108312111.001 was prepared as a draft USGS Water Resources Investigations Report (WRIR). This qualification report focuses on the specific data selected to support the infiltration analysis of Hevesi et al. (2000). To the extent that only subsets of data within a specific DTN were used by Hevesi et al., only those data are evaluated for qualification. The unqualified data considered in this report support unsaturated zone flow and transport modeling.

1.3 DATA QUALIFICATION TEAM

The **Responsible Manager** for this data qualification task is Robert F. Wemheuer.

Chairperson

The Chairperson for the Data Qualification Team is Charles R. Wilson. Dr. Wilson has a Ph.D. (1970) in civil engineering with an emphasis in groundwater hydrology. He has 20 years of experience in site characterization for nuclear facilities. He served on the data qualification independent Peer Review Panel and was Chairperson of the U.S. Environmental Protection Agency (EPA)-mandated Conceptual Models Peer Review Panel for the license application for the U.S. Department of Energy's (DOE's) Waste Isolation Pilot Project. Dr. Wilson has had no involvement with the collection or processing of YMP data.

Technical Representative

Stephen R. Alcorn is a Data Qualification Team member. Dr. Alcorn has a Ph.D. (1981) in geology with an emphasis in geochemistry. He has 22 years of experience in site characterization, contaminant transport modeling, and licensing and environmental permitting for nuclear facilities and DOE/Department of Defense sites and facilities. He has primarily worked in accordance with DOE, U.S. Nuclear Regulatory Commission (NRC), and EPA Quality Assurance programs and regulatory criteria. Dr. Alcorn has had no involvement with the collection or processing of YMP data.

1.4 BACKGROUND

The precipitation data in the aforementioned DTNs are unqualified because they were collected prior to implementation of the YMP-approved USGS Quality Assurance Program Plan (QAPP). The USGS QAPP was approved by the Yucca Mountain Project Office on May 3, 1989. Data obtained by the USGS prior to that date can be qualified through the processes described in procedure AP-SIII.2Q, *Qualification of Unqualified Data and the Documentation of Rationale for Accepted Data*. Data collected by the USGS after QAPP approval are qualified unless they were found to not be in conformance with that plan's requirements or have not completed the USGS internal reviews. After May 3, 1989, a series of USGS Hydrologic Procedures (HPs) became the approved implementation protocols for USGS data collection activities. The USGS began developing and implementing these procedures as early as 1983 but they were not formally adopted by the USGS to support the QAPP until 1989. The unqualified precipitation data considered in this report were collected between 1987 and 1989. For these data, descriptions of the collection methodologies are found in USGS HPs prepared prior to acceptance of the USGS QAPP. The surface geology map and cross-sections by Scott and Bonk (1984) are unqualified because they were prepared prior to implementation of the YMP-approved USGS QAPP.

2. QUALIFICATION METHODS

Qualification methods of corroboration and technical assessment were used by the Data Qualification Team. The corroborating data method was used in comparing different data sets to evaluate the consistency of independently acquired data. In addition, technical assessment methods were used to evaluate data collection protocols and precision requirements. The qualification methods were applied in the following manner.

Corroborating Data. As stated in procedure AP-SIII.2Q, Attachment 2, the corroborating data approach may include comparisons of unqualified to unqualified data as well as unqualified to qualified data. Corroboration of the precipitation data was facilitated by the large sizes of the unqualified data sets, which contain accepted data collected at the Nevada Test Site (NTS) as well as unqualified data collected by the USGS for site characterization at Yucca Mountain. Corroboration of the geology data was achieved by comparing the unqualified map and cross-sections with qualified and accepted geologic maps and cross-sections of the same areas.

Technical Assessment. For precipitation data, technical assessment focused on the data acquisition methods used by the USGS. The appropriateness of the methods was reviewed and the procedures used to collect the unqualified data were compared with those approved for use at a later date to collect qualified data from the same stations. For the geology data, technical assessment methods were used to identify and describe the degree of consistency among the various data sources. It is recognized that mapping precision commonly decreases as the size of the study area increases and the definition of geologic units becomes more generalized. Because of the varying requirements of different data users, technical assessment of the geology data focused on checking the consistency and identifying the differences in the various maps to help a potential data user determine the appropriateness of the unqualified map for a specific application.

For all data, the technical assessment also included evaluations of the reasonableness of undocumented data collection methods and results, the limitations imposed by measurement and instrumentation technology at the time the data were collected, the use of such data in non-project applications, and the general acceptance of such data by the technical community. The technical assessments were conducted by subject matter experts in accordance with the requirements of procedure AP-SIII.2Q, Attachment 2.

All data sets were applied by Hevesi et al. (2000) to generalized uses where conclusions were not based on the precise value of a single data point or on minor differences among a small number of data points but rather upon the cumulative evidence of many corroborating data points. In addition, all data sets were technically reviewed by Hevesi et al. prior to use.

2.1 EVALUATION CRITERIA

The unqualified data were considered qualified based on consideration of the following evaluation criteria. These criteria were selected to incorporate the considerations in procedure AP-SIII.2Q, Attachment 2, the applicable qualification process attributes listed in procedure AP-SIII.2Q, Attachment 3, and the data-specific considerations identified above.

1. Are the data collection methods reasonable in view of standard measurement and instrumentation practice at the time the data were collected?

2. Are the data collection methods comparable to the methods approved for use under the USGS QAPP?

3. Are these data or similarly collected data generally accepted by the technical community for use in non-project applications?

4. Does analysis of comparable qualified, unqualified, and accepted data sets suggest similar conclusions?

Although these criteria were considered in determining whether the status of the data should be changed to qualified, the final recommendations of the Data Qualification Team were based on a preponderance of evidence, and not all of the qualification criteria were necessarily applied.

2.2 DATA QUALIFICATION FOR GENERALIZED USES

Because of the inherent variability in earth sciences data, particularly in data collected on a regional scale where broad interpolations among data points must be made, the Data Qualification Team has concluded that a finding that the data are qualified means that the data are adequate for generalized use. Such data can be appropriately used in a wide variety of applications, so long as consideration is given to accuracy, precision, and representativeness of the data for an intended use in a technical product.

Although precise definition of the accuracy and precision of a data point is often not possible, particularly with older data, the team recognizes that even qualified earth sciences data have an inherent variability. This variability can result from natural fluctuations in the field as well as from minor changes in measurement techniques and should be expected. A generalized use of

data is therefore a use wherein conclusions are not based on the precise value of a single data point or on minor differences among a small number of data points but are rather based on the cumulative evidence of many corroborating data points. Such use tends to be self-correcting, it simplifies identification of significant errors and outliers, and it focuses on general trends and ranges of values. A generalized use of data is therefore most appropriate for data points with mixed origin and pedigree.

3. EVALUATION RESULTS

The evaluation results are described in the following subsections, each reflecting a qualification method previously described:

- Section 3.1 provides a technical assessment of the precipitation data and the USGS procedures for collecting precipitation data that were available during the time period of data acquisition.
- Section 3.2 provides a review of corroborating precipitation data from independent data sources.
- Section 3.3 provides an evaluation of corroborating geology data from independent qualified and unqualified sources and documentation of the uncertainty that may be inherent in the unqualified source used by Hevesi et al. (2000).

3.1 TECHNICAL REVIEW OF DATA COLLECTION AND ANALYSIS METHODOLOGIES

The unqualified precipitation data directly used by Hevesi et al. (2000) were taken from DTNs GS960108312111.001 and GS000208312111.003. These DTNs are addressed separately in the following paragraphs.

3.1.1 DTN GS960108312111.001

This DTN is a draft USGS WRIR by Hevesi and Flint (1996) entitled, *Geostatistical Model for Estimating Precipitation and Recharge in the Yucca Mountain Region, Nevada – California.* A precipitation volume/station elevation regression equation taken from Table 4 of this DTN was directly used by Hevesi et al. (2000, p. 36). This equation was based on 114 weather stations in the region, mostly accepted data from the National Oceanographic and Atmospheric Administration (NOAA) network. The specific information taken from this DTN was the regression equation which defines a method that was adopted for use in the infiltration analysis. This method is not data and its use does not require qualification. No further consideration was therefore given this DTN by the Data Qualification Team.

3.1.2 DTN GS000208312111.003

This DTN contains unqualified Yucca Mountain site characterization precipitation data collected by the USGS from July 17, 1987 through May 2, 1989 from Weather Stations WX-1 and WX-3 at Yucca Mountain. Daily precipitation volume data were used from these stations by Hevesi et al. (2000, p. 36) to develop a daily precipitation database for Yucca Mountain. These data are

unqualified because they were collected by the USGS before the USGS QAPP was approved on May 3, 1989. The stations used Sierra-Misco Model 2501 tipping bucket rain gages with 1 mm resolution. The data collection methodology is documented in USGS Hydrologic Procedure NWM-USGS-HP-179, *Field Measurement of Precipitation Using a Tipping Bucket Rain Gage* (ACC: NNA.19880531.0034). This procedure became effective on May 20, 1988 and was subsequently approved for use under the USGS QAPP after May 3, 1989 without revision. This procedure later underwent two revisions and was rescinded in January, 1997 as a result of investigative actions for Nonconformance Report (NCR) NCR-USGS-96-0004 (ACC: MOL.19971009.0011). This NCR documented a failure to comply with procedural requirements for periodic inspection of the rain gage's mechanical operation. Although this nonconformance was issued in 1996 and did not involve the unqualified data set considered here, an evaluation by the USGS determined that the tipping bucket pivot points had been inspected in the field at the time of gage removal to confirm free mechanical movement and no impacts on the data were identified. The procedure was rescinded because the USGS was no longer collecting precipitation data using the Sierra-Misco instrument and the NCR was closed in March, 1997 (ACC: MOL.19980224.0193).

Two quality assurance issues have been raised regarding the precipitation data set considered here. Audit Finding Report (AFR) AFR-USGS-9002-05 was issued in 1990 and addressed a failure to calibrate the Sierra-Misco tipping bucket rain gages and other instruments in accordance with technical procedure requirements. The laboratory-based calibrations were considered by the USGS to be unnecessarily elaborate for the gages and HP-179 was revised in 1991 to include new calibration procedures based on the manufacturer's recommendations. Application of the new calibration procedures indicated that the gages were operating within tolerances and no impacts on the data were identified (ACC: NNA.19920618.0033). As a result of this AFR, the USGS reviewed its pre-1989 precipitation data for adherence to established procedures and determined that data collected before July 17, 1987 at Station WX-3 (gage serial number 4103) would not be used for site characterization (ACC: NNA.19920618.0033, p. 38). In compliance with this determination, the precipitation data for Station WX-3 in DTN GS000208312111.003 begins on July 17, 1987. The Data Qualification Team considers the USGS review of earlier data for procedural compliance to be good evidence of quality consciousness. This AFR was closed in April, 1992 (ACC: MOL.19980314.0354).

The second quality assurance issue raised regarding this precipitation data set is documented in NCR-USGS-96-0006. Although this NCR is listed in the TDMS for DTN GS000208312111.003, a review of the NCR indicates that none of the cited nonconformances were associated with the Sierra-Misco gages. Therefore, this NCR is not an issue in this Data Qualification Report.

3.2 CORROBORATION OF PRECIPITATION DATA

The unqualified Yucca Mountain precipitation data presented in DTN GS000208312111.003 were corroborated through a comparison with accepted data from two nearby weather stations at the NTS. The Yucca Mountain data were collected at the two aforementioned USGS weather stations WX-1 and WX-3. The NTS Mid Valley and Rock Valley weather stations were used in this corroboration. The two USGS weather stations are about 5 kilometers (km) apart. The two NTS weather stations are each about 32 km from the USGS stations and are about 35 km apart.

These NTS stations were selected for corroboration because their records were readily available, their records overlapped the USGS station records, and their locations are in reasonable proximity to the USGS stations and to each other. Data for the NTS stations were obtained from the NTS Air Resources Laboratory (TIC: 247173; DTN GS000200001221.002). Because of the highly irregular pattern of precipitation in southern Nevada, the two sets of stations were not investigated for consistent precipitation volumes but rather for consistent precipitation variability.

Corroboration is established by comparing the discrepancy between monthly total precipitation volumes measured at the two unqualified YMP stations with the discrepancy between monthly total precipitation volumes measured at the two accepted NTS stations. Discrepancy is defined as the absolute value of the difference between two numbers divided by the average of those numbers. Discrepancies were calculated for the 16-month period of overlapping records, from January, 1988 to April, 1989. The details of these calculations are presented in Appendix A. Discrepancies between monthly measurements at the two YMP stations ranged from 0 to 2.00 and averaged 0.76. Discrepancies between monthly measurements at the two NTS stations ranged from 0 to 1.71 and averaged 0.74. This simple check indicates that the variability between the two unqualified stations is similar to the variability between two accepted stations in the same area, and provides corroborative evidence supporting the adequacy of the unqualified data.

3.3 CORROBORATION OF SURFACE GEOLOGY DATA

The digitized version of the Scott and Bonk (1984) map (DTN MO0003COV00095.000) is directly used by Hevesi et al. (2000) to support infiltration calculations. The digitized version was prepared from a hard copy of the 1984 source map. As previously mentioned, this DTN is unqualified because the source map was not prepared under the YMP-approved USGS QAPP. The digitization was performed by the Management and Operations (M&O) contractor's Technical Data Management Department using qualified ARC/INFO software (ACC: MOL.20000523.0207). The reference to a 1993 Scott and Bonk geologic map in the documentation of DTN MO0003COV00095.000 appears to be erroneous. The cited source DTN, GS930283117461.001, was submitted to the TDMS in 1993 but consists of the Scott and Bonk geologic map that was published by the USGS as an OFR in 1984. No evidence for the existence of a 1993 Scott and Bonk map was found.

Data from three surface geologic maps were used to develop inputs to the grid constructed for the infiltration calculation by Hevesi et al. (2000, Section 6.6.4). The most detailed map (Day et al. 1998) is qualified. The Day map was produced at a scale of 1:6,000 and covers the central block area of Yucca Mountain. The map was prepared to provide a detailed depiction of the stratigraphic units and structural relationships in the central block area.

The digitized version of the Scott and Bonk (1984) map (DTN MO0003COV00095.000) contained the unqualified data used by Hevesi et al. (2000). The original Scott and Bonk (1984) map used in the digitization (DTN GS930283117461.001) was prepared at a scale of 1:12,000. It includes the area covered by the Day map but has slightly less detail. It focuses on the geology of Yucca Mountain and vicinity and was the most complete map reference for the area at the time it was prepared.

The third map, prepared by Sawyer et al. (1995), was produced at a scale of 1:100,000. It includes the area covered by both the Day and the Scott and Bonk maps and is less detailed than either. It is primarily a compilation of published USGS quadrangle maps with original scales ranging from 1:24,000 to 1:62,500 and covering the NTS and vicinity. The Sawyer map is also a USGS OFR and is designated *accepted data* by the YMP.

Corroborative methods were used by the Data Qualification Team to evaluate the Scott and Bonk map for qualification. The digitized version of the unqualified Scott and Bonk map was checked against the original hard copy version and no differences were identified. The unqualified Scott and Bonk map was also compared with both the qualified Day map and the accepted Sawyer map. These comparisons were performed in two ways. First, the maps were visually compared to ascertain the level of detail in each. This focused on the degree of lumping/splitting of geologic units. Second, overlapping portions of the maps were generated at the same scale by the YMP Technical Data Management Group using qualified software and superimposed to compare locations of specific example contacts. This allowed the Data Qualification Team to readily identify similarities and differences among the maps and quantify an approximate range, in feet, of lithologic contact deviations. These observations were then used to assess the extent of similarities and differences among the maps and evaluate their suitability for general use.

In evaluating suitability, it was kept in mind that geologic maps typically vary from one another for several reasons. The maps may be produced for different purposes; for example, one may place particular emphasis on the distribution of alluvium while another may focus on the detailed distribution and relationships of faults. A contact location may be interpreted or inferred in different ways by different geologists; for example, one may locate the contact based on lithologic gradation in the rock outcrop while another may estimate the location using aerial photographs. Individual geologists may differ in their emphases, interpretations and assumptions. A smaller-scale geologic map usually has fewer lithologic subdivisions, relatively smoothed and more generalized contacts, and generally less detail than a larger-scale map.

The Data Qualification Team compared the locations of contacts that define major units on the various maps. The major units were considered to be those presented on the Scott and Bonk (1984) map. Some of these units were subdivided on the Day et al. (1998) map to provide additional detail. Differences in contact locations between the two maps generally ranged from insignificant (less than 50 feet) to several hundred feet. At certain locations the difference is greater than several hundred feet. This is usually where the Scott and Bonk map shows bedrock in areas where the alluvium is very thin, whereas in those same locations the Day map shows alluvium. There are numerous areas within the coverage of Day et al. (1998) where this is evident. Several examples occur on the western slope of Yucca Mountain, for example west of Highway Ridge and approximately 2,000 feet south of the Nellis Air Force Range southern boundary. Here locations of thin alluvial and colluvial deposits shown on Day et al. (1998) are portrayed as the underlying bedrock in Scott and Bonk (1984). Another example may be seen approximately 750 feet north of the Nellis Air Force Range southern boundary, where a westward-running tributary canyon to Solitario Canyon with an alluvium-covered bottom (Day et al. 1998) is shown largely as bedrock (Scott and Bonk 1984). A third set of examples occurs

on the west side of Solitario Canyon, where several tributary canyons are shown floored with thin alluvium on Day et al. (1998) and bedrock on Scott and Bonk (1984).

The differences between the Scott and Bonk (1984) and Sawyer et al. (1995) maps are similar in magnitude to the differences between the Scott and Bonk and Day et al. (1998) maps. This is not surprising because although the Sawyer map has a scale of 1:100,000, it was compiled mostly from considerably larger-scale maps. On the other hand, because of its scale the Sawyer map has fewer and more generalized geologic units.

The Scott and Bonk (1984) map was accompanied by geologic cross-sections that were also reviewed by the Data Qualification Team. The surface contacts as presented on these cross-sections are essentially coincident with the contacts as drawn on the Scott and Bonk (1984) geologic map. As with the surface geologic maps, the cross-sections are similar in major elements to those from Day et al. (1998). In reviewing the Scott and Bonk cross-sections, the Data Qualification Team assessed similarities and differences among approximately 25 other map sources and five geophysical studies, and no substantive conflicts in interpretations among the cross-sections in the Yucca Mountain vicinity were identified.

The Day et al. (1998) and Scott and Bonk (1984) geologic maps each exhibit two cross-sections that have similar locations and orientations. The cross-section labeled C—C' on both maps runs from west to east across Yucca Crest, between the Ghost Dance Wash and Dune Wash, and south of Boundary Ridge and north of Bow Ridge. The cross-section labeled A—A' on both maps runs northwest to southeast across Yucca Crest and through the vicinity of Live Yucca Ridge and Antler Ridge. The cross-section line A—A' on the Day et al. (1998) map is oriented slightly more west—east than the section line A—A' on the Scott and Bonk (1984) map and intersects Live Yucca Ridge. Cross-section line A—A' on the Scott and Bonk (1984) map intersects Antler Ridge.

Given the differences between the maps in terms of purpose, investigators, scale, detail, methods, and interpretations, the cross-sections are essentially identical with respect to major stratigraphic units, dips, major faults, and fault orientations with depth. Differences are manifest in the details: a greater subdivision of lithologic units on the Day et al. (1998) map and cross-sections; a greater number of speculative faults (shown as dashed lines) on the Scott and Bonk (1984) map and cross-sections; and a few differences in fault orientation with depth due in all likelihood to differences in interpretation.

The comparisons among the three maps clearly indicate that they are representative of the surface geology they are meant to portray, given the scales at which the maps were produced and the purposes for which the maps were intended. Independent geologic maps of the same areas are typically different from one another for the reasons discussed above, and such differences are known and expected within the technical community.

Based on the corroborative evidence provided by the Day et al. (1998) and the Sawyer et al. (1995) maps, the Data Qualification Team found that the differences in the unqualified Scott and Bonk (1984) map did not exceed what would typically be expected among independent geologic maps and that the Scott and Bonk map provides an acceptable interpretation of the surface geology of the Yucca Mountain area. It is incumbent upon users of geologic maps to take into

account the common variations in maps and their causes and ensure that a map is suitable for the intended purpose. Based on comparisons of the three maps, the Data Qualification Team concludes that the Scott and Bonk (1984) map and cross-sections are suitable sources of geologic data.

3.4 SUMMARY OF EVALUATION RESULTS

Upon review, the Data Qualification Team found that the only information used from the first DTN, GS960108312111.001, was a precipitation volume/station elevation regression equation. This equation was based on 114 weather stations in the region, mostly from the NOAA network. This equation defined a method that was adopted for use in the AMR. This method is not data and its use does not require qualification. No further consideration was given this DTN by the Data Qualification Team.

The second DTN, GS000208312111.003, contains unqualified daily precipitation data collected by the USGS at Yucca Mountain weather stations WX-1 and WX-2. These data are unqualified because they were collected by the USGS before the USGS QAPP was approved on May 3, 1989. Most of the data were collected following a written procedure that was later approved without change for use under the USGS QAPP. Although several quality assurance issues were later raised, none were found to impact the data. The unqualified precipitation data were corroborated through a comparison with accepted data from two nearby weather stations at the NTS. Because of the highly irregular pattern of precipitation in southern Nevada, the two sets of stations were not investigated for consistent precipitation volumes but rather for consistent precipitation variability. The data were corroborated by comparing the discrepancy between monthly total precipitation volumes measured at the two unqualified YMP stations with the discrepancy between monthly total precipitation volumes measured at the two accepted NTS stations. Average discrepancies for the 16-month period of overlapping records were nearly identical. The essentially equal variability for the two sets of stations provides corroborative evidence supporting the adequacy of the unqualified data.

The third DTN, MO0003COV00095.000, is a digitized version of an unqualified surface geologic map by Scott and Bonk (1984). This map was corroborated by comparing it with data from two other surface geologic maps. The maps were visually compared to ascertain the levels of detail and overlapping portions of maps were superimposed using qualified software to spot check and quantify differences in contact locations. In almost all cases, equivalent geologic contact locations on the three maps varied from essentially coincident (up to about 50 feet deviation) to several hundred feet. This is a reasonable and not unexpected finding, considering that the maps were developed at different times, by different geologists, for different purposes, and by different methods. The largest differences were observed where the emphases of the maps differed (for example, showing shallow alluvium versus bedrock). The Data Qualification Team notes that these differences were used to advantage by Hevesi et al. (2000), where Scott and Bonk's map was preferred in specific locations because of its emphasis on the infiltration characteristics of the surface and near-surface bedrock geology (Hevesi et al. 2000, p. 48).

The geologic cross-sections that accompanied Scott and Bonk's (1984) geologic map in the original USGS OFR (DTN GS930283117461.001) were corroborated by other cross-sections in similar locations and also found to be acceptable. Given the variability that may be expected

among geologic maps and cross-sections, but more importantly the consistency exhibited among the corroborating sources of geologic information, the Data Qualification Team considers the Scott and Bonk (1984) map and cross-sections to be suitable sources of geologic data.

The Data Qualification Team has concluded that the precipitation and surface geology data considered in this report are adequate for generalized use and can be appropriately used in a wide variety of applications, so long as consideration is given to accuracy, precision, and representativeness of the data for an intended use in a technical product.

4. EVALUATION CONCLUSIONS

The conclusions of the Data Qualification Team's review of the precipitation and geology data are presented below in terms of the four evaluation criteria presented in the controlling Data Qualification Plan (DQP-NBS-GS-000001, Rev. 00).

1. Are the data collection and analytical methods reasonable in view of standard measurement and instrumentation practice at the time the data were collected?

The unqualified data considered in this report were collected and analyzed by the USGS. The precipitation gages used were standard, commercially available instruments suitable for remote sites. The geologic mapping methods and products of the USGS are considered by the Data Qualification Team to be of high caliber and professional quality. The Data Qualification Team does not expect independently prepared geologic maps and cross-sections to be identical because of the professional judgement required in their preparation, their different purposes, and the different methods used in their preparation. The unqualified geologic map and cross-sections considered in this report were found to be in reasonable agreement with corroborating geologic information. Consequently, the data collection methods, documentation, and results are reasonable and appropriate in view of standard practice at the time the data were collected.

2. Are the data collection methods comparable to the methods approved for use under the USGS QAPP?

The USGS precipitation data collection was the focus of this evaluation criterion. Collection of the unqualified data began in July, 1987 and formal documentation of the data collection protocol as a USGS Hydrologic Procedure was completed in May, 1988. This same procedure (HP-179) was subsequently approved for use under the USGS QAPP after May 3, 1989 without revision. The collection methods for qualified data collected immediately after May 3, 1989 were therefore the same as those used for unqualified data collected before May 3, 1989.

3. Are these data or similarly collected data generally accepted by the technical community for use in non-project applications?

The precipitation gages used by the USGS were standard, commercially available instruments in general use by the technical community. The USGS has been responsible for much of the geologic mapping in the United States and their maps have been used by the technical community to support mineral exploration, seismic studies, hydrological surveys, construction projects, and many other activities. The unqualified map considered in this report has been made available for general use by the technical community as a USGS OFR.

4. Does analysis of comparable qualified, unqualified, and accepted data sets suggest similar conclusions?

Corroboration of the unqualified precipitation data was encumbered by the short period of station operation and the high variability of precipitation in the desert southwest. However, the variability of the unqualified precipitation data sets was reviewed and corroborated by comparison with the variability of accepted data from weather stations at the adjacent NTS. The Data Qualification Team's technical review of the unqualified geologic map and cross-sections revealed a high degree of consistency with corroborative geologic information. Differences among the maps were checked and quantified by the Data Qualification Team to help potential data users determine the suitability of the unqualified map for specific applications. The Data Qualification Team notes that the differences in depicting the bedrock geology in the unqualified map was recognized and considered an important and favorable attribute in preparing AMR U0010 (Hevesi et al. 2000, p. 48).

5. RECOMMENDATIONS

Based on a preponderance of evidence, the Data Qualification Team concluded that the unqualified data considered in this report are qualified for generalized use as defined in Section 2.2 of this report. The first DTN, GS960108312111.001, was found to have been the source of a method rather than data, and did not require qualification. All data in the remaining DTNs, GS000208312111.003 containing precipitation data, MO0003COV00095.000 containing a digitized version of the Scott and Bonk (1984) geologic map, and GS930283117461.001 containing the original hard copy of Scott and Bonk's (1984) geologic map and cross-sections, were qualified for inclusion in technical products so long as their use is justified within the context of modeling requirements that support the Site Recommendation and License Application. The status of these DTNs is summarized in the following table.

DTN Status Summary

Old DTN	New DTN	Short Title	Qualification Status
GS960108312111.001	N/A	*Geostatistical Model for Estimating Precipitation and Recharge in the Yucca Mountain Region, Nevada – California.* (Hevesi and Flint 1996)	Remains unqualified. This DTN was the source of a method rather than data in AMR U0010 and does not need to be qualified. The Document Input Reference System entry for this DTN should be changed to "N/A-Corroborative Information."
GS000208312111.003	GS000208312111.003	*Precipitation Data for July 17, 1987 through May 2, 1989 from Weather Stations 1 and 3, Yucca Mountain, Nevada.* (Flint 2000)	Changed to *qualified.* All data in this DTN are qualified for generalized uses by this report.
MO0003COV00095.000	MO0003COV00095.000	*Coverage: SCOTBONS; Digital Version of Preliminary Geologic Map of Yucca Mountain, Nye County, Nevada, with Geologic Sections by R.B. Scott and J. Bonk.* (Brickey 2000)	Changed to *qualified.* All data in this DTN are qualified for generalized uses by this report.
GS930283117461.001	GS930283117461.001	*Preliminary Geologic Map of Yucca Mountain, Nye County, Nevada, with Geologic Sections* (Scott and Bonk 1984)	Changed to *qualified.* All data in this DTN are qualified for generalized uses by this report.

6. REFERENCES

Brickey, D. 2000. *Coverage: SCOTBONS; Digital Version of the 1993 USGS 1:12,000 Geologic Map of Yucca Mountain by Scott and Bonk. Geologic units only.* Yucca Mountain Project M&O, Las Vegas, Nevada. DTN: MO0003COV00095.000

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(Day et al. 1998)

Flint, A.L. 2000. *Precipitation Data for July 17, 1987 through May 2, 1989 from Weather Stations 1 and 3, Yucca Mountain, Nevada.* USGS, Sacramento, California. DTN: GS000208312111.003

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Scott, R.B., and Bonk, J. 1984. *Preliminary Geologic Map of Yucca Mountain, Nye County, Nevada, with Geologic Sections.* OFR 84-494. U.S. Geological Survey, Denver, Colorado. TIC: 203162. TIC: 203162

(Scott and Bonk 1984)