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Study Plan Number 8.3.1.17.3.4

Study Plan Title Effects of Local Site Geology on Surface and Subsurface Motions

Revision Number 0

Prepared by: U.S. Geological Survey

Date: October 25, 1991

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[signature], 11/12/91
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[signature] RES 11/11/91
Director, Quality Assurance / Date

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STUDY PLAN

for

STUDY 8.3.1.17.3.4

EFFECTS OF LOCAL SITE GEOLOGY

ON SURFACE AND SUBSURFACE MOTIONS

Rev 0

October 25, 1991

U.S. GEOLOGICAL SURVEY

PREFACE

This study plan summarizes and extends the discussion of Study 8.3.1.17.3.4 in the Site Characterization Plan (SCP).

Sections 1, 4, and 5 are drawn from the SCP and related Yucca Mountain Project documents, and show the study in the context of the total site characterization program. Sections 2 and 3 discuss the rationales for the planned tests and analyses, and present details of the plans themselves beyond those described in the SCP.

A. M. Rogers is the primary author of the study plan. Frances R. Singer prepared sections 4 and 5, and assisted in writing section 1.

ABSTRACT

Information resulting from Study 8.3.1.17.3.4 will be used to document the effects of the local site geology on surface and subsurface ground motions. The data to be collected and interpreted include (1) instrumental recordings made in Study 8.3.1.17.4.1 (Historical and current seismicity); (2) soil and rock properties determined as part of Investigation 8.3.1.14.2 (Studies to provide soil and rock properties of potential locations of surface facilities); and (3) recordings from surface and borehole seismographs to be deployed at selected localities on and near Yucca Mountain and at the potential sites for the surface facilities and exploratory shaft (this study).

The results of this study are needed as a basis for evaluating the hazards posed by future ground motions in the Yucca Mountain area. The information will be used primarily as input to other studies whose objectives are to determine the potential effects of future earthquakes and consequent ground motions on repository design and performance.

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STUDY 8.3.1.17.3.4

EFFECTS OF LOCAL SITE GEOLOGY ON SURFACE AND SUBSURFACE MOTIONS

Study 8.3.1.17.3.4 consists of two activities:

- Determine site effects from ground-motion recordings.
- Model site effects using the wave properties of the local geology.

The study is a part of the preclosure tectonics program that addresses the ground shaking hazard due to the occurrence of strong earthquakes (fig. 1-1).

1 PURPOSE AND OBJECTIVES OF THE STUDY

The objective of this study is to document the effects of local site geology on surface and subsurface ground motions. Methods will be developed to predict ground motion spectra and peak ground motion values that account for the effects of site geology and structure on expected shaking levels. These methods will be based, to the extent possible, on instrumental recordings of ground motion obtained in Study 8.3.1.17.4.1 (Historical and current seismicity) and from seismographs to be deployed specifically for this study (fig. 1-2). Theoretical models for the observed site effects will be developed to the extent necessary to explain the observations to first order and then used to extrapolate the observations to locations and depths where ground motions must be predicted but where recordings are not available.

1.1 Information to be obtained and how that information will be used

Information on the effects of site geology on ground shaking will be obtained from records of local microearthquakes, regional earthquakes, and underground nuclear explosions (UNE's), and from measurements of the physical properties of soil and rock that underlie and surround the potential sites of the repository and surface facilities. These data will be used to evaluate the relative levels of ground shaking at Yucca Mountain at the repository level and at the surface facility compared to that at surrounding regional sites underlain by alluvium and rock. These data and results will be used to modify the predicted ground motions that are produced by the deterministic analysis (Study 8.3.1.17.3.1) and the probabilistic hazard analysis (Study 8.3.1.17.3.6).

The specific information to be obtained in each activity is discussed in sections 3.1.1 and 3.2.1. Specific uses of the information for measuring repository performance against goals for performance measures are discussed in sections 1.2 and 3.1.9; uses of the information for supporting other studies are discussed in section 4 and summarized in table 4-1.

1.2 Rationale and justification for the information to be obtained: why the information is needed.

This study is needed as a basis for evaluating the hazards posed by potential vibratory ground motion at the site from natural and man-made seismic sources. The information will be incorporated by other studies that will determine the potential effects of future earthquakes and consequent ground motions on repository design and performance (see figure 1-3 and section 4). The data are needed to satisfy regulatory requirements, as described below.

Design Issue 4.4 (Technologies for repository construction, operation, closure, and decommissioning)

For preclosure design issue 4.4 (SCP section 8.3.2.5; this study plan, figure 1-3), information from this study is needed to decide whether the repository will satisfy the tentative goals associated with two performance measures: (1) the locations of surface facilities important to safety (FITS) and (2) the ability to continue preclosure operations and retrieve waste (see SCP tables 8.3.2.5-1 and 8.3.2.5-2). The goals for those performance measures deal with the locations of underground and surface facilities important to safety (see SCP tables 8.3.1.17-5b, -5a, -6b, -6a, 8.3.2.5-1 and -2. For both of these goals, the study will contribute information on the spectral modification at facilities important to safety due to local geology and depth of burial.

In general, the information will be used to support design and performance parameters needed to aid in: (1) the development of a seismic-design basis for repository facilities that are important to safety and (2) the identification of credible accidents that might be initiated by seismic events and lead to the release of radioactive materials. Specifically, this information will be used as follows:

A. In both performance measures: to support design-basis ground motion time histories and corresponding response spectra. Vibratory ground motions will be characterized by a suite of representative time histories and response spectra that have been scaled to the magnitudes and distances of the controlling earthquakes and modified, as needed, to account for the effects of local site geology. The seismic-design basis will account for 10,000-year cumulative slip earthquakes, the potential occurrence of earthquakes on nearby faults, and the potential future underground nuclear explosions at the Nevada Test Site.

B. In the first performance measure only: as input for use in ground motion models for predicting expected values and variances of required ground-motion parameters (e.g., probability versus peak acceleration, peak velocity, and peak velocity response at selected frequencies at surface and underground facilities) as a function of distance and source size.

C. In the second performance measure only: to determine surface and subsurface vibratory ground-motion characteristics for consideration in the design of surface and underground facilities; the design basis ground motions are to be characterized for frequencies significant to facilities important to safety such that there is less than a 10-percent chance of being exceeded during 100 years.

Finally, information from this study will contribute indirectly to the resolution of performance issues 1.1, 1.8, 1.9, and 1.11 (SCP sections 8.3.5.13, 8.3.5.17, 8.3.5.18, and 8.3.2.2; this study plan, figure 1-4) through its contributions to the postclosure tectonics program.

2 RATIONALE FOR SELECTING THE STUDY

2.1 Activity 8.3.1.17.3.4.1 Determine site effects from ground-motion recordings

2.1.1 Rationale for the selected test

The measurement of the effects of site geology on relative ground shaking levels is a necessary adjunct to accurate evaluation of the deterministic and probabilistic ground shaking hazard. Data collected during the monitoring of the Southern Great Basin Seismic Network (Study 8.3.1.17.4.1, Historical and current seismicity), which includes several stations on and near Yucca Mountain, will be combined with (1) recordings from additional seismographs to be deployed in close proximity to the sites of the potential repository and surface facilities (as part of the present study), and (2) rock and soil physical properties data (Investigation 8.3.1.14.2, Studies to provide soil and rock properties of potential locations of surface facilities) to provide the information required for making this evaluation.

There are only two alternatives to the actual measurements discussed above, and both will be applied during the conduct of this study. The two alternatives are 1) to estimate the effects of site geology on strong ground shaking levels using only measurements of low-level shaking; and 2) to calculate these effects using theoretical models. The disadvantage of option (1) is that low-level motions may not adequately simulate all aspects of strong shaking such as non-linear soil behavior, while its advantage is that this method provides a kind of stochastic sum of ground motion effects including waves that reach the site from azimuths other than the source direction. Furthermore, the method has been shown to predict strong shaking effects for some alluvium types and moderate strain levels (Murphy and others, 1971; Rogers and others, 1985). The principal disadvantages of option (2) are that: a) these methods generally do not account for non-linear soil effects and controversy exists concerning non-linear soil behavior theory, b) theoretical methods may require data that are difficult to obtain, c) the methods are generally expensive and time-consuming to apply, d) these models frequently require simplifying assumptions, and e) the models do not always apply to the full frequency band of engineering interest. The advantages of theoretical modeling are that: a) some methods can be used to model source, path, and site effects simultaneously, b) the methods commonly produce time series for scenario earthquakes on specific faults, c) where uncertainty is associated with input parameters, parameter variation studies can help determine the range of expected motions, and d) where few data exist reasonable assumptions about input parameters can be used with theory to compute expected ground motions.

2.1.2 Rationale for selecting the number, location, duration, and timing of the test

The number and location of recording stations within the Southern Great Basin Seismic Network and collection sites for samples of soil and rock for physical properties testing are dictated by Study 8.3.1.17.4.1 and Investigation 8.3.1.14.2, respectively. With regard to the present study, approximately eight surface and three borehole seismic stations will be deployed at selected locations in close proximity to the potential sites of the repository, exploratory shaft (ESF), and surface facilities (fig. 1-2). These additional stations are needed to provide the most reliable data possible bearing on the effects of local site geology on surface and subsurface ground motions. The new sites will be occupied long enough to record at least ten events simultaneously at each station in order to permit adequate statistical development of the site effect characteristics. Earthquakes from a range of incidence directions and distances are expected to be recorded at the rate of about 20 per month greater than local magnitude 1.0 (Rogers and others, 1987). From these recordings, a representative sample of well-recorded events will be selected. We anticipate that about one nuclear event per month will be recorded. These events will be restricted to a narrow azimuth and distance range because they will originate at either Yucca Flat, Rainier Mesa or Pahute Mesa. At least one year will be required to complete the field experiment. One year will be required to complete the data analysis and interpretation.

2.1.3 Constraints: factors affecting selection of tests

The choice of the test methods for this activity was unaffected by the following factors: impacts on the site; simulation of repository conditions; limits and capabilities of analytical methods; scale and applicability of measurements; and interference with other tests. With regard to timing and interference with the ESF construction, the deployment of instruments in the ESF will be coordinated through groups responsible for ESF construction and testing. It should be noted that other studies and activities in the preclosure tectonics program will utilize data from this activity to achieve their specific objectives.

2.2 Activity 8.3.1.17.3.4.2 Model site effects using the wave properties of the local geology

2.2.1 Rationale for the selected test

Because the measured effects of site conditions on ground motion can only be obtained at a limited number of site locations and depths, methods need to be adopted that permit extrapolation of these effects to other locales and depths where site conditions may differ from those in the empirical data base. The successful prediction of site effects at selected control sites also provides confidence that the process is understood and the model can be used at other locations. This test is required for issue resolution (see sec. 1.2) and for input to other studies (see sec. 4).

2.2.2 Rationale for selecting the number, location, duration, and timing of test

Predictions of the mean relative site effect will be conducted at all of the recording sites occupied in Activity 8.3.1.17.3.4.1 using several theoretical models and the measured physical properties of sites that will be obtained in Investigation 8.3.1.14.2 (Studies to provide soil and rock properties of potential locations of surface facilities). Stochastic and deterministic modeling of earthquake ground motions for both point and finite sources and incorporating both linear and non-linear soil effects will be conducted (e.g., Joyner, 1984; Joyner and others, 1988; Lee and Finn, 1978; Spudich and Frazer, 1984; Hartzell, 1978). One year will be required to complete the analysis and interpretation.

2.2.3 Constraints: factors affecting selection of tests

The discussion in section 2.1.3 applies to this section.

3 DESCRIPTION OF TESTS AND ANALYSES

3.1 Activity 8.3.1.17.3.4.1 Determine site effects from ground-motion recording

The objectives of this study are (1) to measure and predict the effects of geologic conditions, including the effects of geometry on strong shaking using observations of these effects from low-level ground motions from small local earthquakes and UNE's at the Nevada Test Site (NTS); and (2) to predict these effects and the effects expected during strong earthquake shaking using theoretical models of ground motion propagation and soil behavior.

3.1.1 General approach

The basic data to be acquired in this activity are three-component digital ground-motion recordings of local, regional, and teleseismic earthquake recordings, local blasts, and underground nuclear tests at Pahute Mesa, Rainier Mesa and Yucca Flats. These recordings will be obtained at sites underlain by both alluvium and rock and at the top and bottom of boreholes at select locations. Fourier spectra will be computed for each recording and alluvium-to-rock spectral ratios will be formed for alluvium/rock station pairs that have short interstation distances relative to the source-station distance. Surface-to-downhole spectral ratios will also be computed. Thus, each spectral ratio will approximate the local alluvium site effect at the alluvium station (Murphy and others, 1971) relative to the rock sites used in the analyses. An estimate of the relative variation among rock sites will also be determined by computing the spectral ratios of rock sites relative to an arbitrarily chosen rock site for multiple events. For each alluvium/rock pair a geometric mean site transfer function will be computed from multiple records at these sites. The mean site transfer function for the surface sites can be used to modify empirically or theoretically predicted rock design spectra at the site for low-strain strong motion. Empirical prediction of strong motion at Yucca Mountain using the world wide strong motion data set cannot be applied directly because this data set implicitly contains site effects and attenuation properties that may not apply to the southern Great Basin. Strategies, however, will be developed to use such data or to provide bounds on the range of expected motions.

The spectral amplitudes of subsurface motions will be compared with the spectral amplitudes for the corresponding surface motions and with the amplitudes recorded at surrounding sites by Study 8.3.1.17.4.1. Previously recorded and relevant NTS data as analyzed by Sandia National Laboratory will also be considered. Additional instruments will be installed at approximately eight surface sites on and near Yucca Mountain and at three or more boreholes and ESF (or drift) sites (fig. 1-2). It is expected that seismographs deployed specifically for this study will be in the field for only a portion of the time that those fielded for Study 8.3.1.17.4.1 will be operational. During this time, the recordings from these more temporary stations will contribute to the objectives of

Study 8.3.1.17.4.1 as well as to the objectives of this study. The data will be used to quantify spectral changes in motion with depth as a function of frequency in order to modify ground-motion predictions at the surface to values that are expected at the level of the repository.

Study of the effect of geologic site conditions on peak ground motion parameters such as peak acceleration or velocity is not warranted when using the recordings proposed in this study because variations in peak values for small events may be entirely different compared to variations produced by large events. The effect on peak parameters may be best studied by application of empirical results to stochastic modeling or theoretical modeling (see Activity 8.3.1.17.3.4.2).

3.1.2 Test method and procedures

The collection of data for this study is governed by the technical procedures required for Study 8.3.1.17.4.1 (Historical and current seismicity). They are SP-01 (Earthquake location procedure), SP-04 (Earthquake magnitude determination procedure), SP-05 (Determination of earthquake source parameters), SP-06 (Determination of earthquake focal mechanisms), SP-11 (Operation and calibration of remote telemetered seismic array), and SP-12 (Portable seismic array studies). Technical procedures for the analytical parts of the study have yet to be prepared.

3.1.3 QA level assignment

Quality assurance will be implemented according to Graded QA procedures.

3.1.4 Required tolerances, accuracy, and precision

The accuracy of seismograph calibration is described in Technical Procedures SP-11 and SP-12 (Operation and calibration of remote telemetered seismic array; Portable seismic array studies). Under normal operating conditions, it is expected that the seismographs will be calibrated to within ±20% over the range of frequencies of engineering interest, i.e. 0.2 to 20 Hz. Since the range of site factors that we are attempting to measure can vary by ±1000% or more, this accuracy is adequate to address the problem.

Other problems affecting accuracy are the inherent variability in ground motion due to earth complexity and data processing related variability. For example, the site effect can be expected to demonstrate some variability due to the azimuth and distance of the source relative to the site. This variability is expected to be on the order of 50% (Rogers and others, 1985; Murphy and others, 1971). Data processing variability is related to the stability of spectral estimates and the stability of spectral ratios, which in turn depends on the degree of spectral smoothing that the data permit and the total number of recordings at each station. Generally, this variability can be controlled and limited to values that are lower than other variability. The magnitude of this variability is unknown at present, but is likely to be less than ±20% (Rogers and others, 1980). It will be estimated as part of the data analyses.

3.1.5 Range of expected results

Based on earlier studies in the southern Nevada region, it is known that the range of site effects can be large. Factors of 10 in the spectral ratio at frequencies of engineering interest have been observed at some locales on the NTS and the surrounding region (Murphy and others, 1971; Murphy and Hewlett, 1975). These effects, however, are commonly frequency dependent and can produce deamplification at some frequencies, but particularly at high frequency. On the other hand, it is widely known that ground motions at depth tend to be less than on the surface (Okamoto, 1973; Owen and Scholl, 1980; King, 1982; Dowding, 1978; Seale and Archuleta, 1989). This reduction can be a factor of 2 or more, but is also commonly frequency dependent.

3.1.6 Equipment

The equipment in this study consists of portable autonomous digital seismographs and the equipment that is to be a part of the digital network upgrade. Analyses of the data will be conducted on both main frame digital computers and PC or desktop computers using standardized software packages, such as IMSL, Fortran, Minitab, IBM Scientific Library, and Matlab. Standard graphics, data base management, and regression software may also be employed.

3.1.7 Data-reduction techniques

Data reduction consists of computation of Fourier spectra using standard Fast-Fourier Transform techniques (FFT), smoothing of these spectra using established smoothing routines, and computation of Fourier spectral ratios and geometric mean spectral ratios. Horizontal- (radial and transverse) and vertical-component records will be treated separately. Spectral variability will be calculated both theoretically and measured by computing the standard deviation of the geometric mean spectral ratio estimates.

3.1.8 Representativeness of results

These results should predict the local site effect within about ±50% of the true value with 90% confidence for strong ground motions that do not exceed strains of about 10^{3}. If strains are expected to exceed this level the measured site effects will require modification to correct them for non-linear soil behavior (see Activity 8.3.1.17.3.4.2).

3.1.9 Relations to performance goals and confidence levels

The measurement of site effects in the Yucca Mountain area is essential for input to studies involving evaluation of the deterministic and probabilistic seismic hazard of the repository site. This study has a direct relation to design and performance goals as indicated in section 1.2.

3.2 Activity 8.3.1.17.3.4.2 Model site effects using the wave properties of the local site geology

The objective of this activity is to develop a calibrated theoretical site-effects model for use in extrapolating the observations documented in Activity 8.3.1.17.3.4.1 to locations and depths where ground-motion predictions are needed, but where instrumental recordings are not available. The model predictions will also accommodate high-strain conditions that may occur at some sites during strong ground shaking from a large or close-by earthquake.

3.2.1 General approach

Theoretical site-effects models will be developed, based on measurements of the wave properties (shear- and compressional-wave velocities, material damping, and densities) as determined in the investigation of soil and bedrock properties (Investigation 8.3.1.14.2). As part of those studies, the seismic velocity structure of the site will be determined to crystalline basement. The structure to crystalline basement will be estimated on the basis of the known geology and geophysics of the region, and is an important factor in determining ground shaking levels across the spectrum of engineering interest.

The approach to modeling will be to construct the simplest model that predicts the first-order features of the observed site-response functions. The initial model will assume a one-dimensional velocity structure, linear response, and vertically incident body waves. More complexity (e.g., non-vertically incident body waves, surface waves, equivalent-linear site response, two-dimensional velocity structure, etc.) will be introduced as necessary.

3.2.2 Test method and procedure

This activity will only synthesize and compile data collected by other activities. All evaluations and calculations will be documented or verified in conformance with QA requirements.

3.2.3 QA level assignment

Quality assurance will be implemented according to Graded QA procedures.

3.2.4 Required tolerances, accuracy, and precision

The accuracy of site effects modeling is not well known. In general, models are only first-order approximations of the real-earth behavior; furthermore, none of the theoretical models have been thoroughly tested under all site conditions. In particular, considerable controversy exists regarding the adequacy of existing soil behavior models to predict site effects under conditions of ground shaking strong enough to induce non-linear soil behavior. Inaccuracy in model output originates in two ways: 1) inadequate knowledge of the actual behavior of earth material properties under various levels of ground shaking and consequent construction of unrepresentative models; 2) measurement error or inaccurate representation of earth material properties that are input to the models. Models that are used in this activity will be or will have been tested with strong-motion and weak-motion data from earthquakes and, perhaps, strong motion recordings from recording sites in the near-field of nuclear explosions at NTS. These comparisons will serve to establish the accuracy of the models under at least some conditions, preferably conditions of greatest relevance to the Yucca Mountain and Midway Valley sites. Because the true accuracy of the results cannot be known until ground motions are recorded at the prediction sites in a damaging earthquake, a variety of calculations will be performed that will permit a reasoned judgement concerning the range of expected results. The complexity of models used will be a function of the complexity of the geology that is determined both from the drill holes in this study and other geological and geophysical data that are brought to bear in the construction of velocity models for the site.

3.2.5 Range of expected results

The range of expected results is identical to that stated in section 3.1.5. To some extent, however, the range of results in the modeling of site effects will be related to the inherent limitations and (or) assumptions of the models, as noted in section 3.2.4. These limitations will be explored and clarified for those that will ultimately use the results.

3.2.6 Equipment

The only equipment required to conduct this activity is a mainframe digital computer to carry out the modeling computations.

3.2.7 Data reduction techniques

All data reduction is completed in other activities (i.e., 8.3.1.17.3.4.1, 8.3.1.17.4.1.2, and 8.3.1.14.2). This activity is only concerned with the calculation of theoretical results and their validation. Model validation will be conducted by comparison of model results with observations of strong motion and weak motion data from both the southern Great Basin and other regions of the world. In some cases model validation by others published in reputable geotechnical journals will be accepted using standard QA procedures. Models will be considered valid if they reproduce the first-order behavior of ground motion behavior. Factors such as predominant site period(s) and mean spectral level will be considered first-order parameters. Correlation between empirical and theoretical parameters can be established using standard statistical procedures.

3.2.8 Representativeness of results

The models will be used to predict site effects at locations where no recordings have been obtained, but where earth material properties are known or inferred. That these results are representative can only be roughly tested by comparison of predictions at other locations with measured results. Such comparisons are the principal step in the validation of the models. Other checks on representativeness of the results will be obtained by using several models and comparison of the predictions of these models.

3.2.9 Relations to performance goals and confidence levels

The uses of the information from this activity for measuring the performance of the repository against the tentative goals for applicable performance measures are discussed in section 1.2.

4 APPLICATION OF RESULTS

This section identifies other studies that will use the information obtained in the present study. The description is summarized from information in the SCP. Table 4-1 shows what information from the study will be used and how that information will be used in other site characterization studies. Related discussions in section 1.2 draw on section 8.3.5 of the SCP to consider the uses of information from the study in the context of issue resolution and performance goals.

Spectral amplification functions that represent the effects of local site geology on surface seismic motions and the effects of depth on underground seismic motions will be used to correct predictions of the regional ground-motion models developed in Study 8.3.1.17.3.3. These data will also be used to modify the predicted ground motions that are produced by the deterministic and probabilistic seismic hazard analyses (Studies 8.3.1.17.3.1 and 8.3.1.17.3.6 respectively). In addition, the spectral content of strong-motion time histories (generated in Activity 8.3.1.17.3.5.2) will be corrected for local site effects (as necessary).

5 SCHEDULES AND MILESTONES

Figure 5-1 shows the principal milestones for this study and its scheduling ties to other studies. This information is abstracted from the most current and complete project schedule being used to develop the long-range plan and (or) the integrated project schedule.

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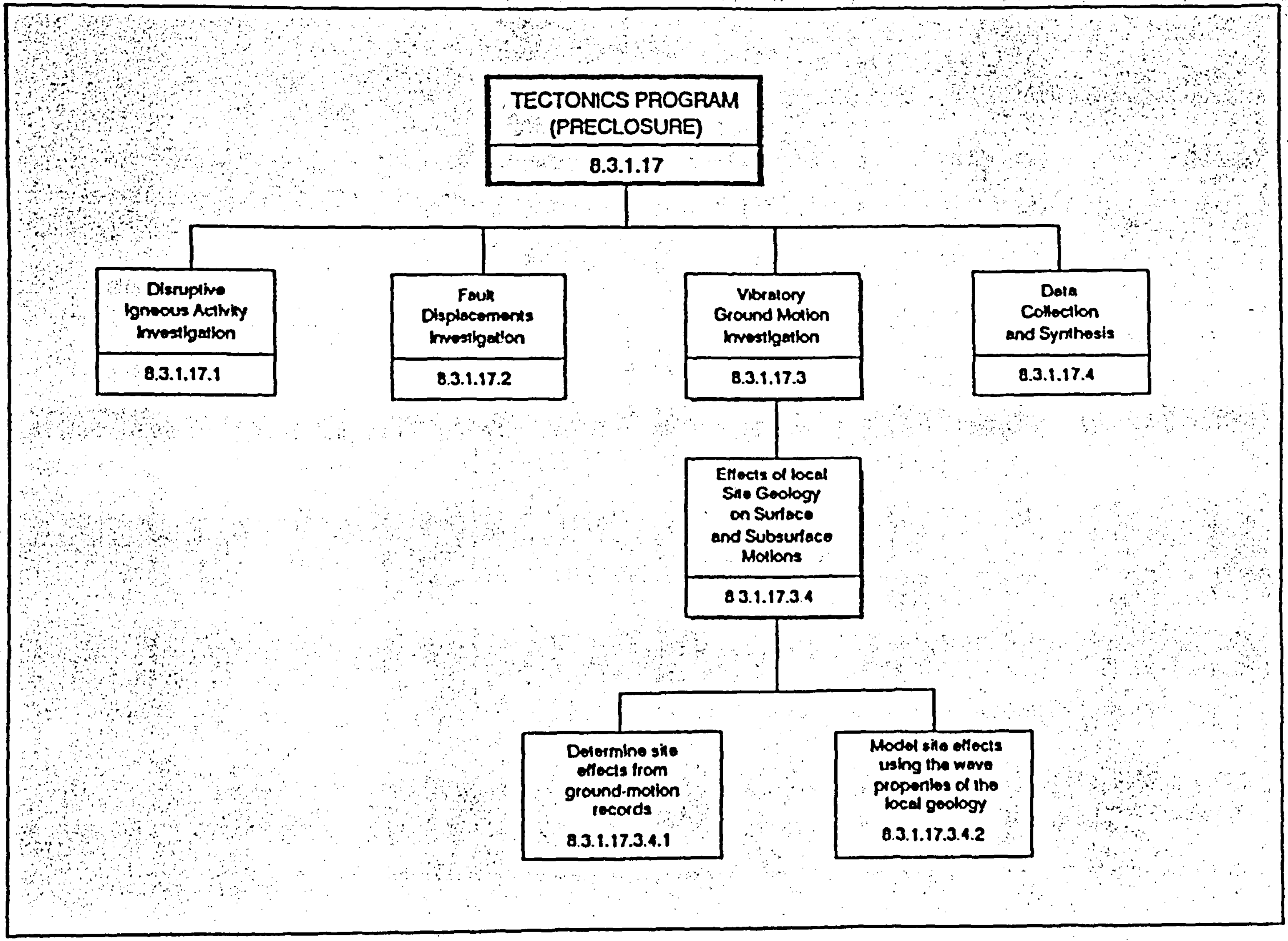


Figure 1-1. Relation of Study 8.3.1.17.3.4 to the preclosure tectonics program.

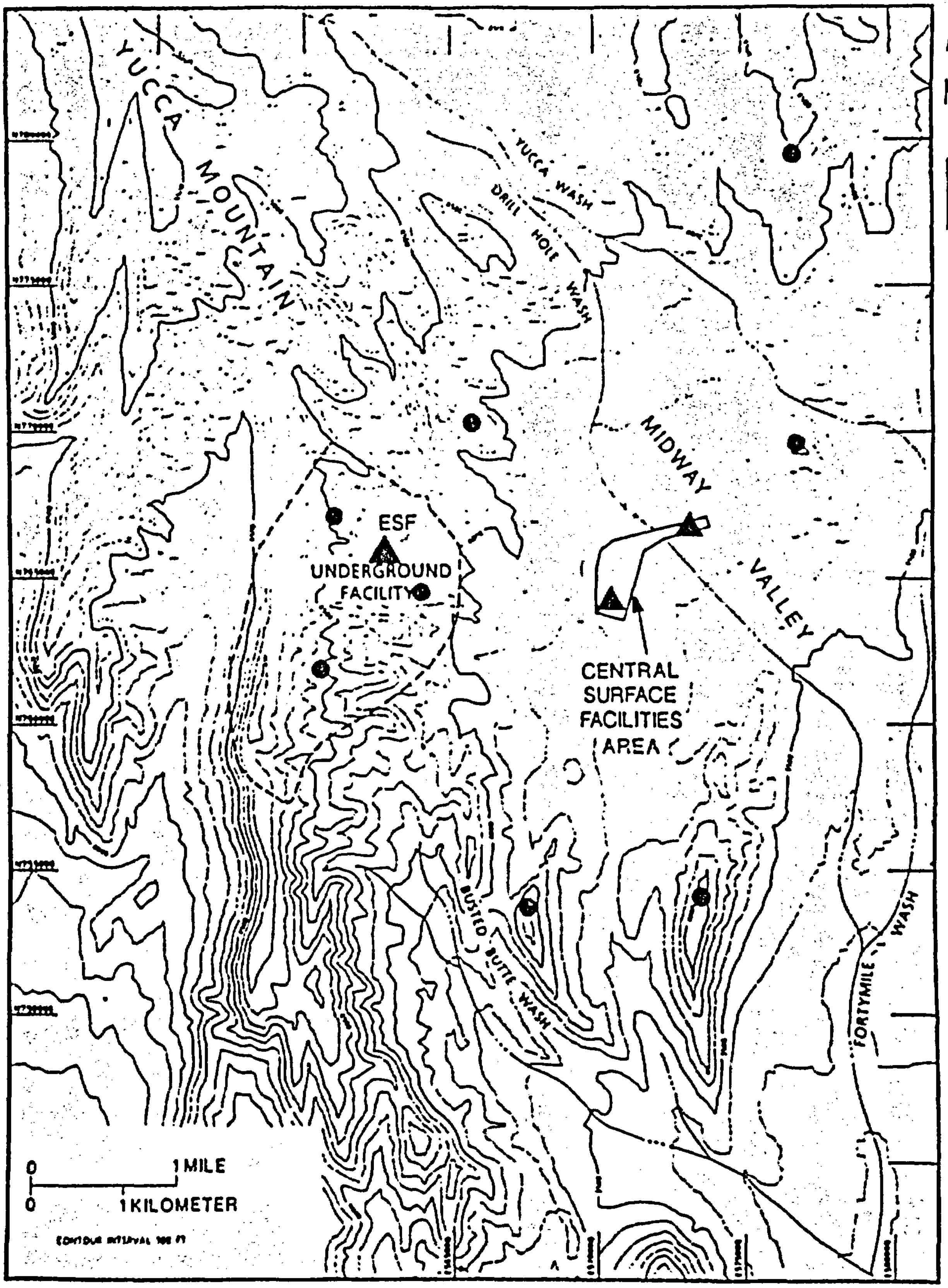
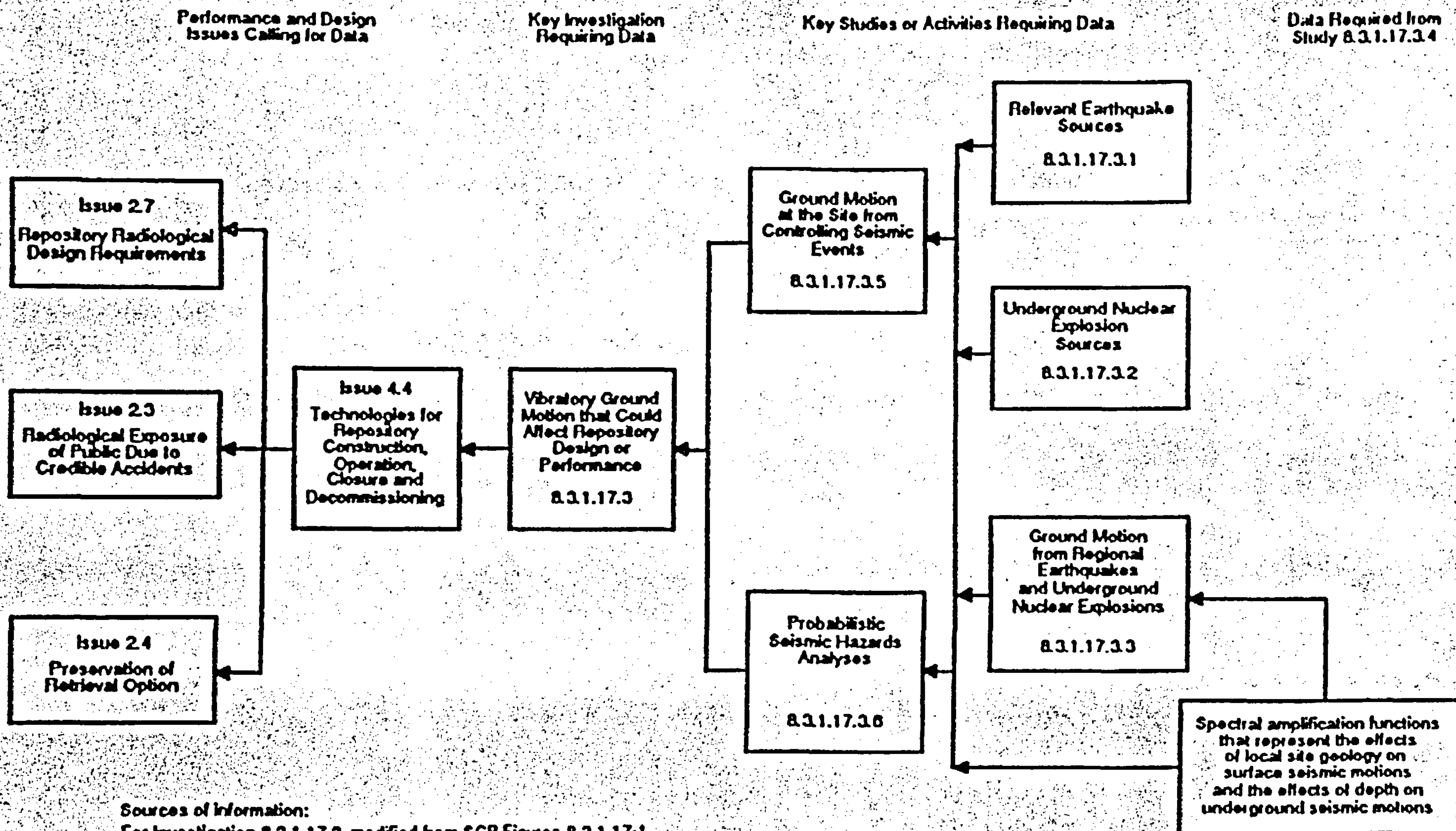


Figure 1-2. Index map of Yucca Mountain area showing location of proposed surface and underground facilities.

▲ Tentative borehole locations for shear velocity measurements and uphole-downhole seismic stations

● Tentative temporary surface recording seismic stations



Sources of information:
For Investigation 8.3.1.17.3, modified from SCP Figures 8.3.1.17-1 and 8.3.1.17-5.

Figure 1-3.--Information required from Study 8.3.1.17.3.4 for issue resolution through studies in the preclosure tectonics program.

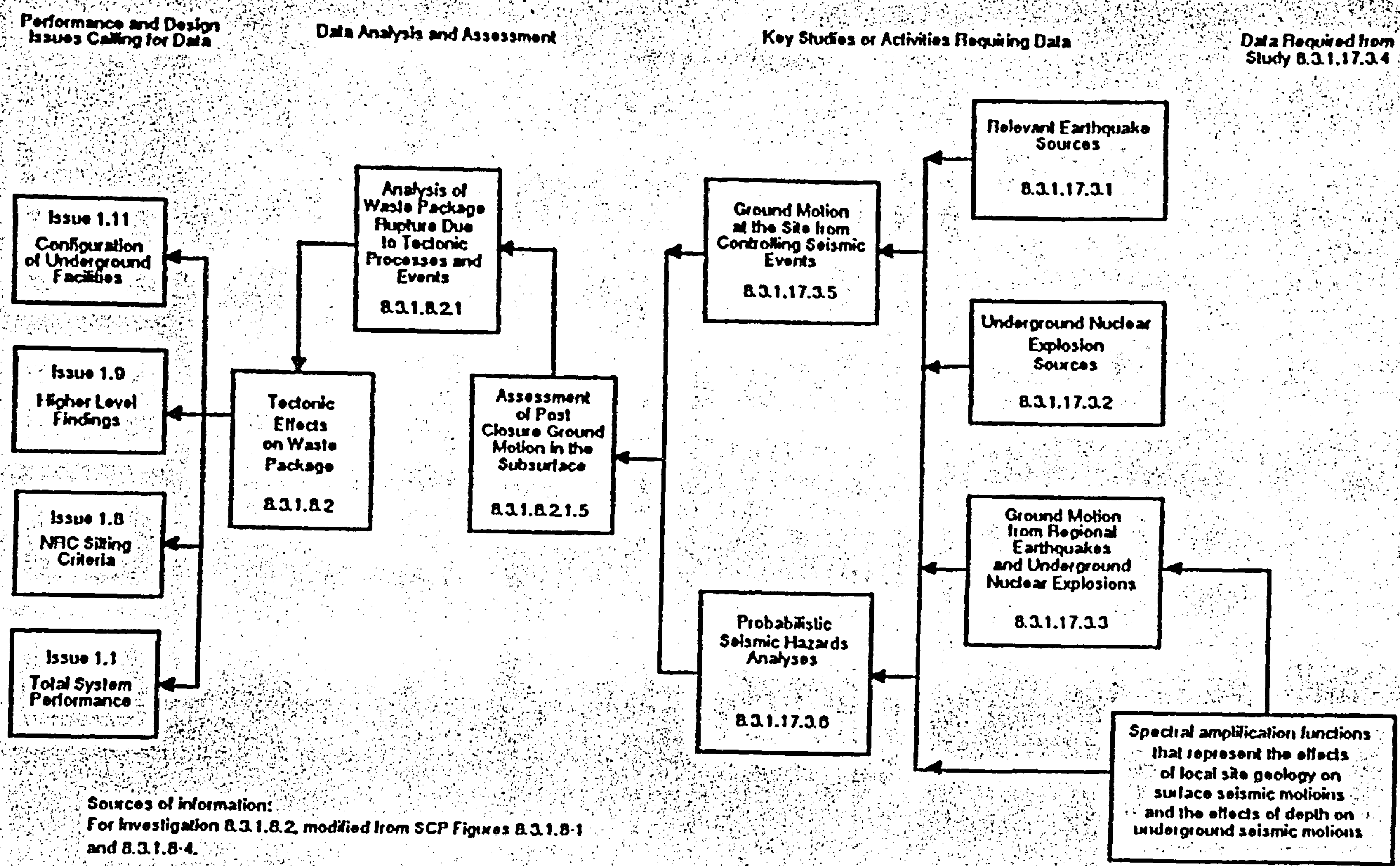
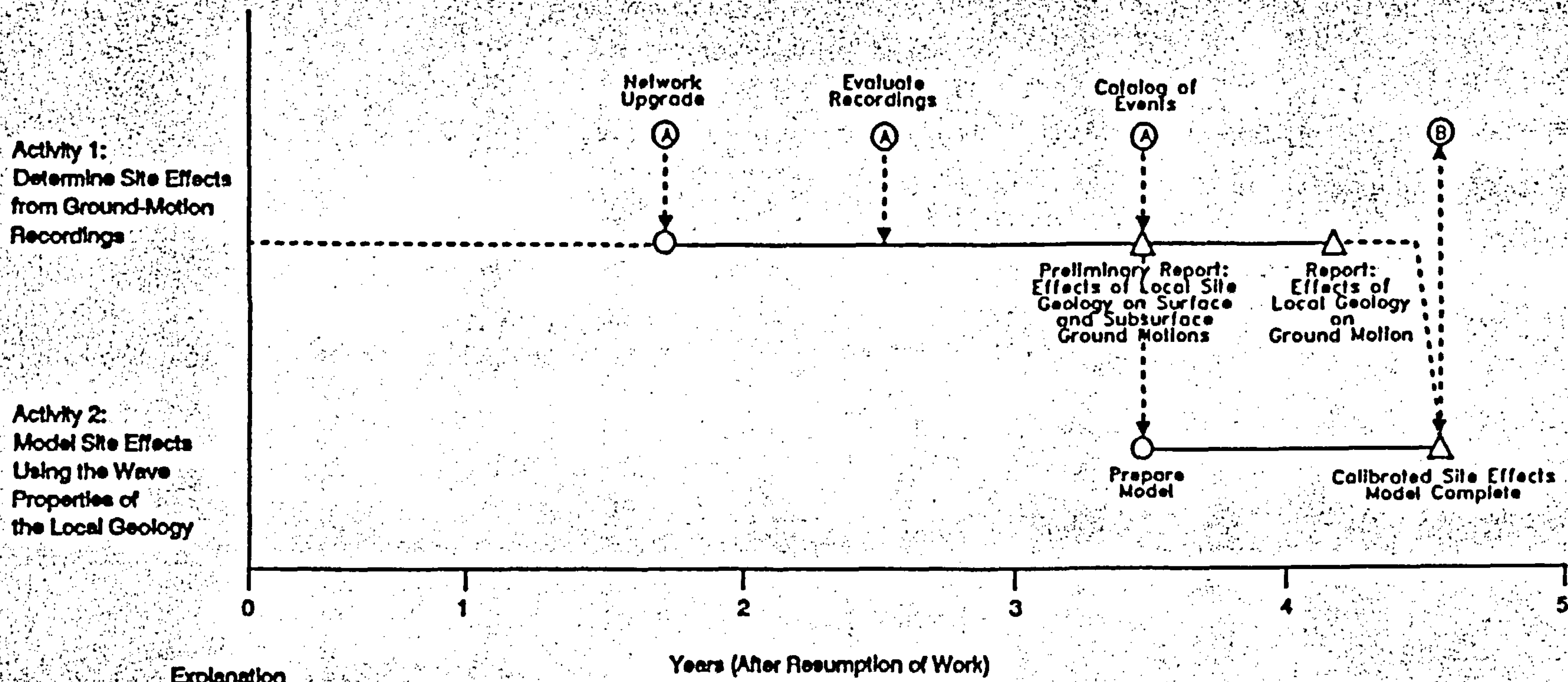


Figure 1-4.--Information required from Study 8.3.1.17.3.4 for issue resolution through the post closure tectonics program.



Explanation

- △ Level 3 milestone
- ○ Scheduled input or output of data
- — Test duration
- Ⓐ Data input from Study 8.3.1.17.4.1 (Historical and current seismicity)
- Ⓑ Data output to Study 8.3.1.17.3.5 (Ground motion at the site from controlling seismic events) and Study 8.3.1.17.3.6 (Probabilistic seismic hazards analyses)

Note: Milestone level according to administrative procedure AP-3.1Q

Figure 5-1.--Schedule for Study 8.3.1.17.3.4: effects of local site geology on surface and subsurface motions.

Table 4-1.--Information to be provided to other studies by Study 8.3.1.17.3.4

Information to be obtained from this study	Where information will be used[1]	How information will be used
Spectral amplification functions that represent the effects of local site geology on surface seismic motions and the effects of depth on underground seismic motions.	8.3.1.17.3.1.1*	To modify the predicted ground motions that are produced by the deterministic seismic hazard analysis.
	8.3.1.17.3.3	To correct predictions of regional ground-motion models.
	8.3.1.17.3.5.2	To correct the spectral content of suites of strong-motion time histories for local site effects.
	8.3.1.17.3.6*	To modify the predicted ground motions that are produced by the probabilistic seismic hazard analysis.

[1] Studies or activities in which information will be used

8.3.1.17.3.1.1: Identify relevant earthquake sources

8.3.1.17.3.3: Ground motion from regional earthquakes and underground nuclear explosions

8.3.1.17.3.5.1: Identify controlling seismic events

8.3.1.17.3.5.2: Characterize ground motion from the controlling seismic events

8.3.1.17.3.6: Probabilistic seismic hazards analyses

*Information from Study 8.3.1.17.3.4 will be used indirectly in this study/activity.