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UNITED STATES
NUCLEAR REGULATORY COMMISSION

In the Matter of:)

THE TWENTIETH ANNUAL MEETING OF)
THE ATOMIC SAFETY AND LICENSING)
BOARD PANEL)

ON)

THE PERMANENT HIGH-LEVEL WASTE)
REPOSITORY AND OTHER NEAR TERM)
ISSUES.)

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ATOMIC SAFETY AND LICENSING BOARD PANEL)
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THE PERMANENT HIGH-LEVEL WASTE REPOSITORY)
AND OTHER NEAR TERM ISSUES.)

Metro Room 1
Bally's Hotel
3645 Las Vegas Boulevard South
Las Vegas, Nevada

Tuesday,
December 13, 1988

The above entitled matter came on for hearing, pursuant to notice at 8:30 a.m.

PROCEEDINGS

8:30 a.m.

MR. FRED SHON: We are being recorded. There will be a transcript made of these proceedings. Because questions from the audience are not readily picked up by the transcriber's microphone, I would like to ask all the speakers to take note of the little cubby outfits that set down here on the rostrum, saying, for the record, please be sure to repeat any questions from the audience. If someone asks you a question, I would like to have you, as speaker, repeat that question so that it surely gets on to the record. Otherwise, the transcript does not make sense. We had a little trouble with that yesterday. The questioner should identify himself or herself and the speaker should read that into the record also.

Our first lecturer today will not be Ralph Stein, it will be Keith Klein, who is Deputy Associate Director for Systems Integration and Regulations at the Yucca Mountain Project. He is going to give us an overview of the high level waste program.

MR. KEITH KLEIN: Good morning. Yesterday, you heard from several other major participants in this program, including NRC staff in the State of Nevada. I rather feel like we are part of a javelin team and I have been elected to receive, after getting a bit of a rundown this morning on the presentations of yesterday.

As I think you are probably aware, it has only been a year since our efforts have focused on the Yucca Mountain site. It has been a heck of a year. We have learned a lot. We are, of course, very serious about this. It is a very important program. It has very long-term implications and we very much appreciate you coming out here at this early state in our program to familiarize yourselves with our activities and so the historv of the program.

We have a number of speakers today. With the exception of myself, they all work out here. They are very intimately familiar with the site and with our program to-date. And I think we are prepared to answer any questions that you may have.

Let me address first, what I might characterize as our efforts to get off on the right foot. We very much appreciate the need to have a qualified Quality Assurance program in place covering the acquisition of data and information that is going to be so important to the success of this program. We have committed ourselves to have such a fully-qualified QA program in place for all new site-characterization activities that are going to take place. We, very early on, issued a consultation draft site-characterization plan. We are not required to issue such a consultation draft, but when you have one shot at a program like this, you have to do it right. And the extra time, we felt, that would be used by issuing this as a draft, knowing full-well when there is a hundred different ways to skin a cat, and no one knows what is the best way, that potentially any of those ways could work successfully.

It is important to obtain the views of other major program participants, in particular the NRC staff in the State of Nevada. It is sufficiently worthwhile to take that time to obtain those views to see if we had not thought about something. Basically, to satisfy ourselves, that we are doing the best job that can be done in characterizing this site. We have taken a few knocks as a result. The program, I think in everyone's opinion, though, is much better off as a result.

I think we have demonstrated a willingness and intention to take strong measures when needed. We have issued stock work orders. It is not something that is done lightly. We have certainly gotten across to our contractors, I think, our seriousness about this and this message has been received. We have changed the way we do business. It is a much more disciplined rigorous approach than it was a year ago. And I think that will become evident, too, as we go through today's presentations.

Similarly, we have numerous meetings with the commission staff. We have, in my opinion, been responsive to their concerns and comments, recognizing that we are not yet an applicant. But, again, that we want to do the best job we can. It has been not an unanimous position within our program participants, that we be as responsive as we have to the NRC concerns.

We have come to treat the exploratory shaft facility as part of the repository and not just a hole in the ground to get data, to help determine if the site is suitable or not. We are going about that as an engineer facility that can have long-term implications and are applying the requirements to proceeding with that exploratory shaft facility program as if it were the repository itself.

You will hear more, and we will be presenting information to the NRC, on the design acceptability analysis that goes to the heart of the design-control process that was used for designing that facility. We will know very well just what it is that we have. So will the NRC and so will the State. All the measures that were taken in the design of that facility and how that relates to our future efforts in the design, which is what we call Title II, or the final design.

We will be issuing the site characterization plan in about two weeks. You should all be aware that that is an enormous document. There will be an overview document that goes along with that, that will be a more concise, and intended as a summary of the site characterization plan for knowledgeable, but interested, technical people.

With that, if I could have the first slide Bob. The remainder of my remarks will be along the lines of program structure. I will talk about the headquarter's organization for proceeding with this program, tell you more about the legislative authority that is behind it, our regulatory compliance efforts, summary information on our schedule, and status of selected activities. The remainder of the day, you will be hearing from the Yucca Mountain project personnel on the detail status of these activities.

As far as the headquarter's organization, we are an office created by law, the Nuclear Waste Policy Act, which sets up its office in the Department of Energy to be headed by a director who is named by the President and confirmed by the Senate (Presidential appointing). We have, at the current time, four major offices within that office: an Office of Program Resources Management; Office of Facility Sitings and Development, one of two main technical offices; Office of System Integration and Regulations (Ralph Stein is the Associate Director of that office and I am Ralph's Deputy); and an Office of External Relations and Policy.

Ben Roche was our first Presidential appointee Director of the office. His Deputy was Ed Kay, who assumed the reins for a period after Mr. Roche left. He has since accepted a high-level position in the Department of Interior. Sam Rousso, who has been the Associate Director for Program Administration and Resources Management, is now the Acting Director. Steven Kale is the Director of Facility Sitings and Development.

I believe Carl will be telling you more about the organization at the local level. But the way the DOE operates is primarily through our operations offices throughout the country. There is an operations office here in Nevada, that is responsible for, besides this activity, testing at the Nevada Test Site Weapons' Program. The Yucca Mountain project office, which Carl Gertz heads, reports to the Nevada operations office, Nick Aquilina.

The headquarter's organization provides

policy, overall technical guidance, as the main interface with the NRC staff in Washington. The Waste Act, the Nuclear Waste Policy Act of 1982, signed into law in January of '83, was a major milestone, of course, in this overall program. It had been preceeded by many fits and starts, if you will, on the waste problem.

Going back to Lyons, Kansas and even before that, recommendation by the National Academy of Sciences in '57, I believe, saying underground disposal for geological depositories is the way to go for a permanent solution of these wastes.

Up until this Waste Policy Act, the program for reaching that goal has been pretty much subject to different administration desires and thoughts. One point of view was that we need not be in a rush for deep geologic disposal, but that some sort of long-term surface storage for decades if not 100 years or so, was an appropriate measure, at this point. Others felt a more compelling desire to not defer the ultimate solution to the waste problem to future generations. They felt that having long-term surface storage would amount to deferring a solution. There was some shifting, back and forth, between these two points of view that were reflected by different administrations and different congressional committees and so forth.

In the end, the growing recognition that a legislative mandate was required to establish firm policies, to establish funding sources, and its overall direction and guidance for what was recognized as a very long-term and contentious, not to mention politically sensitive, effort.

Given that there is no single congressional, if you will, constituent, for a long-term repository, I think it is a credit to our system that people came to recognize this as a national problem, requiring a national solution and it made the priority list for action.

It was not until the end of a congressional session of the 1982 Congress, and it did not satisfy everyone. I do not think that anyone would claim that it was a perfect law. Everyone was gratified that we finally got a law and that we would have some long-term direction.

It established a schedule for siting, constructing, and operating repositories with a number of checks and balances in it, protecting the public and the environment. It assigned responsibility for the high-level waste management to the Department of Energy. It provided a major role for states' Indian tribes and public in the program from the very beginning.

I think everyone here is cognizant of the different things that are going on with the Department of Energy facilities and programs around the country at this point. Most of those were started in the waning years of the second world war, of course. They were not done under the eyes of public scrutiny. In fact, they were, for good reason, done with secrecy. Those programs evolved. They continued to be conducted in an air of secrecy and it has not been until the last several years that we have begun reconciling the various effects of those programs with what are, admittedly, much tighter environmental standards at this point in time.

This program is different, being started, basically as an open process with full public participation. These last several years have been new to us. It is, of course, very difficult to balance what you see as a schedule mandate and trying to get a job done within a certain time frame. It is good managers with the goal of allowing the meaningful public participation, knowing that to be responsive to concerns of others, to criticism, means, at times, changing the program. It means doing more than, sometimes we think absolutely needs to be done, but is done in the full spirit of cooperating.

Lastly, this Waste Act provided a Nuclear Waste Fund which basically amounts to a tax on utilities that generate nuclear power. They each pay one mil per kilowatt hour of nuclear electricity generated into the waste fund. It brings in revenues, in the order of 300 to 500 million dollars a year. We have, additionally, levied a fee on fuel that was discharged prior to the date of enactment of the Waste Act.

The important feature there is that a funding source is provided for the continuation of this program. Prior to the Waste Act, every year was a different program. The congressional direction, or redirection, could be written into any appropriations. Considering the number of divergent views on the Hill, that also contributed to a number of prior fits and starts. So, again, it is stability that adds to the confidence that the job will get done.

Just a year ago, the Amendments Act was amended. There were revisions in the first repository, second repository, monitor retrievable storage, an area called Benefits Agreement, and a Nuclear Waste Negotiator. These changes were in response to experience obtained nationally over the years since the Waste Act was passed.

As far the first repository, it was decided that we should focus our efforts on one site, the Yucca Mountain site. It terminated activities at other sites that we had been characterizing in Texas, in Hamford. It established that we may begin constructing exploratory shafts at the Yucca Mountain after submitting a site characterization plan to the NRC, the Governor, the Legislator of the State of Nevada, and the public for comment.

It specifies that we are to allow 90 days for comments on site characterization plan and we were to hold public hearings on this plan in the vicinity of the Yucca Mountain site. Again, we issued a consultation draft of the site characterization plan early this year and have been revising it in response to comments and new insights we have gained over the last year.

If the sight is found suitable on the basis of the information gathered during the site characterization program, we may then submit a recommendation to the President that he approve the site for our next phase of the program, namely that we go forward to the NRC with a license application. That recommendation to the President is to be accompanied by an Environmental Impact statement.

The State of Nevada, may submit a notice of disapproval to Congress within 60 days of the

Presidential site designation, that is him accepting the Department's recommendation. Such a state disapproval prevents use of the site, unless Congress passes a joint resolution of siting approval within 90 days of continuous session. If the State does not issue a disapproval or if the notice of disapproval is overturned by joint resolution, then the site designation becomes effective.

When the site designation becomes effective, we will then apply to the NRC for a license to construct the repository. This application must be submitted within 90 days after site designation. Needless to say, that means that we have to be working on that application many months before site designation becomes effective.

NRC will review the application and hold licensing hearings. It may then authorize construction. After construction is complete, the DOE will update its license application, submit it to the NRC, seeking approval to begin operations receiving fuel. There is a later phase then, after the repository is full, that would involve NRC approval to permanently close the site.

The Department shall offer to any state Indian tribe or unit of local government to designate a representative to conduct on-site oversight activities at such a site. That is another new requirement under the Amendments Act.

As far as the second repository is concerned, many of you may recall this was a very contentious activity that was initiated by the original Waste Act. There is a growing recognition that not as much spent fuel was going to be discharged as had been originally projected and benefits to be gained by experience with the first repository, not to mention the considerable expenses involved in the site characterization program. Congress elected basically to repeal the requirement for a second repository or at least defer the issue for a number of years. Now the Department is to come to Congress with a recommendation in the 2007 to 2010 time frame on the need for a second repository.

Research on granite hard rock, which was a primary contender in the second repository, was terminated and cites that specific activities for a second repository were prohibited by these amendments.

As far as the MRS is concerned, the Amendments Act authorized an MRS, but revoked the Department's proposal to site an MRS facility in Tennessee. It placed restrictions on proceeding with an MRS, in particular, it precludes the DOE from beginning any siting activities on an MRS pending a report to the Congress by a separate commission for the MRS Review Commission. It was established to review the need for an MRS and report back to Congress. After that report is submitted, the DOE may begin its survey and conduct site specific activities.

There is a somewhat independent, and parallel siting approach that I will talk about in a minute that involves an alternate process leading to an MRS site. But in the absence of that parallel, independent process, the DOE may not select an MRS site before the repository site designation becomes effective.

Six months prior to the DOE selecting an MRS site, the DOE must notify the states, tribes and hold a public hearing. Again, there is opportunity for state disapproval and Congressional override.

The Amendments Act specified that an MRS may not be located in Nevada. It says that the site selection process for an MRS should be accompanied by an environmental assessment. Conditions on the MRS: I talked briefly about one linkage to the repository program, namely we may not begin a DOE siting activity until the DOE is recommended to the President, suitability of the Yucca Mountain site. The Amendments Act also indicates that MRS construction may not begin until the NRC authorizes repository construction.

Further, that the maximum storage prior to repository operation may not exceed 10,000 metric tons. For perspective, there are now about 15,000 metric tons of spent fuel sitting in pools at reactor sites around the country. There is a limit on maximum quantity of spent fuel that may be received in an MRS of 15,000 tons. Further, acceptance of fuel at an MRS is to be stopped if there are any interruptions in repository operations or a repository license is revoked or some other problem occurs with that.

Let me tell you why all these restrictions on the MRS. Basically, because traditionally, concern with an MRS has been that it would lessen pressure to develop a repository. That once we have an MRS in the system, we would slack in our efforts to develop a repository. Therefore, in that an MRS would become a defacto repository. Not a uniformly held view. There are many people that disagree with that assessment. In fact, the Department's proposal to Congress on the MRS was, in our opinion, to make it an integral part of the system that would go hand-in-hand with the repository and achieve certain benefits, in addition, by allowing it to operate sooner in advance of the repository.

Well let me talk about the MRS Review

Commission. It is to report to Congress further on the need for the MRS. There are three members, basically appointed by the President of the Senate, Speaker of the House. Those members are Alex Rayden, Frank Parker, and Dale Klein, may be known to some of you people. They were to report to Congress by June 1, 1989, but their deadline has been extended by the Congress to November of '89. They are basically to evaluate the advantages and disadvantages of bringing such a facility on-line.

There are a number of things that could happen as a result of the MRS Review Commission, basically submitting their recommendations to Congress. One, nothing could happen. All linkages that are currently laid out would still apply. The MRS Review Commission could say they do not think an MRS is neede. Congress could respond and basically eliminate MRS from the system. Or they could say that they think an MRS is needed and that, furthermore, it could more effective if some of these linkages were altered or there were other ways of dealing with the concern that an MRS could become a defacto repository.

In addition, as I will talk later, there is an office of a negotiator established that has a role for both the repository siting and potential MRS siting. The dealings of this negotiator could result in new recommendations or proposed agreements, basically proposed legislation, going to Congress, with the expectation that Congress would act upon that.

In short, most people believe that the last chapter on the MRS is not written, at this point in time. I would just leave you with that message.

The Amendments Act establishes Benefits Agreements. This goes to social economic impacts and a state's receptiveness to having a repository. Basically, the DOE may enter into a Benefits Agreement with the Governor of Nevada and with the governing body of an Indian tribe, or the Governor of a State containing a site selected for an MRS facility. It would provide for annual payments to those bodies until receipt of waste, and these payments would increase upon receipt of the waste.

There are catches. The states' tribes have three options. They all include payments equal to taxes as the government is basically exempt -- is not a taxable entity -- and this is to compensate. If this repository were a private facility, it would be subject to the full realm of state, local taxes. The three options are that those entities can accept a benefits package as provided in the Amendments Act and waive the impact assistance and their veto rights, basically. Or they could accept the impact assistance and return veto rights but give up the benefits package. Or they can work with a negotiator to enhance the benefits package.

The negotiator is to be appointed by the President. His or her purpose is to seek a state or tribe willing to accept an MRS or repository. The negotiator is to basically negotiate a proposed agreement between the federal government and such a host for proceeding with such a facility. That negotiated agreement has, basically, no affect unless Congress agrees with it, in which case, they are to pass enabling legislation which, in essence, amends or would take precedence over it to the extent specified. It would have, in effect, basically of modifying the legislative authority to-date.

The Waste Negotiator ceases to exist five years and thirty days from the enactment of the Waste Act.

Let me turn now to regulatory compliance. The EPA has promulgated environmental standards and Code of Federal Regulations 40 Part 191. These regulations were vacated and remanded that the EPA, for further proceedings by the U.S. Court of Appeals for the first circuit in 1981. Key provisions on these standards are to put a limit on the amount of radioactivity that my enter the environment for 10,000 years after the disposal, limits on the radiation dose that a person can receive 1,000 years after disposal. And there are requirements for the protection of ground water. These standards, basically, form the umbrella under which the NRC regulations fall. It is primarily then, the NRC regulations that we become concerned with which, then, are consistent with the EPA requirements. The NRC regulations are 10 CFR Part 72 for an MRS, and under 10 CFR Part 60 for repository. 10 CFR 60 provides performance objectives criteria.

There is a minimum lifetime for the waste package, limit on the rate of radionuclide releases from the engineered barriers of the repository. For the natural system at the site, there is a minimum ground water travel time from the disturbed zone to the accessible environment. For the total system, which includes the engineered and natural barriers, minimum release rates in travel times for radionuclides are specified.

As far as the program schedule is concerned, you saw some of this yesterday. We are basically at the point of releasing a site characterization plan in the next couple of weeks. Next, of course barring any objections or after receiving comments from the NRC, we may proceed with the exploratory shaft facility, which would put us on the road of detailed site characterization. Based on these detailed site characterization activities that will take place both at the result of surface-based testing and underground testing of the exploratory shaft, as well as the lateral drifts extending out from the shaft and so forth, we will be making a determination as to the suitability of the Yucca Mountain site. Information will be put together in performance assessments. Additional information on the environment impacts that proceeding to develop a repository at that site would have on public health and safety and the environment. All that information will be put together in the form of an Environmental Impact statement that would accompany a recommendation to the President by the DOE on the site.

We would hope to have a draft of that Environmental Impact statement on the streets in 1993 for public comment, and in full coordination with NEPA provisions. And, then issue a final Environmental Impact statement in 1994, in time to support a Presidential decision in 1995. As, I think you are aware, our legislative authority indicates that NRC should try to license the site in three years, with an opportunity for extension of another year.

Assuming that is able to take place, then we would be able to begin repository construction in 1998. We estimate it would take about five years for construction and begin receiving waste in the year 2003. This schedule assumes everything goes right. We consider it a success-oriented schedule but I can guarantee that it is going to be done right.

And, as we demonstrated in the past, if that means that it takes more time to do something, then that is what it takes. I can also assure you that, we have too much at stake here as a nation. That if the DOE finds something with the site that undermines our confidence in it, we are not going to proceed with it. We are not going to waste NRC resources. We are not going to undermine our credibility and jeopardize, basically, this very important, many-thousand year program in trying to get through a site that we do not have full confidence in. It would not make sense. Our primary job, then, is to do it right. What we cannot afford and we really want to avoid, is something that would disqualify the site for reasons other than its technical suitability.

Basically, what it amounts to is, we cannot afford to have the site disqualified for reasons other than its technical and environmental suitability. I mean by procedural misstep or some other thing like that. So, we are vitally concerned, again, with adhering to the process as well as technical and scientific rigor and quality.

As far as waste types and quantities, the cumulative amount of spent fuel from commercial reactors discharged through the year 2020 is said to be approximately 80,000 metric tons of heavy metal. There is a limit on the capacity of the first repository, or a hold point, if you will, of 70,000 metric tons, at which time we are to evaluate and, at that point, a decision is to be made on the second repository. This would come into play those considerations.

There are also solidified high-level waste as a result of reprocessing activities, both commercial and defense oriented. These wastes would be solidified or -- glass, and would also be destined for a repository.

In the objectives of our site characterization program we will get into this in much more detail as the day proceeds. We will establish the geologic, hydrologic, and geochemical conditions at the candidate site. We are to provide the data needed for the design of the waste package, and the repository. As well as site characterization activities, we will provide the data needed for the performance assessment of the repository that will go into the Environmental Impact statement as well as the license application.

I would also mention that the Waste Amendments Act provides for a Nuclear Waste Technical Review Board. Eleven members selected from the National Academy of Science elected from nominees that would be provided by the National Academy of Science to the President. He would select eleven from these nominees. They are appointed by the President. Their purpose is to evaluate the technical and scientific validity of the secretary's activities. The board will cease to exist not later than one year after the disposal of high-level waste or spent fuel in a repository.

In the interest of making the three-year licensing period as feasible as possible, we have, or course, undertaken a very major initiative as far as managing the information and minimizing the amount of time lost just in paper handling and indexing and so forth. That is the Licensing Support System which you heard about yesterday from a couple of the speakers. I will be talking a little more about that.

The major breakthrough on the M & O Status last Friday, a selection was made and that selection was Bechtel Corporation, supporting by Westinghouse, SAIC, and Patel, Parsons Brinkerhoff. The M & O's management and operating department operates it facilities through such contractors. They are rather unique in the federal government. Relationship, typically, with M & O contractors is rather unique, M & O contractors in the Department of Energy. In the past, we have referred to M & O's as go-co's, government-owned contractor-operated facilities. The Dupont operated Savannah river for a number of years. Savannah river facilities are government-owned, but typically hire contractors with considerable expertise to run these facilities.

In this case, the M & O contractor is envisioned, as a long-term program participant working hand-in-hand with the Department of Energy. We have a relatively small staff in headquarters, approximately 130 people now. In the Yucca Mountain site, which has 60 to 70 people, that is supported by a number of contractors. Our intent here is to have this major contractor be responsible for, basically, in conjunction with the DOE, major operations of the program, putting together the license applications, supporting licensing, repository and MRS design, the waste package effort, and for much of the performance assessment work.

The Yucca Mountain project will continue to focus on the site characterization at the site obtaining good qualified data we use in the performance assessments, constructing the exploratory shaft facility. Pending the results of the site characterization, then it remains to be seen how the program will proceed. Obviously it depends on whether the site is deemed suitable or not.

Lastly, I think you are probably all aware, that the Yucca Mountain site is approximately 100 miles, by road, from here and you will be seeing it tomorrow. It is northwest of Las Vegas. I think one of the key distinguishing features of it, is its remoteness. I think that will become very obvious to you tomorrow. With that, I will take any questions that you may have.

MR. FRED SHON: I just wondered, you may have already been told this but, just what is the first circuit find remandable about the standards in 40 CFR 191? What was wrong with it?

MR. KEITH KLEIN: Fred Shon, from the Board, wanting to know why the EPA regulations were remanded. Let me first ask if we have a DOE lawyer in the room. Are there NRC lawyers in the room? I can talk.

MR. FRED SHON: May I clarify that a little bit. I am not interested in legal technicalities. I want to get some rough idea of how much impact this will have down the line on NRC regulations and that sort of thing. Just the whole thing is all wiped out or certain details or what?

MR. KEITH KLEIN: Fred Shon wanting to clarify the implication, the impacts of these changes. My understanding is that they are not expected to be severe. It has to do with drinking water standards and some apparent inconsistencies between the EPA standards for other materials and these regulations. It appears to be that it could very well be, and we are hopeful and optimistic that the EPA regulations will be changed but they will not basically affect the NRC regulations. They still will provide protection that will be consistent with drinking water standards and other elements. Max, do you want to add or is Carl Gertz here? Carl is there something you would like to add?

MR. CARL GERTZ: No, Keith I think you addressed it appropriately. The conflict is between drinking water standards and radiation standards, with the amount of radioactivity.

MR. KEITH KLEIN: Carl Gertz, from the Yucca Mountain project office basically affirmed that it is a conflict between drinking water standards and radiation standards. Also, he is not aware of any reasons, at this point, that this will be an indication for a setback for the NRC regulations. Other questions?

MR. JIM GLEASON: Mr. Klein, I guess you are the only one that I could ask this question of. It seems to me that the one message of --, is the problems that have developed because of the lack of an alternative site in which to --, is one that goes along with this project. Of course, the message that you hear is that due to that, as we get towards the licensing phase, is as far as the pressures just gets almost unsurmountable as far as it is so large, that it practically dictates the choice. It seems to me that it is a very plausible or reasonable argument. The question, I guess would be, is does this bother you as the administrator of parts of this program? Are there any thoughts that you have about it?

MR. KEITH KLEIN: Your name, sir?

MR. JIM GLEASON: I am sorry. My name is Jim Gleason. I am part-time member with the atomic safety --.

MR. KEITH KLEIN: The question was from Jim Gleason soliciting, basically, any thoughts or concerns I would have about an issue that was raised yesterday, that there is a lack of alternative sites and what should happen if something should be determined unsuitable about the Yucca Mountain site, in the absence of alternatives. Would this put pressure on the NRC, or undue pressure on the NRC licensing process?

Let me just speak as an individual and not as a representative of the Department. Because I do not know that we have taken an official or formal position on this. But spent fuel and these wastes are going to be around for a long time. If there is something wrong with the Yucca Mountain site, we will just have to start at another site. The wastes are accumulating but they are being safely stored at the points of origin. There are a number of alternatives for extending that storage as long as may be necessary and extending it safely. I think the number one priority is would the public health and safety be jeopardized because that could lead to pressures on the NRC or the licensing process.

But absence that, I think the Board, the NRC and others fully appreciate the need to do this right. My knowledge of the people on there -- I just do not know anyone, personally on the commission or in these boards who is going to basically prostitute themselves because there is no other site to pick from at that time. We have learned a lot as a result of this program. If it was required that we characterize another site and start again, maybe we will have lost five years or ten years. But in the longer-term scheme of things, I would tend to think that that is what would have to happen and that the consequences would not be intolerable. Hence the pressures on the NRC, in my mind, would not be as great as what might otherwise be thought. I would remain fully confident. I am not bothered, basically then, by that, in the sense that thinking it would create undue pressures on the NRC.

SPEAKER: I think we can take, at most, one more question.

MR. KEITH KLEIN: One more question?

MR. CHARLES BECHHOEFER: In DOE's preparation of Environmental Impact statement, will the DOE offer public hearings of the draft statement that you are coming up, or the final statement --. We were told yesterday by -- that the DOE, in their preparation of the Environmental Impact statement, will offer the opportunity for members of the public to comment on matters such as transportation of that type of thing. By the way, my name is Charles Bechhoefer.

MR. KEITH KLEIN: It was Charles Bechhoefer asking whether the EIS process will be the only public forum for public participation, questions on things like transportation and other elements of the program and whether there will be public hearings concerning the Environmental Impact statement. No it will not be the only opportunity. It will be a major one.

Of course, until we go into the scoping process on the EIS, which again is an open public process soliciting views of a number of parties as to what should be the scope of this EIS. It will, in all likelihood, address transportation and other aspects, the full ramifications of proceeding with the site at Yucca Mountain. There are public hearings, very much associated with the EIS process, particularly, for the issues of the draft EIS. And there will be public hearings on the scoping process even before that.

In addition, comments on the site characterization activities can be factored into bi-annual or the site characterization process or plan is basically to be updated through progress reports every six months. Congressional appropriations, hearings, MRS siting, I would say that people who have concerns of our program have not suffered from lack of opportunities to make those concerns known or felt. Certainly we have not seen any evidence that they are constrained by lack of a formal process such as the Environmental Impact statement.

Certainly, on the transportation going to an MRS, if there is an MRS site, or whatever, there are hearings there. I might also mention that in the transportation program, for example, we have had, on the average, about every six months, something called Transportation Coordination Group meetings. They are an open forum, states are invited, Nevada was represented, the last one very strongly and we get into considerable detail on all aspects of transportation.

And, similarly, for other aspects of the program, there are typically are forums and avenues that are open. The Mission Plan Amendment is another vehicle. There is a Draft Mission Plan Amendment that has been out for some time and we received extensive, numerous comments on that which outlined our overall program strategy and policies.

MR. FRED SHON: Well, thank you very much. Our next speaker will be Carl Gertz, who is the Yucca Mountain project manager. He will be able, I am sure, to tell us a good deal about what we are going to see tomorrow and what the situation is today. Carl.

MR. CARL GERTZ: Thank you very much Fred. I am Carl Gertz. I am the Yucca Mountain project manager. I live here in Las Vegas and will be responsible for activities at site characterization. Let me just set the stage for what is going to happen a little bit later today. I am going to provide you with kind of an overview of the organization and tell you about who is doing what on the project. I am also going to talk to you about quality assurance, our program for assuring the Quality Assurance program is in place when we start site characterization. In addition to that, I will tell you about the top-level strategy, our overall approach to gathering data to see if Yucca Mountain is a suitable site for isolated wastes.

Later on, my staff will talk to you about what is out there. What is at Yucca Mountain. What we know about it now based on our last seven years of studying. And then, we will talk about what we are going to do in the future. We are going to talk about our surface-base studies and our underground laboratory, both the design of it and the testing within it. The exploratory shaft is the underground laboratories I am referring to.

And then, after that, we will talk about how we tie the testing, from the surface-base testing and the underground laboratories into the licensing process. We look forward to communicating with you today and we look forward to providing you with the information that you want to know. So feel free to ask us questions and we will sure try to respond.

First of all, I would like to remind you there are some missions. The DOE mission right now is to site, construct and operate geological repository in accordance with the Waste Policy Act as it is now stated and amended. Our project mission, though, is to determine if Yucca Mountain is a suitable location for a geological repository.

I cannot repeat it any more, or emphasize it any more that Keith did. As a project manager, if Yucca Mountain is not safe, if it is not the right place, we do not want to build it there. Congress has given us an alternative. They say, "Come back to us. We will start over." So that is the utmost point, as the project manager, that I want to make with you. If is not safe we do not want to build it there. But if it is safe, we want to get on with the national program. If it meets the regulations, we want to move forward. We will not be able to tell that until we get into our site characterization program.

Keith pointed out the organization and let me just emphasize a little bit. Under the lower blue box on the right side, and I take direction from the Nevada operations office which has two programs, and only two programs here. The underground test program for nuclear weapons and the Yucca Mountain project. Essentially, that is all Mr. Aquilina runs and we are one of the major programs. In addition, I take the program at a policy direction from the office of Civilian Radioactive Waste Management, with Sam Rousso now and the Associate

Directors as Keith pointed out the organization.

This is the organization of the Yucca Mountain project. It depicts the participants, those people who are doing the work. This particular organization represents approximately 1400 people working on the project today. The lower tier represents the organizations doing the scientific work. On this project, scientific work is being done by National Laboratories and the U.S. Geological Survey. A preponderance of almost 95 to 98 percent of it is being done by those people.

The U.S. Geological Survey, on the left, is responsible for our geologic and hydrologic studies. They are out there studying those aspects of Yucca Mountain. Sandia National Laboratories is doing our performance assessment and initially did the repository design activities. Lawrence Livermore National Laboratories is involved with the Waste Package design. The Waste Package environment, the release of the radionuclides in the Waste Package.

Los Alamos is involved with volcanism, what is happening in the area of volcanoes along with geochemistry of the site. That is the tier that does the scientific work. On the right-hand side, you see the participants that are involved with the design and the construction of the underground laboratory or the exploratory shaft.

Fenix & Scisson and Holmes & Narver are long-time test site contractors. They have been here for a long time. They are involved with the design of the above grade and the low-grade facilities. Holmes & Narver of the above grade; Fenix & Scisson of the low grade.

REECO, Reynolds Electric and Engineering, is responsible for the construction on the site and doing the drilling for the participants in the lower tier. They are, in effect, our construction management.

On the left-hand side, we have Science Application International, SAIC as they are known. They are responsible for integrating all the activities of the participants, providing comprehensive documents, and, in effect, work quite about on this site characterization plan and integrating what the participants will provide.

In addition, we have MACTEC, a subsidiary of MAC, M-A-C, Management Analysis Corporation, providing quality assurance and project management consulting to the project. Not in a line role, is MAC, but they are to provide consultants to my staff.

Keith pointed out the federal force includes about 60 to 70 people overseeing the project. This happens to be my federal organization. You will hear later from Max Blanchard, on the right, who is responsible for the regulatory and site evaluation and Larry Skousen, on the left, who is responsible for the engineering design of the exploratory shaft.

Keith pointed out this schedule and I will just re-emphasize it again. The blue portion of the schedule, site characterization, is really what it is all about over the next seven years. We are going to spend six or seven years and one to two billion dollars determining if Yucca Mountain is safe, determining if it is suitable, determining if meets the regulations. Only then, we will come forward, if we believe it is safe, to the NRC and enter the licensing process.

In order to enter the licensing process, though, we have to have data that we can use. We have to have a qualified QA program. That is what I want to switch to now, is tell you a little bit about where we stand in the area of quality assurance.

Our project quality assurance strategy is cut in three parts. We have to NRC approval of our overall plan, which we did achieve here in October, October 14th. We then have sequential approval of our project participants. You saw the eight participants up there, seven participants in my office. We have to get these plans approved, some of which the NRC has indicated they will also approve.

Then we have to develop procedures by the participants. Then we have to assure through a implementation audit, that we are performing in accordance with these approved procedures. Only after the assurance, which we observe by the NRC staff, will we then have what I call a "gold star", which then allows us to collect data usable directly in the licensing department. Yes?

SPEAKER: Can you give us some idea of the size of the MACTEC consultancy?

MR. CARL GERTZ: Yes, the MACTEC consultancy runs from 14 to 20 people. The line quality assurance is being performed by the SAIC staff, with a staff of about 45. Each of the participants have their own staff of quality assurance people to assure the line people are doing what they are supposed to do.

SPEAKER: What about are the contractors job? To review procedures and audit the process?

MR. CARL GERTZ: No, the review of the procedures and the audit of the process is the responsibility of the SAIC, the integrator. MACTEC will also review it as a guidance addition to my staff and provide us input but not the line responsibility for approval. The line responsibility for approval rests with the SAIC and the DOE office.

SPEAKER: Then, I take it you have to approve all that yourself.

MR. CARL GERTZ: That is correct. The blue box on top is the final approval. That is right. We will go into that a little bit more and this just leads right into it.

Our 88-9 is the plan I alluded to that has been approved by the NRC. It is a significant step as identified by GAO and the NRC in the program. Below that we will have the participants quality assurance program plans which my office does approve. We approve that.

Below that, our quality assurance procedures which each participants is responsible for approving, and we look at during audits. That is the hierarchy that we use to accommodate participants's needs and to accommodate the NRC needs.

This is what we call our Gold Star Schedule or what is necessary, as Keith pointed out, before we start new site characterization activities. Those activities that are started, the organizations involved with those must have the gold star. You see the organizations, eight of them on the left-hand side, the triangles indicate audits we performed with NRC observations this past year.

On the right-hand side, you will see what is scheduled for the next year in order to get us to a gold star. All you see on there, is the audit, so to speak. The next few graphs shows you what goes into getting a gold star. This is our generic schedule. We have to do this eight times, once for each participants. We have to, of course, have their quality assurance program plans approved, any administrative procedures approved, any quality administrative procedures approved. Then we have to undergo training. All the people working on the project that are involved in these procedures, have been trained and are cognizant of what is in the procedures. They know how it applies to the work that they are doing.

We will do surveillances, both by my office and SAIC and the participants themselves to ensure that the training has been accomplished, and the procedures are in place. We will then resolve open items. We will then have a management review to assure the first bars are complete. Management review by the participants and the DOE management review. And when we are satisfied, we will then conduct our gold star audit which will be observed by the NRC. This is no small audit. The audits that I showed you before with the triangles, have had up to 32 auditors and observers on the team. We expect it to last to up two weeks at a participants. When we are complete with that, we then expect acceptance by the NRC that our program is in place, people have been trained and we can go and gather new site characterization data that will be usable in licensing documentation.

We believe we have made significant steps toward a fully-qualified QA program. As you saw by this schedule, we are talking by next summer for all the participants being ready--having a gold star.

Our project Quality Assurance plan was approved in October by NRC. As I pointed out, GAO and NRC in documentation have recognized that as a significant step. We have even accommodated six comments that the NRC staff had in the SER, Safety Evaluation Report. In addition to that, we have enhanced some other parts. We have sent revision 2 on to them which they have indicated will receive approval.

All the participants right now, the labs, and the A&E designers, and the constructors are in the process of updating their QA plans, of preparing procedures, and of certifying and qualifying and training personnel. As that goes on, we will then flow into the auditing process.

I cannot over-emphasize the importance of quality assurance. Certainly it has been a culture shock, maybe, for some of the scientists on the program but it has certainly been a challenge for us to communicate with them that exemplary scientific work must be accomplished by flawless documentation and approved adherence to the process and procedures. Otherwise, it is worthless in the licensing department.

It is the fact. It is a quote that I have been using and I noticed a paraphrasing on it yesterday. Somebody said and I read the quote in the paper, "It is nothing until the NRC calls it." Well, my quote has been, "It is not data unless the NRC says it is data." And that is a point we have been trying to make with the scientists and I think they are getting to understand it, that this is the way it has to be. It is not a normal scientific endeavor. This is an endeavor that is going to lead to a license, and, therefore, it is litigious at best.

The only other point I wanted to make along this area is, we believe we are making progress with the scientists, with the U.S. Geological Survey, with the National Labs. We really believe we are making progress. And those people who cannot live with this environment, and some people do become a little bit intimidated by 32 people listening to an interview between themselves and a Quality Assurance auditor. To a scientist, sometimes, that is not pleasing. Those people are probably going to be leaving the program and doing something else that makes them happy as a professional. There is no other way and that is tact we are taking.

Now let me talk a little about the top-level strategy because once we get our Quality Assurance program in place, we want to proceed with site characterization. We want to determine if the site is acceptable, if it is safe. Our strategy for the Yucca Mountain site, to provide for the long-term isolation, is dependent upon engineered and natural barriers. I am an engineer and I feel pretty comfortable with the engineered barriers. But in this process, we are dealing with natural barriers too. This is something that no licensing environment, no licensing activity has dealt with to the extent we are going to deal with here. We are going to place primary reliance for the ten-thousand-year-models on the natural barriers.

Our strategy places reliance on the natural barriers and conditions, a low flux -- we will talk about it a little bit more --, slow water movement, long radionuclide transport times in the unsaturated zone. Keeping in mind that there are repositories from anywhere from 500 to 1200 feet above the water table, our projected are rising.

We also have to look at the low-probability, high-consequence events, the destructive processes. What impacts could that have on long-term isolation. We have to identify and characterize them. And then, certainly we have to look at the repository design for surface facilities because we are going to operating for 30 years or so, receiving waste. We are going to also make it retrievable for 50 years. We have to understand how to operate facilities at the location we will be picking at Yucca Mountain.

What I just talked to about the top-level strategy is kind of depicted on this little chart. Let me point out the key aspects of it. Let me just point out that the red area is the repository horizon. It is the repository, the engineered barrier. We are going to place primary reliance on the slow flow of water, or is there any water? Max is going to talk to you about this in detail so I am just setting the stage.

Is there any flow? How much water reaches that barrier in the unsaturated zone? What does it do to the barrier?

Then, how long does it take radionuclides, if they become dissolved in the water, to reach the water table, and then the accessible environment. Because our regulations depend upon 10,000 years of isolation before radionuclides reach the accessible environment. A key aspect, once again, is the distance between the repository and the water table. Once it gets to the water table, it moves quickly, comparatively. Maybe 1,000 years, 10,000 years.

Right now, our estimates of radionuclide travel time from the repository to the water table, is 20 to 80 thousand years based on very limited information. That is why we are going to be studying Yucca Mountain over the next seven years. We do not have enough information to make a case for it right now, but we hope to, over the next seven years, gather the information to make our case.

Now, I just want to point out that the elements in the repository system that contribute to the isolation of waste, are the engineered barrier system. Its objective is to limit the release of the radionuclides for a certain amount of time, 300 years to 1,000 years. The natural barrier system provide the long radionuclides travel time. Then, of course, we want to make sure the construction of these traditional facilities will not compromise the ability to meet waste isolation in the long run and to operate in a safe environment. In other words, the mine and the surface facilities can be done without impacting the long-term isolation.

This graphically depicts some of those objectives of the components. It is just the same things that we talked about. The natural barriers include an arid climate, low precipitation, high evaporation, no ground saturation. We are in a welded tuff. It is strong. It is not plastic. It is easy to build a repository in it structurally, in the unsaturated zone. As we near the saturated zone, we have some zeolitic rock. We have some high sorption capacity. Then we have the deep water table.

When we go to the engineered barriers, we have the waste form which is resistant to dissolution in itself. We have the containers, the waste packages which prevent access to the waste form early on. If there is no water at all, and we can assure there is no water, those waste packages may last for a long time -- well beyond 10,000 years, if we can determine what attack or what the water situation is. We are going to engineer an air gap around that package and we have elevated rock temperature because the heat of the spent fuel will elevate the rock and kind of drive any water that is in the matrix away.

That is the picture. That is the engineered barrier. We are either looking at putting it in the floor, as that picture shows inside a drift; or putting in a wall.

It just, once again, describes a certain objectives for the components of the system. What we expect from the engineered barriers and the natural barriers and what we expect from them. And, of course, the components of the facilities.

Our top-level strategy was used to focus site characterization. If we now the performance that we expect from the barriers, both natural and engineered, then we need to go out and find some information. We need to gather information at the site. So, that has lead us to our site characterization program. We need to know what is happening in the unsaturated zone. We have to investigate the conditions around the waste package, the near field around the waste package. We have to look at the potentially significant events. We have to develop programs for that and, in preclosure, during operation we have to develop and design criteria to ensure safety of the facilities.

This is in your handout. It expands just a little bit more our key area of emphasis in the site program. It expands what we are going to look at the unsaturated zone and in the waste package. These are expected or nominal conditions. The yellow at the bottom talk about the disruptive conditions we are going to look at. The impacts of future climate, we are going to be studying. The effects of future faulting. Probabilities of volcanism. Certainly, the three issues that are on everyone's mind: climate, seismic activities and volcanism. We have a lot of studies laid out over the next seven years to understand those effects.

Then on the right-hand side is understanding the design aspects for the facilities.

A while ago we identified potentially adverse conditions. We identified those in the environmental assessment in 1986. These conditions are still potentially adverse and it is conditions that we need to study and mitigate. Our site geohydrology will be difficult to characterize and model. No doubt about it. It is complex. There certainly is evidence of active faulting and igneous activity throughout the quaternary -- throughout the last 1.8 million years.

Early available data are insufficient to establish in view of the frequency or recurrence of the earthquakes could increase. We need to know more about that. No doubt about it. We have a tendency for sheet flow or flooding. We have to make sure our facilities are not designed in an area that would be subjected to that. And we need to know the thickness and the lateral extent of the repository horizon. What is down below ground.

The only way we can find out some of this data, is, of course, to begin site characterization program, both the surface-based testing and the exploratory shaft or underground laboratory.

On the other hand, there are some attributes at Yucca Mountain that contribute to its suitability as a repository. It is in the unsaturated zone. We talked about that. The only repository that DOE had been looking at that was in the unsaturated zone, above the water table. We are in a desert environment. We do have zeolite out there. Our testing to-date, we have done over 300 holes and trenches out there in the area to-date have indicated zeolite would be a long potential flow paths. They would lead to the retardation of radionuclides, should they every be dissolved.

Our population density is certainly very low. Probably one of the lowest population densities around Yucca Mountain in the nation, if not the lowest. And our site characterization activities are not expected to cause significant adverse impact. In other words, the mining of the drips during site characterization, the construction of the facilities during site characterization, are not expected to cause environmental impacts of any significance for that part of the project.

In summary, our top-level strategy for the site, addresses the requirements of EPA and NRC. We have to understand and gather the information so we can establish models for the ten-thousand-year performance. Focus is on understanding disruptive conditions and processes, because that is also a consideration. Our emphasis is certainly on the unsaturated zone, the waste package facility and the repository facilities.

As a project manager, I like to keep projects on schedule and presentations on schedule and I think I am right on schedule. I will surely address any questions you might have and there will be a lot more later on. Yes sir.

MR. CHARLES BECHHOEFER: My name is Charles Bechhoefer. How are you going to establish a --.

MR. CARL GERTZ: The question by Charles Bechhoefer with the panel is, how are we going to establish a confidence level with a permissible margin of error in the data that we gather. I think Max is going to address that a little later. Max, do you want to address it very briefly right now.

MR. MAX BLANCHARD: Yes. I am Max Blanchard. I work for Carl in the Yucca Mountain project office. The subject of the last talk of the day addresses the question you just asked. Basically, we have two inherent approaches in the site characterization program. One is to examine the features, the anomalies at the site and understand how they effect the site's ability to isolate waste. We also have a program which is geostatistically oriented so that we determine the mean standard deviation, the variance of the site parameters that are important to waste isolation. By combining the both, we feel that it is a strong step to gain reasonable assurance on what our predictions are.

But we do not stop there. We have a fair amount of redundancy in the kind of information that we are going to acquire. When Carl mentioned certain values in some of his top-level strategy, one of them was flux. We are measuring flux in many different ways so that we can have an understanding of what the statistical value is that we are trying to put in to calculations for ground water travel time or radionuclide transport.

MR. WALTER JORDAN: Could you say what flux is? I am Walter Jordan.

MR. MAX BLANCHARD: Sure Walter. Flux, simply speaking for the purposes of the discussion here, just think of it as a volume of water moving past the repository in a downward direction that would pick up radionuclide and move them down to the accessible environment, wherever that might be. It is not correct, strictly speaking, because the units are millimeters per year, but it is a plane. If you put time on it, then you can apply it. Okay? Yes sir?

MR. CHARLES BECHHOEFER: -- I would like to ask you a question that I asked somebody at the State yesterday. You say one of the key areas of emphasis is to predict the impact of the climate conditions on the -- system at the site. Does this include global warming, and its effects on rainfall, as a result of the Greenhouse Effect over the next several decades?

MR. CARL GERTZ: It includes changes in climate, changes in rainfall. I would assume our global warming would be factored into that model, but, the people this afternoon will talk a little bit more in detail about the future studies. Max, do you have anything to add to that right now?

MR. MAX BLANCHARD: There are two approaches, as you know. One is to do climatic modeling, both globally and locally here in the Southern Great Basin. We are doing that. The other approach is to reconstruct the past from helioclimate studies. There are some themes in earth science that say that the past is a key to the future. From a geologic standpoint, that seems to hold up over very long time periods, like millions of years. So by reconstructing past climates over the past two million years, we also hope to provide strong confirmed empirical evidence on what happened in the past and use that in our modeling.

MR. FRED SHON: Thank you very much Carl. Why don't we try to get back here by 20 after 10:00. That will give you a full fifteen minutes. Okay?

(Short recess.)

MR. FRED SHON: Our next speaker is going to be a gentleman who has already had a little bit to say, Max Blanchard. He is going to expand his remarks. He is the Director of Regulations and Site Evaluation Division in the Yucca Mountain project. His subject this morning will be the geological description of the Yucca Mountain site. Max.

MR. MAX BLANCHARD: Thank you. Good morning. Mike Gora, where is he? He was supposed to pass out the handouts. Please raise your hand.

As Carl mentioned, I work for him. I work also for the Nevada Operations Office. I would like to talk with you this morning about a very general topic, the geologic description of the Yucca Mountain site. That, of course, includes the geology, the hydrology, the geochemistry, the climate, rock mechanics, total earth science information.

I managed a group of 300 to 400 people during the last 3 or 4 years while we have been preparing the site characterization plan. This plan is a very comprehensive document, as you know. The information that is required in both the Waste Policy Act as well as 10 CFR 60. The document, as it exists, is about 7,000 pages long. It has nine volumes, eight chapters. The first half of the document is chapters 1 through 7 and I will talk a little bit about those in the near future.

That is half the document. The other half is the plan -- one chapter -- the plan. Then there is an overview as was mentioned by Keith Klein earlier this morning. There is also an index which is a separate volume. These 7,000 pages explain what we know about the site from all the publications that are available discussing earth science and then, what our plans are for the future.

What I would like to do is to take chapter by chapter, geology, hydrology, geochemistry and so forth, which is 200 to 300 pages long, explaining what we know and to still that down to a single word view graph by identifying the four or five major features that we think are important to the site with respect to waste isolation. Then I would like to show you a few view graphs or figures that were taken out the site characterization plan, to give you a better feeling for that particular topic in earth science and the site.

Finally, what I would like to do is to have a view graph which has 3 or 4 points which are the major things we are going to focus on during site characterization.

Before I go into that detail that explains what we know about the site and what our principal focus is on the planning efforts, I would like to spend a few minutes describing the attributes of the site with some air photos.

I have a feeling that there is going to be some problems listening. I can hear a movie going on pretty loud there. Are you all disturbed by that? You can hear all right? Okay.

Well this is an exciting town but, not because of me. Okay. To start with, before I show you some air photos, what I would like to do is give you some general orientation so you will not get lost while we look at the air photos. This right here, is an artist rendering of the general vicinity of the test site. And that is Yucca Mountain. To the east is Jackass Flats. To the west is Crater Flats. There is a mountain range back here called Bare Mountain. They are distinctly different rock types that what Yucca Mountain is made out of. The main road running up to Reno down to Las Vegas is here, Highway 95. Down here is the Amargosa Desert. South of the Amargosa Desert is Death Valley. You can see the area of the test site, Yucca Flat, Pahute Mesa is where underground testing is currently being conducted. There is an area in here I will talk about a little bit later on this morning, about Rainier Mesa, where there is a series of tunnels there, in the same kind of rock type that we have at Yucca Mountain.

And then you see things called Calderas, Black Mountain Caldera and Timber Mountain Caldera. These Calderas were the sources of the volcanic rocks that were deposited around the site 10 to 15 million years ago. They are very thick lateral extensive volcanic rocks all over the test site. Some are float rocks, some are ash fall, some are welded tuff. It is these rocks that we will be talking about because they make up Yucca Mountain.

Yucca Mountain was once just a flat horizontal plain of rock. And as the basin and range aged during that time, the valleys on either side down-dropped and Yucca Mountain was left tilted as a rock unit above and it formed a mountain. That is true for many of these other ridges in the vicinity of the test site.

Okay. If we can have the first air photo. We may want to dim the lights. Is there a control on the lights here or not? Can you see all right in the back of the room. This is a high-altitude air photo. I have in red some labels -- those at the front can probably read. Unfortunately, those in the back may not be able to.

That is Yucca Mountain. There is a major canyon I will talk about later, Solitario Canyon is on the west side. Midway Valley. I will talk about Midway Valley a little later and so will Larry Skousen. There is a major drainage feature from the high country called 40-mile wash. This is Jackass Flats. This is Crater Flats. There is some basalt cinder cones which are relatively young in age. They are thought to be last waning stage of volcanism, which was once extensive in this basin and range province.

These cones are on the order of a million years old. There is some debate about the age of

Lathrop Wells' cinder cone down here. It could be considerably younger.

If we can have the next view graph. This is an air photo taken from the north end of Yucca Mountain, looking south. Here is the ridge line. You can see the very resistant cap rock of Betiwa Canyon and the bedded tuff underneath it and then the Topopah Spring rock unit. This is Solitario Canyon. There is Crater Flats and Bare Mountain is to the west. There is a cinder cone that is out in the flats.

This expansive area back here to the south or southwest is the Amargosa Desert. The only thing that drains through that is the 40-mile wash and then the Amargosa River. They are dry. They have been dry since the last ice age. The mountains that you can just barely make out are those on the extreme eastern edge of Death Valley, the Funeral Mountains and the Great Pine Mountains.

The mountain itself is tilted. The rock units are strong and they show this resistant line here and continue on down in that direction. They slope to the east some 5 to 7 degrees. The next air photo is looking -- we moved from over here around this way. We moved west so we are looking southeast. We are looking along the ridge. You can see a drill rig up here where they were drilling an unsaturated zone hole. There are a few roads here. Right here is Jackass Flats. Access across the test site, is across Jackass Flats into the area where Yucca Mountain is. That prominent feature is called Busted Butte. You will not miss it when you go on your field trip tomorrow.

There is a valley up here called Midway valley and I will talk a little bit more about that later. It is a potential location for the surface facilities. Then some roads come into location for the exploratory shaft and then into Drill Hole Wash.

The next air photo, we moved a little bit farther south and we are looking almost due east where you can see the road come across. Calico Hills, very colorful hills on the other side of 40-mile wash, this dry wash I was mentioning. Here you can see the main road coming into the exploratory shaft site. In a little while, I will look at that from the east side looking west.

The valley that we have tentatively identified as desirable for the surface facilities is here. It is called Midway valley, and I think the next view will show us a little bit closer air photo. There is a little hill called Exile Hill. That line across there, is the result of a geophysical profile that was taken across that valley so we could look at the structure beneath the alluvial fill in the Valley.

Here are two trenches. They run across or are perpendicular across the fault, which is on the east side of the valley. You do not see any surface expression of the fault. The fault is very subdued. It appears to be quite old. However, you can see a color change from white to gray. Because of the geologists that were working on this, they had spotted that, they trenched it and are now studying it. This is the Bow Ridge Fault. This happens to be two locations where some calcite silicon deposits have been found and we have been involved in much debate. We have some outside -- review of the origin of these findings and it is a concentrated study in the site characterization plan.

A view looking to the east, at Yucca Mountain, right up the canyon where the exploratory shaft site is. The exploratory shaft ES1, ES2, are on the south-facing slope of this hill. There is the ridge of Yucca Mountain, and behind the ridge, you can just make out the mountains, called Bare Mountain, which are paleozoic rocks, a very different origin, a very different time.

We are looking west. I may have made a mistake. The highlights of the geology. This comes from Chapter 1 of the site characterization plan. As

Carl had mentioned, we have been doing geologic studies since the late 1970s so a far amount of information is known about the geology, and the hydrology, and the geochemistry of the site, from which we built about a 300-page chapter, Chapter 1.

Distilling all of that information down to five bullets, I would like to relay to you, first that, from a geologic standpoint, we have reasonably stable geomorphic conditions and very low erosion rates at Yucca Mountain. There is a thick section of volcanic rocks, with extensive lateral and vertical continuity. The repository facilities would be located in the Southern Great Basin, which is in a region that has experienced considerable faulting over the last 15 million years, as you see by the air photos and as you will see when you go out to the test site tomorrow.

However, the historic natural seismicity in the site vicinity has been lower that the surrounding region in the Southern Great Basin. Also, the available data suggests a low potential for mineral and energy resources for future human intrusion over the next several generations. Some of the figures taken from the site characterization plan -- this shows the Calderas. There are a whole series of Calderas back over many millions of years, they being the source rocks as you can see large volumes, very extensive and thick sequences of these ash flow welded and ash flow tuffs make up the surrounding area of the Nevada Test Site. Yucca Mountain is just representation of one of those thick lateral extensive sequences.

This shows the major quaternary normal faults. Here is Yucca Mountain. The stippling are the volcanic rocks. The white is alluvial material. These are the cinder cones of basaltic composition, over a million years age here, considerably younger here.

Bare Mountain is here on the west. The first fault I would like to point out is Paintbrush Canyon fault. Although the -- show right here on the east side of Midway Valley, we have drawn those lines on down and connected them together thinking that all of the fault lines might be connected. We came up with a distance for the length of that fault, which is debateable but it could be stretched out as long as 30 kilometers, depending upon some people's view.

Across Midway Valley, we have on the east side of Midway Valley, another fault called the Bow Ridge Fault. I showed you that. That is where the trenches were. If this valley turf proves to be a good location for the surface facilities, there would be a tunnel from the surface facilities underground into the mountain and the underground exposure for the repository would be a triangle, shaped something like that. It would go right across that fault.

The exploratory shaft location is in that little tributary there. Solitario Canyon, that is a fault. It runs from here and dies out north and it dies out south. Then there is a series of other mountain ridges as you move westward. Each one with a bounding fault. This fault here, Windy Wash fault, has shown some movement in the last 6,000 years, (a few millimeters).

Then there is a range front fault here at Bare Mountain where paleozoic rocks have been uplifted with this valley down-dropped.

Okay. Next air view graph. The geologists are trying to get a better understanding, map the faults in greater detail, and map the fractures in greater detail. This is an exploded or enlarged view over what I just showed you. Again, there is Yucca Mountain, there is Midway Valley. Here you can see evidence between the volcanic rock and the white, which is the alluvial valley fill. These lineations running in a generally north to south direction, thought to be normal faults.

This right up here looks like it might be a strike slip fault. I do not think it has yet been demonstrated but we are suggesting that it probably is. There is also some other linear features in here which would suggest that they may be a strike slip too.

The shaft location is right up about the Drill Hole Wash area, right about here on that hill, I think. If I am not mistaken.

Next. From a seismicity standpoint, we have got a map here that starts with the Pacific Ocean and we go across California into Arizona and Utah. You can see several inter-mountain seismic belts, Walker Lane Belt, East-West Seismic Belt. The area that we are referring to of relatively low historic seismicity is right in here. The things that show up as seismic events which are historically plotted with events greater than or equal to magnitude -- intensity, are a consequence of water loading behind the dam at Lake Mead. And then, at the north end of the test site, there is after shocks that occur up there as stress is relieved as a result of underground nuclear tests. Also, it is not certain whether we have identified all of the tests that were announced. There could be some natural earthquakes occurring in that too. Yucca Mountain is right there at the star.

Okay, next. The major geologic questions that have been drawn from Chapter 8 are four. What is the probability that the repository would be penetrated by basaltic magma? Right now, the availability of information suggests it is below one chance in a million. As we conduct site characterization, we will get better numbers on this.

What are the origins and ages of the calcite-silica deposits in faults and fracture zones like the Bow Ridge fault, where I showed you the trench that crossed those two different rock types. Do they occur because of up-welling hot hydrothermal fluids, or do they exist there because they are pedogenic? A consequence of precipitation and calcite-silica deposits forming at the surface, as they do so ubiquitously in the Southern Great Basin.

What earthquake magnitude and reoccurrence intervals should be used for performance and design, especially design of the surface facilities for its 100-year operation? Right now, our perception is that it is the faults on either side of Midway Valley. They are only a kilometer away and, if you look at the Paintbrush Canyon fault, it could be considered a very long fault. So we are looking at that as the major control in earthquakes for the design of the surface facility. One could surmise that an earthquake magnitude of 6.5 might be possible on that fault. So, it is important to understand the ground motion. It is also important to understand whether or not we will get surface rupture in the valley beneath the surface facilities.

And then, to what extent can future tectonic events cause changes in ground water conditions? Could we have some sort of a disruptive event that would cause the water table to rise? Significantly, which would shorten the ground water travel time.

Okay. If we can go on to geoengineering. That is Chapter 2. The major geoengineering characteristics. Well, this particular rock is confident, thick and continuous, as I have mentioned. It is fractured and faulted. The stresses are low in extension, with no expectation of gas, water inflow or temperature problems during mining. The shafts and drifts underneath Yucca Mountain can be constructed using standard techniques and standard mining practices.

There is a high probability of long-term stability of the excavations with minimal support. I would like to talk more about that in a minute. There is also a high probability that retrieval operations, if they are needed would be carried out in a stable environment.

Next slide. The reason we believe this right now is that here is -- you are going to visit this -- this is G tunnel. We are over at Rainier Mesa, which is a thick flow of volcanic rocks. They are not quite the same rock units that you are going to see at Yucca Mountain, but they are welded tuffs and they are bedded tuffs, and there are flow rocks there, all types of rocks. They have the same geo-mechanical properties.

This tunnel has been here for a number of years. For approximately 28 years, that tunnel has been operational. Maybe 17 years during that time, there were underground nuclear explosions conducted in that tunnel. If we can have the next view graph, I can show you some tunnel complexes.

After that, some 14 years of chemical tests with TNT were explosions. That tunnel has been operational all during that time. You are going to visit that U12g tunnel. All of these other tunnel complexes in Rainier Mesa are used for underground weapons testing. Currently, N-tunnel, about 3 miles away, is the active tunnel area where UNEs are being let off. This tunnel has no problem. People work in that tunnel every day of the week.

Next view graph. The major geoengineering questions. How will the data about these rock characteristics be obtained? From the exploratory shaft facility and then combined with the bore holes from the surface program that we have. How will they be shown to be representative of the overall Yucca Mountain area? That I will address partly in the last talk. The gentleman here in the front, asked a question about how are you going to show that it is representative and what kind of statistics you are going to have on that.

Will the rock mass respond to mining and heat in the manner predicted? Because we are changing that rock when we put waste in it. It has to dissipate heat.

Will the significant geomechanical impacts to the site be avoided by designing controls? We think so, but, it is up to others to review that to determine whether or not they want to agree with our design controls.

Moving into Chapter 3, which is hydrology, we only have two features here. The unsaturated zone, which is where the repository is going to be located, and the saturated zone. The features of the unsaturated zone: Carl has mentioned that the repository will be above the water tables, 600 to 1100 feet. The difference is that at one end, since the mountain slopes, it is closer to the water table than at the other end. And the repository takes advantage of the natural slope of the rock; so the repository has a drift of about 5 degrees to it.

Also, it is more than 650 feet below the land surface. The current estimate for this flux, which is a water flux, which is in millimeters per year, is low. We are using a number of 0.5 millimeters per year. Of course, that number is debated. Many of our staff think it is 0.1 millimeters per year. Some of our staff advocate it is 0.01 millimeters per years. Nevertheless, we do not have enough information right now, to really have high confidence that that is what the flux is. So, that is what we are going to conduct an intensive unsaturation zone site characterization program in hydrology.

The current estimate, as Carl mentioned, for the pre-waste emplacement ground water travel time, that part of 10 CFR 60.113 that says it must be greater than a 1,000 years. Right now, the range looks like it is between 20,000 and 80,000 years with a mean of 40,000. And it tails off in each direction. We have this -- ground travel time model that has been prepared for that using the available information. But again, the available information is not complete. We are just embarking on an intensive site characterization. So, expect these numbers to change, as well as the way we calculate that travel time.

Also, the current evidence indicates that water flow is mostly confined to rock matrix. And I want to talk a little bit about that later, because, that is a fundamental characteristic of waste isolation in the unsaturated zone. If that is not true, we probably do not have a viable site.

The saturated zone: the ground water is derived principally from the precipitation within the basin. The flow direction is to the southwest. Discharge is in the Amargosa Desert to the south. And, within the saturated zone, the water seems to move relatively fast and the hydraulic conductivity is controlled by fractures, joints, and bedding planes.

This is a sketch of the ground water basin. There is three sub basins: the Ash Meadows, the Alkali Flat-Furnace Creek in the Oasis Valley, and these are the boundaries of the Death Valley water basin. As you can see, recharge is in the mountains, where the water would flow east or south, from up here. And, along the spring mountains, where the water flows north on the spring mountains. In general, the flow of the near surface water and the ground water is in a westerly and southerly direction.

This basin is an enclosed basin. It does not drain into a river that connects to an ocean. It actually drains south through Amargosa Desert and then north into Death Valley. The Amargosa River has not really been a water-carrying river since -- time, some time in --.

Also, there is some discharge. There are springs, some springs down in Death Valley, springs here at the northern end of the Spring Mountains. By in large, here at Franklin Flat and Ash Meadows, there is a marshy area and there is a lot of discharge hot springs and most of it is evapo-transporation. It is believed, right now, as we begin site characterization, that the principal discharge is here in the evapo-transporation areas.

A picture of the hydrology would not be complete without a cross-section. Here we are looking northward. This is west. That is east. I see Yucca Mountain right here. The information to compose this cross-section has been compiled from drill holes, like H-5 and H-4. This one over here, UE-25 p#1. The rock units you see are the Betiwa canyon, which is a very resistant rock unit that will outcrop to the top of the mountain.

The next one down that you saw outcropping is the non-welded bedded tuff, the Paintbrush. This one here, where you see the stippling, which is a much-exaggerated repository, is a Topopah Spring welded unit. A very thick unit. Beneath that, that which we are concentrating on for understanding its ability to act as a natural barrier, the lower part of the Topopah Spring and then the Calico Hills. Those are natural barriers.

The Calico Hills is a rock unit, which consists of two types of rock. At the western side, it is vitric. It is glossy --. It is -- in composition. To the eastern side, the glossy material has been converted to zeolite. As you know, zeolite have good absorptic properties for trapping radionuclides.

The water table is shown here. And then beneath the water table, we have the same kind of rocks with lots of zeolite, and slowly moving southeasterly direction flow of water.

Okay, can we have the next. The major hydrologic questions that we discussed that need to be fulfilled or answering in Chapter 8. What is the rate and aerial distribution of the net infiltration near the surface? Obviously, we have to have that number before we can decide what the flux is in the repository horizon.

What is the rate and direction of ground water movement in the unsaturated zone from the surface down to the repository? Is there a significant component of lateral flow in the unsaturated zone, either above or below the repository? Is the unsaturated ground water flow predominately in matrix? I will talk a little bit more about that -- or in the fractures. What is the rate and direction of the ground water movement from the repository horizon to the accessible environment? Principal questions that address the isolation capability of the site.

Now, I want to talk about this view graph in two ways. One, just from a standard standpoint of looking at relationships. Two, from a conceptual standpoint. This is a plot of ground water travel time versus flux. Let me mark a few things up here.

I will come back to this in a minute, because I want to mark it a little bit more. The point I want to make is as this plot's ground water time versus flux, as the flux gets high. If it is 10 millimeters per year, the ground water travel time is pretty short. It is like 100 years, according to our calculations right now. If the flux is low, 0.5 millimeters is shown right here -- that is the number I used in the previous view graph, -- then it looks like it may be in the order of 10,000 to 100,000 years.

Where this boundary zone is, is of obvious importance to us in assessing the waste isolation capability of the site. So our goal is to understand where this boundary is and how water moves in the unsaturated zone and matrix fracture flow.

What I would like to do is take advantage of this little artist cartoon to illustrate that point. This block here, I have drawn to show things which would represent parts of the rock in open areas. Around the rock, I have shown open pour spaces, which are now filling in. If we had a drop of water, like the unsaturated zone has now, it is relatively dry, we would have water coating these grains. And as we add more water, a second drop and a third drop, the water by capillary attraction, stays in these pours. And as under very high tension, it goes nowhere except under the influence of some pressure which forces it to move.

We have capillary attraction keeping the water in these pour spaces. When we add one more drop, we reach the point beyond saturation. Then, out drops an -- volume of water and it moves down a fracture. Where that transition occurs, in the artist concept, is what the goal of our hydrology program is. Try to understand how that operates and when it changes from matrix flow to fracture flow.

SPEAKER: Why doesn't it seep into another matrix?

MR. MAX BLANCHARD: Well, it does. If capillary traction will allow it. But if the fracture is large enough, then it would go down in fracture flow rather than jump across the opening. Of course, recognize that this is in an ideal world and Mother Nature never really operates that way.

Okay, Moving into Chapter 4, the geochemistry, the major geochemical characteristics we have identified here are five. You have heard Carl mention zeolite and clays. You have heard me mention them. They occur in the rock below the repository, especially in the Calico Hills and they are expected to provide considerable retardation for those radionuclides that get out of the waste package. They can be --.

We also have matrix diffusion operating in this particular type of rock. And this should provide retardation for non-sorbing species and additional retardation for those which are sorbic species. Also, the retardation should not be significantly effected by natural processes or whatever the effects are from construction and operation of the repository.

The dominant minerals constituents in Yucca Mountain and beneath the repository horizon are not prone to dissolution. And the minerals present are expected to be stable in the predicted repository temperature field. This is taken from G-4 which is very close to the exploratory shaft. It is a plot of depth versus mineral content. Here is a clay mineral -- and here are two zeolite, clinoptilolite and mordenite.

The repository horizon is right about here in the Topopah Spring --. It is above the principal occurrence of these zeolite. It is above the water table. There is Calico Hills. As you can see, there is something on the order of 20 to 70 percent clinoptilolite in the Calico Hills. And there is something on the order of 10 to 30 percent mordenite.

We feel this information, we need a better understanding of its distribution and of currents throughout the entire mountain, so that we can assess this appropriately.

The major questions from a geochemical standpoint, are how will confidence be gained about the quantity and distribution of these sorptive minerals along the flow paths? What geochemical data are needed to adequately support the assessment of radionuclide releases over the 10,000 years? And then, how will the results of laboratory tests about retardation and matrix diffusion be translated reliably into field conditions? As you know, those measurements have to be made in the laboratory.

Moving into Chapter 5, which is the climatology. Our major climate characteristics, Carl had already mentioned them this morning. Yucca Mountain site is located in the desert. We get about 6 inches of rainfall per year. Most of the precipitation is lost, through either runoff or evapotranspiration.

Regionally, the number we are looking at is about 97 percent is lost. Relatively high wind speed contributes to dispersion in the vicinity of Yucca Mountain. And future climate is expected to be wetter, because we assume that the peluvial cycles will continue to reoccur. And, cooler, at the same time as wetter. But, current information suggests it might double the amount of precipitation. That is not a significant increase when you look at six inches to twelve inches per year, and when you are looking at that kind of evapotranspiration and runoff.

Yucca Mountain lies in a rain shadow. In fact, Death Valley and the entire Southern Great Basin lies in a rain shadow. The weather comes in from the Pacific and, during the last 10 to 15 million years, the Sierras have been rising and they are continuing to rise. They cut off the weather as it migrates inward. The weather is generally dry and it will remain to be dry for a long time for a lot of physical features that exist in California.

Our major climatic questions, how are we going to bound future climatic conditions and move that into our assessment of waste isolation potential? I will talk more about that later, but, suffice it to say, that looking at the paleoclimate, reconstructing past climate over the -- period, certainly during the -- time, by looking at lake deposits, looking at shorelines, looking at -- deposits, paleobotanic data, --, things of that sort where we can reconstruct climate, are the basis for getting empirical information over the last 50,000 to 100,000 years.

Also, though, we cannot rely simply upon the past, because we are not sure what the present is going to be like. So we will be doing climate modeling. There is lots of information available from climate modeling globally from NOAH, from NASA, from other agencies. What we really need to focus on is understanding the climate modeling in the Southern Great Basin.

Finally, what will be the impact of these climate changes on the ground water? Will it raise the water table significantly? Is that really likely, or not?

Okay. In summarizing in what I have said this morning, is first, I tried to describe the major characteristics and the major questions about the site that are encompassed within the site characterization. I have done that in a very simplistic way but, if you want some heavy reading, then I would offer you a copy of our 7,000-page site characterization plan.

Later on this afternoon, we will be talking about surface. Jean Younker from SAI will come over and discuss surface based test program. Mike Voegele will discuss the surface base program, that which is going to be conducted from the exploratory shaft.

Finally, bringing the whole picture together, how do you relate data to performance requirements? I will talk about that and reasonable assurance in the last presentation of the day. That is all I have for this morning's talk. I would be pleased to answer any questions that you might have.

MR. WALTER JORDAN: Oscar Paris has mentioned the possibility of a Greenhouse Effect and in the publications in the last year, besides other places, have indicated that the rise in temperature from the Greenhouse Effect, is going to be superimposed upon those from the changes in position of the sun, the moon's orbits, and so on. And, if you believe it, there really is a significant change of 2 degrees centigrade for the next few hundreds of years. So, are you neglecting that or not?

MR. MAX BLANCHARD: No. I don't believe we are neglecting that. We are trying to bound that by considering a return of the ice age in peluvial cycles like what the past paleoclimate records looks like. Then, from a modeling standpoint, we are going to incorporate those by a bounding-type scenario. How much water could the mountain withstand in terms of precipitation and what would that do to the flux level of the repository horizon?

Now, whether or not, we are considering it appropriately in the eyes of the NRC technical staff, and in the eyes of the State, is subject to debate once they start reading the site characterization plan.

MR JORDAN: I did not see in your slides, anyplace where it is mentioned, the Greenhouse Effect.

MR. MAX BLANCHARD: That was meant to be encompassed within our hydrologic modeling program on the next to the last slide. I am sorry. I meant climate modeling program.

MR. FRED SHON: Could you repeat the question.

MR. MAX BLANCHARD: I am sorry. Did you all get the question well enough? Okay. The question was does the site characterization program that focuses on understanding climate changes, encompass or include the potential for greenhouse effects? Other questions?

MR. STAN SHEPARD: Would you care to comment on the Ghost Dance fault.

MR. MAX BLANCHARD: Sure, I would be pleased to. The question is would I care to comment on the Ghost Dance fault? The Ghost Dance fault has been mapped recently by Scott -- of the geological survey. They published several maps. Also Maldonado published a map recently that covered that area. They have recognized it as an offset in the rock units which would be approximately the lower third of the repository. We do not have an age on that. My personal perception is that it is likely to have been associated with the formation of Yucca Mountain. It dies out north and it dies out south.

As you move to abandon wash, it disappears. And as you move north, over by the exploratory shaft site, it disappears. It has all the indications to me as a geologist, of being the kind of thing that would be associated with the structural formation of Yucca Mountain. It is not at all like the Paintbrush Canyon fault, where you can trace by --, looking at air photos and go out in the ground and walk them out. Many kilometers of -- which should then connect as in the case of the Paintbrush Canyon fault or the Bare Mountain fault on the west side or the Solitario Canyon fault.

What is it you would like to -- when you are up on the field trip, I am sure people there will be pleased to point out the Ghost Dance fault, and compare it with the other faults that are much more prominent.

MR. MORGANSTEIN: Could the Ghost Dance fault act as a conduit for water from the surface getting into the repository?

MR. MAX BLANCHARD: That is a good question. Could the Ghost Dance fault act as a conduit for water reaching the repository? That is a good question. We will not know a reasonable answer to that question, until we have conducted site characterization. As you know, we have a drift from the exploratory shaft planned at the repository horizon to go in to Topopah Springs westward to the Ghost Dance fault, and make a number of hydrologic measurements on the Ghost Dance fault. I think, on the basis of those measurements, we should learn what the hydrologic properties are there.

SPEAKER: If that were possible, might not other faults and fractures at Yucca Mountain also transport water?

MR. MAX BLANCHARD: Of course, anything is possible. If that is possible, might that also mean that other faults and other fractures would transmit water? The answer to that is, of course. If that is possible, I think the corollary goes with that. As you recall, the purpose for conducting an intensive site characterization at depth in the Topopah Spring horizon, is to conduct those kinds of scientific experiments needed to obtain information and make the kind of assessment about which you are asking a question. We have a number of hydrologic tests planned. And we have a number of geologic mapping going on to identify where all the fractures are so that we can appropriately fit the fracture information into the hydrologic models. Thank you.

MR. FRED SHON: Fred Shon again. I notice a little discrepancy in certain ways -- maybe it is not really discrepant -- between what we were told yesterday and what we are hearing today. But, in particular, one of our speakers, I think it may have been Mr. Johnson, said yesterday that this is one of the most seismically active areas in the country next to California --. He also said that it is one of the most productive areas for minerals and thermal energy and that sort of thing and showed many mines on the map there in this general area. And you suggested that it has a low potential for mineral and energy resources. Why the different views?

MR. MAX BLANCHARD: The question that Fred asked pertaining to mineral resources. There seems to be a difference of opinion there, as well as in seismicity of the region. I think the answer is probably partly in the eyes of the beholder. As you would guess, we are about to embark on intensive site characterization program that, to the best of our ability, we will try to answer those questions. But, what is relatively important, a lot depends upon the point of view that the person comes to ask the question.

For instance, mining. Of course, there are ore deposits at Bare Mountain in paleozoic rocks along the fault zone, a major bounding front fault. That is not like Yucca Mountain. And from the 50 or 60 drill holes we have drilled out there since the 1970, we have not seen anything to lead us to believe that there is an ore deposit. Nor, have we seen anything to lead us to believe that someone would want to invest the money to economically find out whether they could mine at a profit.

We do not know what the markets will be 50 years in the future. If you look back in the 1900s, no one would guess that we would be using rare earth phosphorus for color television screens. So I think it is very hard to predict into the future. I think Carl is right, from that viewpoint. We just do not know what will be there. But, we see right now, no reason to believe that there are significant anomalies from other areas that people would be interested in exploring in the vicinity of Yucca Mountain.

With respect to seismicity, the information on that view graph was compiled from historical information. As we know, there are certain limits with all of the historical information available. It has its limit, in terms of looking backwards. And even the reports where you use a -- scale, are not all that accurate for depicting magnitude of earthquakes. However, we do have an extensive seismic network that the geological survey has been operating and will continue to operate throughout this program.

The data that was plotted on that graph came from both the historical information as well as that network. I submit that the information coming in from the seismic network supports what I said.

MR. PETER BLOCK: Peter Block. If I understand Commissioner -- yesterday, is that the purpose of the program is to find our whether or not, you can provide a reasonable assurance for the repository. But I notice there is some subtle differences of wording as you look at specific questions through here, including, especially, the third point of the summary. It says "how can it provide a reasonable assurance?" which is not the same question as "will it provide reasonable assurance?" And I think you are right, it really matters what question you are asking, because you tend to find what you are looking for.

MR. MAX BLANCHARD: That is a true point. If you feel I have asked an inappropriate question, I stand corrected and I apologize for that.

MR. CHARLES BECHHOEFER: Charles Bechhoefer here. Has the DOE attempted to assess what effect the climatic changes would have on future population in the area. Like an increase in rainfall of 6 to 12 inches, would that draw more people into the area, for any reason?

MR. MAX BLANCHARD: The question is have we assessed the change in climate might have with respect to population increases. It is incumbent in the climate program that is described in the SEP. We have not done those studies yet but there is a fair number of models that we can draw from. For instance, as you move north in Nevada, move up to Ely Nevada, a small mining town, or farther north, they get more precipitation than we get. Perhaps a factor of 2. They are still not very large towns.

The question would be economically, what would drive a significantly large population here in Las Vegas and would people want to go to farming or something else like that which would increase water use?

I do not know the answers to that. Those are studies that have to be done in the future.

MR. CHARLES BECHHOEFER: You are saying that they are being done?

MR. MAX BLANCHARD: They are planned. Sir?

MR. FRANK DIXON: Frank Dixon, with the State of Nevada. When I first heard of the unsaturated zone, I was impressed because it seems to me to be a dry place. But then when I read some of the documents that come out on the amount of water that is in the pores of those rocks, actually there is more water in the pores than air, ranging up to 90 percent filling. So, I just bring this up, so that you can discuss it, Max.

MR. MAX BLANCHARD: Thank you. His question is whether the unsaturated zone is really unsaturated. I am not sure what to say about that except that we know that water has to move under potential. In the saturated zone, there is pressure difference and then it moves, depending upon the porosity and the pressure difference. The principal pressure difference we see in the unsaturated zone, is the force of gravity pulling the water down. If the capillary tension is high, it is greater than the graph force of gravity pulling it down, except when things are disturbed and the water goes into fracture flow.

It seems to me what we need to get a better understanding of the process, is to get some age measurements. We have a number of experiments where we are going to try to get samples and make chlorine 36 measurements on water samples, in hopes of finding out how far any of the material that could have been deposited and infiltrated into the surface, from precipitation events, during the time of the air blast nuclear program. We are hoping that that will give us a better understanding of how far the water migrates and how it migrates as it infiltrates.

But also, we have each measurement planned should we get samples of water like perched water from the Topopah Spring or in the bedded tuff. Because, if that is the case, than maybe we can get an inch measurement. We would like very much to be able to do that.

MR. FRANK DIXON: I seem to remember from one of the publications of this area, that the pores range from 60 to 90 percent in their water content. That is very important in your model, it seems to me, because you do not have to add very much to fill the 90 percent filled pour units. You only need 10 percent.

MR. MAX BLANCHARD: That is true. His question was that there seems to be information about the hydrologic characteristics of the rocks that suggest that voracity is between 80 and 90 percent water and we do not have to add an awful lot more water to saturate it. His point is well taken.

MR. WALTER JORDAN: Walter Jordan here. Are you saying that the flux might, instead of being 10 per millimeter, or something like that, might actually be zero because of the fact that the surface tension will hold them there. So, it could be as low as zero.

MR. MAX BLANCHARD: Yes. I think that the scientists that are working on this, have flux estimates that range more than an order of magnitude, perhaps 2 below that value that I used. Although, we have critics who would say that that value is too small, it is really higher. In order to get a better understanding of the infiltration, we are setting up a number of experiments. Some of which will drill 20 to 30 holes that will be relatively shallow, maybe 50 feet deep at different places on the mountain.

Then we will look at natural infiltration with neutron probes. In other cases, we are going to places where we are actually going to create artificial rainfall and then overload the system as if there was a climate change. See if we test how much it will take and then monitor that too. And then, also, we have experiments where we put -- and other types of instruments in bore holes in the rock or in the rock from the exploratory shaft at the repository horizon, to gain a better understanding of how water moves in the matrix and when it goes into fracture flow.

MR. GEORGE FERGUSON: My name is George Ferguson. I am with --. It seems to me that if a repository is built at this proposed location, it is reasonable to assume that there must be some limitations on the use of the test site. My question is, can you comment on what limitations such a repository would have on the use of the test site?

MB: The question concerns potential conflict between the repository and the test site. And I see my boss, Carl Gertz, standing up. I am sure he is quite anxious to address that. Carl?

MR. CARL GERTZ: We have looked at potential conflicts between the testing program and Yucca Mountain project. Defense programs has indicated to us, based on the best they can tell what is in the future, there is no conflicts. Right now, they are testing between 20 to 25 miles from Yucca Mountain, which creates very little below ground motion and some above ground motion, but significantly less than any designs that we have to adhere to for the natural phenomena of earthquakes.

Now, lots of things can change. We have a test ban treaty that limits us to 150 KT. Should the test ban treaty change, we might have to have bigger blasts. But, we have done some studies and some limiting things. We believe there is enough area in many areas of the test site, to take care of this for the future. There is no immediate conflict and no immediate agreement that they have to prohibit anything or there is no intention to come up with one. We are off by ourselves.

That part of the test site we are going to see tomorrow, has been dedicated to research and development activities, not to nuclear testing -- the southwest portion of the test site. So all the ideal geology for underground nuclear testing is in another part of the test site, sufficiently away not to create a problem for us or them.

MR. FERGUSON: May I pursue the question a little further?

MR. CARL GERTZ: Sure.

MR. FERGUSON: Let's assume the repository is built. Let's assume that activities at the test site continue into the future. It is reasonable to assume that there may come a time when some activities at the test site may have some impact on the repository. Has anyone ever looked at the question of what has the priority at that time? That is do you cancel at the repository and go on with the program at the --

MR. CARL GERTZ: That would become certainly a national policy issue at that time. Right now, we are limited to the amount of testing we could do at the test site because of its effect on Las Vegas structures. We can only put so much of an underground blast up there before you would shake buildings more than it is acceptable here. Right now, certainly even at our 150 limit, we do shake buildings. We ask people not to have window washers here and things like that when we detonate a test and we publicly announce it so I think a lot of other policy decisions come into play before we can much different things at the test site. One of the factors would be what would be the effect on the Yucca Mountain, if any.

MR. MAX BLANCHARD: Thanks Carl.

MR. DICK FOSTER: Dick Foster. I am with the panel. In order for this water to get to the accessible environment, it has to go down to the saturated zone, and then move sideways. You showed us on your maps, conceptual paths that you think it might follow. What kind of a program are you going to have in order to really pinpoint the direction of movement of that ground water below the repository?

MR. MAX BLANCHARD: That is a good question and I will have a more comprehensive answer later on in three parts once we talk about the surface base program this afternoon. The second one when we talk about the hydrology experiments from the exploratory shaft and then, again, when I talk about reasonable assurance and performance assessment.

But, suffice it to say, that our strategy is to look at the empirically and statistically. And that we are having two types of surface base characterization programs. One where we look at anomalous features to try to gain an understanding of what they can do to waste isolation. But, when you transfer that information into a statistical calculation, you are transferring a known anomaly. We call that a features-based program.

We have another program called systematic drilling program where we statistically decide where to drill holes and acquire more information about hydrologic information, hydraulic conductivity and things of that sort.

That is driven by pure geostatistics and the combination of both those, we think, will give us the kind of information we want to fold into our overall mathematical model, numerical models that we will be deriving to try to understand flow paths and flow directions.

The geostatistic one is a systematic drilling program that provides us with what we think is a good foundation for geostatistics. It will allow us to have values like mean standard deviation variance, and things like that, which we can treat with a little more confidence than if we just translated those measurements straight from anomalous sums.

FOSTER: But no -- measurements?

MR. MAX BLANCHARD: Oh yes. From the exploratory shaft we will be conducting numerous hydrologic tests in -- to characterize water migration, water flow directions in the paths that water takes, given different amounts of water --. Also, from the surface bore hole program, we will be placing instruments down the holes to make -- measurements throughout the site. When someone talks about that -- Jean Younker will talk about that after lunch -- when she discusses the surface base program and I think, you can ask her some additional questions. Thank you. Other questions?

MS. FEDERLINE: Margaret Federline. It is my impression that the exploratory shaft location is at the far end of the planned repository area. I am just wondering how that location was selected to provide representative information for the total repository area?

MR. MAX BLANCHARD: That is good question. The question was how did we decide to locate the exploratory shaft where we located it. Well, we had a screening report done a number of years ago which compared attributes that were desirable for locating the shaft. It considered some aspects of performance in waste isolation, aspects of environmental, aspects of rock characteristics.

Probably the most important driving reason that we think now, that that location is quite appropriate is that

the stacastic ground water travel time model shows us -- and bare in mind it is based on tentative hydraulic conductivity measurements and they could be in error -- that model shows us that the ground water travel times are the shortest or the water travel velocity is the fastest in the northeast corner, which is the area around where the exploratory shaft is.

The distance between the repository horizon and the water table is also the shortest there. Now, if there was a desire to preserve those areas that can offer the most for waste isolation for the real waste and placement areas, then you would want to reserve the rest of the site, not for experiments, but for waste and placement. And then if you were going to drive a conservative program, you would want to conduct the measurements about hydraulic and your potential for waste isolation, and the impact that the exploratory shaft might have on isolation. You would want to conduct those experiments in the area in the site, where you thought you would get the worst numbers.

I do not want to say that we purposely located it there because it was the worst place, but what I would like to say is that the screening report has been tempered by the publication of Scott Sinnock's ground water travel time model, where he has taken the entire site and divided it up into 10,000 vertical columns. The columns go from the bottom of the repository or the bottom of the disturbed zone, down to the water table.

And then, in a stacastic manner, he has gone out and grabbed random numbers that have been derived empirically from measurements on the test site -- hydrologic measurements, values of porosity, hydraulic conductivity, permeability -- whatever there is needed in this ground water travel time calculation. And then, in 10-meter intervals, for each one of those columns, he has added up the travel times. As a consequence, he has produced travel time maps. And every time he produces his maps, he continues to show that the northeast corner is where we have, not only the shortest distance, but the fastest travel time.

So we think it is a good area to conduct -- experiments for that reason. It is also a good area not to plan to put waste and placement. Any other questions before we break for lunch? One more.

SPEAKER: What evidence supports matrix versus fracture flow in the unsaturated zone?

MR. MAX BLANCHARD: I am sorry. I missed the first part of your question.

SPEAKER: What evidence do you have that supports matrix flow versus fracture flow in the unsaturated zone?

MR. MAX BLANCHARD: The question is what evidence do we have that supports the concept of matrix versus fracture flow.

SPEAKER: No, not the concept. Matrix flow versus fracture flow.

MR. MAX BLANCHARD: What actual evidence do we have that supports matrix versus fracture flow? Only laboratory evidence and textbook evidence and the hydrologic testing that has been done from the UZ holes that have been drilled out there to-date, which have provided very little hydrologic information because we have not been able to get water out of the holes in the unsaturated zone. The way to get water seems to be to grab a piece of rock and then to centrifuge it in an ultra-centrifuge and try and squeeze a little bit of water out of it. That takes a very high pressure to get water out of it.

There is, I think laboratory evidence, supported by theoretical evidence, that is well-founded that the water is in the matrix. Thank you very much.

MR. FRED SHON: Thank you Max. I notice you just told us you can get water out of the stone, no blood though I suppose. Try to be back here by 12:30 and we will be right on schedule. Thank you.

(Whereupon, the meeting recessed at 11:25 a.m. for lunch.)

MR. SHON: On the record We are ready to start. We have Carl Gertz again this afternoon, speaking on an overview of the near-term site characterization activities. That's quite a mouthful.

MR. GERTZ: Thanks a lot Fred. Before I start, let me tell you what is going to happen this afternoon. I'm going to give you an overview of the near-term site characterization activities and some other things. What we're going to be doing in the near-term.

Followed by that you have a expanded presentation on the surface base aspects of that. Then a presentation of the design of our exploratory shaft or underground laboratory. And then a description of the testing that is going to go on in the underground laboratory, the exploratory shaft and then a description of how all the testing ties together to come up with the license application.

All based on the assumption that the material and information we find still indicates Yucca Mountain would be safe. Anytime we find it's not safe, as we've pointed out, we won't be submitting a license application.

Let me just respond a little bit though, to an earlier question that, by Fred, that kind of peaked my interest a little bit. And it was a question to Max about identifying something he had said and comparing it with maybe something that Carl Johnson had said yesterday. And I think it was point out that different sets of facts can be viewed differently by different people.

Let me point out a story from my other life. I have a, if you think it is controversial being a Project Manager at Yucca Mountain Project, I also officiate high school basketball and football, which is also somewhat controversial. And to get on with the story about viewing different facts differently, let me point out a little situation that happened to me a couple of years ago.

A very important game as to which football team was going to go forth to the State tournament. Second quarter, one team is getting pushed all over the field and they finally get a drive mounted and they have about a third and nine, the quarterback scrambles around the area, alludes some tacklers, gains about seven yards and gets tripped up and his knee hits, but only slightly, he bounces up and goes for what is an apparent first down. I blow the whistle, pick the ball up, move it back short of the first down where his knee hit. And I happen to have a good view of this one, I was very confident about it. All of a sudden the Captain comes to me and he says time out, time out Mr. Referee. He says my coach wants to talk to you and I'm sure I know what the coach wants to talk about, because he's over on the other sideline, kind of yelling and screaming.

He comes out and he says gee whiz Carl, he says we got some momentum and you have taken our momentum away. He says that was a terrible call. I says, Coach, I was right on top of that and did see his knee hit. He says, well let me tell you, I was screened out, some of my assistants said that's what may have happened, but I've got to do something to get my team jacked up. So, how about if I just stand here and point at you a little bit. And he does that and I say okay Coach and he says now I'm going to pull a Billy Martin, I'm going to throw some grass at you too, so he reaches down and throws the grass down, you know.

Now the crowd is getting a little excited, the kids are getting a little excited, they're viewing this situation as a little different than what it really is. And the radio announcer, my wife is listening to it at home and he's saying the Coach is really giving a piece of his mind, so to speak. And I said Coach, that is enough now, you know you start to embarrass me. He says, forth and two, fourth and 17, I'm going to punt anyway. And with that I just throw my flag right up in the air, you know.

Now, there is more cheering goes on and everything else. Probably threw it higher than the stadium, because I was getting a little excited at that time myself. And finally he did go off and the crowd cheered and everything else, but that situation was viewed a lot differently to the people involved. To he and I it was viewed differently and to the stands and to the media that covered. It was even written in a newspaper story that the Coach had gave me a piece of his mind and as a result his team had played a little better. Bottom line, they didn't win either. So, that's in response to Fred's question, about we're going to have a lot of different facts, scientific disagreement is going to occur on this project and we're just going to have to work our way through it and come up with what is the truth, or what is the right answer. And geology and hydrology, there may be lots of interpretations that are equally correct.

With that, let's point out what is going to happen in the near-term. You heard about the site characterization plan, it will be released by the end of December. We will be having some public hearings on the site characterization plan.

Max told you about it, it's just up there again, he has talked about the first five chapters as to what we know. Chapter 8, as to what we're going to do is going to be described later today.

Another aspect of this project has been our Out-Reach Program. We have had what we call project update meetings. In February we are going to continue to have those. We have asked those people around the State what they want to hear about. We will respond to what they want to hear about in February, but we're also going to then tell them what's in the SCP, it's a new document that just came out. We're going to try to communicate to the public what's in the SCP, in preparation for the bottom bullet, which will be the public hearings which will be in March.

So they will have an opportunity to ask us questions one-on-one, we will have scientists around the room after the presentations for the public to talk to on one-on-one, in the different areas. And we hope to communicate on a one-on-one basis and answer whatever questions they may have, along with some informal presentation.

In addition, our Out-Reach Program is included responding to anybody that asks. If you want to hear about Yucca Mountain Project in this State, we will come out and talk to people about it. We will try to present the objective facts, as we see it, and the program as we see it.

State and Local officials may request some individual briefings on the SCP, we don't know, but they might.

Certainly we're expecting comments, it's by law the NRC will provide us comments, what they call a site characterization analysis in approximately June. We had hoped to get some comments no the exploratory shaft part of the SCP in March. We may or may not get them then. Utilities will undoubtedly have comments, the State of Nevada has already presented us some comments that we will be looking at in this time frame. Local Governments, the affected Counties and the public will have comments on the SCP.

Comments will be considered, they will be addressed through revisions in the plans, which we call our Semi-Annual Progress Report. Before we start, we will want to make sure that we understand what the comments are and if the comments affect our program. If they affect our program and we think it's prudent, we will be changing our program.

We've talked about new cite characterization activities, but at the site over the past years we've had some activities that have been ongoing. I'm just going to address to you what's ongoing out there now. What's happening out there now.

We had defined ongoing as on May 28th studies that were in progress at the site at that time, are considered ongoing. We are monitoring hydrologic things. We're looking at existing bore holes, stream flow gages, debris flow, precipitation, some laboratory tests of core and crushed tuff. And additionally, geological activities are being monitored. Obviously our seismic networks are always working and always recording events.

Looking at survey bench marks to determine tectonic movement. Sampling and mapping of existing trenches, mapping and collection of samples, so we don't loose anything, so we don't have any loss of retrievable data.

We do the standard weather monitoring. We look at geomechanical activities in the laboratories, activities in long term testing that was going on at Los Alamos, particularly, and geochemical also.

Another ongoing activity was alluded to a little bit by Max, but I want to just expand on it a little bit and it falls into the category of maybe different sets of circumstances are viewed differently by different people, depending on the timing. This talks about some volcanic centers that were active within the quataniary and we have identified seven in the Yucca Mountain area. These are Sleeping Butte, it's about 45 miles from Yucca Mountain and the closest one is in Crater Flats, or about 12 miles from Yucca Mountain -- Lathrop Wells is about 12 miles from Yucca Mountain, excuse me. And these are a little closer out in Crater Flats.

Keep in mind, I'll talk about the two youngest ones. We've looked at these seven and we've identified two that are fairly young. This one at Sleeping Butte, one at Lathrop Wells. Young meaning less than 20,000 years old.

These are what we call some additional findings. The most recent of which just occurred last October. No reports have been written, it's just been an observation of some of our scientists. But the conclusion that they're coming up with is that the last eruptions from two of these centers, about 12 and 27 miles from Yucca Mountain, may have occurred less than 10,000 years ago.

We believe this new information was discovered by what we call state-of-the-art techniques called geomorphic techniques. We look at the geometry of the cone and looking at similar cones whose age we know, we're able to determine for that climate what the age of this particular volcanic center is. And it's certainly a state-of-the-art technique. It's a technique that wasn't available to us years ago, but it's been able to, preliminarily, identify some young, two of the centers as being young.

Now, two possible -- we're going to study them intensively and there are two possible scenarios at Yucca Mountain. You could have another small volume eruption at Sleeping Butte or Lathrop Wells. What would that entail? What would that occur, what would occur if that happened? Well, if it happened, let me tell you the magnitude of it. The estimate is it would be about one foot thick, about one square mile in area. With the distance from Yucca Mountain, a reoccurrence of that event, would not affect the repository at Yucca Mountain. Affect would be unlikely, due to the distance of the volcanoes from the site.

Also the history as shown on these volcanic centers that there has been, although recent activity, the volume of the recent activity has been less and less and less. So, one would then follow a future activity would even be less. The other scenario would be a formation of a new volcano right at Yucca Mountain. Now, you get into probablistic assessments and right now our current thinking is, the probably of a new volcano reaching a repository is one in 10 million, to one in a billion per year.

We're going to have some intense studies to look at that in the future, but that's the facts as we see it in the area of volcanism at Yucca Mountain.

Our summary is we need new data. It's important to understand the volcanic processes in the area, so we can predict the future, because we'll be looking at 10,000 year models. In addition, we have studied all the volcanic centers that we've identified, we will continue to investigate the young ones and we believe if an eruption occurs, and when we talk eruption, we're not talking the St. Helen's type of eruption, we're talking a Hawaii type of volcano, a slow flow of lava. And we -- what we've seen a repeat of what has occurred in the past, would not affect a repository at Yucca Mountain.

Now, let me move on to our approach to new site characterization activities. I told you about the ongoing stuff we're doing. When we start new activities and that's essentially composed of two areas, surface based tests which you will hear more about from Jean Younker next, and underground laboratory exploratory shaft. This is the new activity that we must have a lot of things in place before we start.

Bottom line, we need to understand the process and phenomena contributing to isolation and performance in situ. Here, we need to look at statistics, geo-statistics of different drilling programs. We have to understand the structural and features in the bore holes that we will be drilling. Over 300 bore holes, by the way.

This is a sketch of our underground laboratory, the ESF. You will hear more about in a later presentation. I'm must setting the stage for you, we have two shafts 12 feet in diameter, they go down about 1,100 feet. Underground we have almost two miles, 10,000 feet of drifts that explore different features, such as ghost dance fault, a drill hole wash and some imbricate fault area. So this will allow us, although a question was asked, if we were only in one corner of the repository, we're still going to do a lot of drifting to some other areas, to examine the representative of the rock at that horizon.

The other program, the drilling program and there is also surface based activity, such as trenching and monitoring and things, but just to let you know here near the end of the year we will have four drilling crews in operation, we hope. Two 24 hour crews and two day-light crews. They will be doing unsaturated zone drilling, saturated zone drilling and some, to start with, some prototype drilling and additional unsaturated zone.

This drilling here, multipurpose bore hole, helps set the stage for our exploratory shaft. It -- I'll talk to you a little bit more about it in the schedule, but our program will be simultaneous. We will be simultaneously doing surface base testing and we will be doing our underground laboratory exploratory shaft construction.

However, before we start any of that new site characterization activities, we have some prerequisites that we must meet. We are still not wholly clear on our land access. We have a few problems and I will discuss those with you. We do need the same kind of permits that you would need if you were a mine in the State. You have to get a clean air permit, sewage permit, water permits from the State. We're going through that permitting process with the State right now. Clean air permit, because we're going to disturb dust. We're going to have construction activity.

Certainly we have to have the SCP review by the

NRC and no objections to any of the activities that would be proposed.

Study plans and additional level to detail below the SCP. We talk about a 6,000 plus page SCP, study plans, 106 of them, maybe as long as 200 pages long that outline in more detail what we're going to do in specific areas. Must be reviewed by the NRC and we must address their comments.

Before we start the exploratory shaft, we better have the design complete. You can't build without a design. And, as I pointed out this morning, before we do any of it, we have to have a QA Program that's been accepted by the NRC before we start to collect data.

Let me just address land issue, as best I can. This is the repository outline. It happens to be lying on three parcels of land. This vertical line to the right of that is the Test Site, DOE land. Above this line is land that is controlled by the Air Force, for the bombing and gunnery range. Just a very small portion of it, but we are on that land. This land down in here in this third of the picture is controlled by BLM. Right now we have access to the BLM land and to the Test Site land through a right-of-way reservation. It's not withdrawn, it's just a right-of-way reservation that says we can go and do tests there.

The Air Force land, we have a letter saying go ahead and do it, but they have not completed their environmental documentation. They're environmental assessment. When they do that, BLM will then grant us access onto this land. That is essence is the land access problem.

We have another interesting situation. We have some mine claims along the crest of Yucca Mountain. They've been filed by a gentleman called Bud Fischetti. He indicates he believes there may be some mineral value in that mountain. And he indicates he would like to start drilling, particularly right here he would like to start drilling. Drilling right there, of course, would create a problem for us, because that would penetrate the repository block and may be unsuitable for long term isolation, unless we control it or buy him out and prohibit him from drilling it. Obviously, he's a fairly wise individual and I think he understands our problems in that area.

His claims predated our right-of-way reservation. So, in reality his claims have precedence. Let's talk about, a little bit about the value of those claims. We've done some assays in the area and surface area. He's gone out there and he's looked at, done some trenching and got some samples, and of course we've got the same samples. The greatest quantity of gold we found was five parts per billion. The economic amount of gold, economic amount that is considered, is to be 1,000 parts per billion, so certainly he is well under what would be perceived by BLM as an economic quantity.

However, his story is going to be, I would like to drill to find out what's down below ground, because that's where I think it is and we're just not going to be able to let him drill, so we're going to have to come to some kind of equitable agreement with him about the value of his claim. So, it kind of boils down just to about a negotiation with him.

Here is a simplified network for ESF construction start. We look at this as one of our major milestones this calendar year. Start the exploratory shaft, the underground facility. Right now we're looking at different prerequisites, different analysis that we have to do. Hopefully, in the end of January or early February, we can start our construction design of the exploratory shaft.

We're going to start that in two packages, one of which is all the underground facilities and things like that. But initially, we're going to start our site preparations, the road to it and the pad where we're going to put the drill rig. We would like to start preparing the pad, the site preparations the roads, along about May. We would then build the roads and the pad, once we get the pad leveled, we'd start our multi-purpose drill bore hole. Bore hole is going to be 1,100 feet, about seven inches in diameter, there is going to be two of them. The purpose of these holes are to identify what the pristine conditions are, before we do the shaft. We want to assure that our shaft construction, we want to understand what affect the shaft construction has on the conditions in the area of the shaft. Also, possibly to come up with any fresh water, should there be any fresh water in the area.

When we get the bore holes done, we then would like to start with our collar for the exploratory shafts. Start the 12 foot diameter shaft in the November time frame. That's our Near-Term approach over the next year. Some other things on there, not on the critical path, but the critical path is outlined in red there.

We talked a little bit about it, it is not in your handout, but it's one I use in many of the presentations, that this proqram is one of the most closely reviewed programs ever undertaken by the Federal Government. I believe when you talk about things nuclear, this review if vital to assure safety and public confidence.

Things nuclear, they carry a lot of stigma with them, a lot of bad stigma. Chernobyl, Three Mile Island, Nagasaki, Hiroshima, when you mention the word, it's just very difficult for the public to feel comfortable with it. Perhaps with all the over-view, they can feel a little more comfortable. Certainly, what it's all about and what we're talking to even to you all about today, is that the Nuclear Regulatory Commission makes the decision. It's not a DOE decision. If we think it's acceptable, that's not all. You have to make that decision. We do fund the State of Nevada in several entities within the State for over-view.

You heard Carl Johnson yesterday from Bob Lux's office, reports directly to the Governor, the Nuclear Waste Project Office. There is an additionally a commission set up by the Governor headed by former Governor Grant Sawyer, who oversees what we're doing. There is the Legislative Committee in the State itself, headed by Senator Tom Hickey, who oversees what we're doing. And in addition, with the Amendments Act, we will be funding Nye County, Clark County and Lincoln County for oversight.

In addition to that, we have the Nuclear Waste Technical Review Board. Certainly there is 38 names been nominated, but it's not been pared down. National Academy of Science put forth the 38 names, but these 11 people are full time, with a staff and they're going to be watching what we're doing.

Edison Electric Institute, they're paying the bills. They're interested in what we're doing. U.S, General Accounting Office. Congress has said quarter observe what DOE is doing and provide a quarterly and yearly report. Many times, as a Project Manager and my staff feels all we're doing is giving presentations to the people who are watching us, sometimes we don't get a chance to do our work. But I think it's part of the process and in this kind of a controversial area it's necessary. We just have to learn to manage our way through this system.

In essence, I think that kind of ends my presentation of what's happening in the short-term. I'll be glad to answer some questions for you for a while, and once again, I just want to point out that we're here to learn a lot about Yucca Mountain, that's my mission, that's the project's mission over the next seven years, to learn about it. And if it is suitable, and then to go on with the license application. If it is not, then go back to Congress and tell them what we find.

Yes, sir?

MR. McCOLLOM: Ken McCollom with the panel. I just wanted the definition of the perimeter drift in that diagram.

MR. GERTZ: Okay, the perimeter drift would be a drift that we would construct that would be the perimeter of the repository. And then within that perimeter drift we would have vertical and horizontal avenues and streets, as I call them, where we would have access to put the waste. We wouldn't put any waste outside that perimeter drift right now. And that perimeter drift helps us in a way, when we do put that in, we're able to understand the characteristics of the rock within the repository.

Yes, sir.

MR. BLOCH: Are there expense -- Peter Bloch. Are there extensive drift holes being made horizontally and do you know whether they will have an effect on the fractured characteristics for water movement?

MR. GERTZ: Peter Bloch. Are there extensive drill holes being made horizontally and will they have an effect on the water movement? We will be doing the two miles of drifting I've talked about.

MR. BLOCH: Is that what a drift is, a horizontal hole?

MR. GERTZ: A drift, no, -- yes, it's a big hole. It's 12 feet by 24 feet, so a drift is in effect, you will see what a drift will be looked like, if you go to the Climax Mine tomorrow. So yeah, there's two miles of drifts. We think, when we get underground, it would be an atmosphere just like this room. There is water vapor in the room, but it's essentially dry. As you go down the drift, you would be able to walk in it and if there are some fresh water, you should be able to see that. We haven't seen any in the small holes we've made. But yes, we will have extensive horizontal holes down there and that will be, eventually incorporated as part of the repository.

Yes, sir.

MR. KELBER: Charles Kelber, Panel. You took a lot of that data prior to this date, that you described at the first part of your talk. At the -- taking steps to put the records of the raw data and the qualification of those data into a retrievable form, are they going to be of the same general level of quality as you anticipate the data coming?

MR. GERTZ: Charles could you repeat again, your name again?

MR. KELBER: Kelber.

MR. GERTZ: Charles Kelber, and his question that has been asked, is data that we've taken prior to now, and we've taken a lot of data, can we, will we be able to use that in future licensing calculations in licensing scientific data. Yes and no and let me address that.

We have used a lot of that data in order to plan our program right now so it has been very useful for us. However, it was not collected under a formally approved NRC QA Program, so to use that directly in licensing, will not be acceptable. But NRS has a new reg on it, saying here is how you can use previously gathered data. I think it's 1298 or 1198, or something like that.

And that new reg has some processes that we could use that data. One is by peer review, examining by peer review, two is an examination of the program, Quality Assurance Program, that was in place that you gathered it in an objective determination is that close to a formally qualified program.

Third you could use it if you have some confirmatory data. If you go take some holes and information in the same area and it all falls into the same category, the same point on a graft so to speak, perhaps you could use it then. And there is another one which I forget right now, but there are four ways to use it. But, we are, and you will see tomorrow, where the majority of that information is being kept. We have a state-of-the-art sample management facility and you will get to see the exiting core.

MR. KELBER: The existing core.

MR. GERTZ: Sure. And we are now archiving it with the state-of-the-art facilities. A year ago we didn't do that, we had it scattered here and there. But now we have it so when it comes time to use it, we hope we will be able to use what we can.

MR. JORDAN: One quick one.

MR. GERTZ: Sure.

MR. JORDAN: You made reference to the experimental shaft and the location of it as being, at one time you said it was well to the North of where the main, the repository is going to be, but just now you said that experimental shaft might be part of the repository. I'm confused on that. Walter Jordan.

MR. GERTZ: Water Jordan is wondering about the exploratory shaft. And what I meant to say and I will show you on this map, is it's in the North part of the repository block, the exploratory shaft is right there. It's in the repository, but in the Northeast corner of the repository. I hope that clarifies it for you.

SPEAKER: I didn't fully understand your answer about the drift. Where are the drifts going and how many of them are there?

MR. GERTZ: Okay. The drifts, there will be essentially three of them. One of them will go to Ghost Dance Fault, which will head out towards the West, I believe.

SPEAKER: They're really big, right? They're like --

MR. GERTZ: Twelve foot by 24 feet or so, yes. They'll exactly replicate the kind of mining we will do when we do the repository, it will be the same size of the drift that we would have for either an emplacement or access drift to the repository. And we have another one that goes somewhat to the East and another one that goes heading towards the North.

SPEAKER: Is that at about the level where the repository.

MR. GERTZ; At the exact level of the repository, exactly. These would, assuming we find everything okay. Assuming Yucca Mountain is safe with these scientific determinations, these would then be incorporated into the repository, it would be part of the repository itself, as an access strip, to where there is a placement drifting.

MR. SHON: Well, thanks again Carl, that certainly cleared up a lot of things for us. Our next speaker is Jean Younker, who is Manager of Geo Sciences for SAIC, that is for Science Applications Incorporated. Her subject is going to be a summary of the Surface Base Testing Program. Jean.

MS. YOUNKER: Thank you very much. I would like to be able to talk with you this afternoon about the Surface Base Program that we have set up for the Yucca Mountain site. Hazel do you want to flip the first one up there.

Okay, Carl has just given you a real good introduction to this on the first view graft here, you can see that, as he told you, we're divided into two parts. We have a Surface Program and an Exploratory Shaft Facility Program that you're going to hear more about from Mike Voegele in a little bit.

The activities that we're going to conduct, of course, are different from the two perspectives, surface testing versus in situ great deal at one location. So we will differentiate the kinds of data that you can get from those two types of testing programs.

In terms of study plans, dropping down to the last bullet, oh it's this. They got smaller. I used to teach and we had the big ones that you had to carry around, you could barely hold them, you build a lot of muscle doing that. Now, how do I keep from pointing it at you? I got it, all right.

We were talking about study plans. Carl told you that the detail that we built for you to understand the real testing program that the NRC staff will be reviewing, to really understand the procedures we're going to follow, the details of the testing, is displayed in these things called study plans. And we have a total of 106 so far, that have been planned.

Within those, there is a whole nother sub set of details that breaks things out into activities, so that you have kind of tasslary into the activities described. And what I wanted to show you here is although the total number is 106 and everyone focuses a lot on the exploratory shaft facility, because it is such an expensive facility and also a very valuable facility, if you look at the total ratio of the types of study plans that we have designed right now, you see that a large proportion of them are for surface base testing, the kinds of work that I'm going to talk about with you right now.

Okay, why do we need surface base testing. You might think that the whole site Characterization Program could be conducted just from the exploratory shaft, but it is pretty clear, if you think about it, that if you want to really be able to predict spacial variability in the rock properties that are most important to us in understanding long term performance of the site, it is clear you need to have some samples over that whole rock volume instead of just a lot of data from one particular locality like the exploratory facility.

So, one key reason then for a large and well scoped Surface Based Program is so that you can get at spacial variability in the rock properties that you have reason to believe are the ones that will help you to predict how the site will perform over the 10,000 year period.

Okay, another really important reason for us is that we have to obtain information about the Calico Hills unit and we will tell you a little bit more about that. I think Max probably told you about that this morning when he talked about the site a bit.

Calico Hills unit is the zeolitized unit that underlies that, the rock that we think is the potential host rock for the repository if we end up putting one at Yucca

Mountain. And that Calico Hills unit, of course, is one of our primary natural barriers that will help to retard radionuclide should they get into the water that's moving down through the site.

Right now, the current plans that DOE . .s is to not take the exploratory shaft down into the Calico Hills, the Site Characterization Plan and the designs that we have remain -- take that position for now, however we do leave open the possibility to re-evaluate that position and if it is determined that the risks are not that high the benefits are great to getting information in situ with large scale testing in the Calico Hills at that site, at that location, then the -- has agreed with the NRC staff that after consultation and mutual agreement we may then decide to take the exploratory shaft down into the Calico Hills. That design is remaining flexible so we can do that, current plans are we could make that change, but right now we will not be taking the Calico Hills down, excuse me, taking the exploratory shaft down in the Calico Hills.

Okay, we're going to talk about a whole series of different types of investigations with different purposes as I get rolling here. There is basically, you've already heard a little bit about the geology inside from Max. Carl just covered some important features of the volcanology concerned with the question of reoccurrence intervals or probability of volcanic activity at the site. Hydrology, of course, I'm sure Max covered this morning for you, but the hydrology is one of the key items that we need to have a better understanding of the spacial variability and the important hydrologic properties of the site. Tectonics clearly is one topic that I will mention, and you've already heard about and we need to have a good understanding of what kind of variability there will be in the rock properties that are important to geoengineering. And when Mike Voegele tells you about some of the in situ testing in the exploratory shaft, he will give you some idea of the kinds of engineering studies that we're doing.

Okay, we will have a whole series, I think going onto the next view graft will enlarge on that last bullet. There are about five techniques that are major sources of information from the Surface Space prospective. One of those, of course, is drill holes, which allows us to go down and go deep or shallow for that matter, but really to investigate a fairly small volume of rocks. Because you can't really, even with some fairly fancy geophysical techniques, you still can't sample a really large volume from a small diameter bore hole.

All right, trenches clearly are a good access to near surface information that we're interested in. You will, tomorrow I think -- do they, Max do they visit Trench

14?

MR. BLANCHARD: I think so.

MS. YOUNKER: Do they? Okay, so you will get a chance to visit one of the trenches and see one of the faults that's intersected by a trench of the sites that has some interesting deposits in it that you will get to talk about, I'm sure.

Trenches are useful to get at surface traces of faults and any other information that is near the surface that you can get at by just a backhoe and that kind of activity.

Geophysical surveys allow you to indirectly characterize subsurface structure, getting at what the faults do when you get underground. Nature of subsurface deposits, especially interesting if there is any kind of volcanic material that hasn't made it to the surface that's still somewhere down deep, we can detect that. Any kinds of subsurface conditions that we're interested in throughout the whole hole strike area, because we looked at through different geophysics techniques.

We have monitoring stations set up. I think Carl just mentioned a couple of those. They help us to get at long term behavior of both surface and ground water hydrologic systems. Help us to understand what kind of infiltration we get. You know it's a very dry site, very dry setting, but for that water that does come in emphasitic, big cloud bursts, we need to understand how much of that water really infiltrates, gets below the zone of evaporation and makes it down into the rock that the repository would be build in.

We need to understand the natural size of the -- in the area. We need to understand what kinds of just general changes in the level of the rams is occurring. Right, we have also laboratory studies that are a part of our service based program. Here we're trying to get at any of the properties where you take the sample home and you need a, you basically need a controlled environment or you need equipment that it isn't easy to use in the field. Make thermomechanical measure before you look at the affects of the heat that you're going to introduce into the rocks on rock properties, how the rock will respond. Look at hydrologic changes in the rock when you heat it up, also just to look at various hydrologic perimeters that you need controlled conditions for. Geochemistry, of course is generally, a lot of our work has been in the laboratory and will continue to be, just because you need to be able to control conditions in a way you really can't in the field.

Okay, the biggest effort we have, like Carl said, is in the drilling program, and of course if you look at this total, he told you it was over 300. It certainly looks like over 300 to me.

We have some very deep unsaturated zone drill holes. I'm not going to go through the details of this, but just to give you an idea of the kinds of program that we have set up. We intend to really gather a lot of information about the Yucca Mountain site. Deep unsaturated zone getting at the characteristics of the unsaturated zone, because that, as I think Carl and Max have already told you and Max will talk about it some more later, is the primary barrier for this site. It's a very dry site. We need to understand what the boundary conditions are. Why it's dry and how long it's going to remain dry, given any kinds of changes that are likely to occur over the 10,000 year period of isolation.

We're going to look at shallow and saturated zone. Mostly there, the information we're interested in, is how much water does go down when you have any kind of a precipitation exempt over a short period or over a long period. How big of a infiltration or source trim do you really have under current conditions that, water that could ever be available to attack the waste canisters and pick up radionuclides.

All right, since we have saturated zone, we're obviously interested in the saturated zone, because that exists below the unsaturated zone below the repository.

Should we ever have any waste migrating, could eventually reach the saturated zone, then head out -- I think Max described to you the model for that -- head out laterally, probably to the South and Southeast. These drill holes will help us to confirm our current understanding of the saturated zone.

We have some systematic drilling that's planned to give us a real good statistical handle on the variability and the rock properties that are most important for giving us statistically valid predictions of the long term travel times, where you do -- transport times. This is a very important part of the program that I think in part, in our NRC staff comments, we have really spent a lot of time trying to understand the best way to design a program that will give us confidence and hopefully give all of you confidence too. That we have an adequate understanding of the variability in the rock properties, that will be most important for predicting post-closure performance.

We have some water table monitoring just to get at holes that will help us to get at the stability of the water table. Because part of the model, obviously, for the unsaturated zone, it comes on the water table positions staying where it is. Or at least if it moves, we need to understand why it's moving.

Volcanic drilling, we have some drill holes I'll talk about in a minute that are to get at the question that Carl brought up about the potential rates reoccurrence of volcanic activity in the area. We have some geologic core holes just to get some good qualified information on the geologic properties of the samples from DELP.

Okay, there is a whole series of maps that are in your package and I suspect that in order for these to be very meaningful to you, you may have to flip to those packages and perhaps even outline. There is colors on my maps, but yours are in black and white, so you will have to just sort of follow along.

The first one that you're going to come to -- how long does it take?

THE REPORTER: Two minutes.

MS. YOUNKER: All right. I need -- All set?

THE REPORTER: Yes.

MS. YOUNKER: Okay. So if you will look in your notebooks, that would be useful. This one is just simply overall, all those little dots that you see on this one. If you look at the next page in your handout package you will see the legend for this one, that tells you what each of the little symbols means. Let me flip to mine as well, so that I can see what you're seeing.

All right, I would like -- the first one there, Marylou flip up your legend for that one for a minute, let me make sure I'm on the same one you are. Is that the unsaturated Southern drill holes? Okay, that's the complete set of proposed activities. All right, let me get back to that. Okay.

All right, that one I think, is more just for reference for you, as far as the complete set of activities that we have planned. I would like to go, skip over the legend and go to the next one, because it gets us down to a bit larger scale, that I think I can talk to you about.

Okay, good. Let me get on the same one you're on now. Okay. This one should be hopefully the second one in your package and this one should have on it the expanded view of the proposed activity, so you can look a little bit closer to the site.

If you look at the next page in yours, you will see that there is these blocks that you've noticed out here are drill paths, so you can get an idea of the distribution of the drilling. This one, you will notice, most of the drilling is out around the prifery of the actual perimeter drift that someone asked about a little bit ago.

We have some other drill holes that don't require paths, that are shown with little red dots, I believe. We also have some trenches and you should be able to see some of the trenches out in this area. Flip over to the next one. This whole series of maps is just kind of to give you an idea of where we're going to focus our surface activities.

SPEAKER: On a map here?

MS. YOUNKER: No, I think there is a word one comes up next, okay. All right, one of the ones we're going to talk about a moment is the unsaturated zone drilling, testing and monitoring. And obviously what we're after in this particular set of drill holes is to look at hydrologic behavior of rock units above the water table.

All right. Why do we need to understand this? Well, clearly the movement of both liquid water down to the water table and now the passing through the repository horizon, as well as water vapor and air movement within the unsaturated zone is important to us. We need to understand the vapor movement because if there were any early releases when you have gaseous phasary nuclides present, in order to model their behavior, you need to understand how vapor transport occurs in the unsaturated zone. This is an area that's probably, as much as any of the areas that we have in this program, one that is at near state-of-the-art, in terms of the techniques available for us to get at and model the vapor transport.

Okay. It involves drilling to sample the state of moisture in the unsaturated section. There is a variety of techniques that have been used both by NRC contractors and by contractors for the DOE to sample the state of moisture. It's not a direct measurement, it tends to have a lot of uncertainty in it, so we have to look at a lot of different techniques, go at it from a lot of different directions.

We try to get at flow properties of fractured rock units, because we need to understand how much of the water at any given time, is in the fractures, versus in the matrix of the rocks and I think Max told you a little bit about the importance of that this morning.

We also will put in instruments in the unsaturated zone drill holes to investigate long term behavior of the hydrologic system. Clearly, we need to have an understanding of how much fluxuation is, or how much fluxuation is to be expected in those parameters, hydrologic parameters that are the driving parameters for the calculations we're going to make. So, some of these long term monitoring instrumentation experiments are going to be very important over the next five to ten years, as we understand the unsaturated zone better.

Okay, we also have some surface studies that I think you will also hear about one in the exploratory shaft. Where we're going to actually simulate radionuclide events in a controlled test location that's prepared for that purpose, such that we can look at the amount of infiltration that you get for a given volume of precipitation. It turns out if you wait for it to rain at Yucca Mountain, you might wait a long time and besides that it doesn't tend to come in a way that you can really work with it as a controlled environment, because it comes down so hard. So, it's really nice to be able to set up a bit of a controlled facility and that's what these are meant to be.

I think you have a map coming up next, the locations of some of the controlled plots that we intend to do. Actually I think first, I think the first one may be the unsaturated, flip through the legend for that one, go one more down, I think that's probably the unsaturated zone drill holes. Right, just giving you the distribution of the unsaturated zone drill holes that I talked about. Go to the next one then and that's the artificial infiltration experiments.

Okay and a point I wanted to mention on this one, just for your information, you notice that if you look at the topography, most of these experimental plots are in washes. And of course that makes sense if you know the layout of Yucca Mountain and if you know what happens when it rains real hard up there. Basically, all the water runs down these washes. And if there is any infiltration in these rainfall exempts, it's most likely to be in the washes.

The other source would be if you had a little bit of a snow cap and in the Spring when that snow melts you may get a little bit of infiltration if there is any kind of open fractures or if there is any, if the matrix is porous enough on the surface, you might be able to get some infiltration from the surface. So we will look at some infiltration at the surface at the top as well, although I think those are probably going to be relatively difficult ones to get reasonable information out of.

The ones down here in the washes, hopefully we have enough, such that we can compare them and get some useful information about how much rain it takes to get a certain amount of infiltration to start down into the unsaturated zone.

Okay, we obviously care about the saturated zone too, as I mentioned earlier. We need to understand what would happen if radionuclide material moving down in that small amount of core -- that we think is there, ever reaches the saturated zone under the site. We have drilling, as I said there were seven or eight drill holes that were listed on that table. We will sample the water from the saturated zone to try to understand a little bit more about it's makeup. One of the important questions is source areas for that water. There is a lot of different models in effect. They're in vogue right now that can be tested by looking at chemistry variations and isotope variations and the agents of the water.

We have some drill hole testing that actually are set up to be single well and multiple well prosport hole tests, where we will try to look at the migration of chemical tracers between bore holes. In this case of course, you're going to be pumping it, so you're over driving the experiment in a sense and then you have to back out what would happen under natural conditions. Those kinds of experiments have been done in lots of other places. This is not state-of-the-art. It shouldn't be a problem to get some reasonably good results out of these studies.

Okay, water table drilling testing and monitoring is designed to characterize the water table elevation and monitoring its fluctuations. These holes will be instrumented. We also have a number of holes already instrumented out there that do penetrate the saturated zone. They monitor the fluctuations in the water table. Both in response to underground nuclear testing at the nearby Nevada Test Site, as well as to earthquakes. There has been a lot of recent concern about questions of stability of the water table. So this whole set of water table monitoring holes are very important to us, to get good qualificated information that we can use as kind of a boundary condition, if you will, on the unsaturated zone, because that's the bottom of it. We need to know what controls that position.

Okay, this particular map that you have in your package and that shows you the location of both existing and new water table holes. I think one thing that you should be impressed with, if you look through this set of maps is that over an area of probably about 10 kilometers, radius from Yucca Mountain, we either have or ready, or will have an incredible number of different types of penetrations of the site from the surface, such that if we complete this program, together with what we know already, it's really hopefully at least for many of us that are geotechnical background, we really think we should have it defined to the point where we won't get any big surprises. I know that may be a naive thing to say, but I think we've mined enough at the Nevada Test Site in similar type of rocks. If we do a surface program like this, if we do a large in situ facility like the exploratory shaft, I think some of us hope that that will give us adequate confidence that when we actually go in and open up the repository drifts within that perimeter drift that we talked about earlier, that we will have a pretty good handle on what kind of variation we will get in the rocks within that volume of rocks that will inplace waste.

MR. JORDON: May I just ask this, the map is there. Are all -- this is Walter Jordon -- are all of the water table holes outside of the repository area?

MS. YOUNKER: Okay, the question was is -- Walter Jordon?

MR. JORDON: Yes.

MS. YOUNKER: Walter, are all the water table holes outside of the repository conceptual drift boundary. And I believe that there are a couple within. Is that right, Max? Do you know the location?

MR. BLANCHARD: What's not shown on this map are those that already exist. There is a large -- there are a third that already exist. Some of those -- repository --

MS. YOUNKER: I think the earlier map actually has the preexisting ones on it. That first one that shows all proposed, I think it has existing and planned. One of these maps does, I know, because I was just looking at it.

SPEAKER: It's in the back.

MS. YOUNKER: And I know that there is at least within that, I think I have a list on my wall, it seems to me it's like something like two within the actual perimeter drift that do go to the water table. I think that's right, so I don't know if there is anybody here that knows the number for me. We can check on that though. Okay.

MR. PARIS: What will happen to those. Will you backfill those or how will you submit the water table.

MS. YOUNKER: Yes, would you give your name too, please.

MR. PARIS: Oscar Paris on the Panel.

MS. YOUNKER: Oscar Parish?

MR. PARIS: Paris.

MS. YOUNKER: Paris, okay. And his question is what would we do with those if the site becomes a repository. And there are sealing requirements, the State has sealing requirements, so that you have to go back and seal any bore holes, so yes they would be sealed.

Okay.

MR. BECHOEFER: You mean can you seal the existing ones?

MS. YOUNKER: You have to, the State -- what is your name?

MR. BECHOEFER: Charles Bechoefer.

MS. YOUNKER: Charles Bechoefer.

MR. BECHOEFER: Bechoefer.

MS. YOUNKER: Okay. And the question was can you seal those and I think yes, there is standard sealing technology that you use to seal bore holes that's required by the State. Okay.

Let me talk about the systematic drilling program. When we get to the question and answer time, if you would like to, we can come back to that, but I think there is a couple of points that we could discuss on that. Why don't we roll on through then I will put it up for questions.

The Systematic Drilling Program that I mentioned, is really important because it allows us to get a statistical handle on the variability in the rock units. We will drill a series of holes to characterize the systematic and predictable variations in the various physical properties that are important.

This helps to fill in gaps in those cases where our previous sampling strategy has been to get anomalous, or anomalous features, when you go out without kind of a plan systematic statistically based program, what you tend to do is go in those places where it's interesting to look. That's what geologists like to do, is go find interesting things to look at. You don't want to drill someplace where you don't really think you're going to get anything but just some more information just like the information you got over in the other drill hole.

So, what we have now is we've forced the geologists in the program to take a back seat and we said come on statisticians, lay out a program for us that will give us the kind of three dimensional spacial variability that we need in order to have credible predicted models for radionuclide transport.

So, as a result of that we do have a drilling program then that would be boring to geogeologists, but very useful to statisticians and that's the other element, kind of, the other element of our program.

So the statistical models then that we use help us to get at the kind of parameter variability that we have to deal with when we're making any of the kinds of 10,000 year predictions for a travel times rate of nuclide travel times, granaliter travel times over the longer time periods. We also need, obviously if we're going to rely on any kind of radionuclide absorbtion down in those zeiolites that I mentioned, we clearly need to have a pretty good idea of what their three dimensional spacial variability is.

So, this systematic drilling program will help us to also get at the three dimensional variability that we can expect in the geochemistry properties of the rock.

Okay and what you see there is the program that the geogeologists on the site would really probably rather not have had to deal with, but you see here the coverage worked out by statisticians, are statistically orientated geogeologists on the project, that have helped us to determine that there are some drill holes that we need to plan into the program for the main purpose of giving us a three dimensional spacial variation of the site that is adequate for the kinds of calculations we have to make to predict post-closure performance.

So you see these circles are kind of the spheres of influence if you will, of the bore holes that give you an idea, given the inherent variability of the properties that we're looking for, properties that we're tracking, what kind of distance can we assume that that particular hole is representative over. Over which it is representative, well, anyway you got the picture. Go on, you can ask me a question about that one too.

All right, we have some volcanic hazard assessment drill holes. We're going to look at future volcanic hazards, based on obviously our understanding of what has happened in the past in the area. There are several potentially varied intrusions. And this probably should have said we think they're intrusions. They're bodies of igneous rock, would have been a volcano, but it didn't make it to the surface. They stopped down in the subsurface, several kilometers down, and they're just sitting there, cooled off, presumably hard rock by now.

The idea is to go in and drill those, drill into them and see if they are in fact intrusions and then to also get an idea of the volume. I think Carl explained to you a little bit earlier that one of the things that we have reason to believe are people who are volcanologists on the project, think that we see a decreasing volume of the volcanic activity through time and this is seen throughout the rest of the Western U. S. in certain areas and, so it's not an anomalous, but we would like to be able to get some more data points on that curve of the decreasing volume through time.

So, if we drill these intrusions and can get some volumetric estimates, they are in fact are intrusions, first of all and then estimate their volume, that will give us some more data points.

All right. There are also some other geologic core holes that are planned. Not really as part of the volcanic hazards assessment program, but to just augment our overall geologic data base. I think part of the reason for drilling these to get better information is because of the question of qualification of pre-existing data.

We need to make sure that we get some core holes where the samples, sample handling and the data extracted from those samples will absolutely meet the NRC requirements for level one data. So, part of this program is for that very purpose.

Yes, why don't you -- the next one. We have a variety of these shots of the upper mountain. I think this one is a little clearer than the previous one that I had in my package. But one of our drilling platforms up here on top of Yucca Mountain, I think Max used this one this morning. Did you talk much about it, or -- okay. Well, we're looking basically at the solitary canyon West, the steepest side of Yucca Mountain. The Crater Flat that Carl talked about is out here to your right on the diagram. If you're looking off to kind of Southeast. Over here is the feature that you will see tomorrow, called Busted Butte. That's good enough, they will see more pictures of it as we -- you'll see the real thing tomorrow, that means a lot more.

All right, also this schedule Carl put up for you and just simply to emphasize that if we get the qualified QA Program set up and if we get the permits and a few of the other pre recs, we will have by about fiscal year '90, we will be pretty busy out at the site. We assume that some of us will be pretty busy here in town too, processing all that information. And so the bulk of the information from the Surface Based Building Program comes in in the '90, '91 time frame on the current schedules that DOE is operating under.

Okay, we obviously have other ways, like I said earlier, of getting surface based information. Trenching is a good way. We get data from trenches to get assessed the magnitudes and history of past movement on faults throughout the whole site area. We have to get at anything that has moved within the last 2 million years from a regulatory perspective. We are also interested, just from the standpoint of understanding the geology and tectonics of the area. Additional objective is to investigate minerals found in fault zones. Trenches on the Bow Ridge but I think you will probably visit tomorrow and I have a picture of it coming up. Will be supplemented with a lot of shallow bore holes to try to understand the distribution of these fault deposits. And of course the question on these, I think Max probably reviewed this with you this morning, but the question on these has to do with whether there is any potential that these deposits in the fault zones could represent some kind of hot water movement coming up from the shallow, I mean from the deep subsurface on some kind of recurrence interval that would be enough -- would be short enough to be of concern in the repository time frame.

So, we need to understand what these deposits are, how they form and what recurrence interval if it is an upflowing of hot fluids that formed them. We need to understand that so that we can then include that in our modeling of repository performance.

Okay, obviously we also are very interested in what kind of faulting we might have at the location of the service facilities in Midway Valley. And I'm sure you will visit that site tomorrow, so you will get a chance to see for yourself what it looks like out there.

Okay, the current -- this is the preliminary location, so some of this may change. But the faults that you've probably heard the most about if you've listened to other discussions on this, then I think you probably heard about them this morning. There is a Paintbrush Canyon Fault, we're out on the East side of Yucca Mountain now, just to make sure you're orientated, out off the ridge, probably I don't know a kilometer something like that. And there is a Paintbrush Fault here, which is the fault that is probably our most important fault from the standpoint of seismic hazards at the surface facility location. We have the Bow Ridge Fault across which the two trenches that I'm going to show you in just a minute go and I think probably is one of your stops tomorrow.

And there is a potential fault somewhere. And these big question marks tell you that we have a Fault that's named, it's out there somewhere probably, we're not even sure it comes to the surface, but it's called the Midway Valley Fault. And it's probably -- it's somewhere between the Paintbrush and the Bow Ridge and where it goes and exactly how much offset, what's it's existence, where it's exact traces we don't know. But, in order to be certain that we know where to put the service facilities and to make sure that we know that we have them in a safe location, we're planning some fairly long trenches here, this little cross right there are the trenches.

I can't recall exactly what the length is on those, but -- Bob do you know what the lengths on the surface trenches are? That was a piece of information I was going to bring along and I didn't log it in, so --

MR. JACKSON: On the order of a mile.

MS. YOUNKER: I asked Bob Jackson that question for the Reporters. And it's on the order of a mile long each of them, it seems like it was on -- I know it was over 3,000 feet, because I remember thinking, geez that's a really long trench.

But we need to understand exactly what kind of surface traces of faults there are on the subsurface to be certain we have that facility in the right place.

Okay and here are two of the trenches across the Bow Ridge Fault. The Bow Ridge Fault is there, however, on this view graft it's -- or on this picture, it is very difficult to pick put. Even when you're standing out there, you have to sort of split, you know, you lift one eyebrow, one of those and the geologist there will tell you that, or the people who really are into field studies of faults, will tell you that it is a very obvious fault. I tend to be one of those people who having had a modeling background, kind of stand there with that squint in my eye thinking, right. But you will get a chance to look at some of these features tomorrow. Trenching is a really good way for the people who have had experience with dating soil horizons to get at offsets in the near-surface.

Okay, we have a lot of monitoring activities going. You've already heard a lot about some of these at least. The seismic network is probably one of our most important, 54 stations that are telling me there are two's. The U. S. Geological Survey in Denver. Portorable ray that we deploy intermittently at Yucca Mountain. Get information on both the active processes for the, I mean the active processes for the tectonic -- of Yucca Mountain. Cite specific data for the preclosure seismic hazards assessments associated with the service facility location, that we just looked at.

We also have monitoring of meteorological precipitations. Stream flow monitoring, stream flow I would think about this, I come from the Mid-West and stream flow monitoring out there is a slow stream flow gauge that sits in the river and tells you how much water is flowing in the river channel. Here when you go look at it, of course, it's a dry wash, you're standing there and you don't want to be standing there if there is water flowing in that stream, or the stream flow gauge is working, because it's probably flowing rather rapidly. It's one of those little off, run off periods that you have right after one of the big storms that we get out here once in a great while.

Okay, line table monitoring I already told you about. We're going to have something like 25 drill holes at or near for characterizing the stability of the water table through time. The natural infiltration monitoring I already mentioned. We have something like, I guess I mentioned the one where we're actually going to add water to the site. There is also natural infiltration where we simply sit there and wait for water to come. At about 100 locations we have neutron monitoring probes in the holes or we can lower them down the holes and detect how deep water has penetrated from any kind of natural precipitation it got.

Okay and this one shows you the distribution of precipitation, neurological monitoring stations. And once again like I told you before when we talk about unnatural infiltration from our rain fall plots, we also look in the places where we most expect there to be some infiltration when we're looking for it, so we look at the locations in washes around Yucca Mountain.

Okay and this one emphasizes the location of the natural infiltration rays and also the shallow boring. You should see them mostly out along here and in washes there in there, running up along Solitario Canyon, which should be a zone where, because it's a faulted valley, there should be some infiltration there. If there is any going on anywhere.

Okay and then obviously what do we do with some of the sample that we get from our Surface Based Program, we take them home and we work on them in the laboratory. Many types of measurements then scale simulations of natural properties are planned. Some are ongoing. We have a drilling technology program underway. I think Carl mentioned this one. I believe he mentioned the prototype drilling for getting our techniques for dry drilling and coring, retrieving some rock samples from a dry drilling technique in place. Getting procedures written, such that we can maintain that operation at a Level One Program, so that the samples and data we get from that are totally acceptable.

We are going to require something like 70,000 of core, similar quantity of drill cuttings, which are just the little pieces that you get and about a million pounds of bulk samples will be collected under the program that we have set up right now.

We have a 28,000 square foot sample management facility that Carl mentioned and that we will visit tomorrow as I understand, set up to handle the samples that we will collect during the site program. And we have a number of field laboratories either planned, or already set up to measure some of the sensitive hydrologic properties where you don't want to take the sample all the way back to Denver. You really want to measure it very near the site, but you need more control than what you have if you do measure it right at the drill hole. So that's our other way of just getting this kind of information.

Now, what we're going to do is we have some time left for questions I guess, but I also want to mention that we will tell you now about the way we're going to design and construct the exploratory shaft facility, which then gets us down into one particular location up there in the Northeast corner of the site, where we will do a lot of very detailed process type testing to get at phenomonomology or get at the way the site behaves hydrologically, rock mechanics. Mike Voegele will tell you a lot about that. I think before that, Larry Skousen is going to tell you a little bit about the design of that facility. So thank you for your attention and I'll be glad to answer questions.

MR. SHON: I have a question.

MS. YOUNKER: Great.

MR. SHON: Fred Shon here, of course. -- -- of the business of sealing up bore holes. When you say there were standard State requirements to sealing bore holes. I presume those requirements weren't developed with criteria that would meet those necessary dependent creatively waste, nuclear waste storage facilities, isn't that right. How do we know if they were -- for this sort of thing.

MS. YOUNKER: This is Fred Shon?

MR. SHON: Yes.

MS. YOUNKER: And he is asking about whether the kinds of sealing requirements that we have from the State of Nevada would meet the kinds of sealing requirements that the NRC would care about, from the standpoint of performance. And I suspect that those, the sealing requirements that we have from the State, I would guess, are from the environmental viewpoint, or from the standpoint of what you would do to something like that when you construct it and then you want to leave it. I'm not a real authority on this part of it, so if Max or somebody wants to answer some questions on this, that would be helpful.

MR. BLANCHARD: To help complete Jean's answer, Fred. I think there are two things that are going to address that. One is that the sealing requirements intends of R-60 will be met and that includes sealing any openings from the surface that could impact waste isolation, could have an adverse impact on it.

So, it turns out that the NRC agrees that we should seal all those bore holes, I'm sure we will and we will seal them with whatever sealing methods are at the state-of-the-art, at the time the decision would be made to seal it. Sometime 100 years after the repository has started it's operation.

The second thing is the regulation also requires that all bore holes be drilled in pillars. And so each bore hole that is located within side the perimeter drift will have a pillar around it, so that the bore hole would not go into a waste emplacement area.

The third thing is that from, because we're in the unsaturated zone and we're interested about water flow, we want to make sure that when we do things to the site, we do them with the full knowledge and understanding of what we think the long term impact might be. And it's not all together certain at this time, or this state of site characterization that it's to our advantage to seal those off and fill them up.

For instance, if you filled it up and it did become a, it degraded and it became a leak source, then you would build water up in there and it could pond. and then water under a head moves differently than water in capillary attraction. So, I think before we would embark on an extensive sealing program, at the terminal phase of closure of the repository, I think we would want to satisfy ourselves from a modeling standpoint and from a hydrology standpoint, that it was in the best interest to do that and then we would use the state-of-the-art type sealing techniques.

We do have some sealing test programs being conducted and they're defined in the Site Characterization Plan in Chapter 8.

MS. YOUNKER: Thanks Max. That was Max Blanchard.

MR. McCOLLOM: Ken McCollom with the panel. What kind of Air Force activities are carried out at Nellis Air Force Range.

MR. YOUNKER: Okay, the question is from Ken McCollom and the question is what kind of Air Force activities are carried out at Nellis. Who is my best source of that kind of information? Carl, you're still here, great. Carl Gertz is going to come up and answer that question.

MR. GERTZ: Nellis supports the Tactical Air Command for their non-classified missions and they do bombing runs, dog fights, those kinds of trainings. They have Red Force Exercises, Green Flag, Red Flag Exercises where they do do the fighting between them and the bombing runs. They also just recently announced where up in the Northern part near Tonopah, the base for the Stealth Fighter and future Stealth Bomber.

MR. McCOLLOM: Do you consider any impact on the facility?

MR. GERTZ: No, the only impact on the facility that Nellis has and I've talked to both the previous General and the General out there now, is if we build a repository and we restrict overflight for where the repository would be, does that hamper their mission. Right now we do restrict it, it's our air space. We say they can't come down below 5,000 feet, below 500 feet and things like that, or if we have drill rigs they've got to stay above 1,500. But if we put any new restrictions on it, as a result of it being a repository, we then have to provide some alternate air corridors for them around that area. And we have some alternates available, so that's the only conflict that we have with them.

MS. YOUNKER: Thank you. Yes.

MR. FOSTER: Foster. A two part question. Your map showing potential site facilities shows a couple of sewage treatment lagoons. Part one is will those sewage treatment lagoons be in operation at the time that you are trying to get information on moisture movement through the rocks. Secondarily, if so how close is the nearest test wells to that?

MS. YOUNKER: Okay, and your name was again?

MR. FOSTER: Foster.

MS. YOUNKER: Foster, right. And the question has to do with the map that shows you the location of the surface facilities and it shows you a couple of sewage lagoons and I think probably Larry Skousen knows best about these designs and I will take a crack, but I know that the plans are, Larry, for the sewage lagoons to be lined, so there wouldn't be any potential for leakage, or at least a very limited potential. Larry Skousen just seconded that.

Is there anything else that you would like to add Larry? Do you want to come up? No? Max Blanchard is going to give us some more information.

MR. BLANCHARD: Looking at that map, you recognize that's out in Midway Valley. It's kilometers from the waste emplacement area. And so whatever moisture works it's way into the ground would not be related to the ability of the rock at Yucca Mountain, or beneath the mountain to isolate and contain waste from a hydrologic standpoint. And the -- we'll have to ask Larry Sousen whether he's got a sewage treatment lagoon on Yucca Mountain itself for the exploratory shaft.

MR. SKOUSEN: We do have exploratory shaft facilities Max and --

MR. BLANCHARD: Well you were going to talk about that later.

MR. SKOUSEN: I have a view graft that will show that yes.

MS. YOUNKER: Okay. Larry said that we do have some further up on Yucca Mountain and that he will talk about those in his presentation. I think your concern, to some extent was whether or not that would in any way interfere with our testing?

MR. FOSTER: That's correct.

MS. YOUNKER: Yes and we've certainly thought about that and spent a lot of time worrying about the potential for any kind of interference. Yes.

MR. MORGANSTEIN: Morganstein from Mitchellan and Associates. I noted that you are going to be drilling something in the neighborhood of oh, 135,000 feet of drill holes. I'm "ery concerned about the drill fluids that might be used in the sense of jeopardizing -- -- on the repository. How many 10's of thousands or 100's of thousands of gallons of fluid would be used in the drilling?

MS. YOUNKER: Right. This is Morganstein from Mitchellan Associates? Right. And his question is about what kind of drilling fluids and how much you might be using during all the drilling program that we've just talked about. I think the most important thing for you to remember is that the first thing we're going to do is get some dry drilling techniques prototyped and get procedures developed for them and in any of those areas where we have any concerns about anywhere the near the repository from the drift area, where we're concerned about putting any kind of fluids into the ground either from a standpoint of test interference or from potential for just adding water to a very dry site, we would like to keep dry, we indent to use dry drilling techniques. So, we aren't going to use fluids.

MR. MORGANSTEIN: No fluids then will be used during drilling?

MS. YOUNKER: That is the plan.

MR. MORGANSTEIN: Thank you.

MS. YOUNKER: Now Larry will tell you a little bit more about the techniques during sinking of the exploratory shafts. There of course you do have some amount of fluid, because of needing to control dust and the equipment you have to use requires some water, so.

MR. SHON: I guess we're sort of running out of questions.

MS. YOUNKER: Good, thank you very much.

MR. SHON: Thank you very much. Before we take our break, Elva has some announcements of great importance to all of us. Such as what bus you have to get on to avoid being left at the post.

MS. LEINS: Tomorrow on the DOE tour --

MR. SHON: Could you all be quite please and listen to this.

MS. LEINS: Tomorrow on the DOE tour, those who are going on that tour know who they are. There are going to be two busses and I will read the names of the people on each bus. If someone that you know is not here, please note the bus that they're on to tell them. Charles Ader, this is Bus No. 1; Charles Ader, Guy Arlotto, Dennis Bechtel, Steven Bradhurst, Margaret Carver, Richard Carver, Barbara Cerny, Janice Dunn-Lee, Margaret Federline, Joe Garcia, Virgil Getto, Linda Gunter, Frank Hersman, Elwood Holstein, Ben Hayes, Ann Hoyle, John Hoyle, Carl Johnson, Dean Kunihiro, Elva Leins, Maria Lopez-Otin, Richard Major, Malachy Marphy, excuse me. Barbara Raper, Clyde Raper, Mary Revert, Robert Revert, Lidia Roche, Stan Schofer, Betsy Shelburne, Melvin Silberberg, John Skoczlas, Stephen Shoinki, Stephen Spector, Rosetta Virgilio, Ian Zabarte, Jack Whetstein, and Bill Hughes of DOE.

On Bus No. 2; Sebastian Aloot, George Anderson, Sher Bahadur, Charles Bechhoefer, Peter Bloch, Glenn Bright, Dixon Callihan, Jim Carpenter, John Cho, Richard Cole, B. Paul Cotter, Jr., James Cutchin, George Ferguson, Charles Fitti, Harry Foreman, Richard Foster, Harold Denton, James Gleason, Cadet Hand, David Hetrick, Ernest Hill, Frank Hoooper, Helen Hoyt, Elizabeth Johnson, Walter Jordan, Myron Karman, Charles Kelber, Jerry Kline, James Lamb, Robert Lazo, Morton Marguiles, Kenneth McCollom, Marshall Miller, Kenneth Rogers, Oscar Paris, Jack Scarborough, David Schink, Frederick Shon, Paul Prestholdt, and Michael Gloria. That's Bus No. 2.

Now, you are reminded to wea- warm comfortable casual clothes and very flat shoes, because I understand it is rough terrain. No cameras or binoculars are allowed. The buses will promptly depart at 6:25. You must be down to load at 6:15 in the morning.

SPEAKER: Which door?

MS. LEINS: Flamingo Road side, the side entrance, that was the next thing, I skipped one. Most important thing. The Balley's entrance, side entrance here as you get off the elevators here, go to your right and it's that very first entrance on your right.

SPEAKER: That's the one we came in.

MS. LEINS: No, you came in the front entrance when you checked, probably. Oh you didn't --

SPEAKER: Maybe you came in a cab and they deposit you near a bus. Bell Transpc t probably put you there too. Well, then you do know where that is. Okay.

MS. LEINS: Some did and some didn't. I'm just telling you where the door is.

SPEAKER: Next is -- let's see. You need to get badged first and the DOE cafeteria and the restrooms are immediately on your left as you enter the DOE lobby. I would suggest --

They told me the weather this week is a little bit warmer than normal. So maybe that too will lower some of that cold temperature they anticipated for upper --

SPEAKER: Do we need a jacket to go out?

MS. LEINS: I wouldn't think so. If you've got pockets you can probable handle it. I don't think -- If you got too cold I think you could get back on the bus. It is suggested that you purchase canned beverages to take along for the afternoon, as you know, there are no planned stops for water. We're going on a desert tour, so -- There is going to be quite a span between the time that you have lunch and when you come back to the hotel. So, they do suggest that you take some things with you.

SPEAKER: Where do -- --

MS. LEINS: At the DOE cafeteria you can buy them here or there is a 7-11 down at the end of the street here if you would like to take a walk down there, but the DOE cafeteria is pretty well stocked.

SPEAKER: Where would you have breakfast then?

MS. LEINS: You would have breakfast here at the hotel before you leave. -- -- breakfast. There are no stewardess or flight attendants on this bus with food. Now, something that is very very important. The busses do have restrooms, okay.

SPEAKER: Great.

MS. LEINS: now, the only other thing and this is very important, the bus that you're assigned to be sure that you get on that bus after you are badged and after each stop, that's very important, because they do head counts and all this and we might be late coming back. Now, we expect the bus to return to the hotel at 5:50 and do you have any questions?

Now the buses are going two separate routes you know one way and one the other, but we're all going to cover the exact same material, okay. No questions. Thank you.

MR. SHON: Let's take a break until 2:15.

(Whereupon a short recess was taken.)

MR. SHON: It is now after the break. We have Larry Skousen, who is Chief of Exploratory Shaft Engineering. We got him right here, yes I think we have. Larry.

MR. SKOUSEN: Thank you.

MR. SHON: One brief announcement, I've been asked to make. Tomorrow on the buses there will be no smoking while we're actually on the busses. DOE -- I was afraid I'd get boos and hisses and possibly a ripe tomato or two, but -- right.

MR. SKOUSEN: Good afternoon ladies and gentlemen. My name is Larry Skousen, I am the Director of the Engineering and Development Division for the Yucca Mountain Project.

As such, I have responsibilities in the exploratory shaft area to facilitate and initiate the design up through the different titles of design and into the construction phase of the exploratory shaft facility.

Today I might, I apologize if some of these view grafts might be redundant, or that you've seen them this morning. I think it is important though that the things that I have to say, that I address them and maybe I'll bring a different context from what they was initially spoke of this morning.

I would like to draw your attention to the view graft presently on the screen and if you haven't been given the information, we're approximately the Yucca Mountain areas, you see in the shaded area, which represents the Nevada Test Site is entirely in Nye County and it's approximately 95 miles to Yucca Mountain from the Las Vegas area.

What I would draw your attention to is the remoteness of it, the sparse population. You will notice that Armargosa, which is the closest to the Yucca Mountain facility and Beatty are both at a less than 1,000 inhabitants and very sparsely populated.

We're going to talk more about the exploratory shaft area, but that's where it stands relative to Nye County and also the distance from Clark County.

The next view graft is an actual area of photo, in which we have super-imposed the perimeter drift of the repository outline and also showing the central surface facilities as they are presently proposed. I think Jean told you that this is the proposed site and certainly there are other sites under investigation, dependant upon geologic analysis of faults and other activities that might be in that area.

You will see that this perimeter, the Repository Surface Facility, is a large area encompassing both, that represents about 35,000 acres in that perimeter. And for talking purposes the repository horizon outline there, is approximately close to 2,000 acres. And I might, in fact it says 1,500 under there, I think that is just slightly conservative.

Go onto the next view please. We just passed that -- in your packet. Just let me explain that in your packet so that you would have further definition and explanation, we have put some narrative, or some bullets in there that give an impetus to the preceding view grafts that we have talked about. As I said the site of the SF is, I said 95, I think 95 is more correct. I apologize for that. The locations of the exploratory shaft facility and the perimeter drift of the repository were on the proceeding photo.

You've seen this view graft earlier this morning, but I would like to talk to it just briefly. It's an artists conception of a cross section of the exploratory shaft and the underground configuration where we were going to do the testing. You will notice here the exploratory shafts, ES-1 and ES-2 as presently exploratory shaft 1 and

2. Exploratory shaft, we will talk about it is a science shaft, the ES-2 shaft is a shaft that not only facilitates the egress in case of emergency operations, but also allows us to escalate our mucking, our extraction of the waste material from underground. When I say waste, the rock extraction, not pertaining to any fuel consideration.

You will see up at the corner here, through our road, we will have an explosive storage area, and equipment storage yard. And then different -- the configuration of the drill pad and the head frames themselves.

You will notice that as we go down to approximately the 600 foot level, you will see a break-out. Excuse me -- there is a upper demonstration break-out room where we will conduct some tests and I won't get into the definition of those tests or articulate them in any detail at all, because Mike Voegele is following me, has a very detailed presentation on the types of tests that are going to be performed. All I wanted to do is to show you our plan of construction, how we intend to facilitate construction and the type of construction that we will do.

So, there is an upper break-out room and then we go down with the shaft to approximately the 10-50 area, where the main test level of the exploratory shaft facility will be constructed. And we will talk about that in a minute.

I would also like to draw your attention to these drifts that will be excavated, that will take us to different faults of question. We are talking about the Drill Hole Wash Fault in this direction. The Imbricate Fault Zones in this area and to the Ghost Dance Fault, it comes back over in this area.

This is an ES, exploratory site facility sight plan and just to give you a brief explanation of how the site is going to -- the configuration and layout of the site. We were talking about the exploratory shaft 1 and 2 right there. That will be the main path, where all the surface facilities and construction will take place in ES-1 and ES-2. Of course we have the storage road where I showed you on the proceeding view graft that goes up to explosive storage pad. We have water storage up a canyon in this area and other facilities that will support us. We have a parking and storage facility here for top soil, with parking areas. Equipment storage is down here.

We talked briefly, or Jean alluded briefly to the lagoon area. We do have a lagoon area down here. The purpose of it will be mainly to collect waste water from excavation. Let me at this time just talk to you briefly about our excavation techniques methods.

It was very -- once we determined that Yucca Mountain would be a proposed site for site characterization, it was determined very early on in the 1981, '82 time frame, that it was most important to characterize the site in it's pristine environment. Mainly, because we are in the -- above the water table. And so, the determination was made that we would do mainly drill and blast technique or very common mining practice. We would not, even though we have the technology, we would not use large drill rigs to, rotary drill rigs to excavate those.

The purpose of that, we had a very detailed shaft and analyzation by U.S.G.S. and mapping procedures and other things that they intend to work in the ES-1 slot. I mention that that was a scientific investigation site. And so for the purpose of the scientists to do thorough examination of that surrounding geologic area, it is important that we kept that just as dry as possible so that we would, in order to reduce any drilling fluids as one of the previous questions, so we are going to do the regular drill and blast technique, which is common throughout industry, where it is not drilled.

Mainly, that we will have facilities of work index. We will have sinking hammers, pneumatic hammers that drill the hole or load them with power and detonate them, blast them and then remove the muck. And I use the term muck, that is the waste extraction that we remove from the bottom of the shaft as we go down.

So, that is principally the area. I would like to also mention that we intend to have a very very progressive quality program watching the water induction into this area, as we do our conventional mining techniques. And certainly any water that is placed on the pad or the surface for dust control and everything, all the water that we intend to use will be cataloged, it will be tagged. There is a complex, I don't remember the type of tags that they use, they're very complex. There is four or five different systems that they're going to use to analyze and tag the water from different areas, so that if we -- if we recover any water at all, we can determine where that water came from and what it was used for and so that it can be placed into the proper, into it's proper position as construction water.

It is also our intent to mitigate any water usage that is not necessary. Certainly in construction procedures such as this, it is necessary to introduce some water into the construction process. But that is going to be very limited. It's going to be very very controlled, from a quality standpoint, and we will not allow any excess water to permeate the surrounding geology.

So, that's part of the intent of our excavation techniques and the way we intend to proceed in that direction.

The surface facilities layout, the main pad will consist of certain, the two hoists that I mentioned. The ES-1 hoist and the head frame, ES-2 hoist and head frame. The hoist house will be a common hoist house at this present time that will house both hoists. The utilities will be in trenches that will be put up to the main pad from existing substations for the electrical and water supply. They'll all be trenched and covered over. There will be trailer facilities and shopping facilities will be on the main pad to support both the laboratories and the construction workers in the effort and construction there.

The next view graft, the intent there is to show you just a portion of the proposed repository and to show you how the exploratory shafts will integrate into the repository area.

This is the test configuration of the main testing level and this is an area that has been kept for the testing purposes. If the proposed repository site characterization is successful and the proposed repository is moved to the Nevada site, these are the areas that would be supportive of the repository themselves, showing ramps and main drifts that would run. And these are panels and I will talk about this panel towards the conclusion of my presentation, or a panel similar to that and how the repository is incorporated into the, or the exploratory shaft area and facility is incorporated into the repository.

The next view graft is a cartoon and the intent of this cartoon is just for those of you that might not be acquainted with mining techniques and construction. This in no way typifies exactly how to look at the exploratory shaft area, but I just wanted to show you since I will be talking a little bit about requirements. When we talk about a collar, it's this area right around here. The interface of where we start penetrating the surface of the facility and excavate downward.

Some of the hardware that the workers will use and this mining configuration, when we talk about a sinking deck, it will be the deck that the miners work off of. There will be a muck bucket and a mucking machine. A criterman type maybe or some other type of a mucking machine that will, after we have blasted, permanently blasted and the air is cleared, then the muckier will go down there with this mucking machine. He will load the mucking bucket and that will come, that will be hauled to the surface and then dumped in a shoot here and down into a truck, which will take it to an adjoining area, where we will store all the rock waste that has been extracted from the underground areas.

Again, I would like to just emphasize that water usage will be kept at a minimum in that process.

I would like to just mention briefly, also some of the design requirements that we have imposed in our requirements for the construction and methods of the exploratory shaft as it is going to be excavated by the drill and blast method, which I have tried to explain to you. Blasting, there will be blasting procedures. They will be very, they will also be under a very stringent QA Program. There will be preliminary and there will be proto-type testing and has been testing in areas off the site.

You will see G-Tunnel tomorrow and then you will see an area in G-Tunnel where we have encountered a zone that is very similar to the zone that we anticipate at the main testing level. And we have done some blasting studies there to determine just how to control the blasting techniques. We talk about controlled blasting. Those of you that are acquainted with underground techniques, there are several methods of controlled blasting. But our intent is to make sure that it will be well monitored so that there will not be any blast damage outside the excavation area or any blast damage will be very limited. So it is very important. There will be very strict blasting techniques and procedures followed during that operation.

We also have requirements that are appropriate for the collar and I mentioned the collar construction, at the shaft collar. It is important that all the collars for exploratory shafts ES-1 and 2 are bounded in solid rock, in bed rock. That they're not in any alluvium. And the shaft locations have been moot previously at a direct request so that they would be bounded in solid rock. They're reinforced to serve as a head frame foundation and they also structurally are isolated from the shaft liner. And they are designed to meet a surface design codes.

In the liner, near the shaft, the shaft will have a concrete lining. The shaft excavation will be normally a 14 foot in diameter. That will be the raw excavation and then it will be lined to a 12 foot minimum, with 12 inches minimum thick concrete. It will be cast directly against the rock and the joints, there will be joints allowed between the sections. They will be poured in joints. There will be permanent embedments emplaced in the concrete for bolts and other things that have to be used to support. The brow structure will be reinforced as necessary to meet the seismic design criteria and is required for support.

The next view graft I would like to draw your attention to is a general arrangement of the main test level. Now it is not my intent in this presentation to discuss the types of tests that will go on here as Mike Voegele will address you shortly and he will have in detail those types of tests and talk to you about the tests and what the intent of those tests are. But I just wanted to show you that at the main test level, and again that's approximately 1,050 feet beneath the surface.

Our first area of work, I mention that the ES-1 would be a scientific excavation, to support the scientific studies of that excavation. It will be slower than ES-2. We intend to develop this area primarily first and into this demonstration break-out area. And while excavation is continuing there, then next we will come along here. You will notice here that we have dotted lines that go to these different fault zones that we talked about previously, to the Imbricate Zone and also to the Ghost Dance Fault Zone. Those areas will be secondary and they will be developed.

And as we move in this area, then we will develop these areas for these different existing tests, until we get down to here and this will be the last area of construction as we develop the underground testing facility. And it's approximately two years in the construction effort there.

Now, some of the purpose of developing some of these initial areas, is on a priority basis in areas that have to have a long period of time for characterization. We want to get the investigators in there, the testers just as soon as possible so they can set up their equipment and start their testing procedures.

I just draw your attention to the test area is based no an operational core area and is surrounded by test alcoves and take offs of the long exploratory drifts, which

I have indicated to you. And there again, provide access to the geologic faults of interest that we've determined are of interest.

This is a preliminary drawing, a cartoon if you please, showing the repository complex. I would just -- I thought that it was important to show you that we are going to incorporate the area of exploratory shaft into the repository complex. Now, the exploratory shafts, i.e. exploratory shaft 1 and 2, if again the proposed repository is constructed at the Nevada site, then the exploratory shaft 1 and 2 will be air intake shafts providing air into the repository in the construction and in the waste emplacement mode.

Off to -- as you saw on our aerial photo, removed away from the horizon of the repository, because of surface conditions, very rough surface conditions, this is the proposed area that we presently located for the surface facilities. And there is several, it encompasses a large area. There is -- it encompasses a hot cell, there will be a highway that comes in and also railroad tracks here and bring in spend fuel into the hot cell areas. There they will be removed from the transportation casts and packaged as necessary throughout the procedure. And once it has been housed into the waste package, into the waste package itself, there will be ramps that go from the surface facilities on an incline down into the repository and they will, the actual spent fuel and the waste package will be removed from the surface facility, go down this ramp and emplaced into the repository area that has been excavated, previously excavated and provided and that's where it will housed.

Just some of information that's on your view grafts, some of the -- if we -- we are still determining in the Nevada project, whether we will emplace spent fuel in a horizontal mode or whether we will emplace it vertically in the drifts. Now, as you go out on your tour tomorrow and you go into the climax facility where we did a demonstration project, you will notice that those are all vertical emplacements. And it is not yet determined exactly how we intend to proceed at the Nevada proposed repository site.

There will be a ramp for waste deliver, as I said. There is going to be separate emplacement and development ventilation for the replacement side, the development side. Those two ventilation systems will be separate, so that there is not any opportunity for waste, if there is any release of that waste, that it would not get into the construction site. So we have separate ventilation systems. Of course we have filter systems, heat and filter systems on the surface and everything to mitigate any circumstances that might arise.

The slope from the -- there will be slopes from the drift to the emplacement exhaust shaft. Will be -- there is -- the area of the repository horizon is not exactly flat. The geologic layering there is sloped and there will be sloped drifts to the emplacement exhaust shaft.

The design lifetime is 100 years and approximate temperature conditions in the access drift, it be approximate 50 degrees C for 50 years. And really I mention these just in approximate.

Again, this is a exploratory shaft layout, similar to the one that we talked about earlier. It's within the planned repository setting and again I mentioned that there was a -- these panels -- this is an outline of the whole repository perimeter showing the perimeter drifts. And the waste main drifts. I apologize that I'm not less nervous of this light, but, as it jumps around, but these three drifts that you see here, the waste main and the tuff main and this other, the drift here, are these that come right down here, you will -- the exploratory shaft facility is right in this area here. And then you see these series of panels and these panels will be mined to emplace the proposed 70,000 metric tons of spent fuel that will come to the site.

And then we have one small panel there showing the emplacement drifts. We have panels there. And then there will be emplacement drifts running between those panels.

It's quite significant. There is approximately close to 100 miles of drifting that will take place underground. These drifts, I think Carl told you today the size. They're not small drifts. In some instances 16 by 24, 14 by 24, depending on what the drifts are for, but the emplacement drifts and the drifts that we bring the waste down are very very large drifts. We have not -- it's only in conceptional, certainly it lends itself well to tunnel boring machines for mining methods and that is the proposed method when we get into the repository area, doing these long, these long emplacement drifts and the long access drifts, is with a tunnel boring machine.

Yes sir?

SPEAKER: What's a panel?

MR. SKOUSEN: Well these panels, or these square sections you see, it's just a definition, between the drifts of the repository themselves. Let me walk here just for a minute. It's these areas right in here between the drifts, the emplacement drifts. If you can't see them on that, they're in your handout.

SPEAKER: I can see that there are lines there, but I don't --

MR. SKOUSEN: Well, those indicate total drifts and the -- I don't have them to scale, but those are the drifts that are 12 -- 14 by 24 and 12 by 24 feet. So they're 12 feet, 16 feet, 12 feet high and --

SPEAKER: Is the panel a divider that somehow breaks up --

MR. SKOUSEN: It's rock, it's engineered barrier. It's part of the tunnel, that's part of the mountain itself.

SPEAKER: Larry, the next view graft kind of --

MR. SKOUSEN: I intend to go to the next view graft, and that will, I hope is the -- if you will look here that would have been simpler. Here is the -- these are the panels that I was talking about showing the tunnel mains here and certainly the emplacement drifts, as they run horizontally here. And again, this area -- this is a very large area. I mentioned it is approximately 2,000 acres in size. You will be on top of the Yucca Mountain tomorrow and as you look down the length of Yucca Mountain, it's approximately 3 miles long and 1 mile wide, so you will get a good understanding of the significance or the size of the -- the proposed size of that repository horizon.

The only thing I neglected to mention in this view graft is that we also, as this will be the waste emplacement drift, there will be construction continuing, going on even as emplacement, as these panels are -- as these panels are readied, then waste will be emplaced and there will be construction going along, even as waste is being emplaced so that the extraction or the much extraction tunnel is also a ramp, a proposed ramp and it will lead out here to a holding area of the muck storage area.

SPEAKER: Will all the panels have emplacement drifts running through them?

MR. SKOUSEN: Yes, the emplacement drifts are these drifts that you see right in here.

SPEAKER: They will be in all the panels?

MR. SKOUSEN: They will be in all the panels, yes sir. This was just for detailed information -- to show detailed information. They -- all the panels will be similar like that.

This concludes the presentation that I have brought to your attention. We will certainly entertain any question or try to entertain any questions that you might have.

SPEAKER: Question.

MR. SKOUSEN: Yes, sir.

MR. FOSTER: Foster again. What determines the perimeter here, which is irregular? Is that the extent of the tuff formation that you can use?

MR. SKOUSEN: The question from Mr. Foster is what determines the perimeter drift. It is determined by the geology, the geology for that breakout horizon. Max would you care to enlarge upon that, exactly the plane -- the geologic plane where we're going to have the breakout zone is only so thick and I'm not sure exactly what that is. And as we get out to the perimeters, the edges, it narrows down, so it -- at a certain point that it would no longer be capable of housing the repository area. Max can --

MR. BLANCHARD: Maybe I can help Larry out. Larry has shown you a conceptual repository layout. Bear in mind it's at the time before we initiate site characterizations, so as we gather more information it could well be that the design of the repository would change significantly as we move into advanced conceptual design and then to a license application design.

This is one of many possible layouts that have been considered. The size of the perimeter drift is largely depenoant upon how much heat you feel you need to dissipate based on the age of the waste coming in.

And so if you need a lot of rock in between the waste packages, then your panels have to be farther apart, which makes the perimeter larger. And so it's all taylored together and it has to fit into the natural geology and there are constraints on over-burden, 10 CFR 60 has a limit as to how close to the surface you can get. We've placed our own limit with respect to how close we want to get to things like Imbricate Fault structures or through going faults. We've also placed a limit with respect to how close we want to get to the water table, because ground water travel time requirement and so since the repository drifts down or slopes down as we move Eastward, we don't really want to move very much more East, because then we get to shorter and shorter travel distances.

So, I think you have to take a systems approach and then you have to do it intertiavely as we get more information in from site characterization and fold that into conceptual designs and undoubtedly you see the systems approach change the conceptual repository design as we move forward, wouldn't you say so Larry?

MR. SKOUSEN: Yes.

MR. BECHHOEFER: Just a quick question. Charles Bechhoefer. In your preliminary -- -- -- is there any other way this facility going to be seismically qualified?

MR. SKOUSEN: The question was is there any, when we talk about the surface facility to the repository, and is there any other way that the site is going to be --

MR. BECHHOEFER: -- is the fault?

MR. SKOUSEN: Max would you like to --

MR. BLANCHARD: I would be glad to.

MR. SKOUSEN: Max is our --

MR. BLANCHARD: Okay. Fred has asked me to make this quite short. The things that are most susceptible I think to ground motion and faulting with respect to safety of workers, is going to be the surface facility located in Midway Valley, because there is two faults, one on either side of the surface facility. So we want to make sure that the design basis earthquake, the ground motion, the spectra and the ability to withstand small ground ruptures, is inherently in the location, or the design of the surface facilities.

As I mentioned earlier, the long through going fault here, the Paintbrush Canyon and this other fault here, the Bow Ridge are the two that we're currently using for the design basis earthquake. And it's -- we're using the length distance relationships. We're forecasting something like a six to a six and a half magnitude earthquake could possibly happen on the Paintbrush Canyon Fault.

This would give you a peak ground acceleration of something between .5 and .6. And so the surface facilities would have to be designed to withstand that. Bear in mind now, the surface facilities are simply handling waste elements. The fuel elements in taking them from shipping casts into a hot cell and then from the hot cell into, within the hot cell into a waste canister that's welded closed and then it goes underground.

When you get underground, well we were talking about that. So, the basic integrity of the surface facility, the most sensitive areas, the hot cell and our current design studies on the hot cell designs suggest that when you make that rigid and structurally strong enough to be safe for handling as a hot cell and from a radiation safety standpoint, it's already strong enough to be -- to meet the design basis earthquake that we're expecting.

Now, this is very preliminary. It's probably got information in it that has to be changed considerably. But, people that have been the contractors on this, Bechtel, Parsons, Brinker and Haufu, working for Sandea, have reached a conclusion based on a design trade off study that it is certainly within current state of the art to build a surface handling facility and that can meet this with a large margin of safety and not have it be prohibitively expensive.

With respect to the underground itself, that's different. Once the waste is emplaced there, then we have other factors that are coming into action here.

For instance, we have a standoff distance between the edge of the waste canister and the wall of the rock that's on the order of 7 centimeters. So, we're assuming that by design emplacement of the engineered barrier we could tolerate over the 300 to 1,000 year requirement in 10 CFR 60.113, we could accommodate up to 7 centimeters of rock movement before there would be any contact or force on the waste canister outside.

And the design requirements from the regulation for the waste canister, as you know, is substantially complete containment from 300 to 1,000 years and after that a regulated release rate meeting one part in 10 to the fifth, after 1,000. We have to get into the waste package design to talk more about that.

I would prefer to do that after the meeting. I'm not prepared to do it right at the moment. Rest assured that we're looking at both post and pre closure in tectonics and there will be a discussion that I could develop when I talk at the last, give the last talk, which addresses tectonics more thoroughly if that would help answer some of your questions. That you very much, that's a very good question.

MR. BECHHOEFER: One follow up. What happens if the underground fault, Midway fault, like it turns out to be a real one, goes right through your facility.

MR. BLANCHARD: You mean the Ghost Dance Fault.

MR. SKOUSEN: He's talking about the surface facility, I think.

MR. BLANCHARD: Oh, this one here?

SPEAKER: Yes -- if that little question mark turns out to be a fault then what happens?

MR. BLANCHARD: Well, we're -- we may have to move the tentative location of the surface facility. We've done seismic profiles across here to look at the hard rock structure and we have some trenching and the current technology suggests to us for surface facility design that if we don't encounter more than 5 centimeters displacement, providing we can get the recurrence interval of the fault, and I'll talk about that a little bit later. Providing we can identify the displacement and see it, it's more than -- if it's like 10 centimeters or more, then we probably have a problem for this particular location for a surface facility.

If our trenching results suggest that the displacement in this valley in the vicinity is less than 5 centimeters and the recurrence interval was appropriate, then we may have a location that's acceptable.

MR. SHON: Our next lecture is by Mike Voegele and his subject is Exploratory Shaft Testing.

MR. VOEGELE: Would you prefer that I tried to cut this back to get you back on schedule, or what?

MR. SHON: We're pretty close. I mean we're about 10 minutes behind.

THE REPORTER: Mr. Shon, I'm going to change tapes.

MR. SHON: You're going to change tapes.

MR. VOEGELE: Good afternoon, ladies and gentlemen. My name is Michael Voegele, I'm with Science Applications here in Las Vegas, supporting the Department of Energy. I've been principally involved in the development of documents such as the Site Characterization Plan and the Environmental assessment for the site. I have been asked this afternoon to speak to you for a little while about some of the tests that are planned to be carried out in the exploratory shaft facility.

I have provided you with a very thick packet. I have no intention of talking to every view graft in that packet, we'd be here for the rest of the afternoon.

Instead what I would like to do is try to highlight the various types of tests and try to explain to you some of the thoughts that are behind the reasons why we have selected these particular tasks to do in the exploratory shaft facility and the types of evaluations that we've done to demonstrate that we believe we have an adequate and comprehensive program.

I'm going to quickly go through a couple of slides you just saw with Larry Skousen. I'm going to highlight a couple of different aspects of these slides, a little bit different from what Larry was highlighting.

P tting together a couple of pieces of information for you. You've been informed that the repository horizon and the geologic stragophy at the site are both dipping generally toward the East. And as a consequence if we're going to do a single exploratory shaft facility, and get the maximum amount of information about the rock units out of that, we are planning to run tests at different levels within the exploratory shafts, so that we can sample different rock types that might be encountered across exploratory shaft facility.

So, that basically is the purpose for having a break-out room about mid way down the shafts and having a main test level at what is proposed as a repository horizon. The significant difference that you're going to be looking at up in this upper demonstration break-out room, is really due to something -- I don't know if Max mentioned lethivisal cavities for you. There are large core spaces in the rock mass, probably due to gasses coming out of the rock when it was in a molten condition and forming relatively large cavities.

So, basically, as you go up this sequence in the topography springs member you encounter these lethivisal cavities. And our intention is to have an in situ testing program that will allow us to sample both rock from the purposed repository horizon at the Eastern -- Northeastern end of the repository block and something that may be more representative of rock we might encounter as we go up the section as the repository goes toward the Southwest.

Okay, we don't need that one. Larry said everything I was going to say on that slide.

Okay, what I would like to do is basically highlight, this is, I guess, table of contents for the talk. And as I mentioned, we do have tests planned at the upper demonstration break-out room and tests planned at the main test level. There are also tests that are planned to be carried out as we're going down the shafts.

So, what I'm going to do this afternoon, is talk about certain types of these tests to try to give you a feel for the sites of rock, types of rock properties that we're planning on investigating in this testing program.

Okay, before I go into detail on specific tests, it's probably appropriate to spend just a few moments talking about the types of evaluations that we've gone through trying to assess whether or not this is a program that is consistent with some of the regulatory requirements. And specifically what I would like to point out is that we've done evaluations of this Site Characterization Program. In particular, I'm talking about the exploratory shaft testing aspects of the Site Characterization Program.

And we've concerned ourselves with whether or not the running of this Program would in fact have any impacts on the ability of the site to isolate waste. We've concerned ourselves with the question of whether or not we're getting representative data from the exploratory shaft facility, or you know, from another perspective, whether or not the data that we get from the exploratory shaft facility can be coupled with data that we get from the remainder of our Characterization program, so that as a whole we have a representative testing program.

And also, we are concerned with whether or not the test program can be carried out, within the exploratory shaft facility, such that the tests do not interfere with each other. And such that the operation and construction of the exploratory shaft facility does not interfere with the testing of the -- with the running of the tests themselves.

I need to get a little physiological statement out. The mere fact that we're going underground to expose pieces of this rock to look at and run tests on, is going to disturb that rock. As Larry pointed out we have controls in place. We are planning controls in place to limit that disturbance to the absolute extent that it can possibly be limited. We are going to use just the absolute minimum amount of water that can be used, that's consistent with worker health and safety. We're going to use controlled excavation techniques, so that we don't break up the rock mass. And we're developing acceptance criteria for the tests themselves, such that the principle investigator literally accepts the piece of rock that he's been assigned to run his tests in.

So, we're very concerned that this program gives us the best possible data that you can get from an underground program. But the physiological point is, it can never be pristine and perfect. The fact that we've gone underground to get to it, is going to disturb it somewhat.

Yes?

SPEAKER: Have you done scoping analysis to assure yourself that the amount of displacement that's absolutely necessary is not going to affect the characteristic site.

MR. VOEGELE: The amount of displacement, I'm not sure I understand what you mean by the displacement.

SPEAKER: The drilling. I mean other disturbances which you might keep to a minimum, will nevertheless have an impact. Is there some kind of a scoping study to assure you --

MR. VOEGELE: Yes, hang with me for just a couple of minutes. This is just a general introduction. The other point I want to make relative to this, in fact I'm going to get into it when I talk about the interferences, because we do talk, we did do analyses and they're presented in the Site Characterization Plan, exactly of the type that you're asking me about.

The other point that I'd like to make before we go too far into this, is that we really have very limited data at this point in time. I mean, that's the main reason we're trying to embark on a Site Characterization Program, is to get better data about the characteristics of the site.

We believe we have made conservative assumptions in the analyses that we've done to assess the adequacy of this program. The point I would like to make is that we have consciously tried to develop feed back from the test programs themselves that will allow us to confirm the assumptions and to affirm the reasonableness of the data that we used in the evaluations that form the basis for laying out this testing program.

It is our intention that if we do find information from the early stages of the Characterization Program, that would suggest one of our evaluations might not have been conservative enough, relative to the placement of two tests for example, it is our intention to revisit the placement of those two tests and separate them if necessary, so that the data that we get is in fact the best data that we can possibly get from this underground facility.

Okay, the types of evaluations that you will find supporting this Site Characterization Program, that we've put in the Site Characterization Plan really address the questions that's asked by 10 CFR 60.15, which asks us to limit the impacts of our Characterization Program on the isolation potential of the site, to the extent that it can practically be limited. We have done those calculations and we believe we have demonstrated, in fact that our Characterization Program, including the construction of the exploratory shaft, does not adversely affect the site's ability to eventually function as a repository.

We've also assessed the problem, this is the question that I was just asked a moment ago, getting to get into it. We want to insure that the Site Characterization activities themselves, including the construction of the exploratory shaft, or the drilling of the bore holes, do not limit our ability to adequately characterize the site. If we broke up the rock and we're not cognizant of the fact that the rock had been broken up by our mining activity and we went forth and ran some sort of program, say for example assessing the mechanical behavior of that piece of rock, and did not take into consideration the fact that rock had been fractured, we would get a piece of information out of that test program that we really did not characterize the site. And so when I talk about acceptance criteria, the principle investigators are right now doing proto-type tests that I will come back to a little bit later in G Tunnel. Some of them you will see probably on your trip tomorrow, that are helping them to understand just exactly what kind of excavation induced effects they can live with in their tests and what sorts of things they have to find a way to design around, so that they can run a successful test.

Specifically, I want to emphasize this point even more. We've talked about two aspects of the testing program themselves. One of them we call lay-out constraints. The other one we call zones of influence.

The lay-out constraints, basically, are sets of questions that we've addressed that tell us that with which we have assessed the Characterization Program, that tell us in fact whether or not there is some attribute of a specific test that's sensitive to the sequencing in which it's run in the exploratory shaft facility. Whether it's sensitive to some actual absolute physical location in the exploratory shaft facility.

A good example of this is if we're going to run a hydrology test on a fracture for instance, or a fault, we need to go find that fault to run that test. We can't just run it anywhere. There are other ones. There may be a test that has to be run 100 feet away from a fault for some particular reason. So, we've tried to identify those physical lay-out constraints. All this information is also included in the Site Characterization Plan.

We've also, as a third aspect of the lay-out constraints, looked at whether or not the construction and operation of the exploratory shaft facility have any impacts on the running of a test. A good example here is if you've got a truck hauling some rock from a mining activity running in a drift, you cannot run a sensitive, run an experiment that's sensitive to some seismictic phenomena, while that truck is running by. You either have to schedule it so you make the measurement when the trucks are not running, or if it's a long term affect, you have to lay the test out such as it is sufficiently far away from that haulage truck, so that you won't have an impact.

Now, those are the -- the first group are the actual effects that the exploratory shaft facility construction and operation could have on the tests.

There is a second set of concerns that we've addressed and those are the tests themselves. If we're going to place say for example large scale heaters in an area of the test, of the test facility, we need to insure that we understand through what volume of rock that temperature envelope would extend from that test. Such that if we have for example a hydrology test that's sensitive to that temperature affect, we place it far enough away from that mechanical tests, so that they don't interfere with each other. And consequently for each of the tests in the exploratory shaft facility, we've looked at mechanical effects from running the tests, thermal pulses from running the tests. Any hydrological effects in running the tests and whether or not they've come up with chemical affects, due to running the tests.

Now the next three figures I'm going to show through quickly, are just examples of the zones of influence of several of the various tests.

The first one is a pair of mining demonstrations. I'll talk about them momentarily. The angular aspect of these envelopes that I've drawn here is due to the fact that we are allowing sufficient flexibility such that if our understanding of the rock mass structure that governs the layout of this underground facility is not quite precise, we have allowed sufficient flexibility to adjust the inclination of this facility and still have sufficient room to run the remainder of the test program.

So the first thing that you're seeing in there, the blue colored one, is in fact due to the fact that we are anticipating, we're not anticipating, we are allowing sufficient flexibilities, such that if we get underground and determine that we need to change the adjustment of that drift by some small degree, then we have that room underground to do that.

The green shaded area surrounding that is the zone of mechanical disturbance associated with mining that excavation. And basically what we're doing by looking at this kind of a plot is saying, if we have something that is sensitive to a mechanical disturbance, we don't want to put it within that envelope around either that test or that test.

The next one is an example of hydrologic calculation. We've done some scoping calculations about how far the water that you would emplace during construction of the exploratory shafts, and these particular items that are being highlighted here are in fact the shafts themselves. We've done scoping calculations about how far water would move during the construction of those shafts.

Basically, we can draw a circle around them and say that we expect -- go ahead.

MR. COLE: If you're using a dry drilling techniques, where does the water come from? My name is Cole, C-O-L-E.

MR. VOEGELE: Sorry. It is not possible to go underground and mine completely dry, okay. The worker health and safety problems that would associate from the dust in the air, would preclude that. What we are committing to is using the absolute minimum amount of water that we can get away with, that's consistent with worker health and safety.

We're not making bit life for instance, a parameter in this decision. It's worker health and safety that we're worried about. So we will be using small amounts of water while we're drilling the shot holes. We will be using small amounts of water for dust control. And we have developed a plan to recover whatever of that water is recoverable at the bottom of the shaft. We're not going to let it stand on the bottom of the shaft.

The scoping calculations however, assume that something went wrong and the total amount of water would be standing on the bottom of this shaft for something like 72 hours. And these are the kinds of calculations, these are the kinds of distances that our calculations show that water would move. So, these are in our opinion conservative analyses.

MR. COLE: Thank you.

MR. VOEGELE: Okay. This particular example is an example of a thermal interference calculation. Basically, this particular corner is the location of a large scale heater test. And this particular boundary represents the four degree isotherm after running that test for two years. And basically what we've concluded from this, is if we have a test -- we cannot put anything within this green envelope if it is sensitive to a temperature change above 4 degrees centigrade. So, basically, some of the permeability tests the principle investigators may not care to deal with that problem, so we simply will place his test outside that zone of influence.

So those are the types of evaluations that we've done. We've done them for mechanical affects, hydrological affects, thermal affects. Unfortunately we didn't much in the line of -- in the way of chemical affects. But we did address the problem. So with that in mind -- go ahead -- I want to just flip through. These three view grafts, I'm not going to really talk to them, I just want to tell you what they are.

I mentioned earlier that we did have a limited data set to base these calculations upon and in fact that we did have concerns about whether or not our calculations were correct and accurate.

So what we've done, is for tabulated on these next two or three pages for you, the types of information that we're using to monitor our assumptions that we used as the basis for laying out this testing program. So you can see for instance, this one for instance, there is artificial recharge tests, matrix hydrologic property tests and the major bore holes from the Site Characterization Plan itself.

We're going to be looking at infiltration rates. We made technical assessments of what the infiltration rates would be under given heads of water and given permeability procee characteristics to saturation of our unsaturated rock tests.

We're going to try to monitor new information coming in from the Site Characterization Program as quickly as we can get it to try to confirm the assumptions that we made. Or in fact, lead us into a reevaluation if that becomes necessary.

So, those three pages in your hand out are just basically a listing of which particular types of tests provide what types of monitoring data.

So I believe I'm finally ready to start talking about the real test program. The first couple of tests we're going to talk about, focus on getting down to this main test level. And I'm going to talk about something which we call the Multi-Purpose Bore Hole, which is basically the first thing we're going to do, which establishes a monitoring base line for us.

And we've listed four attributes of this test. The first two are certainly that we can investigate for the possibility of perched water. We've not found perched water in this area and we're not expecting perched water, but we're certainly going to drill this hole with an eye towards looking out for perched water.

SPEAKER: What's perched water?

MR. VOEGELE: Perched water would be -- we are above the water table at this site. And it is conceivable that due to stratigraphic contracts, impermeable rock, laying over permeable rock, vise versa excuse me, that small pockets of water could be trapped up against the fault for instance. WE have no evidence of those, but we are laying out our program to look for them in case they are out there.

We will get some confirmatory information about the stratigraphic section and what the rock is like out there, prior to starting shaft construction. But the most important things that the multi-purpose bore hole does for us, it gives us an opportunity to establish base line data on the hydrologic properties.

These are two bore holes that are going to be drilled very near the shafts themselves. And in fact they will be used to monitor any hydrologic changes as the shaft construction takes place. So we will be looking to see if in fact, any water is moving out from the exploratory shafts due to construction. It provides a feed back on that assumption that we have.

It will also allow us to look for any other types of disturbances. But the main one is in fact, the hydrologic disturbance. Okay.

Going down, while we're sinking the shaft, we're of course doing mapping. I figured I wouldn't talk about that. But I did want to talk about the Shaft Convergence Test. This is a cross section through one of the exploratory shafts. And you can see it has a concrete liner.

Now, at selected locations down the shaft, we intend to put what are called extensometors. They're just a big mechanical physical analog to a stream gauge. They tend to have anchors that could be 75 or 100 feet deep. And you put the bottom most anchors back in the rock mass where you will not have any disturbance from your mining activities. The heads of the extensometors, which are -- will allow you to measure deformation, are placed where they are accessible within the liner.

We have two types in here. One is a simple rod extensometer, which makes manual measurements. The other ones are deep anchor multi-point bore hole extensometers, which will have electric readouts. What this will allow us to do is monitor the deformation of the rock. And it will allow us to confirm our assumptions about the rock mass behavior. The modiolus type properties that we've built into our analyses. It will tell us if we're in fact getting, if we get asymmetric movement for instance, on this, we may -- that may lead us to the lead, we're looking at movement taking place on a fracture plane as opposed to the rock mass deforming uniformly. It provides that type of information to us.

I mentioned the demonstration break-out rooms. What -- we have one at the mid-point level of the shafts going down. We have one at the main test level. What these types of tests really begin to do for us, is allow us to look at the blasting methods that will be used in the repository construction and the rock stabilization, the ground support like rock bolts and shock treatment, things of that nature, that would actually be used in the repository construction.

Using the same types of mechanical instrumentation that you would use in something like the convergence tests, you can again look at the mechanical behavior of large room size, repository room size excavations.

SPEAKER: What's the MP-2?

MR. VOEGELE: Sorry -- okay, that is the multi-purpose bore hold number two. See this would be Shaft No. 2 that you're looking at. There is a comparable one -- let me point out something to you in fact.

One thing that drives the location of MP-2, is you will notice that it's in the middle of a pillar. We're trying to maintain -- we're trying to be in compliance with the aspect of 10 CFR 60, that tells us that to the extent that we can possibly can do it, we should place shafts in bore holes in large unexcavated pillars. So you will find those kinds of things factored into this program.

Okay, now, I mentioned the multi-purpose bore hole. This particular illustration shows another existing geologic bore hole. The multi-purpose bore hole is somewhat closer to the exploratory shafts that than one would be. And I mentioned that we would use that to try to monitor fluids moving out from the shaft excavation themselves.

We have two other types of tests in the shaft construction that are looking at the same type of phenomena. One of them is a set of radio bore holes, drilled out at varying distances around the shaft. And what we're looking for is to see what the extent, how far the water penetrates out from the shaft construction, as well as looking at what mechanical effects the shaft construction would have on permeability.

SPEAKER: How much water is going to be used in the shaft construction?

MR. VOEGELE: Oh, I don't have that number at my fingertips. I can get it to you before the close of business today. You're concerned the water in shaft construction itself, as opposed to water watering the roads off the site and things like that?

SPEAKER: No, that's what you're testing for.

MR. VOEGELE: This is what we're testing for here, right. Okay, I'll get you that number before close of business.

Okay, but that is what the purpose of these radial bore holes tests is in fact, is to see how far out from the shaft the mechanical disturbances to the permeability would extend and how far the water might extend.

And also, these are perpendicular to the shaft. We have a set parallel to the shaft, coming down from the upper demonstration break-out room. They're looking at the same types of phenomena. The one is called the radial bore holes tests and the other one is called excavation effects tests. But again, they're looking at what kind of affect we're having on the rock mass, by doing the excavation of this exploratory shaft.

Skip that one, I've talked enough about these types of excavations. We'll just talk about something like other than a mechanical experiment, let's talk about a couple of heater experiments for instances.

This particular one is a canister heaters experiment, that would be in the wall. In the wall of the upper demonstration break-out room, where we would heat the rock mass and look at the way that the temperature pulse moved out from the heater. And we would also look at displacements. You will see that we've also devised a system where we're pressure -- I don't want to pressurizing, we're preventing the escape of any vapor that might be generated as a function of running that heater experiment and measuring that vapor pressure, so that we can get some idea of whether or not we're driving water into the bore hole by heating these things.

That will help us in our assessments of what the waste package environment is like, when we start putting waste canisters into the repository, if that turns out to be the case.

Okay, let me look at the next one. The next one is a larger scale heater. It's a room scale heater. And basically, these are -- this is a vertical section through three drifts. And basically what you can do from these is on the side drifts, you can put deformation measuring instrumentation in and around this central drift, which would be where you would actually place the heater.

Now, we could, if we were doing a vertical waste emplacement test, we would put the heaters in the floor. Or if we were doing a horizontal waste emplacement test, they could actually put the heaters in the wall.

The goal of this particular type of experiment is on a room scale, repository room scale, to see what the effect the thermal and mechanical and hydrological effects are of putting heat into this rock mass.

SPEAKER: Look for deformation of the rock mass through the heating?

MR. VOEGELE: Yes.

SPEAKER: What are the other deformations to look for with the extensometer? In addition to heat.

MR. VOEGELE: Okay. Mechanical relaxation would be one primary one you would look for. Basically, you'd have -- you're hoping that you have an elastic response when you put a piece of instrumentation in like this. Such that you'll quickly get your deformation. Now that means you have to put these pieces of instrumentation in very near an excavated phase just as it's about to be excavated. But we've done that many times and have successfully backed up the mechanical properties of the rock mass.

You can leave these pieces of instrumentation in for very long times, and you can look at subsequent time dependent relaxation of the rock mass, if in fact that is a property of this rock mass. It's something that we don't expect we would see on the scale of time that we're going to be able to run this exploratory shaft facility, but the instrumentation would be capable of telling us if that was occurring, if in fact it occurred.

Okay, the other general category of tests that are going to be run in the exploratory shaft facility are hydrologic type tests. And one thing we're trying to do is to develop a better understanding of the flow processes that work in an unsaturated zone environment.

Most of the science that's known today about the behavior of unsaturated materials, is from soil signs. It's relative shallow water movement studies in agriculture and alluvium.

We've extrapolated some of that information to hard rock. We're using other information which has been developed specifically for hard rock and the complement that we've tried to lay out, a Characterization Program that will not just go out and measure some simple physical process, but to try to help us understand the flow processes that act in something like a large scale unsaturated rock.

And to highlight this, we have things like the bulk permeability tests, where we're going to investigate the permeability behavior of relatively large volumes of rock.

SPEAKER: Do you expect there will be differences between permeability behavior in large volumes than in laboratory size volumes?

MR. VOEGELE: Yes, I do. I think that the fact that this is a fractured rock mass is going to bear very heavily on the difference between a laboratory sample and a field scale sample. We are in fact looking at running samples in the laboratory that do have fractures in them. But the goal of the larger scale test, is to get a representative fractured network involved in our permeability calculations.

Most of these tests have as an underlying theme a relationship to some performance assessed with modeling. Many of them are planned to be -- are tied to the performance of subsequent modeling activities, for model development, and for model validation and verification to the extent that it can be done.

The reason that I expect a very significant difference, or wouldn't be surprised if there was a significant difference, is in fact that when you have water flowing in an unsaturated medium, it's being -- it's moving by capillary forces, as opposed to positive potential forces. It's not being pushed through the rock mass, it's being drawn through the rock mass. And things like fractures tend to be capillary barriers and they tend to prevent the movement of fluid from one pore to another pore, if for instance the fracture opening was larger than the pore diameters that it was moving through.

So, in fact it may be that the fact that this rock mass is fractured, is going to be an effective barrier that we can use in our arguments about the performance of this site. So, it's important to us to understand what those flow processes are on a large room scale.

Okay, here is an example that I mentioned earlier. We are actively going to go out and look for fractures and run tests on them, hydrologic types test, in the exploratory shaft facility. This particular one looks to be something like a fault, but what they've gone and -- what you can see here in fact, is a mechanism that will allow them to change the normal force across that fracture to look at the appeature conductivity relationship for a fracture, in as undisturbed of a state as it could be.

If we could excavate a piece of rock containing that fracture and take it back to the laboratory, but in all likelihood we would destroy the relationship between those plane surfaces, those fractured surfaces that they have in the field. And if any of you have done that type of hydrologic testing, it's virtually impossible to put that sample back together the way it actually existed in the fields. So the goal of this experiment in fact, is to look at some of those relationships in the field, disturbing the sample as minimally as we possibly can.

Okay, the exploratory shaft facility also will be used to investigate shaft and sealing related aspects of our program. Right now we're very early in the process of defining what specific tests would be run in the facility. We do know that because of our interactions with the NRC staff, we do know they have some concerns about some aspects of the effectiveness of the possible seals. And we do know that they have some concerns about fines type material clogging up existing fracture networks.

Many of the arguments we've made about the performance of this site rely upon the site draining. If water were to come into the site from some disruptive event, like a major flood that wasn't expected, we rely upon the site in our arguments today, to be relatively rapid draining.

The staff, the NRC staff, has expressed concerns about whether or not fine silt size material could in fact clog up those fracture surfaces, those fractured pathways and preclude that water from draining away. So we intend to go out and look at that time of a phenomena in our exploratory shaft facility and see in fact whether or not there is an effect such as that.

Our studies to date, suggest that that would not occur, but we intend to investigate it, to get come confirmatory evidence.

That really concludes the number of, the actual number of tests that I wanted to talk about specifically. The package that you have has a paragraph or so, or a picture, on every test that we plan to run in the facility, if you want to look at it at your leisure. But I would like to conclude by pointing out that in fact we are currently doing many proto-type tests in a similar welded tough rock mass out at G-Tunnel, what I understand you're going to see tomorrow.

We're demonstrating some tests concepts. There are many of these tests that people are not familiar with. They haven't been run very frequently, if at all before. And so we're trying to demonstrate some of the concepts in G-Tunnel before we go underground in the exploratory shaft facility. We're also using this as a opportunity to develop quality testing procedures, so that our -- the results of our in situ testing in the exploratory shaft will be more credible.

Any other questions?

SPEAKER: What temperatures do you expect with different kinds at the repository level and what -- how hot will -- what temperatures will you be using in your heat tests?

MR. VOEGELE: Okay.

MR. SHON: Larry Skousen had mentioned a temperature of 50 degrees centigrade.

MR. VOEGELE: I'm going to try to show you what's been done here, the way this has been laid out. The -- okay, the question has to do with what are some of the temperatures that would be expected at the repository horizon. And what are some of the temperatures that we would be running the tests in the exploratory shaft facility to. Okay.

I believe I'm correct in this, and I will check it for you, that the 100 degree C isotherm from the repository is on the order of 50 meters above and below the repository itself. We would not expect that we would change temperatures any more than that. I believe that's an extreme calculation. I'll check that number for you and get it back to you this afternoon.

What I wanted to point out is there is --

THE REPORTER: Back to the mike.

MR. VOEGELE: I'm sorry. There is a requirement in the 10 CFR 60 that we maintain retrieveability. That we maintain the option to retrieve the waste at any time up to roughly 100 years in fact. So, we have 100 year design life for this facility. But that gives you a little bit of a concern. And it's part of the reason that the emplacement panels are laid out the way they are. We can't let this facility get so hot that we can't go back in and get the waste out.

That's a factor in determining your canister spacing. It's a factor in determining what temperature you allow the overall repository horizon to get to during this operational phase. And basically, what's laid out here is a system that enables us to cool these drifts to the point where equipment can get back at that waste.

Now there are offsets. Now, when you get back into these panels themselves, the temperatures get much higher. I'm guessing, I would rather check this number before I gave it to you firmly, but I believe the number inside the panels where you would be actually putting equipment is on the order of 65 to 75 C, maximum, okay. So, we're trying to keep the temperature in the panels, in the rock mass, okay. And then post-closure time, my recollection was, the maximum temperature is about 100 degrees C, with an envelope, it's like 50 meters above and below the repository. As I said, I will check those numbers for you.

Now, we're planning on running the large scale heater tests to get those kinds of temperatures in the rock mass. We're going to power it up, there is going to be guard heaters. We're not using actual emplacement canisters, we're using electric resistance heaters, and we will in fact put guard heaters in the tests, such that we can effectively raise the boundary conditions, so that the heat doesn't flow away, so that we can actually get the temperature of that rock mass up and really look at what the temperature effects are.

SPEAKER: Are there any tests related to the weight of the canisters?

MR. VOEGELE: Weight in terms of causing --

SPEAKER: -- resting on the rock. Maybe it's been --

MR. VOEGELE: That has not been a concern in this program. The bearing load of a waste canister on a piece of hard rock. This is rock that has compressive strength, in tact compressive strength of around 20,000 psi. It's actually very hard rock. It is fractured, but the rock itself should be able to maintain that load without any degradation.

There could be a temperature effect, a long term creep type effect, but again, I wouldn't -- I personally wouldn't expect that to be significant and we don't have any tests planned to investigate that phenomena.

I would have thought of that in the salt program as being a very important test, but it doesn't occur to me that it would be an important test in the tuff program.

MS. FEDERLINE: GAO recently raised questions about the repository capacity, upon sealing anything and the Characterization Program -- -- can you address that?

MR. VOEGELE: Do you have a better scale map that this?

SPEAKER: What are you looking for?

MR. VOEGELE: The question that was asked has to do with the concerned raised by the GAO about extending the repository capacity above 70,000 metric tons. I need a site map.

Basically, the facility itself, the acreage determination that we've portrayed on this particular figure, is a small -- it's basically geared to being able to, to build a 70,000 metric ton repository at the heat load of 57 kilowatts per acre.

We have, as Max was mentioning earlier in response to another question, some of the things that led to the irregular shape of this particular body, had to do with the overburden constraints, the presence of geologic structures, so forth. What we've got here is a portion of the rock mass that falls into the very first cut, simplest category. There's about 30 percent up in this direction that looks just as good as this in terms of first cut of the repository.

There is a lot of rock up in this direction and up in this direction, that also look quite good, that will be looked at during the Site Characterization Program. What we've tried to do is keep it into a single block and not cross the structures. We know of no reason why we couldn't cross the geologic structure in building this repository, but right now the only geologic structure that we're really dealing with within this block is the Ghost Dance Fault, which there is a possibility that's not a major fault and depth as well. So we do have the possibility to extend. I'm sorry it took so long to answer that one.

MR. SHON: That's okay. Thank you very much Mike.

MR. BLANCHARD: Now, what we hope to do this afternoon, in closing, is to try to give you an understanding of the concept we have used while we develop our plans for site characterization to link the regulations with the actual data, or the actual test, that is acquiring information. This has been a lengthy process and it was not done with a great deal of ease, and so I am going to get into some complicated concepts but, in each case, I am going to try to relate it to more simple logic.

First, a bit of philosophy about the difference between this program and some other programs like the nuclear power plant, perhaps. Waste isolation depends upon performance of both the engineered and the natural barriers. The engineered barriers we can design and we can construct them using available technology, and we know technology changes and improvements are made. We would not necessarily try to stay at this state of the art, but something that is reliable and using available technology. However, how that performs, as it ages, especially over a ten thousand year period is the major question, and we have to address that in our uncertainty.

Of course, the degradation depends upon the natural conditions. From a natural barrier standpoint, the regulations require us to rely principally on the natural barrier, not the engineered barrier, because the engineered barriers, like the waste package, are supposed to survive substantially complete containment 300 to 1,000 years. But the natural barriers to be relied on for long term waste isolation.

We cannot design the site, there is a major difference between that and an engineered barrier. We need to understand the processes that act to change those natural barriers, and we need to predict the magnitude of those changes and the consequences those changes might have on waste isolation. Therefore, I feel as an earth scientist, that this is a significant challenge to the earth science community, the modeling community, and the mathematicians, who are supposed to take the earth science information and communicate it to other people who are going to critique it and license it, the facility, and decide whether or not it is acceptable for waste isolation

So, site characterization plan centers on understanding these things related to the natural barriers and, at the same time, as Mike Volgele discussed, has some tests, in situ tests, from the exploratory shaft that is aimed at degradation. I do not think anyone challenges seriously whether or not there is technology available to build a waste handling building or to construct a mine or to build a waste package.

Okay. Now if we can have the next one, Marylou.

To start with, from an overview standpoint, I would like to discuss the strategy that we used for the development and the use of the site testing information. We do that in four steps. First, we really need to understand the regulatory requirements and one tries to read the regulations and understand them, but without discussing it with the regulator, frequently, we are not sure we always understand it. The goal is to determine site suitability. We have translated the regulatory requirements in our program right now into issues hierarchy. For better or for worse that is what have done and that is how we organized the site characterization plan. And I will explain to you the reason for that and what that issues hierarchy was like.

The next view graph is a four step--we developed what we call a strategy for issue resolution, for each one of these issues. The strategy is predicated upon one, understanding the regulation, and two, acquiring the correct information from the site program.

Fourth, we tried to identify the site data needs as a single step in the strategy for resolving the issue, because we think getting the correct data is of paramount importance.

Now, I mentioned I would get to the issues hierarchy in a minute. This, in Chapter 8 of the SCP was an organizing tool which linked the regulations to the characterization program. Regulatory requirements, in its abbreviated form, there is a plethora regulations that apply to the shaft, the ones from the waste isolation standpoint, are of course, 10C 416 40C 4191. There are some redundancy in the regulations when you read them, and so the issues hierarchy, that we created was an attempt to collate the redundancy on similar topics so that we did not have to do the same job several times.

We have only two types of issues. Either those related to performance, which is long-term isolation, or those related to the design and construction of either the surface or the underground facility. The information that is providing to performance and design and hence, demonstrating compliance for requirements, comes from a myriad of multidisciplined earth science activities which are going to be conducted over the next five to seven years.

The issues; there are four, one, key issue one, is postclosure. That means after the time the repositories can be closed and be commissioned and the life of that waste isolation out through 10,000 years and beyond. I will talk a little bit later about total systems performance as an example of how we trap something that total system performance needs, information it needs, all the way down to a site parameter that is going to be gained in a critical area of hydrology.

Key issue two and four are both preclosure. Two focuses on rad. safety and, of course, four focuses on the design. Each of these have performance and design issues, but the most important in key issue one is total systems, containment of waste package, engineered barrier releases, and the 1,000 year ground water travel time.

In key issue two, it is mostly rad. safety for workers and the release to the unrestricted area . In key issue four is where we designed the waste package and designed the repository. So the program reaches the regulations through these issues which are a convenient way to collect information.

The underlying purpose of the issue resolution strategy is to define measures. This is a concept that we struggled with for quite some time. A measure by which we demonstrate compliance with the regulation, that is what we are talking about. A measure to demonstrate suitability. The plans, the second step, in the issues resolution strategy is to develop plans to meet these requirements.

Marylou, the next view graph will be fine. The third one, the issue resolution strategy, is using these preliminary measures and plans from one and two, then try to determine--ask yourself a question, what and how much information do you need about the natural site processing and conditions? That is not an easy answer to get.

Fourth, develop a systematic process for determining the status of these evaluations of suitability, and also for evaluating the progress towards meeting the regulatory requirements. We must be cognizant of both at the same time, in parallel.

Performance allocation is a term that we have coined in developing Chapter 8. We did not create it, it was a consequence, or an outgrowth, of a number of meetings between the performance assessment staff, technical staff, and the NRC, and the DOE. There have been several day-long meetings talking about performance assessment and performance allocation. So, it was an agreement to make an attempt to try. Well, what is it? It is that process that we use to define the natural and engineered barriers that are expected to be relied upon. In other words, very early on in organizing Chapter 8, we had to decide for a first cut given the available information what we thought we were going to rely on. Because there is myriad of activities, multidiscipline, and it is costing a lot of money and it is taking a lot of time, we would like to have some confidence, both the regulator and the department, that we are spending our money prudently. And that we are going to spend time investigating things that are really related to waste isolation, as opposed to things that are research where we continue on with the quest for an answer which we always look for another decimal point before we say we are satisfied.

So, performance allocation, then, is a concept where we take the regulation and try to determine which things we might rely on, assuming the available information is somewhat representative of what the site is really like. Performance allocations was used, then, to prioritize the tests and the experiments to be conducted from both the surface and the underground.

It helped us focus on the site data needs. The site information for those barriers that we feel will be providing primary contribution were given the highest priority. We felt this was prudent, the NRC's performance assessment people also felt that was prudent. Now, that forced us into taking a position, early on, as we wrote Chapter 8. We had to identify those things we thought we were going to rely on.

Carl will talk about a top-level strategy a little bit later on, and what I would like to do towards the close of this talk is give you some examples of what performance allocations was like, how we related those things.

The emphasis is placed on characterizing the natural setting with the focus on long-term barrier to radionuclide movement. The testing program addresses both the site conditions that exist currently and disruptive events that could occur over the next 10,000 years. We have to have that in mind all the time we conduct performance allocation as we examine what kind of site information do we want.

Again, the regulations require reasonable assurance.

I am not sure I know, collectively, what all is encompassed within reasonable assurance. We have some aspects of reasonable assurance inherently built into Chapter 8. For instance, we have extensive redundant testing in those areas that we think are going to be most importantly linked to waste isolation. We have not called those reasonable assurance, but it is there if you look at it. We think that is an aspect of conservatism in the program.

Bounding calculations, especially where conditions lead us to believe there will be high uncertainty in the calculation, or in the test results. Mike Volgele talked about bounding calculations in an attempt to determine how important water from the surface of the mountain might be at the repository level 1,000 years into the future. We have done some bounding calculations. You may criticize those, you may criticize the assumptions, and you may criticize the numbers we used. We used the numbers that were available and we are hoping to get better numbers as we do site characterization. But one of those bounding calculations you will find in 8.43. Assume that there was lake on top of Yucca Mountain about 10 feet deep and it changed the hydraulic conductivity of the rock beneath that lake three orders of magnitude, and it drained that lake in two days. Then it calculated the amount of water that would reach the repository arising, and according to the calculational method that was used, and the numbers that went into that calculation, the conclusion was 1,000 years later the flux past the repository horizon did not change at all. In fact, it was 10,000 to 100,000 years before the flux increased and then it increased by a factor of 2.

What was happening? Well, if this model is any good, it suggested that the bedded tuff, that is beneath the Betiva Canyon and above the Topopah Spring, absorbed large volumes of water in the core spaces because it is not a welded tuff. It acted as a sponge, and since the amount of water that went into it did not fill up that core space then it slowed down the process of the water migrating into the Topopah Spring.

Whether we, collectively, believe that calculation is viable is something that each person is going to have look at, examine the assumptions, and examine the actual values that went into the calculation. We offer it up as a bounding calculation along with many other bounding calculations based on the available data we have now. We want, very much, to have critiques of that. We also want to crank new information and new assumptions into those kinds of calculations as a guide for running the program.

Okay, can we have the next--? Components of the program. Jean, in her earlier discussion, mentioned there were 106 study plans, studies, described in the SCP. There will be approximately 106 study plans submitted, over the next year, to the NRC for their review and to the state for their review. These go into a great deal of detail. There is approximately 350 activities supporting those 106 study plans. Somewhere between one and eight activities for every study plan. Looking at the areas of investigation, you can see that we are trying to focus on those things that we think are most important to waste isolation.

For instance, we have 16 studies, 54 activities, in geohydrology. In geochemistry we have 31 activities and 16 studies, and in tectonics we have 102 activities and 30 studies. Those are the areas that we think are most likely to impact waste isolation and we need to understand the conditions and the processes that will act to change those conditions in the future. So, we are spending our money there.

Now, the strategy for conducting a program is going to get more complicated but, this logic diagram is basically all it amounts to. Simplistically, we start with the issues and we must have a concept of a system description and a general understanding of uncertainties from the available information when we start.

As those two are inputs we then, using this concept called performance allocation, identify what we think are site data needs, and develop a strategy for testing, we then conduct the investigations. We then ask a question, Is there a significant change in the site description and the conceptual model given the results of the test? If the answer is yes, then we need a series of alternative conceptual models, which we have identified in Chapter 8. Perhaps they are not complete but they are there for working hypothesis. We go back up here, modify the description and go back through another performance allocation.

If the answer is no, then we go down and ask another question. Are the site data needs met with the needed confidence? If the answer is no, again, we come back through testing hypothesis, looking at alternative conceptual models, conduct other investigations, or we come up here, decide whether or not we can do another allocation. If the answer is no we have to decide, Well, do we really have a suitable site?

If the answer is yes, then we are back in this process. Simply speaking, that is the logic we have tried to use in this performance allocation process.

SPEAKER: Have you --anything out of the--yet?

MR. BLANCHARD: Down here?

SPEAKER: No, where it says, "Can performance be reality? No." It is a no--

MR. BLANCHARD: Well, since we have not started site characterization, I would hesitate to say we know what will go in here.

SPEAKER: Okay. You could know from comparing the testing strategy for the needs whether some of the tests are unlikely to meet the needs. Especially, because you are going to do this test over a short period of time, and you need to predict things over a long period of time.

MR. BLANCHARD: You are quite right, and in laying out the tests we went through, you might say, knock down, drag out battles in multidiscipline groups over the several years it took to develop Chapter 8, where people propose tests and we said that looks like an interesting research project. But we are not sure we understand how it relates to either safety or waste isolation.

A number of the test activities that have been proposed have been changed in scope. Some went up, some went down. Some of the favorite things that some people would like to do they actually lost completely. So we have used that process and probably followed our way into that from a planning standpoint, but we do not have the information, empirically, to support moving into that direction yet. But we expect that will happen.

SPEAKER: I guess that is not quite what I was saying. You got the study design, and you have a set of needs, you must know that there are some areas of the study design that will give only weak information to some of the needs. You know what the weak spots are in the study design, in terms of insurance safety because of the needs. There have to be some weak spots here because as you look at this huge project, --

MR. BLANCHARD: Okay. Marylou, can you go back a few view graphs where there is a list of studies and activities? I tried to reflect my concept of that here, in that, we felt we had to spend a lot of time and have a lot of activities involved there in geochemistry and tectonics because we thought those were the areas where the site was weakest, and our understanding was most.

In other areas, like meteorology, surface characteristics, thermal mechanical rock properties, we felt a contribution to waste isolation would be less than in these three areas, therefore, we did not concentrate a lot of studies or a lot of activities there. Is that kind of the question you are asking?

SPEAKER: A hypothetical question? You have 102 studies on tectonics but looking at certain questions that you have to answer you might know that even with all those studies some questions will not be answered. Any questions you know now are going to be answered in a weak way.

MR. BLANCHARD: I think it is premature to try to answer that question, I do not know.

SPEAKER: Well, not if the test had been designed, you could know that now.

MR. BLANCHARD: Not all the tests have been designed. The study plans right now, as they are taking shape, we are only submitting five with the SCP in December. Their excavation affects study plans for the exploratory shaft construction face. The remaining 101 will be coming to the NRC later. The study plans are 100 to 200 pages long and so we are going to accumulate more planning documents and study plans that we have already accumulated in the SCP.

Those studies and those activities are still being designed. What is fixed right now is the purpose of those studies and the purpose of the supporting activities to accomplish those studies and then the studies fit their way in through performance and design requirements into the regulations. A couple of view graphs later from now I would like to show you how that link has gone in which will give you some insight as to whether it looks like some of the studies are impossible or whether they are very critically linked to waste isolation.

Now, inherent in this process--maybe we can pick up on this a little bit later--is an 11 step sequence described in Chapter 8. Again, I have been talking about issue identification. I have talked a little bit about performance allocation. I have talked a little bit about issue resolution strategy and what I would like to do is to take each of these steps in just a little bit more detail. So if we could go into that.

We will go through this in four steps, identification, performance allocation, with a top-level strategy in mind, data collection and issue resolution. We have talked about the regulations and the issues hierarchy, now I want to focus a little bit on the system description.

Here we had to have a conceptual model in mind, we had to have a conceptual design in mind, and we had to identify the system elements. Carl talked about the unsaturated zone, the engineered barrier system in the saturated zone. So the elements we have in mind from the available information are the unsaturated zone, the saturated, and engineered barrier elements.

When we moved into performance allocation we had to set a licensing strategy consistent with our understanding of the system as well as the regulations. Then we had to identify measures that would allow us to determine how close we were going to meet that regulatory requirement. That meant we had to move over to this block and identify actual parameters. Now, sometimes a parameter that you gain from the field investigation,is a value that goes right into a calculation in performance assessment. That is very seldom. Most of the time it is a calculated value you have to get in order to put it into the model and you have a myriad of detailed information before you can make that calculated parameter. So, there are one, two or sometimes three steps removed before you can work yourself into a total system calculation.

Setting the licensing strategy. Keeping this is mind, we selected the major elements, with the high likelihood, to meet or exceed 10 CFR 60 requirements. This meant that we had to become proactive and say well, given the available data we have and our limited understanding before we start site characterization, we are just going to make some calculations and assumptions about how we think these will work, backed up with the best of knowledge by our understanding of the site now.

That allows us to set some preliminary testing goals. Here were identifying performance measures. Now, what is this performance measure? It is the basis that we use to assess the performance of an element to meet the requirements in 10 CFR 60. We need a goal. That goal that we set is the value or a limit toward which the testing effort is directed. It does not necessarily represent a regulatory limit, it is not a one to one correlation. We believe they are set conservatively with respect to the regulatory limits. We think they serve as a guide for testing to tell you-- to begin to tell you how much is enough. How much do you really want?

And then, we would like an indication of confidence which was a judgment of how well the current value, that we have now, is likely to match the measured value at the end of site characterization.

SPEAKER: I am Charles Kelber. What is the dimension of the goals? In other words, we were told earlier by both the NRC staff and by the project that this is a risk-based procedure. In risk-based procedures the goals are in terms of risks, expressed oftentimes in terms of fatalities or exposures to a population. There are terms, that I have not seen here at all, such as -- and-- all that, all the paraphernalia of risk analysis. What dimensions of these things that are set in quotes?

MR. BLANCHARD: The question was, "What does 'goals' really mean". From a probabalistic risk standpoint, it is embodied in the work in the issues two and three. There are for safety and for preclosure, the releases to the workers, releases to the offsite, the very traditional things that you are familiar with. They are embodied in this approach.

For a long term performance assessment, I think it is going to take a different picture, because in order to gain confidence you are going to have to understand the site and you are going to have to decide whether or not you believe the site values and the site processes that seem to be acting. And so I do not think it is going to be as simple and straightforward, not that probabalistic assessments are simple and straightforward, but I think it offers a challenge to the mathematician and the mathematical physicist who will doing performance assessment calculations, that they have not encountered.

Maybe we can talk more about that later. I have some staff here, at the close of my talk, that are statisticians and who are earth scientists and mathematicians who will be pleased to discuss that with you in more detail.

MR. BECHHOEFER: Have you established any levels of, what you call indications of confidence--how close do you have to get--?

MR. BLANCHARD: Well, bear in mind, at this stage in the game, this approach uses professional judgment and the available information, and some sensitivity analysis that is embodied in this performance allocation process. The indications of confidence are mostly--if we are going to rely on it for waste isolation, if we think we are going to rely on it, then we need high confidence. If the chances are not very high that it is going to be closely related to waste isolation, or if we do not think we are going to rely on it because something else is going to do the job very, very well, then we have lower levels of confidence. I can show you some examples a little bit later on so you can get a better feeling for this, okay?

Now, we are into the third stage which is data collection and analysis. We are going through these steps right here. 8-3 describes the 106 study plans that were discussed in over 300 activities. Subsequent to the summation of the SCP we will have the study plans which will contain procedures for actually doing the work and conducting the tests.

As the tests are being conducted, data reports will come out, then there will be analysis reports and eventually there will be position papers from which we try to establish how close we are coming to a particular position within a regulation. I will talk more about that later on at the close of my last view graph.

At some point, we get to the point we all have an intent and a desire to begin trying to close or resolve issues. This will be an interview process, because as we try to do that, obviously, the first time we do it people we will be reviewing will not be as pleased with it as they would like to be, and we will go back through the process starting with analysis. Hopefully we will not have to do too much more data collection.

Then we have another logic chart, which is really like we started out in the beginning only it is at the close. Are the data needs satisfied? Should be proceed with a licensing action? This is the point where the department has a moment of truth. Is the site suitable? Should it proceed with building a license application?

We hope to have a lot of interaction with the NRC part of that time. In an attempt through things like position papers and draft issue resolution reports we can find out how close together or how far apart we might be.

Now, the next portion of this briefing, I hope to talk you through an example of performance allocation applied to the EPA release line, meeting 10,000--new release requirements. I have two other examples, which I probably will defer due to time, but I will be glad to discuss them with you privately.

The elements that we talked about that we, at the beginning of site characterization, perceived that we are likely to rely upon are these three. Unsaturated, saturated, and the EPS. Now the next is a listing of those features that, based on our analysis, indicate to us that we will relying on, and we have to understand these quite well.

Just how much is a small amount of ground water? Long, average transport time in the ground water, confinement of the water to the rock matrix, geochemical retardation. If it turns out that that primary barrier does not give us the answer, then we will call into play information we get from characterizing the back up barrier, mainly the saturated rock units where we look at what additional flow time we can get in the saturated zone. What additional geochemical retardation we can get, and what additional gain we can get from the release of raioradionuclides from the waste package.

If we added all of those things up from the information we gained from site characterization, and we ask ourselves, given this system element that we want to analyze, the unsaturated zone rock units, then our function is to limit the radionuclide transport the medium along which--carrying these radionuclides is water--the performance assessment calculation, if you ratio that over the EPA standard, if it was one then we just beat the EPA standard. Well, based on our understanding of the numbers right now at the beginning of site characterization, that were on the preceding slide--let us go back to that just for a moment, Marylou--admittedly this comes from peer judgment, it comes from some sensitivity analysis and bounding calculations, the numbers that we would expect to be using here would lead us to believe--next view graph-- that the tentative goal, if you ratio that which is calculated to the EPA standard that we would be about one 100th of the allowable release rate.

Hence, we think it is very important to spend a lot of time and money understanding the unsaturated zone and understanding the values we are going to get from the test information. If that is true, then we will be successful in meeting the EPA release limit, simply relying on the unsaturated zone rock without calling into play the EVS or the saturated rock unit. That is the kind of process that we have used at the beginning to lay out the site characterization program activities and to decide how many tests and what science discipline to support.

Now, as information comes in this may prove to be an error. As we get new assumptions, better understanding of the processes and more actual values we will be reassessing this continually as, more or less, continually as we go through characterization.

To look at numbers like that tentative goal there for water, a goal here for gas releases, and see how close we are coming from a total systems standpoint. Now we have done this for all the issues and the issues hierarchy for Chapter 8. This is just a cursory examination of what we did for issue 1.1.

A key input to that preliminary calculation for the unsaturated zone is, obviously, what is the average flux? Other important inputs are matrix perocity, geochemical retardation, thickness between the repository and the water table, and the values we have here for tentative goals are largely from the information available at the time we start site characterization. Plus, judgment of our peers, plus some sensitivity analysis.

We talked about an average flux of on the order of .5 millimeters. We have also talked about porosity. We need to understand this is a --. And retardation, you can see in that value where I said one 100th of the amount allowable in 40 CFR 191, in that calculation we made, we are assuming the chemical retardation is one. In other words, there is not any geochemical retardation.

We are not assuming that tuffacious rocks or the zeolites or the clays absorb it. We may want to go back and change that assumption later on. As we understand the distribution of the zeolites and as we understand that the average flux is not really .5 but it is higher than that. But we use these values and we felt we had to have high confidence because this is our primary barrier. Our performance allocation suggested that the beginning of site characterization that we had a good chance just by this barrier alone of meeting the EPA release lines.

That is the way we started the performance allocation process and we are going to let the data come in from site characterization to decide whether or not these are reasonable and when to change them. And what it looks like with respect to really meeting the EPA release lines. We have done a similar thing for the other backups.

Now, what I would like to do is just spend a minute to show you the linkage in the geohydrology program that is gone towards the regulations as well as towards getting the actual value from the test.

If we look at the geohydrology program that is described in 8312 of the SCP, it is feeding information to design, performance issue and other site characterization programs. We have looked at the things that is feeding information to, and I have talked you through this issue 1.1 total systems performance. We tried to look at this and say, what is the worse case information and where do we have to have the highest confidence? Extracting from the myriad list here, we have come up with what we thought was the most important flux value that we need to have.

We work this program this way, which is people that are calling for--requirements or regulations--calling for geohydrology information, and in this case, flux. We also work it in the opposite direction, and in the next view graph it shows the opposite direction.

Here is the geohydrology program divided into surface, unsaturated zone and saturated zone. If you follow the unsaturated zone it divides into numerical models and conceptual models. If we follow the numerical model into the next step we have to have a geologic framework then we need to understand properties, boundary conditions and multiple working hypothesis.

In understanding those boundary conditions we are acquiring meteorological conditions, or characteristics, flux, thermal potential fluid, chemistry, moisture. Then when you go beyond that, there is another set of measurements that are going to give--.

In the next view graph we have taken that fluid flux parameter, keeping in mind the sections in the SCP that it is being used, and feeding what issues. We have looked and there are three different types of flux activities under different study plans that are being conducted and this is the activity number in the SPC and it is described in greater detail, there.

We are going to measure the flux for liquid and gaseous phase in the Ghost Dance Fault, and we are going to do it from the ESF and the fracture and matrix networks and we are going to do it from the Topopah Springs and new welded unit.

The study plan that Mike Volgele talked about where we are going to be measuring in situ fracture and matrix flux--through fracture and matrix, is one of two activities in the study plan that describes characterization of the Yucca Mountain percolation and the unsaturated zone from the exploratory shaft facility. We have two major experiments, intact fracture test and infiltration test.

Now, that gives you a feeling for the struggles we went through, trying to link a regulation into an actual parameter that we should be gaining from a field test program and trying to decide which ones were important. We have also done that from a tectonics program standpoint. I would like not to take the time to go through that, although, I am perfectly willing to stay here and talk with you if you would like to.

I would like to go to the very last view graph, if we can and talk about a concept of where is this all going to go in our minds? How do we get the kind of interaction that we need--not that one, the colored one--how are we going to get the kind of interaction that we think we need to understand how best to build that license application?

Well, I have this divided into four different colors and they represent four different things. It is, you might say it is a program schedule, but it--disregard the schedule because it is the interactions and the logic that counts.

The site investigations surface and underground are shown here pictorially. What is lined out is things that are important to either performance assessment or repository and waste package design; like the geology model or the tectonics model, or the unsaturated zone model.

Site investigative reports, both data reports and analytical interpretation reports will be coming out of this program of site characterization. They will be providing information for designing early and late conceptual designs and a license application design. They will be providing information for performance assessment. Making assessments of how waste package and the total system will actually perform to isolate waste.

The site data reports would combine, with the design information, rolled into performance assessment. We envision--will allow us enough information to begin preparing topical reports which contain an argument for a particular subsection within 10 CFR 60. Not the whole section, not an issue resolution closure, but a subsection that would say, these are the reasons why we think we can demonstrate and we can meet a particular subsection of the regulation.

We envision a draft report being prepared and released by discussing it with the NRC, by discussing it with the state, perhaps coming back the first time with egg on our face. But in an-- cycle eventually, around the table, we trust that reasonable win will reach a conclusion that-- a topical report has made all the arguments that need to be made. If we get to that stage, as we move along in the site characterization program, then several of these topical reports can be considered as modules.

It could be put on the shelf to help us build a license application, later on, so that the job of putting a license application does not consume too many people for too long a time. Likewise, so that the review time that Carl talked about early this morning of three years, the review time is something that can actually be achieved rather than have it stretch out to five years or longer.

So we see these kinds of things, issue resolutions reports and topical reports being modules which would help us make our case when we prepare the license application. And all that I have shown up here is that interactive process between the department and the NRC and the state.

What we have on the top line, which I have not talked about is the release of the SCP and the progress reports and the primary input on the SCP from the NRC called the site characterization analysis.

At this point I think I have concluded the intent of what I hoped to portray. If I have let you down, I apologize. It is a complicated system. It does not have the kind of detail you would perhaps like to see in it if you are familiar with probabilistic risk assessments.

We have a staff available today that can talk to that issue somewhat, who are familiar with performance assessment and will be pleased to do that later. I would be pleased to answer any questions you might have.

MR. SCHINK: Did you use an average chemical retardation factor in your trial calculations and did you plan to save an average chemical retardation factor or are you going to work out each one?

MR. BLANCHARD: No, not at all. The geochemistry program for transport modeling is looking for retardation for every single radionuclide in that waste inventory. They also want to assess matrix diffusion. They will have numbers for-- the only reason I put that up there was for first cut through how much are we going to rely on the unsaturated zone. It looked like if we had no zeolites in the mountain and the rock did not absorb anything, then we would not be too bad off.

MR. SCHINK: In your preliminary assessment, have you identified the isotope that presents the greatest challenge--

MR. BLANCHARD: Well, certainly, gaseous releases do. The unsaturated zone, being a fractured rock media above it, when gases get out of the waste package, one cannot necessarily count on those rocks to contain that gas. So, I certainly think, gas releases are a problem--potential problem--I also think that the protectinate element as it comes out it is not a -- that works as a --that can get into the water with a negative charge and migrate with it. I think that is going to be challenge too.

MR. SCHINK: --did you say?

MR. BLANCHARD: Protectinate, technisium. And there are others. I am not an expert in that area. I will be glad to submit to the experts in the room or a chemist.

SPEAKER: But--gases, I did not think they were a real problem. Are they? What are they zeons, cryptons,?

MR. BLANCHARD: I do not think those are. I think it is principally carbon 14. Can I call on one of my scientists down here? Do you care to amplify that?

MS. YOUNKER: I do not have much more to say than what Max has said but I know that the real concern is something like carbon 14, which is there in quite large quantities early on, can be a real problem for you if you have pinhole defects in your containers. If it escapes where is it going to go? Well, clearly in an open breathing system like we have, it will go right up to the surface. So I think from a regulatory viewpoint it is a concern. From a health and safety viewpoint, I am not an expert, but by understanding is, it is probably not much of a concern.

MR. JORDAN: How about the long life items?

MS. YOUNKER: Is Mike Gloria still here? Mike, do you want to address that one? You certainly know a lot more than I do about this topic. Mike is our licensing manager and he thinks a lot about that kind of thing at SAI.

MR. GLORIA: The iodine 129 is an isotope that EPA specifically calls out, in 40 CFR 191. It is, I do not claim to be a geochemist or anything like that, but it could be relatively mobile. So that is an isotopic concern. The EPA has done quite a bit of looking at that as has DOE in the past on some of their modeling studies. So it is primarily iodine 129. Does that answer the question?

MR. JORDAN: I am surprised that iodine 129 would get through rock. I would have thought that surely it would be attached to--

MS. YOUNKER: Yes, that is exactly the question we need to find out through site characterization and those -- studies that we both talked about --surface based to establish if that is the case.

MR. BLANCHARD: Do you have more questions?

MR. BLOCH: I guess in the beginning you will have a shaft that will be a vehicle for escape is that right?

MR. BLANCHARD: You need to give us your name so that--Peter Bloch. And the question is, we have an exploratory shaft which could be a pathway?

MR. BLOCH: Well, not the exploratory shaft, but you will have some shaft in the facility when you are putting fill in---the first 10 years?

MR. BLANCHARD: Certainly, for pinhole defects, while we are filling the repository we have air coming through our handling shafts. Of course, we will have filters on them.

SPEAKER: And we will have equipment in there that will be detecting releases, should they occur.

MR. DIXON: From the University of Nevada. I am interested in why one of the characteristics that we think you could take credit for in this appearing, that is the presence of free oxygen in the unsaturated zone, has not been mentioned in these two days of presentation. Is that not a factor, or important to worry about?

MR. BLANCHARD: His question was, "Is free oxygen a concern in waste isolation?" Well, I think from the people that are responsible for meeting the requirements from 6113 of our waste package life, they feel it is a real concern. They are concerned with oxidizing the waste package and then pinhole leaks developing, as a result of oxidation. One of the specific design features we have in the engineered barrier system is this seven centimeter air gap between the waste package, once it is in place, and the rock wall.

The hope is of the expectation is that there will always be an air gap around the waste package and that will prevent water from coming into contact with the rock, and if that water had hychloride in it and if we used stainless steel waste package, then the chlorine would corrode the waste canister.

So, the goal of packing that air gap is, in one aspect is, to try to limit the amount of water that can reach the waste package. But, also, there are other goals such as limit the amount--allow a certain amount of distortion in the rock with time so that you use take advantage of that seven centimeter air gap. It will take awhile before the rock ever reached the waste package. I think it is a concern, you are quite right. Another question?

MR. FOSTER: This is a 'what if' question. What if a decision was made to go back and reprocess spent fuel, after all, and you ended up with say, a vitrified waste instead of spent fuel rods, would you do anything different that you are doing now?

MR. BLANCHARD: I am sure we would but I am not in the position to answer what it would be. I am sorry the question was, "If it came to pass that spent fuel was not going to be disposed there, in the repository, but instead it would be devitified glass, would the design of the repository, the approach, and program be different?"

And I inherently believe it would be, especially in that part of the regulation that addresses the waste package. and the waste package releases.

MS. YOUNKER: I can add one thing on that, Jean Younker. I do not know a lot about this but once again, I pick up a lot from working with the people who do this sort of thing. My understanding is since we are including some glass waste formed from the Savannah River Facility, the kind of design we are using is supposed to, right now, accommodate that waste as well as the spent fuel rods.

However, my guess is because that is a lot cooler, that waste that is coming in depending on how cool the vitrified waste was, you probably would be able to say, for example, redesign the repository, maybe put the canisters closer together. I would think that you would probably want to go back and look at what kind of an overall design makes sense. Because you certainly have a potential for having much cooler, biometrically, the material being a lot cooler when you put it into the canister. But, we are definitely not the experts on this, you can see that.

MR. SHUTTLE: I have a couple questions concerning fractures. On one of your bounding calculation examples you gave, where you put this lake on top of Yucca Mountain. Did that example include fractures in the rock?

MR. BLANCHARD: The question was, "On the bounding calculations I described earlier, where there was lake on top of Yucca Mountain, did it include fracture flow?"

Well, to the extent that hydraulic conductivity went from what it is to a factor of 10,000, I think it included fracture flow, because in order to drain that lake in 2.2 days, it had to have gone into fracture flow.

But that was through the Betiva Canyon. And once it got into the bedded tuff, which is right underneath the Betiva Canyon, the, as you know the bedded tuff from observations in G tunnel, do not show the continuous fractures, because it is basically sedimentary rock. So it responded like a sediment, and the water went into that unit and the unit was large enough not to fill up the core spaces. That is why we got the result we got, if I understand the calculations correctly.

You said you had a second question.

MR. SHUTTLE: My other question involved a comment by Mike Volgele when he mentioned fractured--barrier and I would say that the unsaturated zone, the rock is essentially saturated--therefore any water that may flow in washes due to storm events, disclosing fractures--would flow along fairly rapidly to the ground water table and therefore through the repository.

MR. BLANCHARD: Your observation is correct as far as I know. If during our peer position program from the ESF it became clear,--. I am sorry, I neglected to repeat the question. The question was "is a fracture really a barrier and if there is a lot of precipitation along washes where there might be a lot of fractures would that not transmit, fairly rapidly, surface water to depth?"

I think the answer is, if that was the case, and the hydraulic conductivity along that fracture was large then you would obviously get rapid transmission of surface water to depth.

The question is how continuous are the fractures and how large are they at depth? When Mike was discussing the fracture being the barrier, what he was saying is a fracture of 100 microns, if it can exist at the depth, given the pressure that is there, does not allow capillary attraction to develop so the rock that is in the core spaces is in the core spaces and it is going to remain there, when it encounters that fracture. So, at the point, the fracture is a barrier.

But, in effect, if you were in Drill Hole Wash, and that was very --forest area, and our drifting over to Drill Hole Wash showed that was the case, then that would be an area where we would expect surface water to move down through the underlying rock rapidly. We would not use that as a waste and placement area.

MR. SHUTTLE: If the matrix was essentially ciphering, and the flow through the matrix is so slow and essentially can drain, then during one of these storm events, then water will eventually flow through the fractures and not be fused into the matrix.

MR. BLANCHARD: I think you are right, it cannot be diffused into the matrix, if the matrix is already saturated.

MR. SHON: How about one more question?

MR. SWAN: This is not on regulations, but just for my information. What levels of radiation do you expect during the period of time when the repository is open so that you can put things in and out?

MR, BLANCHARD: You mean during-- Eric Swan asked the question,"What levels of radiation would be --would the workers be exposed to during the time they are operating?"

I do not know that number but I believe it meets 10 CFR 20. Mike, do you know what those levels are?

MR. GLORIA: It has been compared to 10 CFR 20, but I do not recall the numbers --

SPEAKER: I was just wondering if that is what you were striving for?

MR. BLANCHARD: Yes, the goal was to fully meet 10 CFR 20.

MR. SHON: I have one more note here from that. The --that he has here today, Bill Hughes, a geologist who will be our guide tomorrow, and who will be glad to answer any questions about the tour tomorrow. Does anyone want to ask a few questions about the tour or is there something that springs to mind?

SPEAKER: I have copies of the itinerary here. I could leave them on the table back here if anyone wants one of them.

MR. SHON: I appreciate that, yes.

SPEAKER: Will they be on the bus also?

MR. SHON: One more thing to mention, another warning. It gets very cold out there, I am told. People should bring warm coats, comfortable walking shoes, and wear Levis or jeans, if you have them. At any rate, informal clothes, but warm ones.

I think with that we can adjourn.

(Whereupon, at 4:30 p.m., the hearing was concluded.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter

of: TWENTIETH ANNUAL MEETING OF THE ATOMIC SAFETY AND LICENSING BOARD PANEL

Name:

Docket Number:

Place: Las Vegas, Nevada

Date: December 13, 1988

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken stenographically by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

/s/ Carole Fagiano

(Signature typed): CAROLE FAGIANO

Official Reporter

Heritage Reporting Corporation

U.S. DEPARTMENT OF ENERGY

OCRWM

YUCCA MOUNTAIN

OVERVIEW OF THE HIGH LEVEL WASTE PROGRAM

PRESENTED BY

KEITH KLEIN
DEPUTY ASSOCIATE DIRECTOR
OFFICE OF SYSTEMS INTEGRATION AND REGULATIONS
U.S. DEPARTMENT OF ENERGY

DECEMBER 13, 1988

UNITED STATES DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE/YUCCA MOUNTAIN PROJECT OFFICE

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

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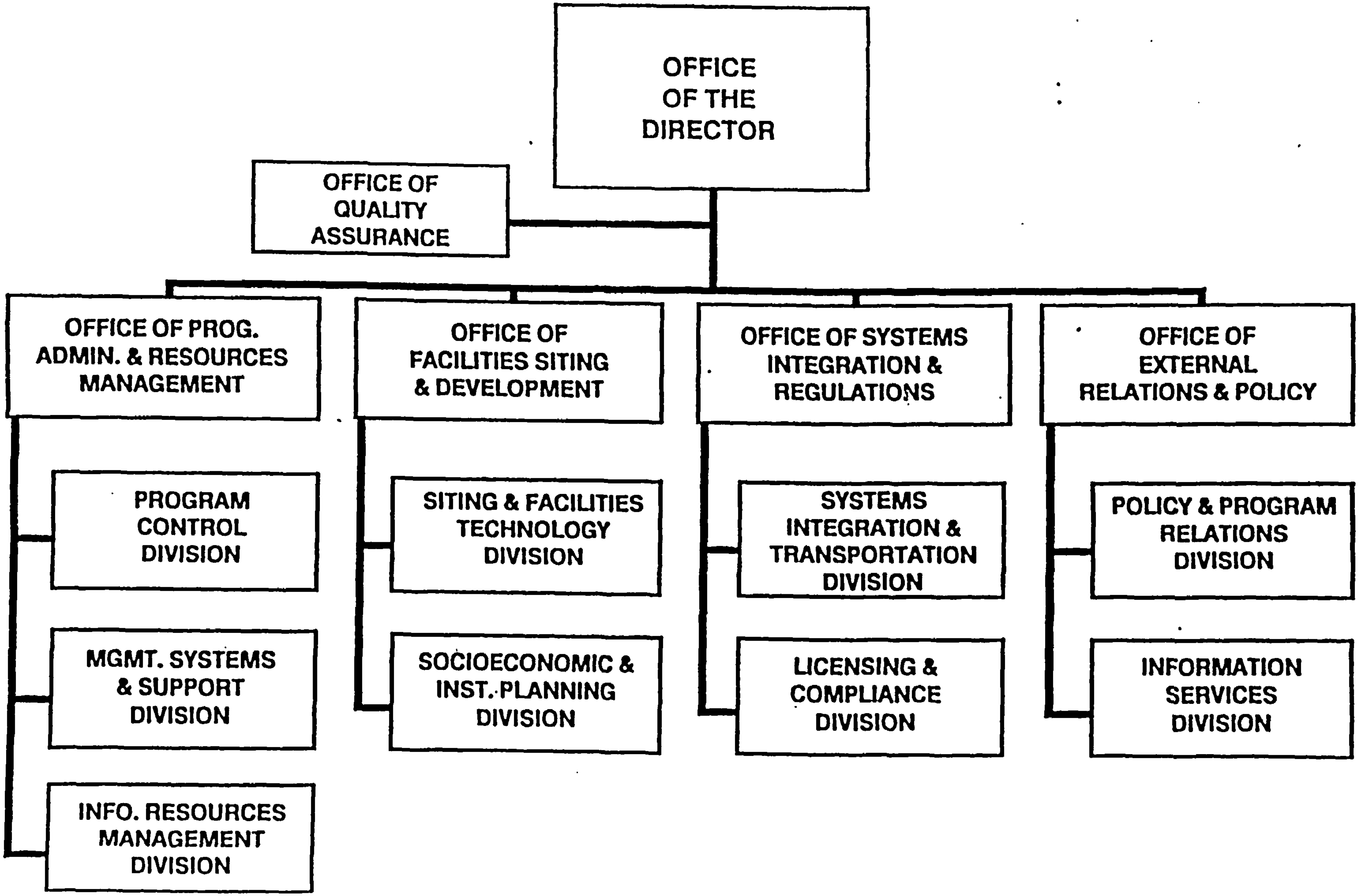
OVERVIEW OF THE HIGH LEVEL WASTE PROGRAM

- OCRWM ORGANIZATION
- LEGISLATIVE AUTHORIZATION
  - NWPA, 1982
  - NWPAA, 1987
- REGULATORY COMPLIANCE
  - EPA
  - NRC
- PROGRAM SCHEDULE AND STATUS OF SELECTED ACTIVITIES
  - SCP
  - NUCLEAR WASTE TECHNICAL REVIEW BOARD
  - LSS
  - M&O CONTRACTOR
- THE YUCCA MOUNTAIN PROJECT

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT



THE NUCLEAR WASTE POLICY ACT (NWPA) WAS ENACTED BY CONGRESS IN 1982 TO SOLVE THE HIGH-LEVEL WASTE PROBLEM

THE NWPA:

- ESTABLISHED A SCHEDULE FOR SITING, CONSTRUCTING AND OPERATING REPOSITORIES WITH ASSURANCES THAT THE PUBLIC AND ENVIRONMENT WILL BE PROTECTED
- ASSIGNED THE RESPONSIBILITY FOR HIGH-LEVEL WASTE MANAGEMENT TO THE DEPARTMENT OF ENERGY
- PROVIDED A MAJOR ROLE FOR STATES, INDIAN TRIBES AND THE PUBLIC IN THE WASTE PROGRAM
- ESTABLISHED A FUND SO THAT THE GENERATORS OF NUCLEAR WASTE PAY FOR ITS DISPOSAL

NUCLEAR WASTE POLICY AMENDMENTS ACT, 1987

REVISION IN FOLLOWING AREAS

- 1ST REPOSITORY
- 2ND REPOSITORY
- MRS
- BENEFITS AGREEMENT
- NUCLEAR WASTE NEGOTIATOR

1ST REPOSITORY

- ONLY ONE SITE (YUCCA MOUNTAIN) TO BE CHARACTERIZED
- TERMINATED ACTIVITIES AT DEAF SMITH COUNTY, TEXAS AND HANFORD, WASHINGTON BY MARCH 21, 1988

1ST REPOSITORY
(CONTINUED)

- DOE MAY BEGIN CONSTRUCTING EXPLORATORY SHAFTS AT YUCCA MOUNTAIN AFTER
  1. SUBMITTING AN SCP TO THE NRC, THE GOVERNOR AND THE LEGISLATURE OF THE STATE OF NEVADA AND THE PUBLIC FOR COMMENT
  2. ALLOWING AT LEAST 90 DAYS FOR COMMENT ON THE SCP
  3. HOLDING PUBLIC HEARINGS ON THE SCP IN THE VICINITY OF YUCCA MOUNTAIN SITE

- IF THE SITE IS FOUND SUITABLE ON THE BASIS OF INFORMATION GATHERED DURING THE SITE CHARACTERIZATION PROGRAM THE DOE MAY SUBMIT A RECOMMENDATION ACCOMPANIED BY AN ENVIRONMENTAL IMPACT STATEMENT TO THE PRESIDENT FOR APPROVAL (SITE DESIGNATION)

1ST REPOSITORY
(CONTINUED)

- STATE OF NEVADA MAY SUBMIT A NOTICE OF DISAPPROVAL TO CONGRESS WITHIN 60 DAYS OF PRESIDENTIAL SITE DESIGNATION

- DISAPPROVAL PREVENTS USE OF SITE UNLESS CONGRESS PASSES A JOINT RESOLUTION OF SITING APPROVAL WITHIN 90 DAYS OF CONTINUOUS SESSION. IF THE STATE DOES NOT ISSUE A DISAPPROVAL, OR IF NOTICE OF DISAPPROVAL IS OVERTURNED BY JOINT RESOLUTION, THEN THE SITE DESIGNATION BECOMES EFFECTIVE

1ST REPOSITORY
(CONTINUED)

- WHEN SITE DESIGNATION BECOMES EFFECTIVE, THE DOE WILL APPLY TO THE NRC FOR A LICENSE TO CONSTRUCT THE REPOSITORY. THIS APPLICATION MUST BE SUBMITTED WITHIN 90 DAYS AFTER SITE DESIGNATION. NRC REVIEWS THE APPLICATION AND HOLDS LICENSING HEARINGS. NRC MAY THEN AUTHORIZE CONSTRUCTION. WHEN THE REPOSITORY IS COMPLETE, THE DOE WILL SUBMIT AN UPDATED LICENSE APPLICATION TO THE NRC. FOLLOWING REVIEW, NRC MAY THEN ISSUE A LICENSE TO RECEIVE AND POSSESS RADIOACTIVE WASTE AT THE SITE

1ST REPOSITORY
(CONTINUED)

- THE DOE SHALL OFFER TO ANY STATE, INDIAN TRIBE OR UNIT OF LOCAL GOVERNMENT TO DESIGNATE A REPRESENTATIVE TO CONDUCT ON-SITE OVERSIGHT ACTIVITIES AT SUCH SITE

2ND REPOSITORY

- REQUIREMENT REPEALED
- BETWEEN 2007-2010 REPORT TO PRESIDENT AND CONGRESS ON NEED
- TERMINATE RESEARCH ON GRANITE
- SITE SPECIFIC ACTIVITIES PROHIBITED

MRS

- ONE MRS AUTHORIZED
- TENNESSEE SITING PROPOSAL REVOKED

MRS

(CONTINUED)

SITE, CONSTRUCT AND OPERATE AS FOLLOWS:

- AFTER MRS REVIEW COMMISSION REPORTS (NOV. 1, 1989)
  - SITE SURVEY MAY BEGIN
  - THE DOE MAY CONDUCT SITE SPECIFIC ACTIVITIES

- THE DOE MAY SELECT MRS SITE NO EARLIER THAN A REPOSITORY SITE IS RECOMMENDED TO THE PRESIDENT
  - SIX MONTHS PRIOR TO SELECTION, THE DOE MUST NOTIFY THE STATE/TRIBE AND HOLD A PUBLIC HEARING
  - STATE MAY DISAPPROVE
  - DISAPPROVAL MAY BE OVERRIDDEN BY CONGRESS

MRS
(CONTINUED)

- NO MRS IN NEVADA
- ENVIRONMENTAL ASSESSMENT REQUIRED

MRS LICENSING CONDITIONS

- MRS CONSTRUCTION MAY NOT BEGIN UNTIL NRC AUTHORIZES REPOSITORY CONSTRUCTION
- MAXIMUM STORAGE PRIOR TO REPOSITORY OPERATION = 10,000 METRIC TONS
- NRC LICENSE REQUIRED
- MAXIMUM QUANTITY=15,000 METRIC TONS
- ACCEPTANCE PROHIBITED IF:
  - NRC LICENSE REVOKED OR
  - CONSTRUCTION STOPS

MRS REVIEW COMMISION

- 3 MEMBERS
- APPOINTED BY:
  - PRESIDENT OF SENATE AND
  - SPEAKER OF THE HOUSE
- REPORT TO CONGRESS BY JUNE 1, 1989 (EXTENDED TO NOV. 1, 1989)
- PURPOSE:
  - TO EVALUATE ADVANTAGES AND DISADVANTAGES OF BRINGING SUCH A FACILITY ON LINE

BENEFITS AGREEMENT

- THE DOE MAY ENTER INTO BENEFITS AGREEMENTS WITH THE GOVERNOR OF NEVADA AND WITH THE GOVERNING BODY OF THE INDIAN TRIBE OR WITH THE GOVERNOR OF STATE CONTAINING THE SITE SELECTED FOR MRS FACILITY

	ANNUAL PAYMENT	
	REPOSITORY	MRS FACILITY
UPON EXECUTING AGREEMENT AND UNTIL RECEIPT OF WASTE	$10 MILLION	$ 5 MILLION
UPON FIRST RECEIPT OF WASTE AND UNTIL FACILITY CLOSURE OR DECOMMISSIONING	$20 MILLION	$10 MILLION

BENEFITS AGREEMENT
(CONTINUED)

- STATES/TRIBES HAVE THREE OPTIONS (ALL INCLUDE PETT PAYMENT AND GRANTS FOR INDEPENDENT SCIENTIFIC STUDY)

1. ACCEPT BENEFITS PACKAGE AS PROVIDED IN "AMENDMENTS ACT" AND WAIVE IMPACT ASSISTANCE AND VETO
   - GOVERNOR OF NEVADA REJECTED THIS OPTION IN A MAY 20, 1988 LETTER TO SECRETARY OF ENERGY
2. ACCEPT IMPACT ASSISTANCE AND RETURN VETO RIGHTS, BUT GIVE UP BENEFITS PACKAGE
3. WORK WITH NEGOTIATOR TO ENHANCE BENEFITS PACKAGE

THE NEGOTIATOR

- TO BE APPOINTED BY THE PRESIDENT
- PURPOSE:
  - TO SEEK A STATE/TRIBE WILLING TO ACCEPT AN MRS OR REPOSITORY
  - NEGOTIATE TERMS AND CONDITIONS
- CONGRESS MUST ENACT ENABLING LEGISLATION
- OFFICE OF NUCLEAR WASTE NEGOTIATOR CEASES TO EXIST 5 YEARS AND 30 DAYS FROM THE DATE OF THE ENACTMENT OF THE NWPAA

REGULATORY COMPLIANCE

- EPA HAS PROMULGATED ENVIRONMENTAL STANDARDS IN 40 CFR PART 191 (THESE, IN 1987 WERE VACATED AND REMANDED TO THE EPA FOR FURTHER PROCEEDINGS BY THE U.S. COURT OF APPEALS FOR THE FIRST CIRCUIT)

REGULATORY COMPLIANCE
(CONTINUED)

KEY PROVISIONS OF THESE STANDARDS ARE:

1) LIMIT ON AMOUNT OF RADIOACTIVITY THAT MAY ENTER THE ENVIRONMENT FOR 10,000 YEARS AFTER DISPOSAL

2) LIMITS ON THE RADIATION DOSE THAT A PERSON CAN RECEIVE 1000 YEARS AFTER DISPOSAL

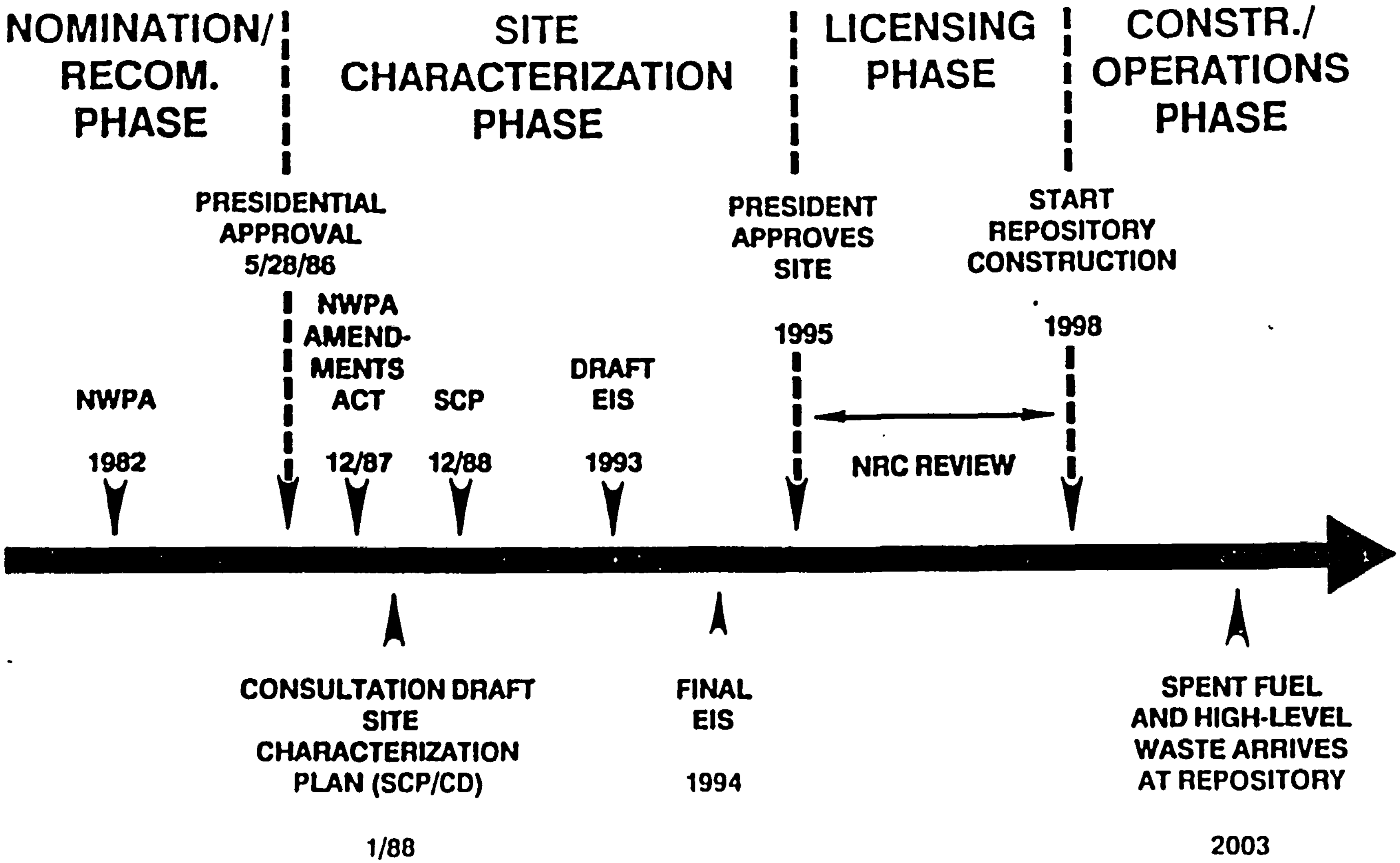
3) REQUIREMENTS FOR THE PROTECTION OF GROUNDWATER

BOTH MRS AND REPOSITORY WILL BE LICENSED BY NRC. MRS UNDER 10 CFR 72. REPOSITORY UNDER 10 CFR 60

10 CFR 60 PROVIDES:

- PERFORMANCE OBJECTIVES (CRITERIA)
  - A) MINIMUM LIFETIME FOR THE WASTE PACKAGE
  - B) A LIMIT ON THE RATE OF RADIONUCLIDE RELEASES FROM THE ENGINEERED BARRIERS OF THE REPOSITORY
  - C) FOR NATURAL SYSTEM AT THE SITE, MINIMUM OF GROUNDWATER TRAVEL FROM THE DISTURBED ZONE TO THE ACCESSIBLE ENVIRONMENT
  - D) FOR THE TOTAL SYSTEM (ENGINEERED AND NATURAL BARRIERS) A MINIMUM RELEASE RATE AND TRAVEL TIME FOR RADIONUCLIDES TO REACH THE ACCESSIBLE ENVIRONMENT

PROGRAM SCHEDULE



WASTE TYPES AND QUANTITIES

1) SPENT FUEL FROM COMMERCIAL NUCLEAR REACTORS - CUMULATIVE COMMERCIAL-SPENT FUEL DISCHARGE THROUGH THE YEAR 2020 IS ASSUMED TO BE 80,000 METRIC TONS OF HEAVY METAL (MTHM)

2) EXISTING COMMERCIAL SOLIDIFIED HIGH-LEVEL WASTE (FROM THE WEST VALLEY DEMONSTRATION PROJECT) - APPROX. 600 MTHM

3) SOLIDIFIED DEFENSE HIGH-LEVEL WASTE - 9000 MTHM BY 2020

OBJECTIVES OF SITE CHARACTERIZATION PROGRAM

- ESTABLISH GEOLOGIC, HYDROLOGIC, AND GEOCHEMICAL CONDITIONS AT A CANDIDATE SITE

- PROVIDE DATA NEEDED FOR DESIGN OF THE WASTE PACKAGE AND THE REPOSITORY

- PROVIDE DATA NEEDED FOR PERFORMANCE ASSESSMENT OF THE REPOSITORY SYSTEM

NUCLEAR WASTE TECHNICAL REVIEW BOARD

- 11 MEMBERS SELECTED FROM NATIONAL ACADEMY OF SCIENCE NOMINEES

- APPOINTED BY PRESIDENT

- PURPOSE:
  - TO EVALUATE TECHNICAL AND SCIENTIFIC VALIDITY OF SECRETARY'S ACTIVITIES

- BOARD WILL CEASE TO EXIST NOT LATER THAN ONE YEAR AFTER THE DISPOSAL OF HLW OR SF IN A REPOSITORY

LICENSING SUPPORT SYSTEM (LSS)

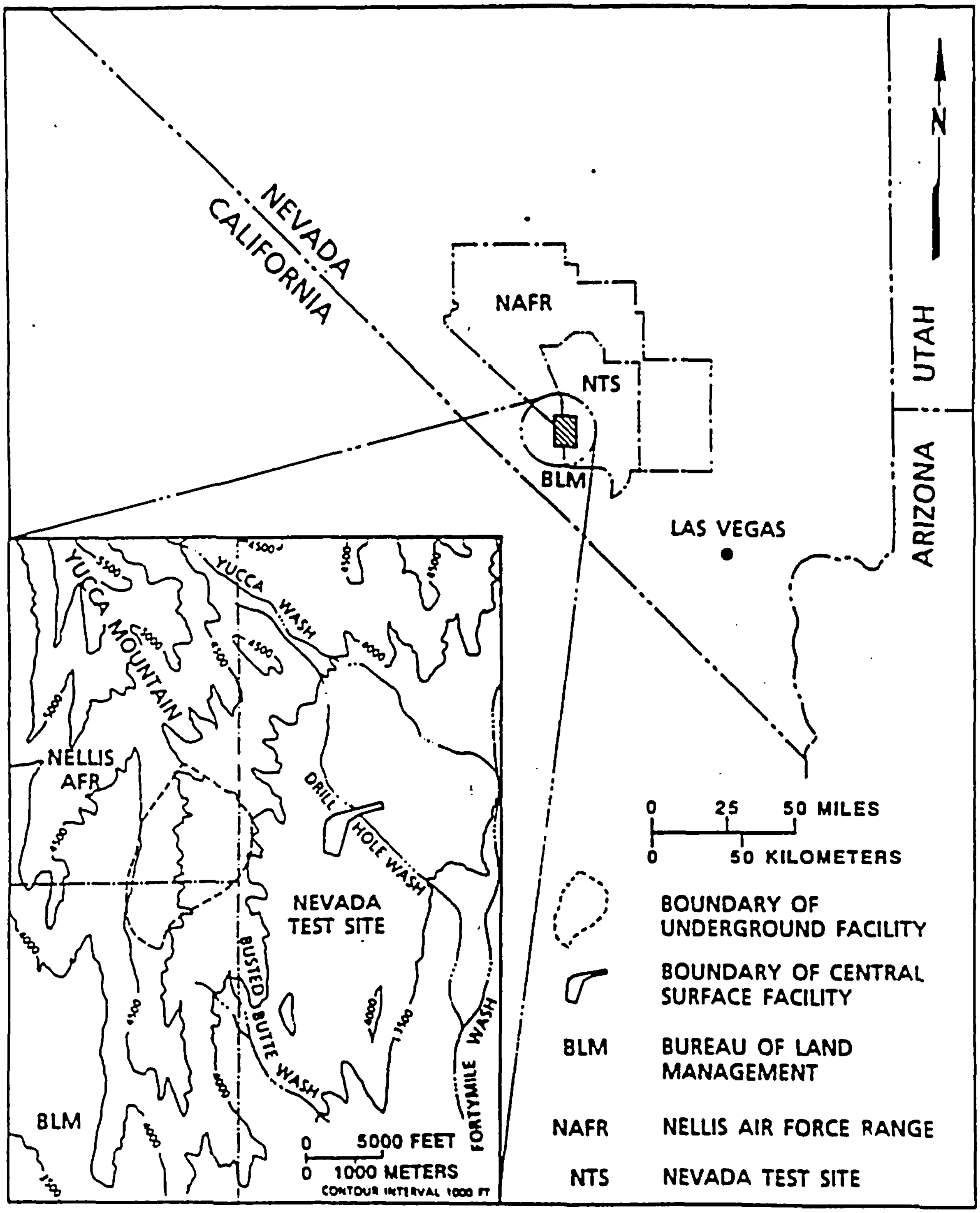
- NEGOTIATED RULEMAKING INITIATED: AUGUST 5, 1987

- PURPOSE: TO DEVELOP A CONSENSUS ON THE USE OF THE LSS IN THE HLW LICENSING PROCEEDING
  - EARLY AND COMPREHENSIVE ACCESS TO LICENSING INFORMATION BEFORE THE LICENSE APPLICATION IS SUBMITTED
  - FULL TEXT SEARCH CAPABILITY
  - ELECTRONIC MAIL

LICENSING SUPPORT SYSTEM (LSS)
(CONTINUED)

- LAST LSS ADVISORY COMMITTEE MEETING HELD JULY 20 AND 21, 1988, IN RENO, NEVADA
- DOE ISSUED FOUR REPORTS: PRELIMINARY NEEDS ANALYSIS, PRELIMINARY DATA SCOPE, CONCEPTUAL LSS DESIGN AND BENEFIT-COST ANALYSIS
- NRC ISSUED NOTICE OF PROPOSED RULEMAKING, NOVEMBER 3, 1988

M & O STATUS



YUCCA MOUNTAIN LOCATION IN NEVADA

U S DEPARTMENT OF ENERGY

OCRWM

YUCCA MOUNTAIN

OVERVIEW OF THE YUCCA MOUNTAIN PROJECT

PRESENTED BY

CARL GERTZ

MANAGER, YUCCA MOUNTAIN PROJECT

U.S. DEPARTMENT OF ENERGY

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

DECEMBER 13, 1988

UNITED STATES DEPARTMENT OF ENERGY

NEVADA OPERATIONS OFFICE/WASTE MANAGEMENT PROJECT OFFICE

U.S. DEPARTMENT OF ENERGY

OCRWM

YUCCA MOUNTAIN

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SCOPE OF THE HIGH-LEVEL WASTE PROGRAM

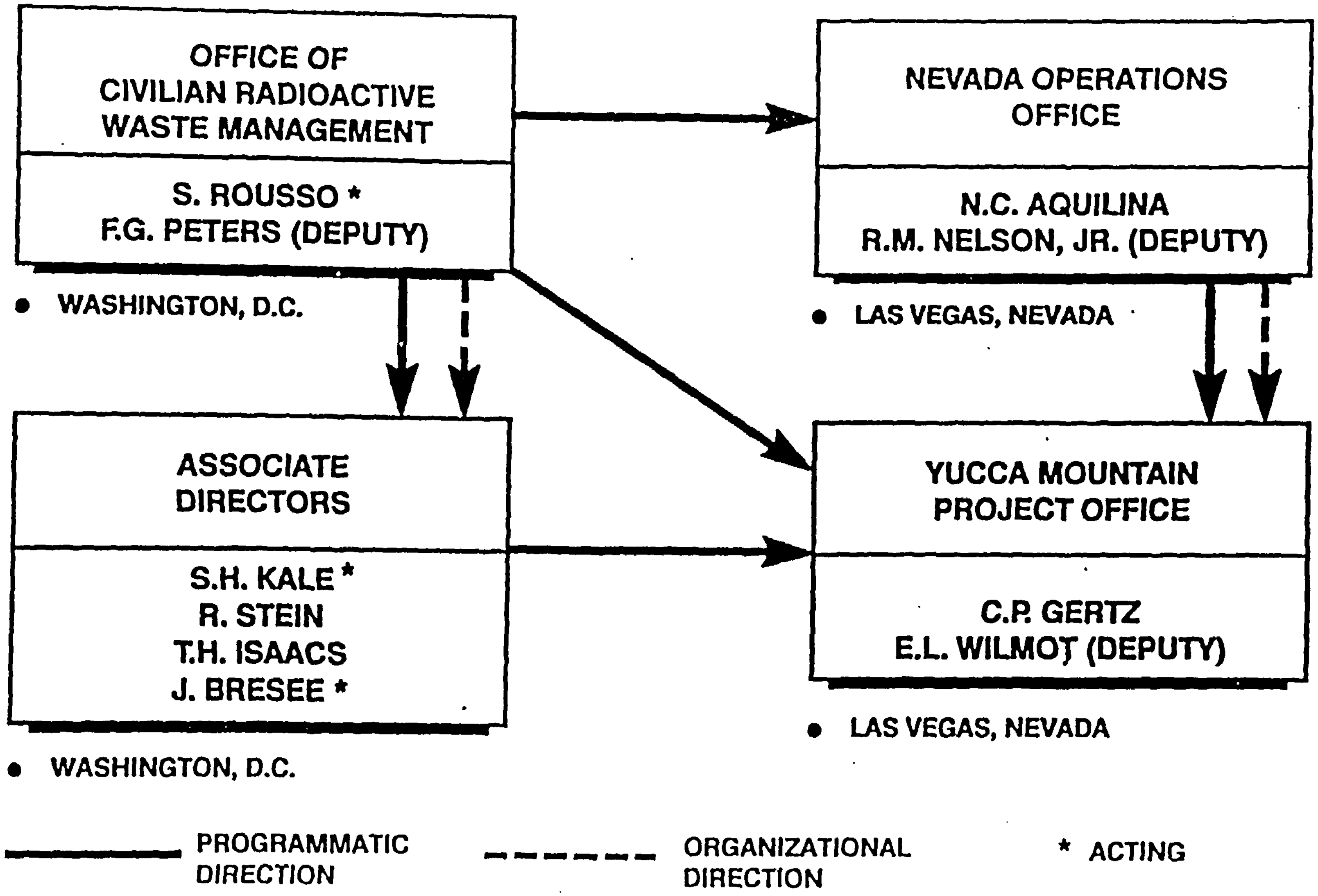
<u>THE DOE MISSION</u>

- "TO SITE, LICENSE, CONSTRUCT, AND OPERATE GEOLOGIC REPOSITORIES..."

<u>THE PROJECT MISSION</u>

- TO DETERMINE IF YUCCA MOUNTAIN IS A SUITABLE LOCATION FOR A GEOLOGIC REPOSITORY.

OCRWM/HQ - DOE NV ORGANIZATION



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UNITED STATES DEPARTMENT OF ENERGY-NEVADA OPERATIONS OFFICE

OFFICE OF THE MANAGER

MANAGER-NICK C. AQUILINA

DEPUTY MANAGER-ROBERT M. NELSON, JR.

OFFICE OF CHIEF COUNSEL

CHIEF COUNSEL RICHARD C. AMICK

ASSIST CHIEF COUNSEL
ROY C. BAUMANN

OFFICE OF EXTERNAL AFFAIRS

DIRECTOR-CHRIS L. WEST

YUCCA MOUNTAIN PROJECT OFFICE

PROJECT MANAGER-CARL P. GERTZ

DEPUTY-EDWIN WILMOT

REG. & SITE EVALUATION DIVISION
DIRECTOR-MAXWELL B. BLANCHARD

ENGIN. & DEVEL. DIVISION
DIRECTOR-LESTER P. SKOUSEN, JR.

PROJ. & OPER. CONTROL DIVISION
DIRECTOR-WENDY R. DIXON

OFFICE OF EMERGENCY RESPONSE AND PROGRAM ANALYSIS

PROGRAM MGR. -DORNER T. SCHUELER

DEPUTY-HARRY U. BROWN

OFFICE OF ASSISTANT MANAGER FOR ADMINISTRATION

ACTING ASSIST. MGR.- JOHN R. WAMSLEY

ACTING DEPUTY ASST. MGR.
LINDA M. SMITH

OFFICE OF ASSISTANT MANAGER FOR OPERATIONS & ENGINEERING

ASSISTANT MANAGER-JAMES K. MAGRUDER

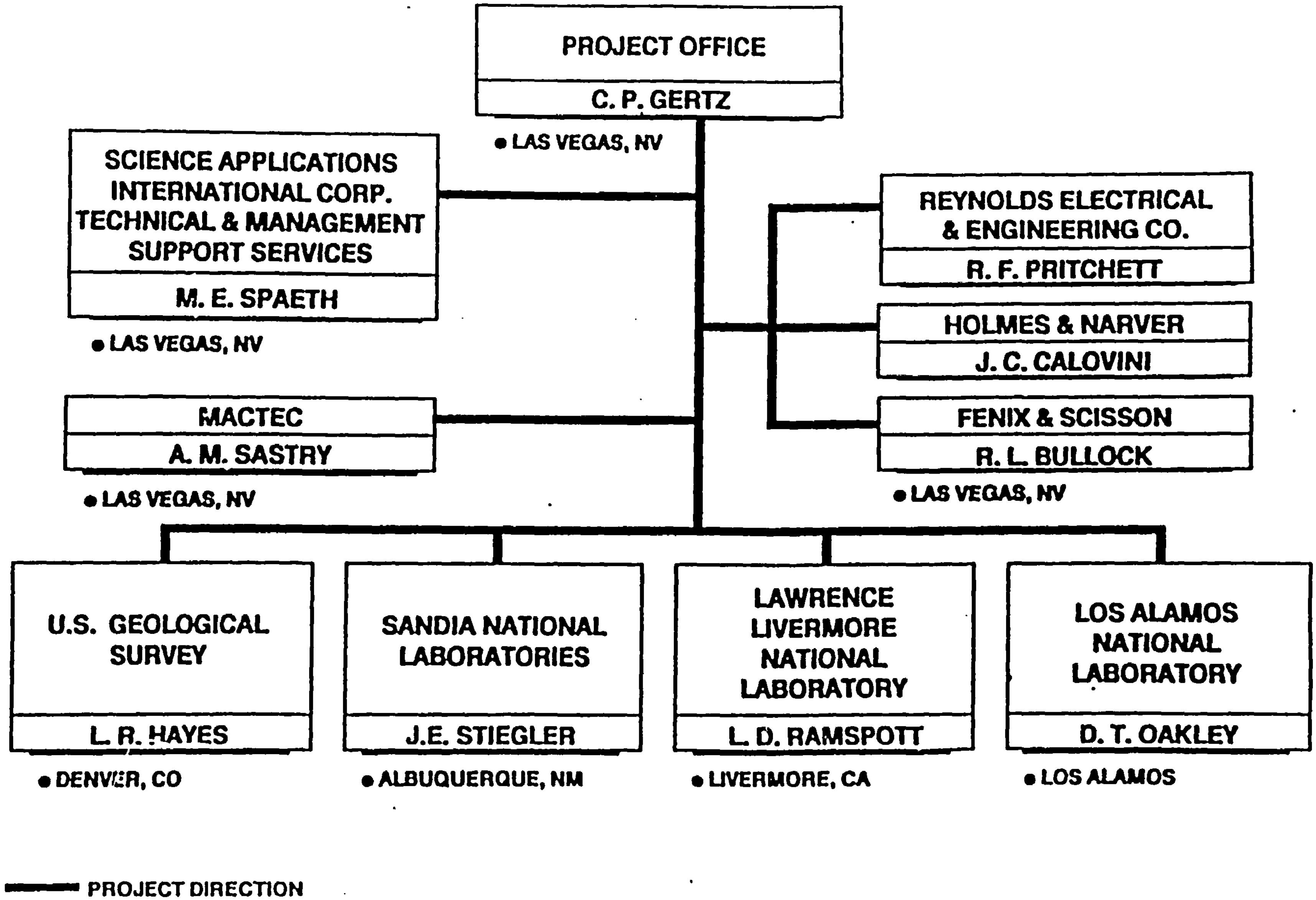
DEPUTY ASSISTANT MANAGER
CHARLES M. CAMPBELL

OFFICE OF ASSISTANT MANAGER FOR ENVIRONMENT, SAFETY, & HEALTH

ASSISTANT MANAGER-BRUCH W. CHURCH

DEPUTY ASSISTANT MANAGER
DONALD L. VIETH

YUCCA MOUNTAIN PROJECT



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YUCCA MOUNTAIN PROJECT CONTRACTOR RESPONSIBILITIES

U.S. GEOLOGICAL SURVEY:	GEOLOGIC, HYDROLOGIC, AND CLIMATE INVESTIGATIONS
SANDIA NATIONAL LABORATORIES:	REPOSITORY FACILITY AND EQUIPMENT DESIGN; PERFORMANCE ASSESSMENT
LOS ALAMOS NATIONAL LABORATORY:	GEOCHEMICAL INVESTIGATIONS; VOLCANISM; EXPLORATORY SHAFT (ES) TEST IMPLEMENTATION
LAWRENCE LIVERMORE NATIONAL LABORATORY:	WASTE PACKAGE DESIGN

YUCCA MOUNTAIN PROJECT
CONTRACTOR RESPONSIBILITIES
(CONTINUED)

FENIX & SCISSON:	DESIGN OF ES FACILITY (UNDERGROUND)
HOLMES & NARVER:	DESIGN OF ES FACILITY (ABOVE GROUND)
REYNOLDS ELECTRICAL & ENGINEERING COMPANY:	RESPONSIBLE FOR ES CONSTRUCTION AND PROVIDE SITE SUPPORT
MACTEC:	QUALITY ASSURANCE CONSULTANTS
SCIENCE APPLICATIONS INTERNATIONAL CORP.:	PROJECT MANAGEMENT AND INTEGRATION, REGULATORY AND INSTITUTIONAL, QUALITY ASSURANCE

YUCCA MOUNTAIN PROJECT ORGANIZATION

QUALITY ASSURANCE STAFF

GENERAL ENGR.	JIM BLAYLOCK [1]
GENERAL ENGR.	ROYCE MONKS
GENERAL ENGR.	WENDELL MANSEL
GENERAL ENGR.	DENNIS ANDERSON
GENERAL ENGR.	AL WILLIAMS
QA SPECIALIST	NANCY VOLTURA
QA SPECIALIST	CATHERINE HAMPTON

PROJECT OFFICE

PROJECT MGR.	CARL GERTZ
DEP. PROJ. MGR.	ED WILMOT
SA/INST. AFFAIRS	ACE ROBISON
ADMIN. OFFICER	CAROL REHKOP
SECRETARY	VICKY DAVIS
CLERK TYPIST	LANI BURKE

MATRIX SUPPORT STAFF

GENERAL ATTORNEY	DAVE GASSMAN
SAFETY SPECIALIST	DON MARTIN
PUBLIC AFFAIRS SPEC.	CHRIS WEST
NTSO GEN. ENGR.	ANDRES VELOSO
AUDITOR	CAROLYN KING
CONTRACT SPEC.	JOHN LEDBETTER

ENGINEERING AND DEVELOPMENT DIVISION

DIRECTOR LESTER SKOUSEN

- EXPLORATORY SHAFT BRANCH
- FIELD ENGINEERING BRANCH
- SYSTEMS BRANCH

PROJECT AND OPERATIONS CONTROL DIVISION

DIRECTOR WENDY DIXON

- OPERATIONS CONTROL BRANCH
- PROJECT CONTROL BRANCH

REGULATORY AND SITE EVALUATION DIVISION

DIRECTOR MAXWELL BLANCHARD

- REGULATORY INTERACTION BRANCH
- SITE INVESTIGATIONS BRANCH
- TECHNICAL ANALYSIS BRANCH

(1) REPORTS TO MANAGER, NV FOR QA/QC INTERACTIONS

▬▬ DIRECT REPORTING
▬ ▬ MATRIX REPORTING

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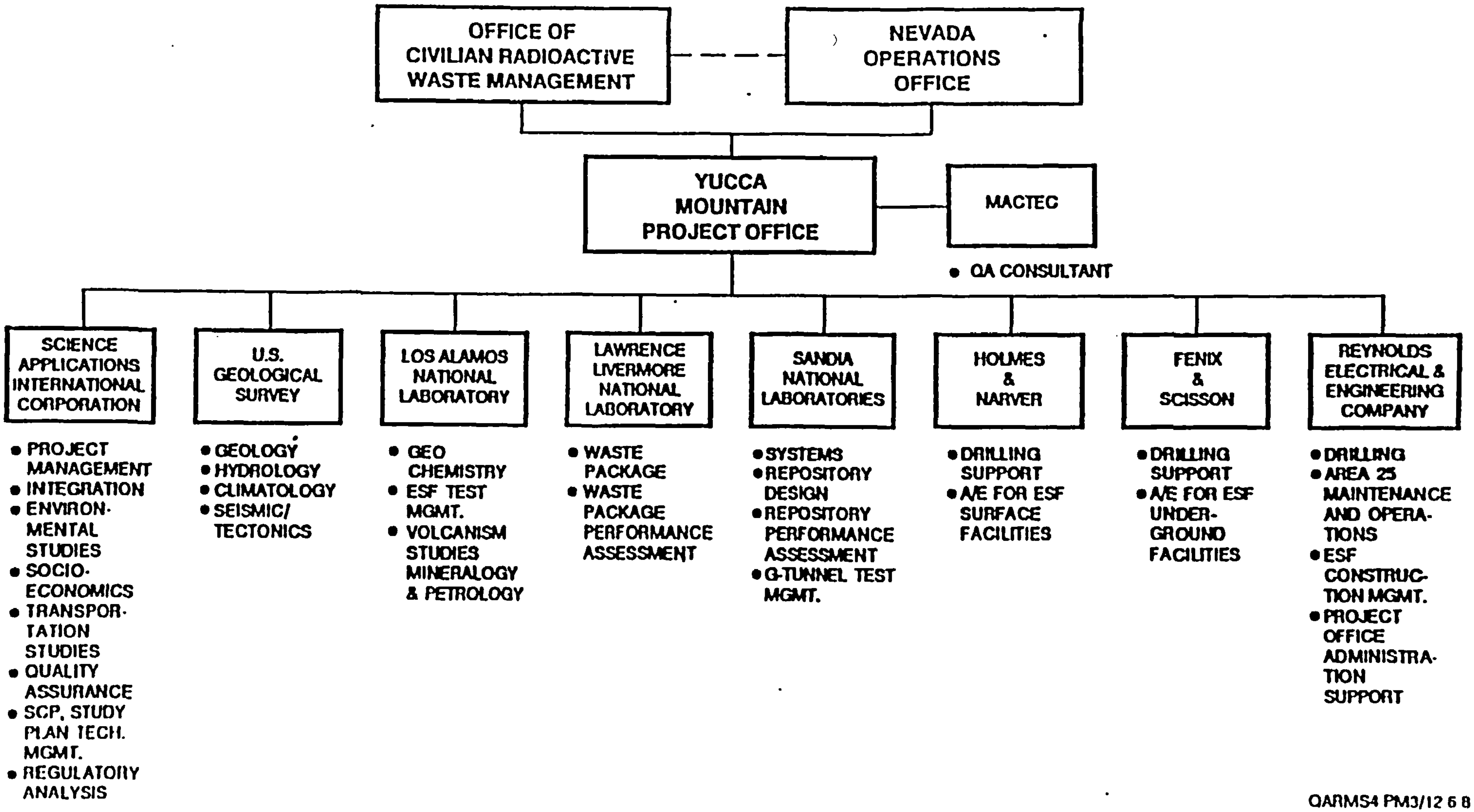
YUCCA MOUNTAIN PROJECT ORGANIZATION AND ROLES OF PROJECT PARTICIPANTS



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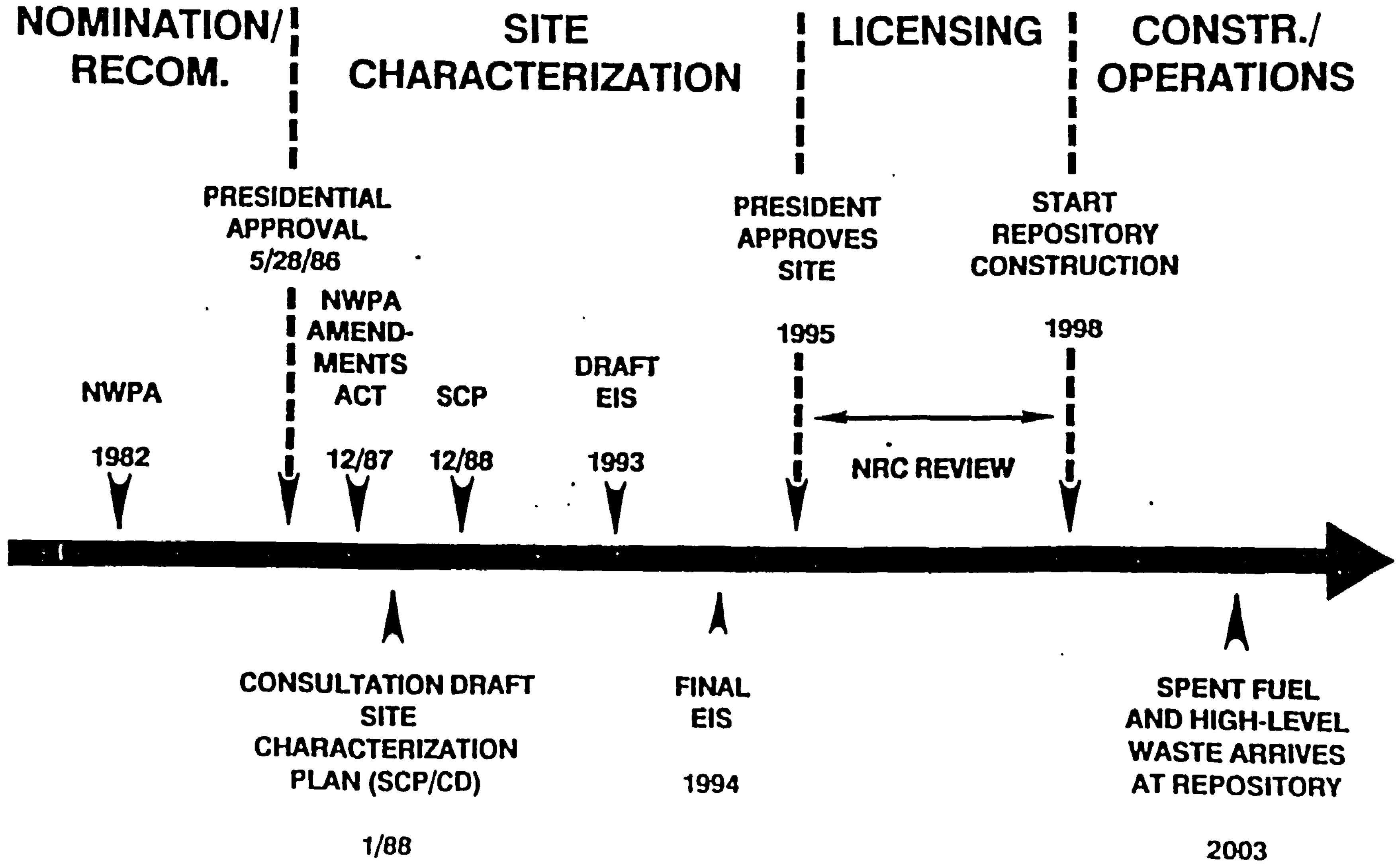
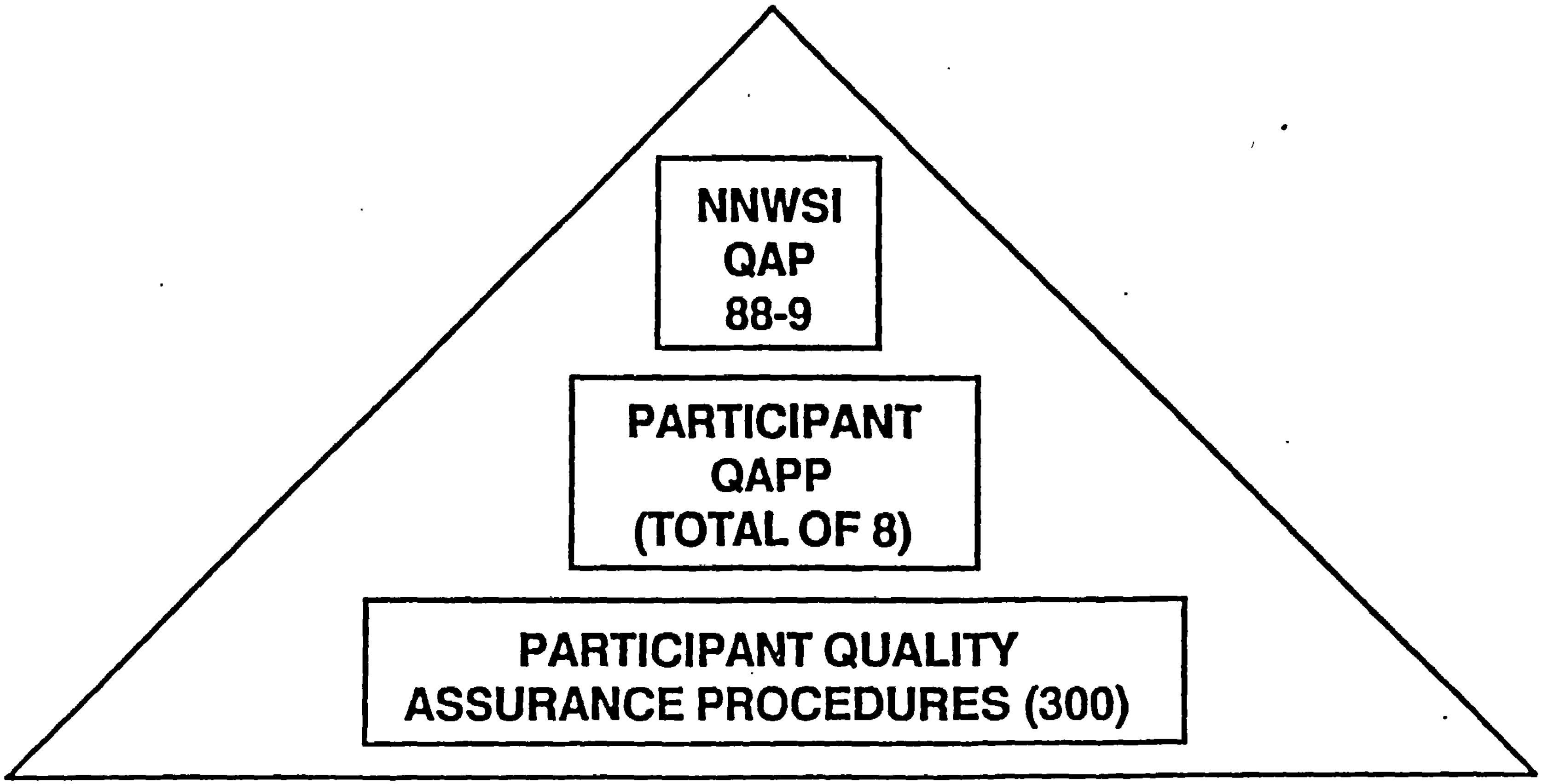
IF YUCCA MOUNTAIN IS FOUND SUITABLE A REPOSITORY WOULD BE SCHEDULED TO OPEN IN 2003



THE YUCCA MOUNTAIN PROJECT QA STRATEGY IS A THREE-PART PROCESS TO ENSURE FULL IMPLEMENTATION OF ALL APPLICABLE QA PROCEDURES ON PROJECT-RELATED WORK

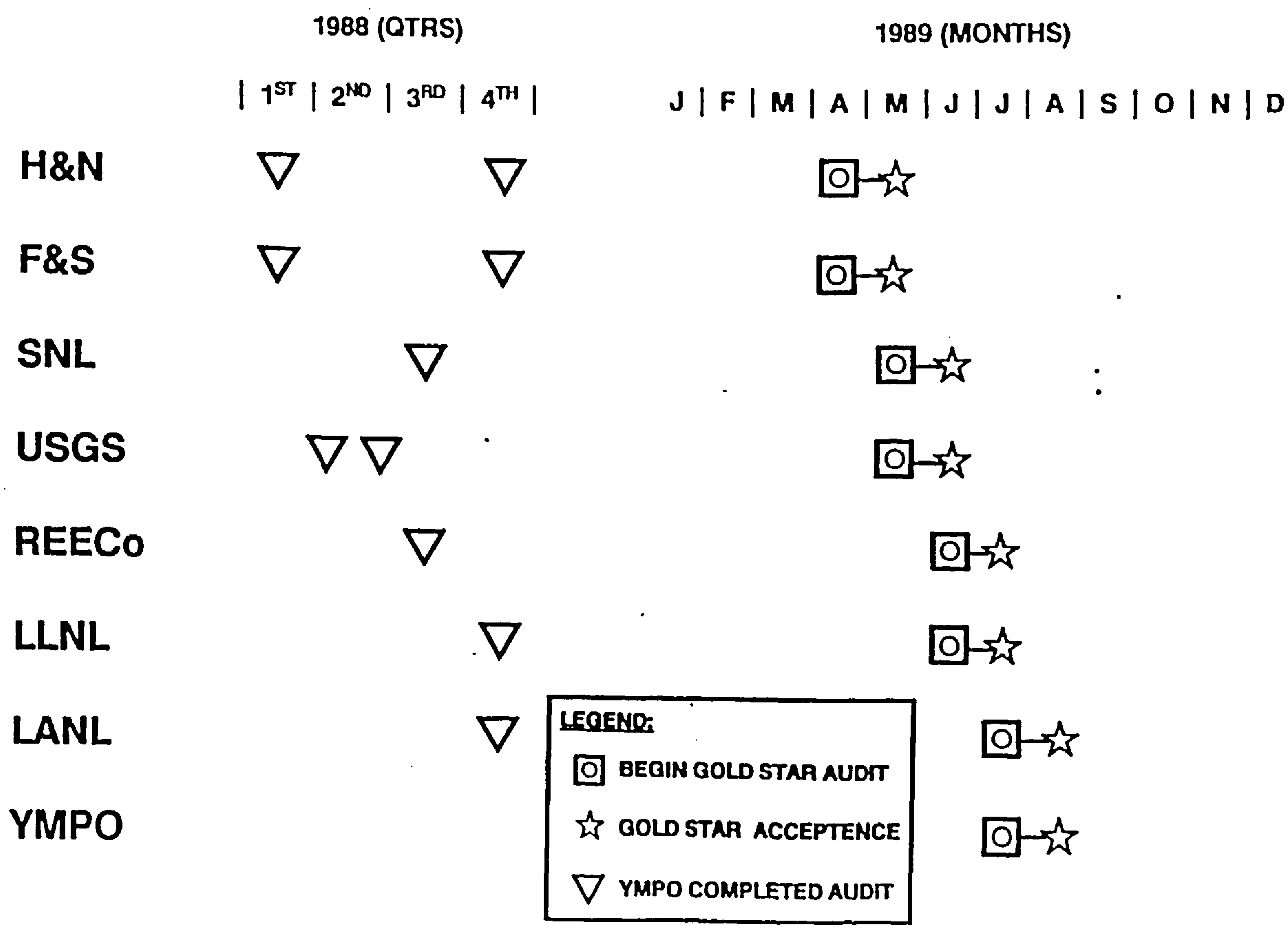
- NRC APPROVAL OF PROJECT QA PLAN
- SEQUENTIAL APPROVAL OF PROJECT PARTICIPANT'S QUALITY ASSURANCE PROGRAM PLANS
  - PROCEDURES DEVELOPED BY PARTICIPANTS
- IMPLEMENTATION AUDITS OBSERVED BY NRC

THE PROJECT'S QUALITY ASSURANCE HIERARCHY IS STRUCTURED TO ACCOMMODATE PARTICIPANTS NEEDS



QA PROGAM QUALIFICATION

REVISED "GOLD STAR" - PRELIMINARY DEC. 6, 1988



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QA PROGRAM QUALIFICATION
GENERIC SCHEDULE LOGIC

QAPP - QUALITY ASSURANCE PROGRAM PLANS

APQ - QUALITY AFFECTING ADMINISTRATIVE PROCEDURES

QAAP - QUALITY ASSURANCE ADMINISTRATIVE PROCEDURES

TRAINING

SURVEILLANCES - DOE & PARTICIPANT

RESOLVE OPEN ITEMS

MANAGEMENT REVIEW - PARTICIPANT

DOE MANAGEMENT REVIEW

YMP/NRC AUDIT

☆ BCOACH9P.A17/12-6-88

PROJECT HAS MADE SIGNIFICANT STEPS TOWARD A FULLY QUALIFIED QA PROGRAM

- TARGETING SUMMER 1989 FOR FULLY QUALIFIED QA PROGRAM

- PROJECT QUALITY ASSURANCE PLAN (NNWSI/88-9) APPROVED BY NRC IN OCTOBER
  - NNWSI/88-9 REV. 2 HAS BEEN SENT TO NRC

- ALL PARTICIPANTS ARE IN THE PROCESS OF
  - UPDATING QA PROGRAM PLANS
  - PREPARING PROCEDURES
  - CERTIFYING, QUALIFYING, AND TRAINING PERSONNEL

THE IMPORTANCE OF QUALITY ASSURANCE IN THE LICENSING ENVIRONMENT

- EXEMPLARY SCIENTIFIC WORK MUST BE ACCOMPANIED BY FLAWLESS DOCUMENTATION AND ADHERENCE TO APPROVED PROCESSES AND PROCEDURES - OTHERWISE THE WORK MAY BE WORTHLESS IN A LICENSING ENVIRONMENT

- "IT'S NOT DATA UNLESS THE NRC SAYS IT'S DATA"

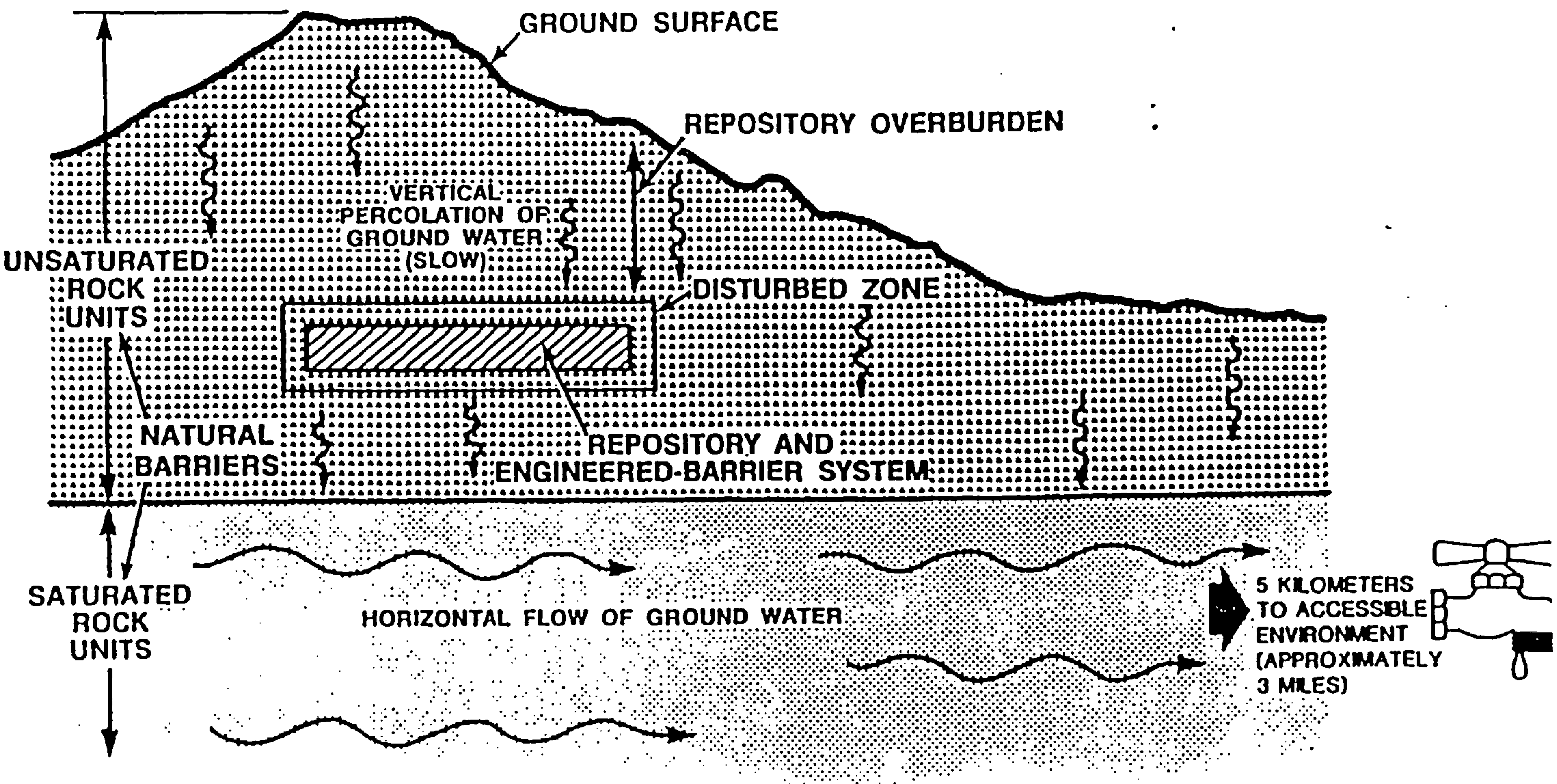
THE TOP-LEVEL STRATEGY FOR THE YUCCA MOUNTAIN SITE IS EXPECTED TO PROVIDE FOR LONG-TERM ISOLATION OF RADIOACTIVE WASTE

- THE STRATEGY PLACES PRIMARY RELIANCE ON LOW FLUX CONDITIONS, SLOW WATER MOVEMENT, AND LONG RADIONUCLIDE TRANSPORT TIMES IN THE UNSATURATED ZONE

- LOW-PROBABILITY, POTENTIALLY DISRUPTIVE PROCESSES AND EVENTS THAT COULD HAVE SIGNIFICANT IMPACTS ON PERFORMANCE OF THE REPOSITORY WILL BE IDENTIFIED AND CHARACTERIZED

- REPOSITORY DESIGN WILL INCORPORATE APPROPRIATE SEISMIC DESIGN REQUIREMENTS

CROSS SECTION OF A REPOSITORY



THE OBJECTIVES FOR THE ELEMENTS OF THE REPOSITORY SYSTEM ARE:

- ENGINEERED-BARRIER SYSTEM OBJECTIVE:

  LIMIT RELEASE OF RADIONUCLIDES TO THE NATURAL BARRIER SYSTEM

- NATURAL BARRIER SYSTEM OBJECTIVE:

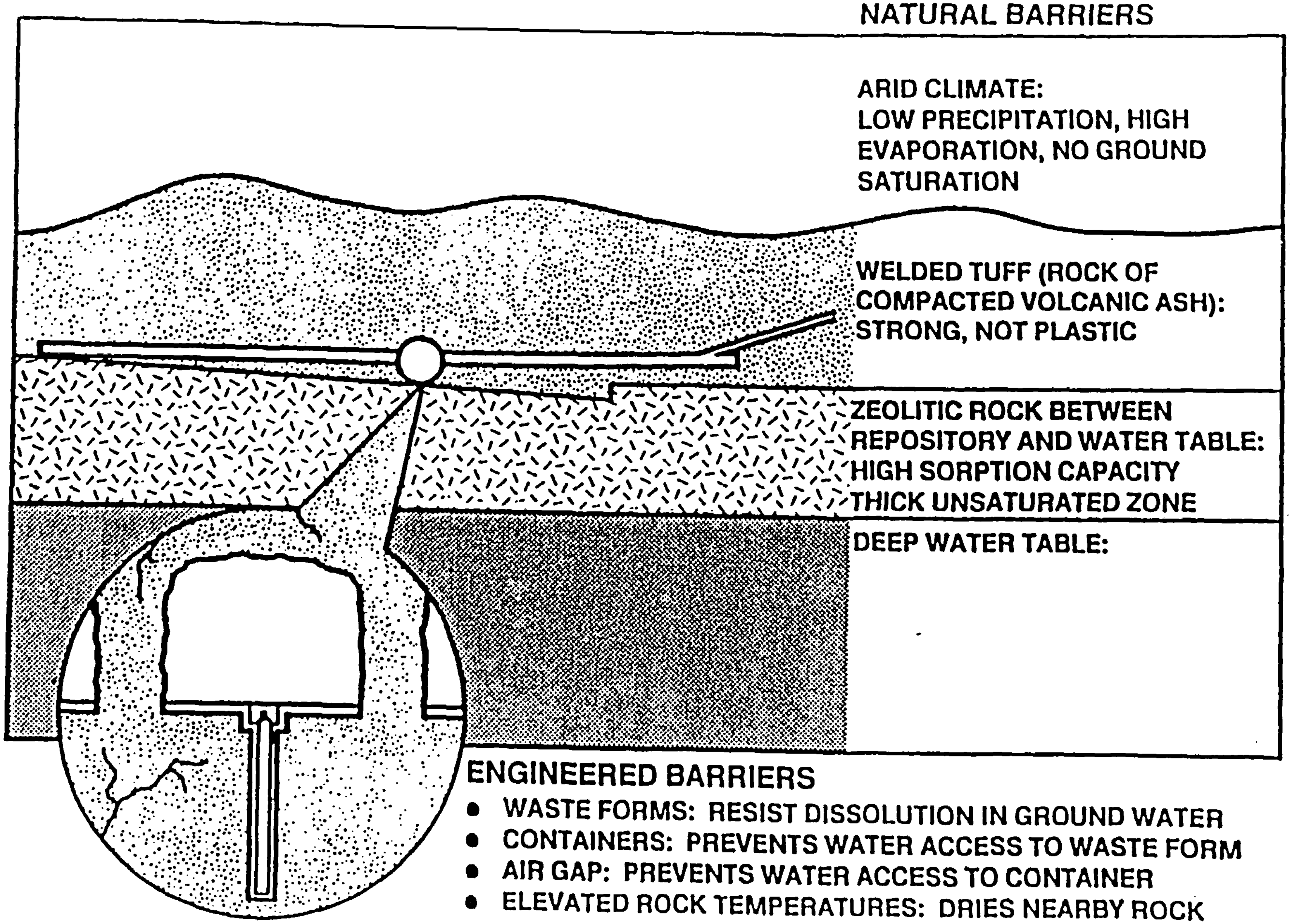
  PROVIDE VERY LONG RADIONUCLIDE TRAVEL TIME TO THE ACCESSIBLE ENVIRONMENT

- CONSTRUCTION, OPERATIONS, RETRIEVAL & CLOSURE OF DISPOSAL SYSTEM IS EXPECTED TO:

  (1) NOT COMPROMISE THE ABILITY TO MEET WASTE ISOLATION OBJECTIVES, AND

  (2) PROVIDE A SAFE OPERATIONAL ENVIRONMENT FOR WORKERS

OBJECTIVES FOR THE COMPONENTS OF THE REPOSITORY SYSTEM



ENGINEERED BARRIERS

- WASTE FORMS: RESIST DISSOLUTION IN GROUND WATER
- CONTAINERS: PREVENTS WATER ACCESS TO WASTE FORM
- AIR GAP: PREVENTS WATER ACCESS TO CONTAINER
- ELEVATED ROCK TEMPERATURES: DRIES NEARBY ROCK

OVERVIEW OF THE OBJECTIVES FOR THE COMPONENTS OF THE REPOSITORY SYSTEM ELEMENTS

	POSTCLOSURE		PRECLOSURE	
	COMPONENT	**OBJECTIVES**	**COMPONENT**	**OBJECTIVES**
ENGINEERED BARRIERS	UNSATURATED ROCK/AIR GAP	LIMIT THE WATER AVAILABLE TO CONTACT AND CORRODE CONTAINERS AND DISSOLVE WASTE	SURFACE & UNDER-GROUND FACILITY CONSTRUCTION	PROVIDES BENEFICIAL OR NO IMPACT ON POSTCLOSURE SYSTEM PERFORMANCE
	CONTAINER	SERVE AS PRINCIPAL CONTAINMENT BARRIER DURING EARLY RADIATION AND HEAT PEAK	SURFACE & UNDER-GROUND FACILITY OPERATION	SAFE OPERATION UNDER NORMAL AND ACCIDENT CONDITIONS
	WASTE FORM	LIMIT DISSOLUTION AND LEACHING OF RADIO-NUCLIDES DUE TO LIMITED WATER CONTACT		
NATURAL BARRIERS	**COMPONENT**	**OBJECTIVES**		
	UNSATURATED ROCK UNITS BELOW THE REPOSITORY	ACT AS BARRIER TO RADIONUCLIDE TRASNPORT BY PROVIDING LONG RADIONUCLIDE TRAVEL TIMES		
	SATURATED ROCK BELOW THE UN-SATURATED ROCK	EXTEND THE TOTAL TRAVEL-TIME OF RADIONUCLIDES		

GENERAL OBJECTIVES FOR THE COMPONENTS OF THE ENGINEERED BARRIER SYSTEM ELEMENT

COMPONENT	OBJECTIVES
AIR GAP	LIMIT THE WATER AVAILABLE TO CONTACT AND CORRODE CONTAINERS AND DISSOLVE WASTE
CONTAINER	SERVE AS PRINCIPAL CONTAINMENT BARRIER DURING EARLY RADIATION AND HEAT PEAK
WASTE FORM	LIMIT DISSOLUTION AND LEACHING OF RADIONUCLIDES DUE TO LIMITED WATER CONTACT

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GENERAL OBJECTIVES FOR THE COMPONENTS OF THE NATURAL BARRIER SYSTEM ELEMENT

COMPONENT	OBJECTIVES
UNSATURATED ROCK UNITS BELOW THE REPOSITORY	ACT AS BARRIER TO RADIO-NUCLIDE TRANSPORT BY PROVIDING LONG RADIONUCLIDE TRAVEL TIMES
SATURATED ROCK BELOW THE UNSATURATED ROCK	EXTEND THE TOTAL TRAVEL-TIME OF RADIONUCLIDES

GENERAL OBJECTIVES FOR THE COMPONENTS OF THE PRECLOSURE DISPOSAL SYSTEM ELEMENT

COMPONENT	OBJECTIVES
SURFACE AND UNDERGROUND FACILITY CONSTRUCTION	PROVIDE BENEFICIAL OR NO IMPACT ON POSTCLOSURE SYSTEM PERFORMANCE
SURFACE AND UNDERGROUND FACILITY OPERATION	SAFE OPERATION UNDER NORMAL AND ACCIDENT CONDITIONS

THE TOP-LEVEL STRATEGY WAS USED TO FOCUS THE SITE CHARACTERIZATION PROGRAM FOR YUCCA MOUNTAIN

POSTCLOSURE

- DETERMINE THE PROCESSES AND CHARACTERISTICS OF FLOW IN THE UNSATURATED ZONE
- INVESTIGATE SITE CONDITIONS AND CHARACTERISTICS THAT COULD AFFECT WASTE PACKAGE PERFORMANCE AND RADIONUCLIDE TRANSPORT
- IDENTIFY AND CHARACTERIZE POTENTIALLY SIGNIFICANT, BUT UNLIKELY, DISRUPTIVE PROCESSES AND EVENTS

PRECLOSURE

- CHARACTERIZE SEISMIC HAZARDS SUFFICIENT TO DEVELOP DESIGN CRITERIA FOR REPOSITORY FACILITIES

KEY AREAS OF EMPHASIS IN THE SITE PROGRAM

UNSATURATED ZONE	WASTE PACKAGE	REPOSITORY FACILITIES
• CONFIRM THE CURRENT VIEW OF LOW PERCOLATION FLUX AT THE REPOSITORY HORIZON • DETERMINE IF WATER IS GENERALLY CONFINED TO THE ROCK MATRIX • DETERMINE FLOW PATHS AND TRAVEL TIME FOR GROUNDWATER • DETERMINE IF DOWNWARD FLOW IS DIVERTED AT INTERFACES • DETERMINE IF THE ASSUMPTION OF LIMITED WATER CONTACTING THE WASTE PACKAGES IS VALID • DETERMINE RADIONUCLIDE RETARDATION POTENTIAL (e.g. SORPTION) FOR MINERALS PRESENT ALONG FLOW PATHS	ESTABLISH CHARACTERISTICS OF WASTE PACKAGE ENVIRONMENT SUFFICIENT TO • ESTIMATE WASTE FORM DISSOLUTION • ESTIMATE CONTAINER LIFETIME • PREDICT ENGINEERED BARRIER SYSTEM RELEASE RATES	• THE PROBABILITY, MAGNITUDE, AND LIKELY EFFECTS OF GROUND MOTION ON SURFACE AND UNDERGROUND FACILITIES WILL BE ESTABLISHED • THE PROBABILITY, MAGNITUDE, AND EFFECTS OF POTENTIAL SURFACE RUPTURE WILL BE ESTABLISHED

EXPECTED OR NOMINAL CONDITIONS

- PREDICT THE IMPACTS OF FUTURE CLIMATE CONDITIONS ON THE HYDROLOGIC SYSTEM AT THE SITE
- PREDICT THE EFFECTS OF FUTURE FAULTING ON THE HYDROLOGIC SYSTEM AT THE SITE
- ESTABLISH PROBABILITIES OF VOLCANIC ACTIVITY AT OR NEAR THE SITE

DISRUPTIVE CONDITIONS

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EXPECTED CONDITIONS IN THE UNSATURATED ZONE WILL BE ESTABLISHED

- CONFIRM THE CURRENT VIEW OF LOW PERCOLATION FLUX AT THE REPOSITORY HORIZON
- DETERMINE IF WATER IS GENERALLY CONFINED TO THE ROCK MATRIX
- DETERMINE GROUNDWATER FLOW PATHS AND TRAVEL TIME IN THE UNSATURATED ZONE
- DETERMINE IF DOWNWARD FLOW IS DIVERTED AT INTERFACES
- DETERMINE IF THE ASSUMPTION OF LIMITED WATER CONTACTING THE WASTE PACKAGES IS VALID
- DETERMINE RADIONUCLIDE RETARDATION POTENTIAL (e.g., SORPTION, PRECIPITATION) FOR MINERALS PRESENT ALONG FLOW PATHS

EXPECTED CONDITIONS AFFECTING WASTE PACKAGE PERFORMANCE WILL BE INVESTIGATED

- ESTABLISH CHARACTERISTICS OF THE WASTE PACKAGE ENVIRONMENT SUFFICIENT TO
  - ESTIMATE CONTAINER LIFETIMES
  - ESTIMATE WASTE FORM DISSOLUTION
  - PREDICT ENGINEERED BARRIER SYSTEM RELEASE RATE

DISRUPTIVE CONDITIONS
WILL ALSO BE INVESTIGATED

- PREDICT THE IMPACTS OF FUTURE CLIMATE CONDITIONS ON THE HYDROLOGIC SYSTEM AT THE SITE
- PREDICT THE EFFECTS OF FUTURE FAULTING ON THE HYDROLOGIC SYSTEM AT THE SITE
- ESTABLISH PROBABILITIES OF VOLCANIC ACTIVITY AT OR NEAR THE SITE

SEISMIC HAZARDS FOR THE REPOSITORY FACILITIES WILL BE THOROUGHLY INVESTIGATED

- THE PROBABILITY, MAGNITUDE, AND LIKELY EFFECTS OF GROUND MOTION ON SURFACE AND UNDERGROUND FACILITIES WILL BE ESTIMATED

- THE PROBABILITY, MAGNITUDE, AND EFFECTS OF POTENTIAL SURFACE RUPTURE WILL BE ESTABLISHED

POTENTIALLY ADVERSE CONDITIONS IDENTIFIED IN THE ENVIRONMENTAL ASSESSMENT

- THE SITE GEOHYDROLOGY WILL BE RELATIVELY DIFFICULT TO CHARACTERIZE AND MODEL
- THERE IS EVIDENCE OF ACTIVE FAULTING AND IGNEOUS ACTIVITY DURING THE QUATERNARY PERIOD
- CURRENTLY AVAILABLE DATA ARE INSUFFICIENT TO ESTABLISH IF EITHER THE FREQUENCY OF OCCURRENCE OR THE MAGNITUDE OF EARTHQUAKES WITHIN THE GEOLOGIC SETTING COULD INCREASE
- THE SITE HAS TOPOGRAPHY THAT COULD LEAD TO FLOODING (BRIEF SHEET FLOW)
- CURRENT DATA ARE INSUFFICIENT TO DEMONSTRATE THAT THICKNESS AND LATERAL EXTENT OF THE HOST ROCK ALLOW FLEXIBILITY IN FACILITY DESIGN

ATTRIBUTES OF THE YUCCA MOUNTAIN SITE THAT CONTRIBUTE TO ITS SUITABILITY AS A REPOSITORY

- THE REPOSITORY WOULD BE LOCATED IN THE UN-SATURATED ZONE RANGING FROM 550-1100 FEET ABOVE THE WATER TABLE
- THE DESERT ENVIRONMENT LEADS TO VERY LIMITED WATER INFILTRATION
- ZEOLITE MINERALS, KNOWN TO RETARD THE MOVEMENT OF RADIONUCLIDES ARE FOUND ALONG POTENTIAL FLOW PATHS FROM THE REPOSITORY TO THE ACCESSIBLE ENVIRONMENT
- POPULATION DENSITY IN THE VICINITY OF THE YUCCA MOUNTAIN SITE IS VERY LOW
- SITE CHARACTERIZATION ACTIVITIES ARE NOT EXPECTED TO CAUSE SIGNIFICANT ADVERSE IMPACTS

SUMMARY

- THE TOP-LEVEL STRATEGY FOR THE SITE CHARACTERIZATION PROGRAM DIRECTLY ADDRESSES THE REQUIREMENTS OF THE EPA AND THE NRC.

- THE STRATEGY FOCUSES ON UNDERSTANDING THE EXPECTED AND DISRUPTIVE CONDITIONS AND PROCESSES AT YUCCA MOUNTAIN.

- KEY AREAS OF EMPHASIS ARE THE UNSATURATED ZONE, THE WASTE PACKAGE AND ITS ENVIRONMENT, AND THE REPOSITORY FACILITIES

U.S. DEPARTMENT OF ENERGY

OCRWM

YUCCA MOUNTAIN

GEOLOGIC DESCRIPTION OF THE YUCCA MOUNTAIN SITE

PRESENTED BY

MAXWELL B. BLANCHARD

DIRECTOR, REGULATORY & SITE EVALUATION DIVISION
YUCCA MOUNTAIN PROJECT
U.S. DEPARTMENT OF ENERGY

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

DECEMBER 13, 1988

UNITED STATES DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE/YUCCA MOUNTAIN PROJECT OFFICE

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OVERVIEW OF PRESENTATION

MAJOR SITE CHARACTERISTICS AND QUESTIONS IN AREAS OF:

- GEOLOGY
- GEOENGINEERING
- HYDROLOGY
- GEOCHEMISTRY
- CLIMATE

APPROACH IS TO INTEGRATE SITE DATA AND DEFINE A LEVEL OF CONFIDENCE IN OUR UNDERSTANDING OF SITE CONDITIONS AND PROCESSES

UNDERLYING QUESTION: HOW MUCH SITE-SPECIFIC INFORMATION IS REQUIRED FOR "REASONABLE ASSURANCE"?

PHOTO OF YUCCA MOUNTAIN LOOKING NORTH

PHOTO OF YUCCA MOUNTAIN
LOOKING SOUTH

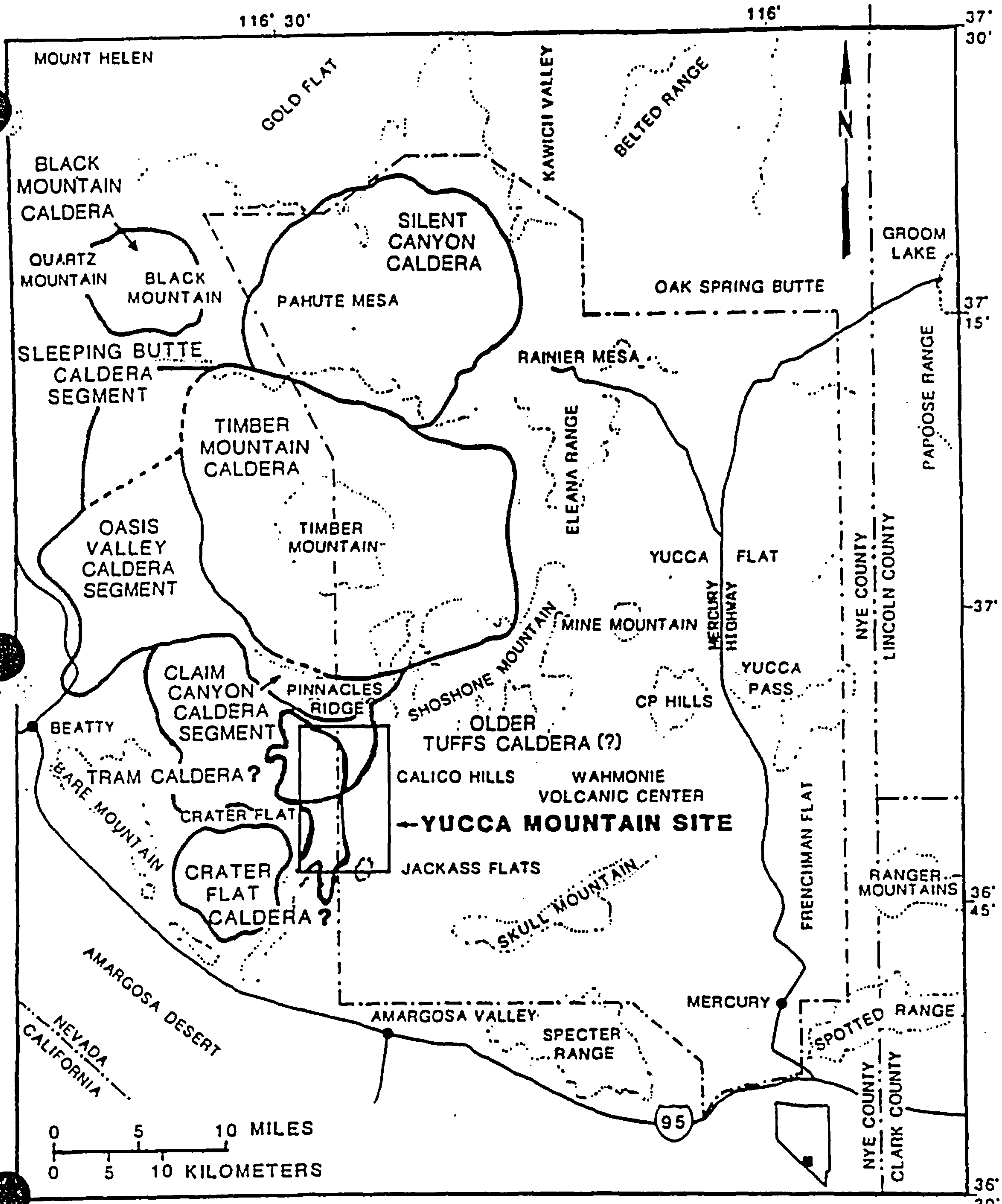
PHOTO OF YUCCA MOUNTAIN
LOOKING EAST

PHOTO OF YUCCA MOUNTAIN LOOKING WEST

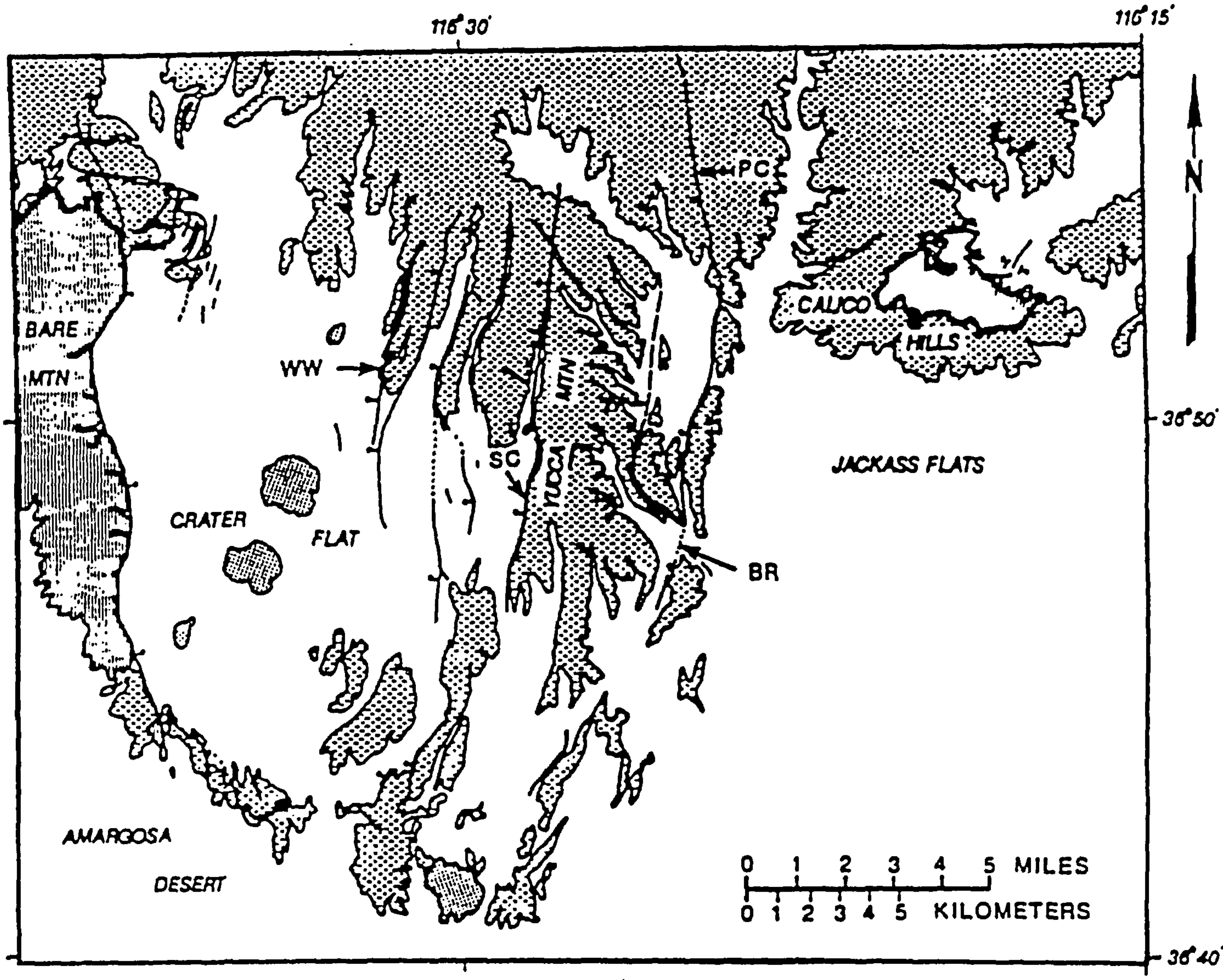
GEOLOGY

MAJOR GEOLOGIC CHARACTERISTICS OF THE YUCCA MOUNTAIN SITE

- REASONABLY STABLE GEOMORPHIC CONDITIONS AND LOW EROSION RATES
- THICK SECTION OF VOLCANIC ROCKS WITH EXTENSIVE LATERAL AND VERTICAL CONTINUITY
- THE REPOSITORY FACILITIES WOULD BE LOCATED IN THE SOUTHERN GREAT BASIN, IN A REGION THAT HAS EXPERIENCED CONSIDERABLE FAULTING OVER THE LAST 15 MILLION YEARS
- HISTORIC NATURAL SEISMICITY IN THE SITE VICINITY HAS BEEN LOWER THAN IN THE SURROUNDING SOUTHERN GREAT BASIN
- AVAILABLE DATA SUGGESTS LOW POTENTIAL FOR MINERAL AND ENERGY RESOURCES



CALDERAS OF THE SOUTHWEST NEVADA VOLCANIC FIELD

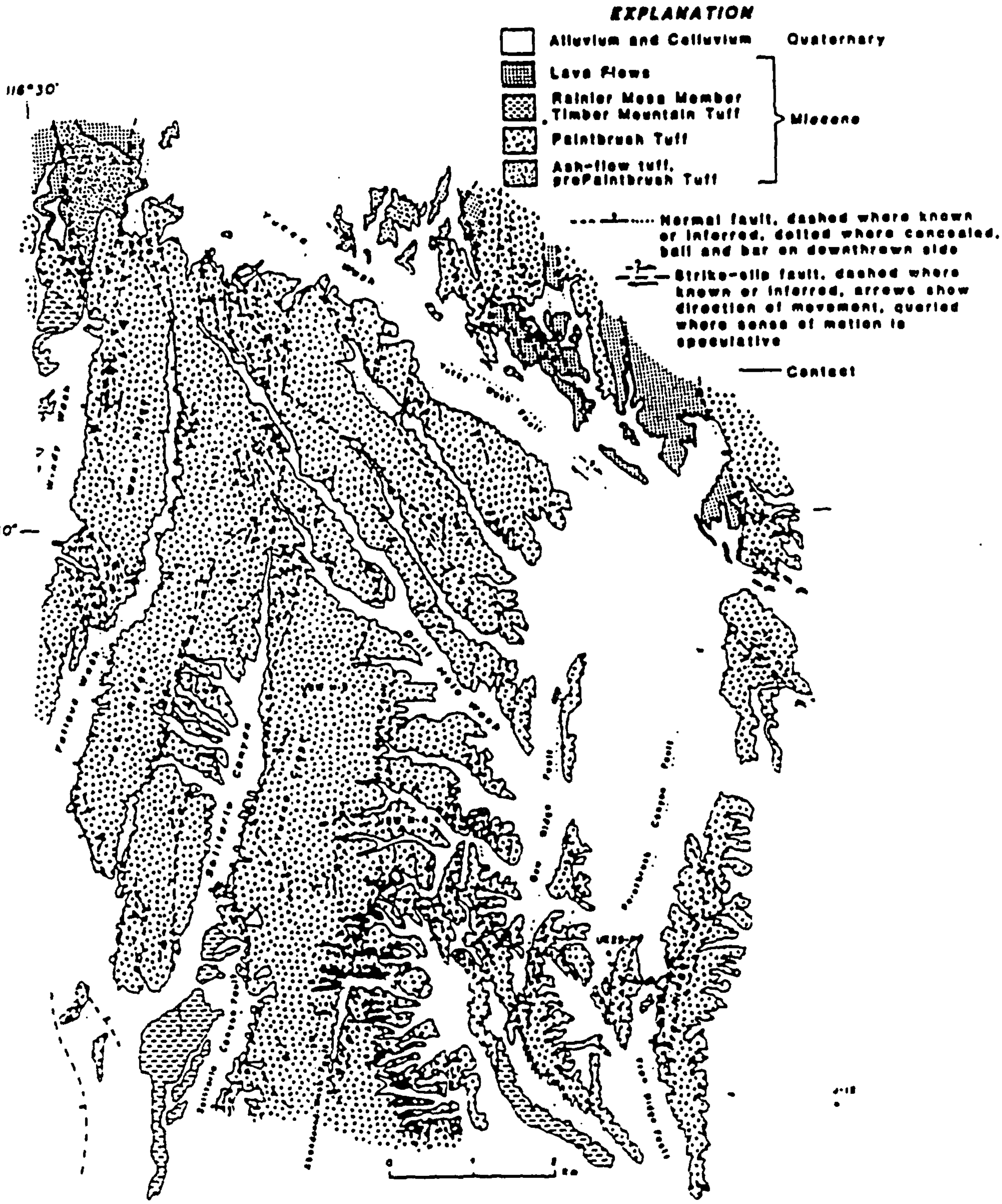


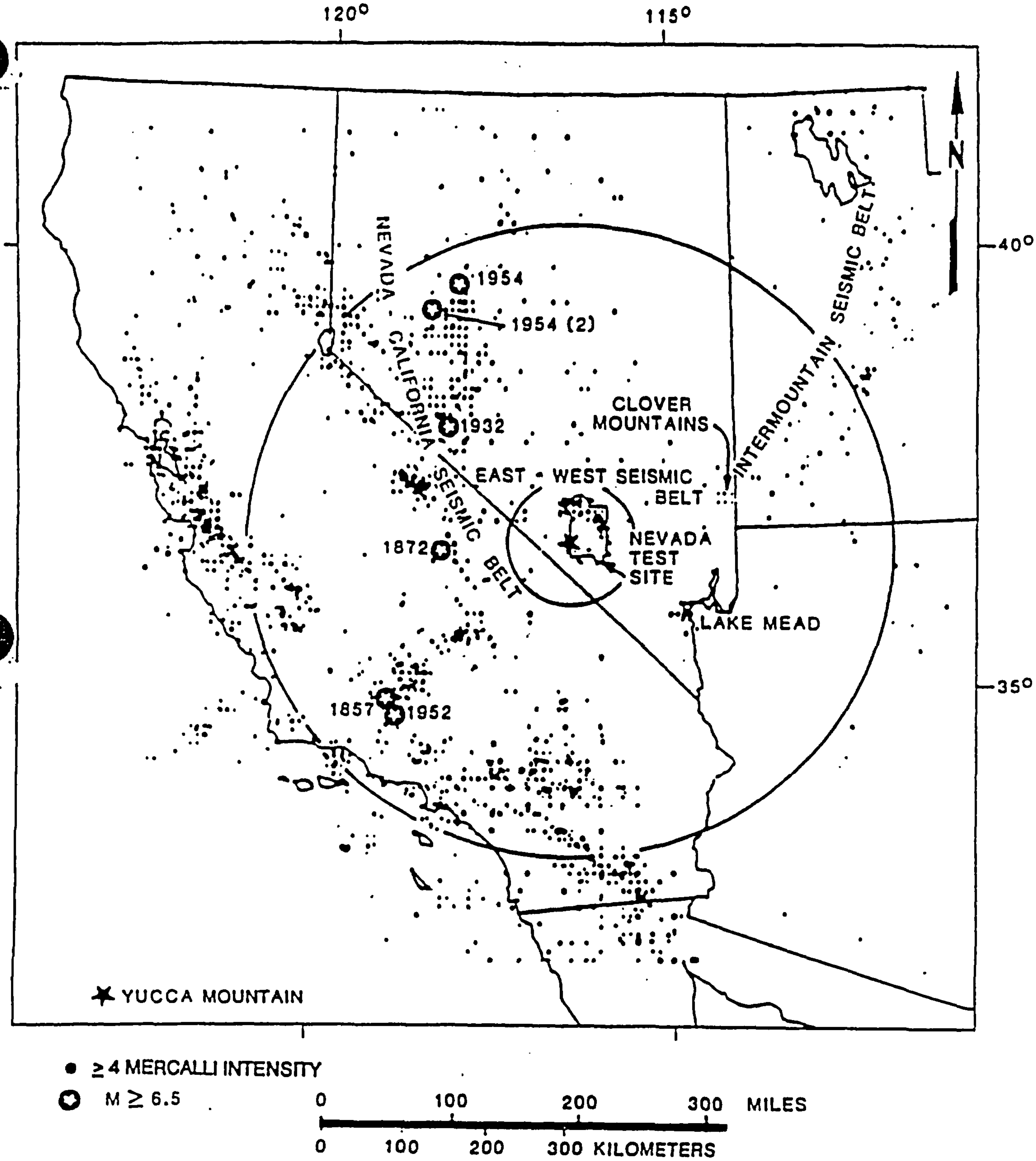
- QUATERNARY ALLUVIUM
- QUATERNARY BASALT AND CINDER CONES.
- TERTIARY VOLCANIC ROCKS
- PALEOZOIC ROCKS

BR BOW RIDGE FAULT
PC PAINTBRUSH CANYON FAULT
SC SOLITARIO CANYON FAULT
WW WINDY WASH FAULT

MAJOR QUATERNARY NORMAL FAULTS NEAR YUCCA MOUNTAIN

GEOLOGIC MAP OF YUCCA MOUNTAIN





SEISMICITY OF SOUTHWESTERN UNITED STATES (1769 THROUGH 1978)

MAJOR GEOLOGIC QUESTIONS REQUIRING INVESTIGATION

- WHAT IS THE PROBABILITY THAT THE REPOSITORY WOULD BE PENETRATED BY BASALTIC MAGMA? (CURRENT ESTIMATE OF PROBABILITY IS LOW, $\approx 10^{-8}$ TO 10^{-10} PER YEAR)

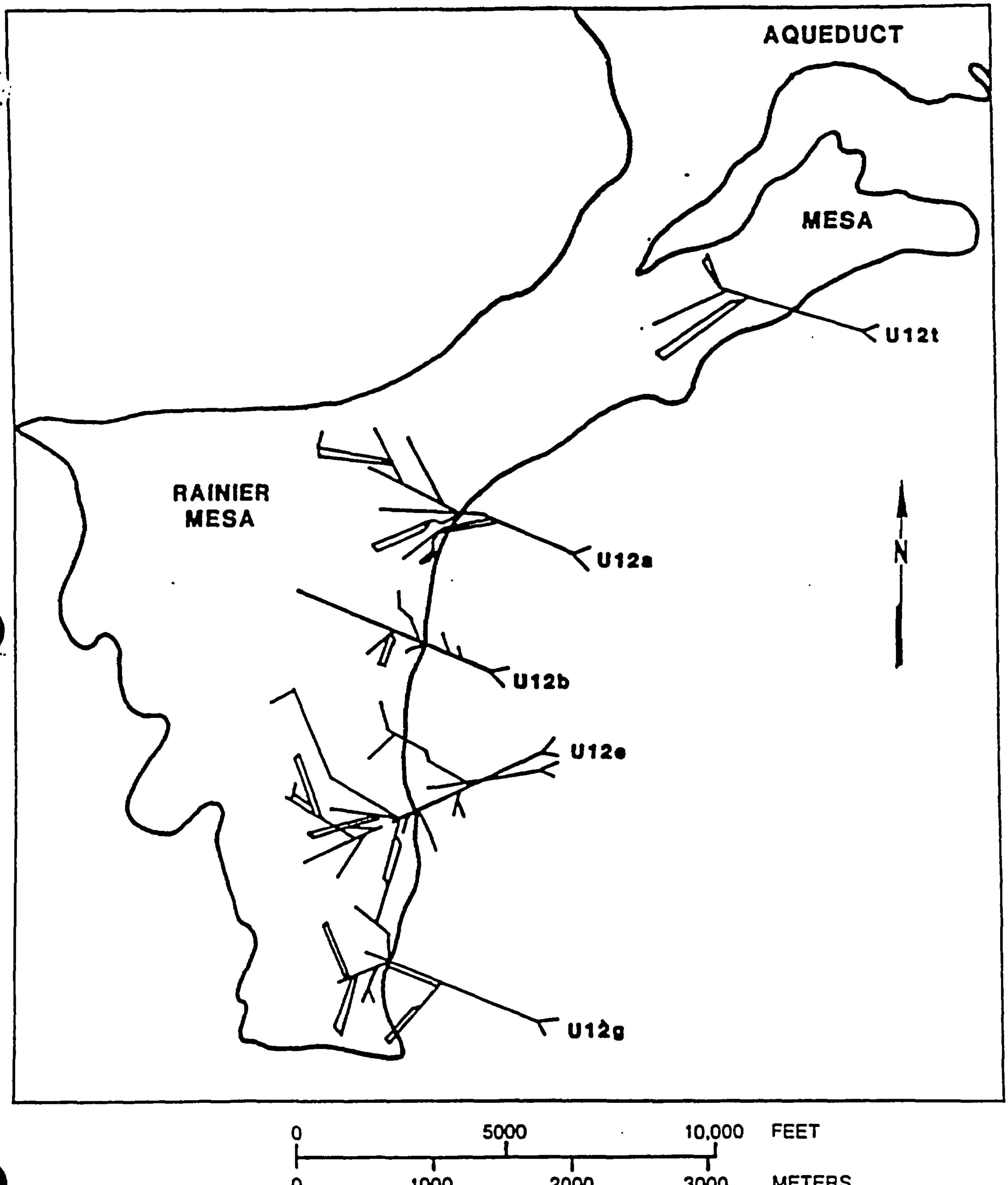
- WHAT ARE THE ORIGINS AND AGES OF CALCITE-SILICA DEPOSITS IN FAULTS AND FRACTURE ZONES? (HYDROTHERMAL, PEDOGENIC, OR OTHER)

- WHAT EARTHQUAKE MAGNITUDE AND RECURRENCE INTERVAL SHOULD BE USED FOR PERFORMANCE AND DESIGN ANALYSES?

- TO WHAT EXTENT CAN FUTURE TECTONIC EVENTS CAUSE CHANGES IN THE GROUND-WATER CONDITIONS?

MAJOR GEOENGINEERING CHARACTERISTICS

- RELATIVELY COMPETENT, THICK AND CONTINUOUS HOST ROCK
- HOST ROCK IS FRACTURED AND FAULTED; STRESSES ARE LOW AND EXTENSIONAL
- NO EXPECTATION OF GAS, WATER INFLOW, OR TEMPERATURE PROBLEMS DURING MINING
- SHAFTS AND DRIFTS CAN BE CONSTRUCTED USING STANDARD TECHNIQUES AND PRACTICES
- HIGH PROBABILITY OF LONG TERM STABILITY OF EXCAVATIONS WITH MINIMAL SUPPORT
- HIGH PROBABILITY THAT RETRIEVAL OPERATIONS, IF IMPLEMENTED, WOULD BE CARRIED OUT IN A STABLE ENVIRONMENT



A PORTION OF THE RAINIER MESA TUNNEL SYSTEM

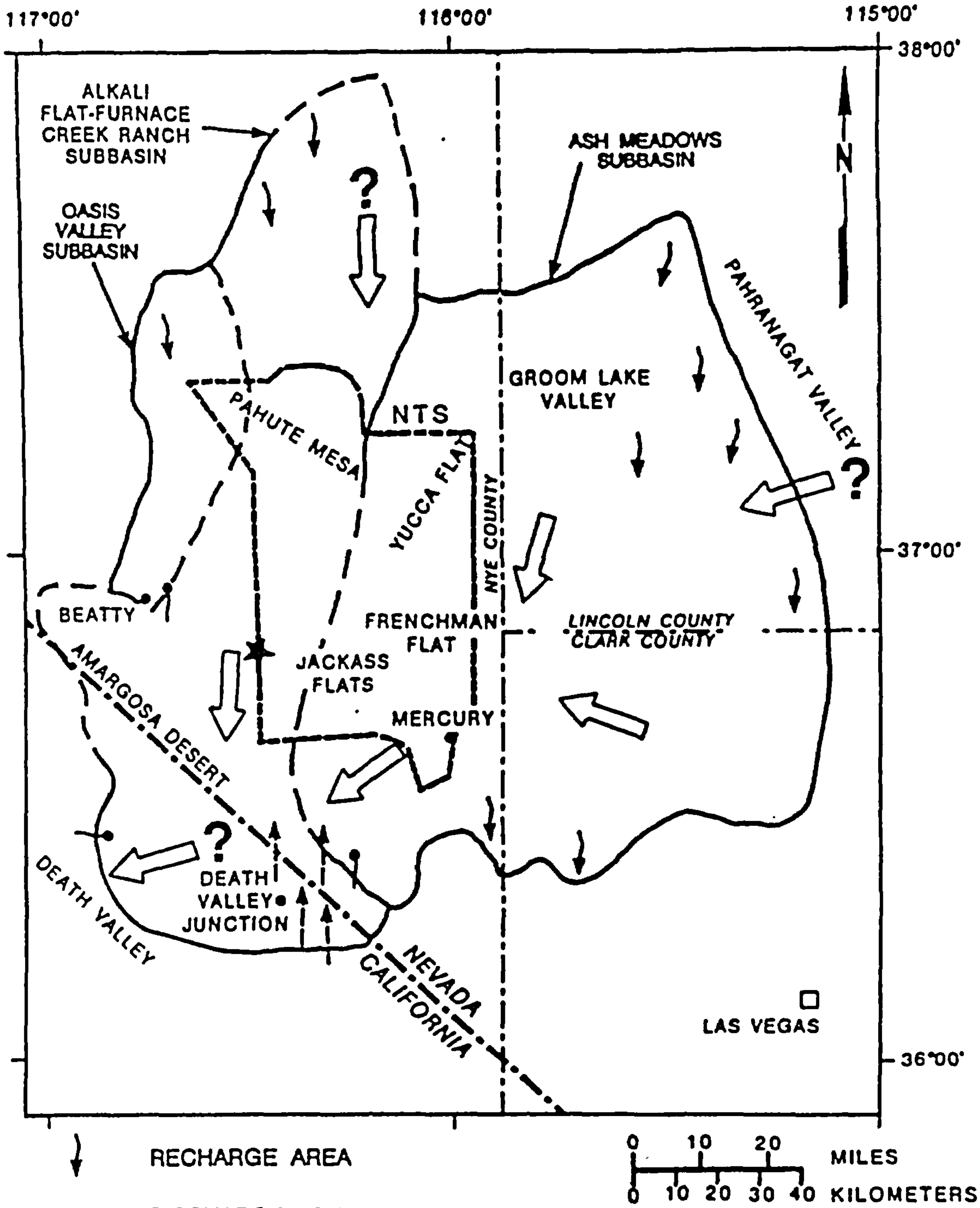
PHOTO OF G-TUNNEL

MAJOR GEOENGINEERING QUESTIONS REQUIRING INVESTIGATION

- HOW WILL DATA ABOUT ROCK CHARACTERISTICS OBTAINED FROM THE EXPLORATORY SHAFT FACILITY AND BOREHOLES BE SHOWN TO BE REPRESENTATIVE OF THE OVERALL REPOSITORY AREA?
- WILL THE ROCK MASS RESPOND TO MINING AND HEAT IN THE MANNER PREDICTED?
- WILL SIGNIFICANT GEOMECHANICAL IMPACTS TO THE SITE BE AVOIDED BY PROPER DESIGN CONTROLS?

HYDROLOGY

- UNSATURATED ZONE
  - REPOSITORY WOULD BE LOCATED 550 TO 1100 FT ABOVE THE SATURATED ZONE AND MORE THAN 650 FT BELOW THE LAND SURFACE
  - THE CURRENT ESTIMATE FOR VERTICAL FLUX IS LOW, ($\approx$0.5mm/yr)
  - THE CURRENT ESTIMATE OF PRE-WASTE EMPLACEMENT GROUND-WATER TRAVEL TIME IS 20,000 TO 80,000 YRS
  - THE CURRENT EVIDENCE INDICATES THAT WATER FLOW IS MOSTLY CONFINED TO THE ROCK MATRIX
- SATURATED ZONE
  - GROUND WATER IS DERIVED PRINCIPALLY FROM PRECIPITATION WITHIN THE BASIN
  - THE FLOW DIRECTION IS TO THE SOUTHWEST AND DISCHARGE IS IN SOUTHERN AMARGOSA VALLEY
  - HYDRAULIC CONDUCTIVITY IS CONTROLLED BY FRACTURES, JOINTS, AND BEDDING PLANES



RECHARGE AREA

DISCHARGE AREA

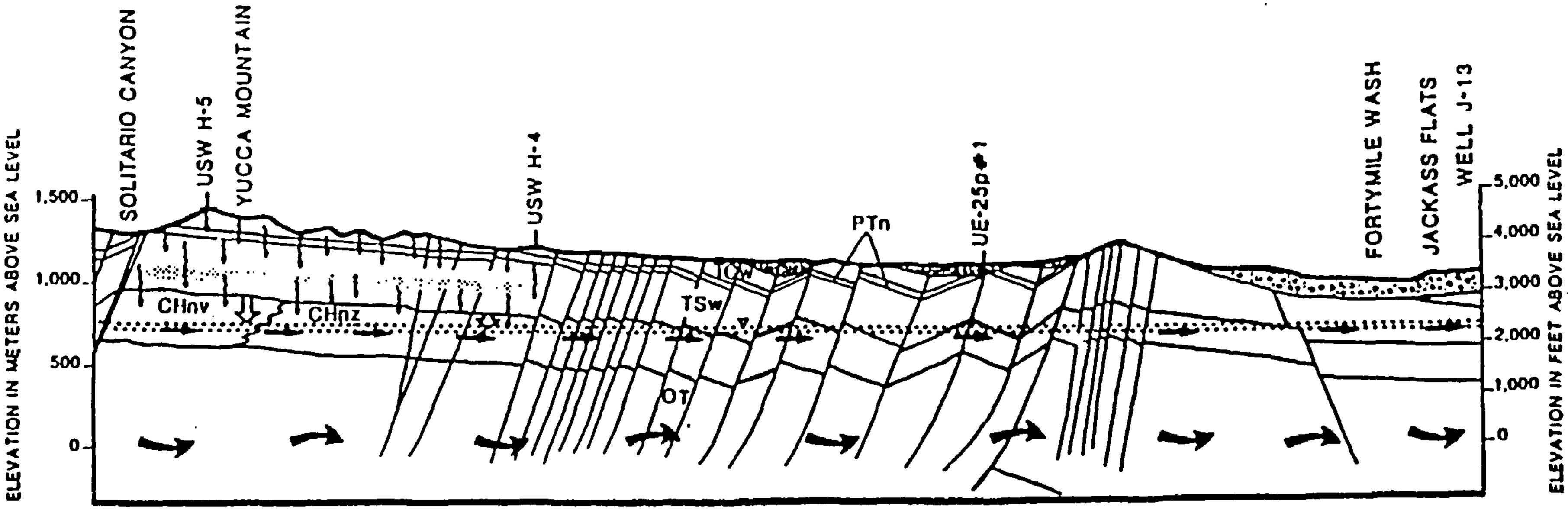
EVAPOTRANSPIRATION

SPRINGS

GENERAL DIRECTION OF REGIONAL GROUND-WATER FLOW (QUESTION MARK INDICATES UNCERTAINTY)

YUCCA MOUNTAIN SITE

A PORTION OF THE DEATH VALLEY GROUND-WATER BASIN



ALLUVIUM & TIMBER MOUNTAIN TUFF

DESIGN REPOSITORY (THICKNESS EXAGGERATED)

WATER TABLE

FLUX THROUGH THE UNSATURATED ZONE

UNSATURATED-ZONE FLOW PATHS USED FOR TRAVEL TIME CALCULATIONS

SATURATED-ZONE FLOW PATH FOR WATER THAT HAS PASSED THROUGH THE REPOSITORY LEVEL

DEEP SATURATED-ZONE FLOW PATHS FOR WATER THAT HAS NOT PASSED THROUGH THE REPOSITORY LEVEL

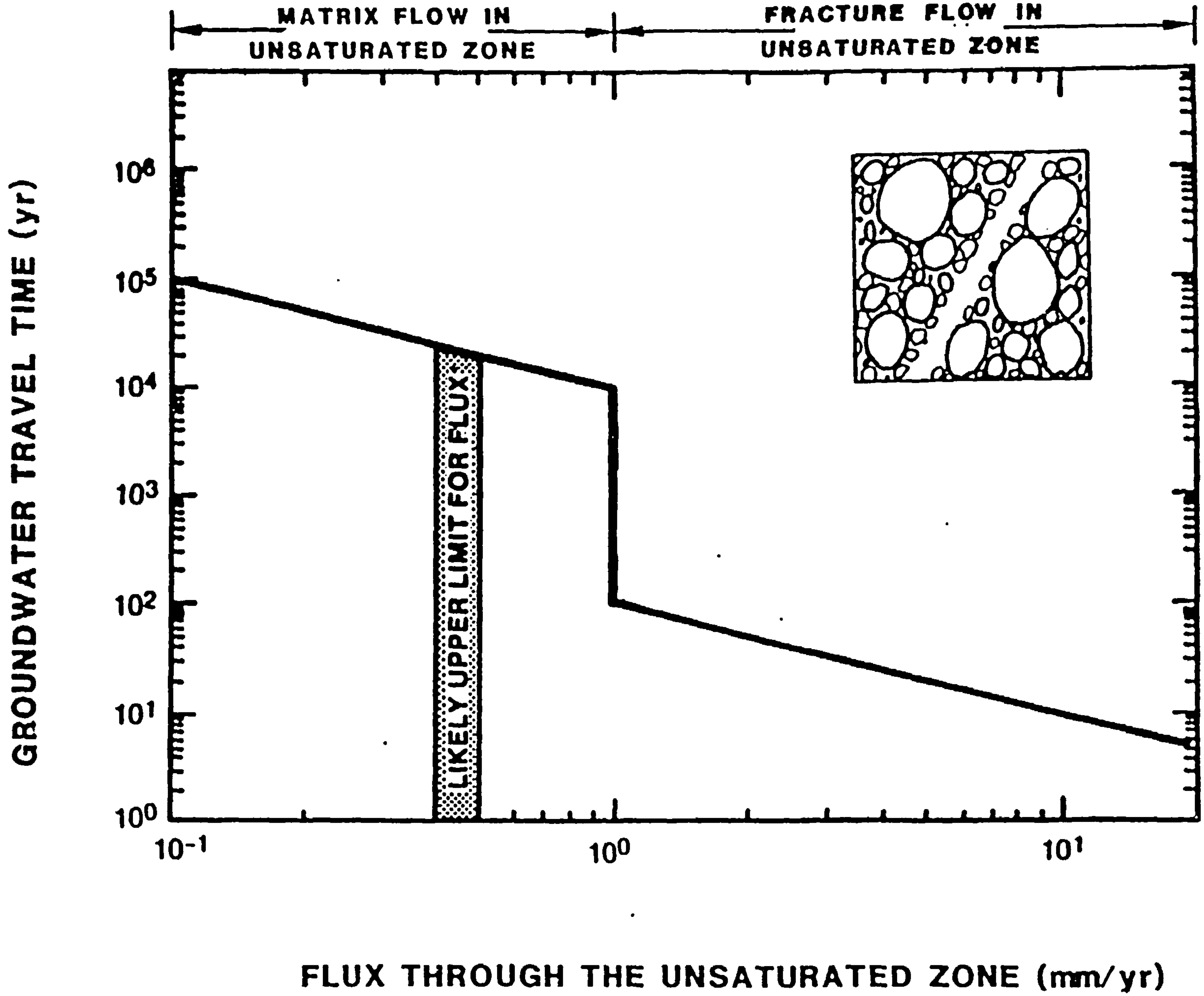
TCw	TIVA CANYON WELDED UNIT
PTn	PAINTBRUSH NONWELDED UNIT
TSw	TOPOPAH SPRING WELDED UNIT
CHnv	CALICO HILLS NONWELDED VITRIC UNIT
CHnz	CALICO HILL NONWELDED ZEOLITIC UNIT
OT	OLDER TUFF UNIT

0 0.5 1 MILES

0 0.5 1 KILOMETERS

CONCEPTUAL HYDROGEOLOGIC SECTION

GROUND-WATER TRAVEL TIME



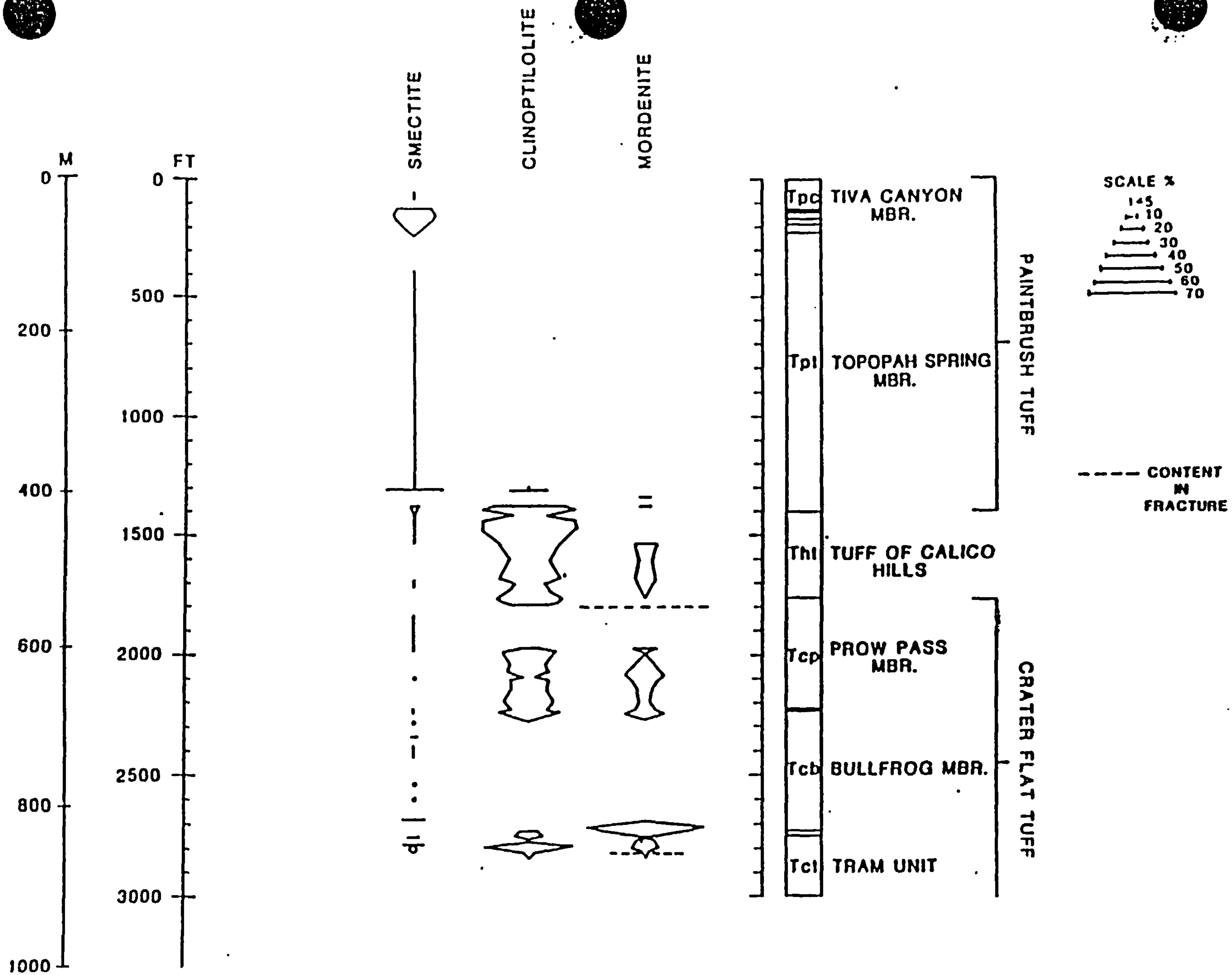
MAJOR HYDROLOGIC QUESTIONS REQUIRING INVESTIGATION

- WHAT IS THE RATE AND AREAL DISTRIBUTION OF NET INFILTRATION NEAR THE SURFACE?
- WHAT IS THE RATE AND DIRECTION OF GROUND-WATER MOVEMENT IN THE UNSATURATED ZONE FROM THE SURFACE TO THE REPOSITORY?
- IS THERE A SIGNIFICANT COMPONENT OF LATERAL FLOW IN THE UNSATURATED ZONE?
- IS THE UNSATURATED GROUND-WATER FLOW PREDOMINANTLY IN THE MATRIX OR IN THE FRACTURES?
- WHAT IS THE RATE AND DIRECTION OF GROUND-WATER MOVEMENT FROM THE REPOSITORY HORIZON TO THE ACCESSIBLE ENVIRONMENT?

GEOCHEMISTRY

MAJOR GEOCHEMICAL CHARACTERISTICS

- ZEOLITES AND CLAYS IN THE ROCK BELOW THE REPOSITORY ARE EXPECTED TO PROVIDE CONSIDERABLE RETARDATION FOR SORBING SPECIES
- MATRIX DIFFUSION SHOULD PROVIDE SOME RETARDATION FOR NON-SORBING SPECIES AND ADDITIONAL RETARDATION FOR SORBING SPECIES
- RETARDATION SHOULD NOT BE SIGNIFICANTLY AFFECTED BY EITHER NATURAL PROCESSES OR THE EFFECTS OF REPOSITORY CONSTRUCTION, OPERATION, OR CLOSURE
- THE DOMINANT MINERAL CONSTITUENTS ARE NOT PRONE TO DISSOLUTION
- THE MINERALS PRESENT ARE EXPECTED TO BE STABLE IN THE PREDICTED REPOSITORY TEMPERATURE FIELD



ABUNDANCE OF ZEOLITES AND CLAYS FROM USW-G4

MAJOR GEOCHEMICAL QUESTIONS REQUIRING INVESTIGATION

- HOW WILL CONFIDENCE BE GAINED ABOUT THE QUANTITY AND DISTRIBUTION OF SORPTIVE MINERALS ALONG FLOW PATHS?

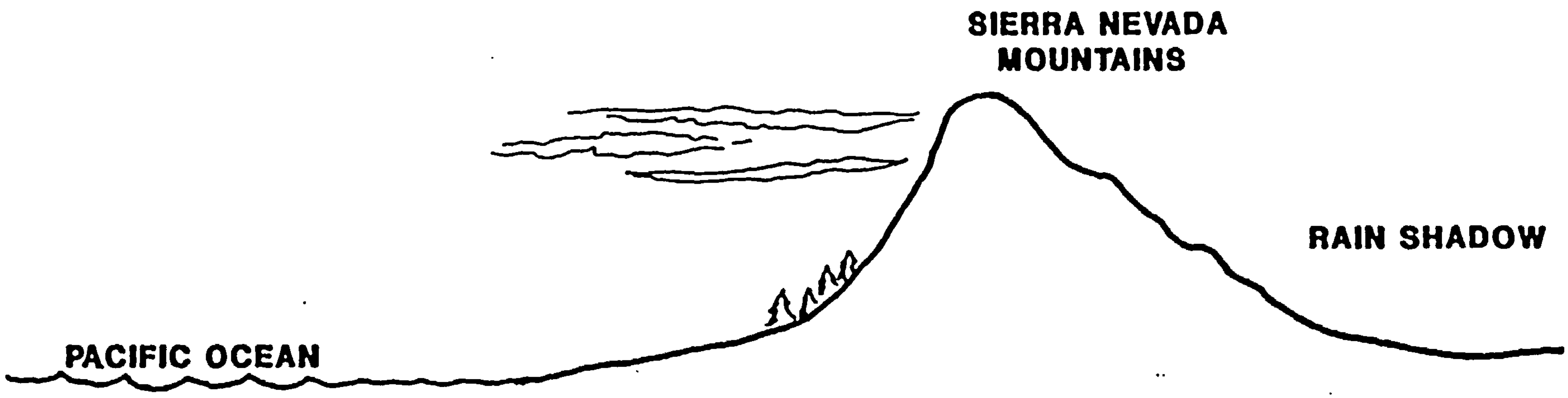
- WHAT GEOCHEMICAL DATA ARE NEEDED TO ADEQUATELY SUPPORT ASSESSMENTS OF RADIONUCLIDE RELEASES OVER 10,000 YEARS?

- HOW WILL THE RESULTS OF LABORATORY TESTS ABOUT RETARDATION AND MATRIX DIFFUSION BE RELIABLY TRANSLATED TO FIELD CONDITIONS?

CLIMATOLOGY

MAJOR CLIMATOLOGIC CHARACTERISTICS

- THE YUCCA MOUNTAIN SITE IS LOCATED IN A DESERT ENVIRONMENT WITH ABOUT 6 INCHES OF RAINFALL PER YEAR. MOST OF THE PRECIPITATION IS LOST TO RUNOFF OR EVAPOTRANSPIRATION (REGIONALLY - 97%; PROBABLY MORE AT YUCCA MOUNTAIN).
- RELATIVELY HIGH AVERAGE WIND SPEED CONTRIBUTES TO DISPERSION
- FUTURE CLIMATE IS EXPECTED TO BE WETTER AND COOLER BUT STILL REMAIN DESERT WITH INFILTRATION NOT CHANGING SIGNIFICANTLY



YUCCA MOUNTAIN LIES IN THE RAIN SHADOW
OF THE SIERRA NEVADA MOUNTAINS

MAJOR CLIMATOLOGIC QUESTIONS REQUIRING INVESTIGATION

- **HOW WILL FUTURE CLIMATE CONDITIONS BE BOUNDED?**
  - LAKE DEPOSITS ARE USEFUL INDICATORS OF PALEOCLIMATE CHANGE
  - TERRESTRIAL PALEOBOTANIC DATA SERVE AS INDICATORS OF PALEOCLIMATE
  - CLIMATOLOGICAL MODELING WILL BE USED TO STUDY PRECIPITATION IN SOUTHERN GREAT BASIN
- **WHAT WILL BE THE IMPACT OF FUTURE CLIMATE CHANGES ON GROUND-WATER HYDROLOGY?**

SUMMARY

- THE MAJOR GEOLOGIC CHARACTERISTICS AND QUESTIONS ABOUT THE YUCCA MOUNTAIN SITE HAVE BEEN DISCUSSED

- FOLLOWING DISCUSSIONS TO DESCRIBE SURFACE AND SUBSURFACE SITE CHARACTERIZATION TESTS

- HOW INFORMATION COLLECTED DURING THE SITE CHARACTERIZATION PROGRAM WILL BE USED TO PROVIDE A "REASONABLE ASSURANCE" THAT WASTE CAN BE ISOLATED FOR 10,000 YEARS IS THE SUBJECT OF THE LAST PRESENTATION

U.S. DEPARTMENT OF ENERGY

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YUCCA MOUNTAIN

OVERVIEW OF NEAR-TERM SITE CHARACTERIZATION ACTIVITIES

PRESENTED BY

CARL GERTZ
MANAGER, YUCCA MOUNTAIN PROJECT
U.S. DEPARTMENT OF ENERGY

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SITE CHARACTERIZATION PLAN TO BE RELEASED BY THE END OF DECEMBER

- SCP REQUIRED BY NWPA SUBSECTION 113
- PUBLIC HEARINGS ON THE SCP REQUIRED BY NWPA SUBSECTION 113(b)(2)

SCP HEARINGS AND COMMENT PROCESS

- SCP TO BE THE MAJOR TOPIC OF YUCCA MOUNTAIN PROJECT UPDATE MEETINGS IN FEBRUARY
  - BEATTY
  - LAS VEGAS
  - RENO
  - CALIENTE

- STATE AND LOCAL OFFICIALS MAY REQUEST INDIVIDUAL BRIEFINGS

- PUBLIC HEARINGS ON SCP SCHEDULED IN MARCH
  - AMARGOSA VALLEY
  - LAS VEGAS
  - RENO

SCP HEARINGS AND COMMENT PROCESS

(CONTINUED)

- COMMENTS ON SCP EXPECTED FROM:
  - NRC (SITE CHARACTERIZATION ANALYSIS) JUNE '89
    * ESF COMMENTS EXPECTED MARCH '89
  - UTILITIES
  - STATE OF NEVADA
  - LOCAL GOVERNMENTS
  - PUBLIC

- COMMENTS WILL BE CONSIDERED AND ADDRESSED THROUGH REVISIONS IN PLANS FOR CHARACTERIZING THE SITE AS REPORTED IN SEMI-ANNUAL PROGRESS REPORTS

ONGOING ACTIVITIES

SITE CHARACTERIZATION ACTIVITIES DEFINED AS:

"THOSE RESEARCH ACTIVITIES, WHETHER IN THE FIELD OR IN THE LABORATORY, THAT ARE UNDERTAKEN TO ESTABLISH THE GEOLOGIC CONDITION AND THE RANGE OF PARAMETERS RELEVANT TO AN EVALUATION OF THE SUITABILITY OF A CANDIDATE SITE" (NWPA, 1982)

"ONGOING ACTIVITIES": SITE CHARACTERIZATION ACTIVITIES THAT WERE ONGOING WHEN YUCCA MOUNTAIN WAS SELECTED AS A CANDIDATE SITE ON MAY 28, 1986.

PREREQUISITES EXIST FOR INITIATION OF OTHER SITE CHARACTERIZATION ACTIVITIES

ONGOING ACTIVITIES

(CONTINUED)

HYDROLOGIC ACTIVITIES

- MONITOR CONDITIONS IN EXISTING BOREHOLES; INSTRUMENT EXISTING BOREHOLES TO INITIATE MONITORING
- MONITOR STREAM-FLOW GAGES
- OBSERVE DEBRIS-FLOW MOVEMENTS
- MONITOR EROSION OCCURING IN WASHES
- MEASURE PRECIPITATION, INFILTRATION, AND AIR & SOIL TEMPERATURE
- LABORATORY TESTS OF CORE OR CRUSHED TUFF

ONGOING ACTIVITIES

(CONTINUED)

GEOLOGIC ACTIVITIES

- COLLECT & ANALYZE DATA FROM 54 SEISMOMETERS
- SURVEY BENCHMARKS TO DETERMINE RATES OF TECTONIC MOVEMENT
- SEASONAL DETERMINATION OF SOIL CHARACTERISTICS
- SAMPLING & MAPPING OF EXISTING TRENCHES
- GEOLOGIC MAPPING & COLLECTION OF SAMPLES

ONGOING ACTIVITIES

(CONTINUED)

METEOROLOGICAL ACTIVITIES

- COLLECT & ANALYZE DATA FROM 5 METEOROLOGICAL TOWERS

GEOMECHANICAL ACTIVITIES

- LABORATORY TESTING AND ANALYSIS OF THERMAL AND MECHANICAL PROPERTIES

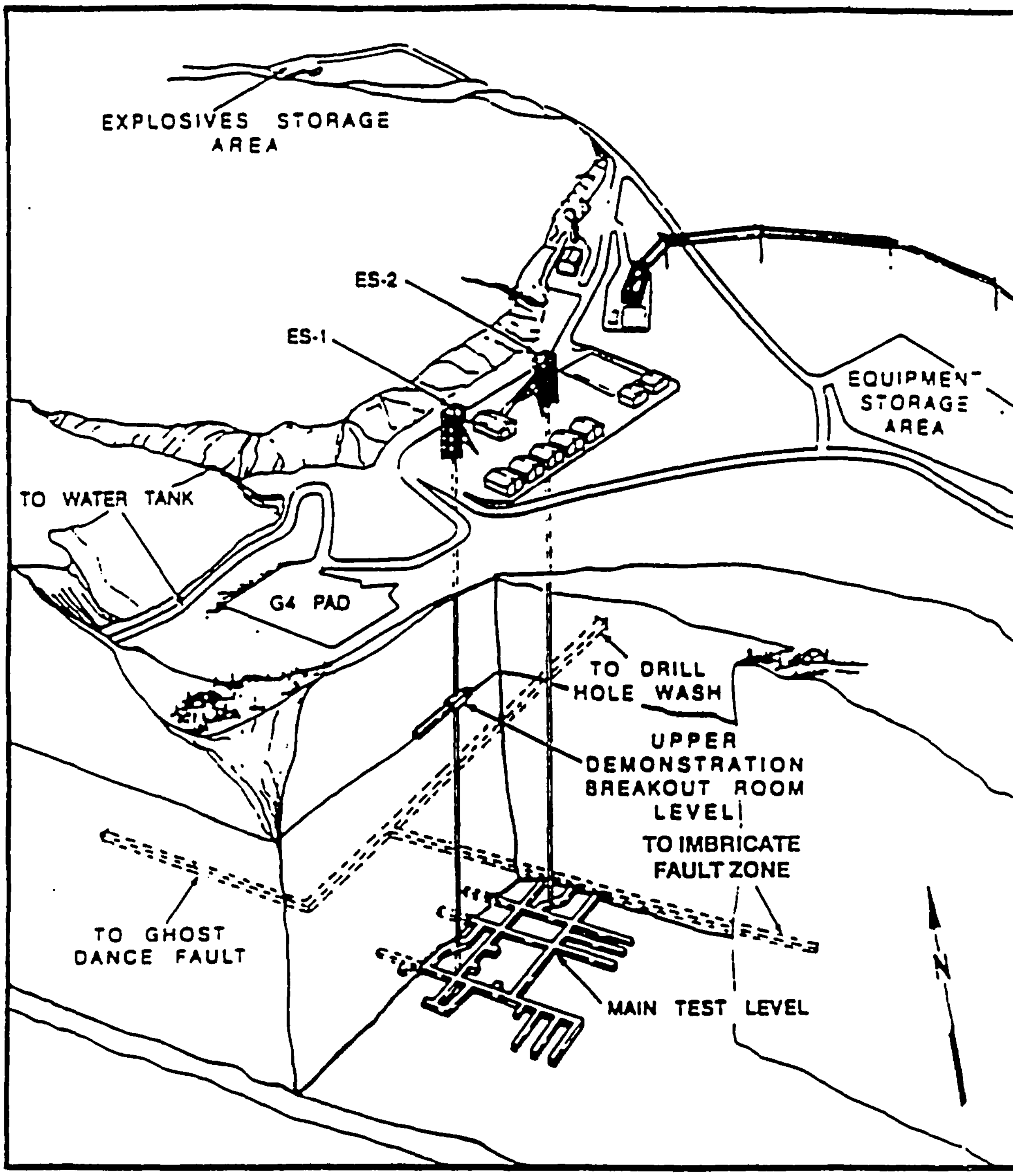
GEOCHEMICAL ACTIVITIES

- LABORATORY TESTS OF SHORT-TERM ROCK-WATER INTERACTIONS
- LABORATORY TESTS TO DETERMINE
  - DYNAMIC TRANSPORT FACTORS
  - MINERALOGY-PETROLOGY VARIABILITY
  - SORPTION COEFFICIENTS
  - NATURAL ISOTOPE RATIOS
  - GROUNDWATER CHEMISTRY

THE DOE APPROACH TO NEW SITE CHARACTERIZATION ACTIVITIES INCLUDES SURFACE BASED TESTS AND EXPLORATORY SHAFT TESTS

- **ESF TESTS TO INVESTIGATE:**
  - PROCESSES & PHENOMENA CONTRIBUTING TO WASTE ISOLATION PERFORMANCE
  - THE EFFECTS OF ESF CONSTRUCTION
  - IN SITU CONDITIONS AT THE ESF LOCATION

- **SURFACE-BASED TESTS TO:**
  - EXTEND THE RESULTS OF ESF TESTS TO THE ENTIRE SITE AREA
  - SYSTEMATICALLY & STATISTICALLY SAMPLE FOR VARIABILITY IN SITE PARAMETERS
  - SAMPLE SPECIFIC FEATURES THAT MAY YIELD EXTREME VALUES OF STRUCTURAL OR STATE VARIABLES



CONCEPTUAL ILLUSTRATION OF THE EXPLORATORY SHAFT FACILITY

PROJECT MUST MEET PREREQUISITES FOR STARTING NEW SITE CHARACTERIZATION ACTIVITIES

- LAND ACCESS
- ENVIRONMENTAL COMPLIANCE AND PERMITTING
- SCP REVIEW BY NRC
- STUDY PLANS REVIEW BY NRC
- ESF DESIGN PARTIALLY COMPLETE
- FULLY QUALIFIED QA PROGRAM ACCEPTED BY NRC

MINING CLAIMS

- RESULT OF ASSAYS DONE BY BLM GEOLOGISTS
  - NO SAMPLE SHOWED SIGNIFICANT AMOUNTS OF GOLD OR SILVER
  - GREATEST QUANTITY OF GOLD FOUND WAS 5 PPB
  - ECONOMIC AMOUNT OF GOLD IS CONSIDERED TO BE 1,000 PPB (0.03 TROY OUNCES/TON OF ORE)

ENVIRONMENTAL PERMITS FOR SITE CHARACTERIZATION

STATUTES	AGENCY	REQUIRED ACTION	COMPLETE PREPARATION OF
1. CLEAN AIR ACT	EPA/NDEP	• AIR QUALITY PERMIT FOR LAND DISTURBANCE (FILED)	JAN 1988
		• REGISTRATION CERTIFICATE/ OPERATING PERMIT FOR POINT-SOURCE EMISSIONS, e.g. BATCH PLANT	JAN 1989
2. CLEAN WATER ACT	EPA/NDEP	• SANITARY SEWAGE DISPOSAL PERMIT	JAN 1989
		• NPDES/ZERO DISCHARGE PERMIT	JAN 1989
3. RESOURCE CONSERVATION AND RECOVERY ACT	EPA/NDEP	• EPA REGISTRATION AND I.D. NUMBER	JAN 1989
4. SAFE DRINKING WATER ACT	EPA/NDH/NDEP	• DRINKING WATER SYSTEM PERMIT	JAN 1989
		• UNDERGROUND INJECTION CONTROL PERMIT (AT HQ FOR REVIEW)	DEC 1989
5. GROUNDWATER USE	NSE	• GROUNDWATER APPROPRIATION PERMIT (WELL J-13) (FILED)	JUL 1988

SCP REVIEW BY NRC

- CONGRESS REQUIRES (NWPA SECTION 113)
  - DOE TO "FULLY CONSIDER" NRC'S COMMENTS
- NRC PROCESS (10 CFR 60) REQUIRES:
  - NRC TO REQUEST THE STATE AND INDIAN TRIBES
    * TO PRESENT THEIR VIEWS ON THE SCP
    * TO MAKE SUGGESTIONS REGARDING NRC COMMENTS
  - NRC TO MAKE STAFF AVAILABLE TO CONSULT WITH STATE
  - NRC TO PREPARE SITE CHARACTERIZATION ANALYSIS (SCA)
    * INCLUDES A STATEMENT OF NO OBJECTION OR SPECIFIC OBJECTIONS, IF APPROPRIATE

SCP REVIEW BY NRC

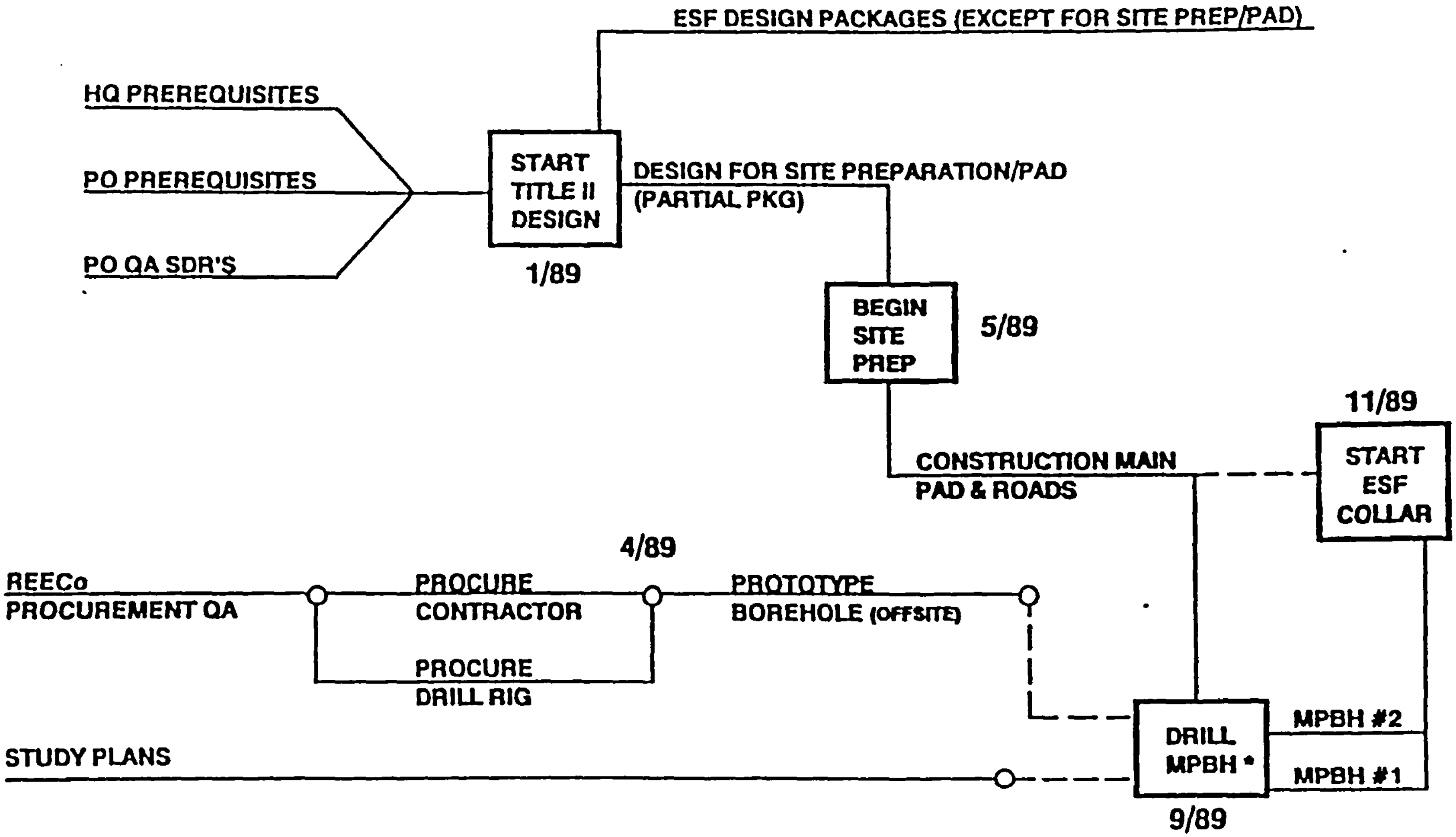
(CONTINUED)

- NOTHING IN SCA CONSTITUTES A COMMITMENT TO ISSUE AN AUTHORIZATION OR LICENSE
- DOE/NRC AGREEMENTS REQUIRE NRC TO COMPLETE SCA 6 MONTHS AFTER RECEIPT OF SCP
  - ESF COMMENTS EXPECTED MARCH 1989
- IN ADDITION, THE NRC MAY ISSUE COMMENTS OR OBJECTIONS AT ANY TIME DURING THE SITE CHARACTERIZATION PROCESS

STUDY PLANS REVIEW BY NRC

- STUDY PLANS "SUPPORT" THE SCP
- CREATED TO HELP DEFINE AN APPROPRIATE LEVEL OF DETAIL FOR CHARACTERIZATION PLANS DESCRIBED IN THE SCP
- DOE & NRC MET AND AGREED ON THE CONTENT, LEVEL OF DETAIL, AND SCHEDULE FOR STUDY PLAN SUBMITTAL AND REVIEW MAY, 1986
  - MEETING SCHEDULED DEC. 15,16 TO REVIEW THIS AGREEMENT AND THE TWO STUDY PLANS ALREADY SUBMITTED
- STUDY PLANS TO BE PROVIDED TO NRC 6 MONTHS BEFORE STUDIES ARE INITIATED
- NRC TO NOTIFY DOE OF "MAJOR CONCERNS" DURING FIRST 3 MONTHS OF REVIEW

SIMPLIFIED NETWORK
ESF CONSTRUCTION START



* MPBH - MULTIPURPOSE BORE HOLE
1100' DEEP, 7" DIAMETER

U S DEPARTMENT OF ENERGY

OCRWM

YUCCA MOUNTAIN

SUMMARY OF SURFACE BASED TESTING PROGRAM

PRESENTED BY

JEAN L. YOUNKER

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

DECEMBER 13, 1988

UNITED STATES DEPARTMENT OF ENERGY

NEVADA OPERATIONS OFFICE/WASTE MANAGEMENT PROJECT OFFICE

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THE SITE CHARACTERIZATION TESTING PROGRAM CONSISTS OF THOSE ACTIVITIES UNDERTAKEN TO ESTABLISH THE GEOLOGIC CONDITIONS AND HISTORY OF THE SITE

- THE PROGRAM IS DIVIDED INTO TWO PARTS:
  - SURFACE-BASED TESTING
  - TESTING IN THE EXPLORATORY SHAFT FACILITY (ESF)

- THESE ACTIVITIES INCLUDE:
  - INTENSE, CLOSE-IN STUDIES OF SITE CHARACTERISTICS
  - STUDIES OVER A LARGER AREA OF THE PARAMETERS NEEDED TO DEVELOP REGIONAL MODELS
  - TOPICAL AREAS INCLUDE GEOLOGY, HYDROLOGY AND GEOCHEMISTRY

- THERE ARE A TOTAL OF 106 STUDY PLANS
  - 14 ARE FOR ESF TESTS
  - 92 ARE FOR SURFACE-BASED TESTS

WHY IS SURFACE-BASED TESTING NEEDED?

- TO OBTAIN ADEQUATE INFORMATION TO PREDICT THE SPATIAL VARIABILITY IN IMPORTANT ROCK PROPERTIES THROUGHOUT THE ENTIRE REPOSITORY AREA

- TO OBTAIN INFORMATION TO CHARACTERIZE THE CALICO HILLS UNIT, THE PRIMARY UNIT RELIED UPON FOR WASTE ISOLATION. (THE EXPLORATORY SHAFT WILL NOT PENETRATE THE CALICO HILLS UNIT ACCORDING TO CURRENT PLANS)

THE SURFACE-BASED TESTING PROGRAM IS A SERIES OF INVESTIGATIONS DESIGNED TO CHARACTERIZE THE GEOLOGIC ENVIRONMENT THROUGHOUT THE REPOSITORY AREA

- THE TYPES OF INVESTIGATIONS INCLUDE GEOLOGY, VOLCANOLOGY, HYDROLOGY, TECTONICS, AND GEOENGINEERING STUDIES

- THE INVESTIGATIONS ARE CONDUCTED THROUGH A SERIES OF DRILL HOLES, TRENCHES, GEOPHYSICAL SURVEYS, MONITORING STATIONS, AND LABORATORY WORK

IN GENERAL, FIVE TECHNIQUES WILL BE USED IN THE SURFACE-BASED TESTING PROGRAM

- DRILL HOLES ALLOW THE INVESTIGATION OF A DEEP BUT SPATIALLY SMALL BODY OF ROCK

- TRENCHES ARE USED TO INVESTIGATE SURFACE TRACES OF FAULTS

- GEOPHYSICAL SURVEYS ALLOW INDIRECT CHARACTERIZATION OF SUBSURFACE GEOLOGIC STRUCTURE, THE NATURE OF SUBSURFACE DEPOSITS, AND SUBSURFACE CONDITIONS THROUGHOUT THE POTENTIAL HOST ROCK

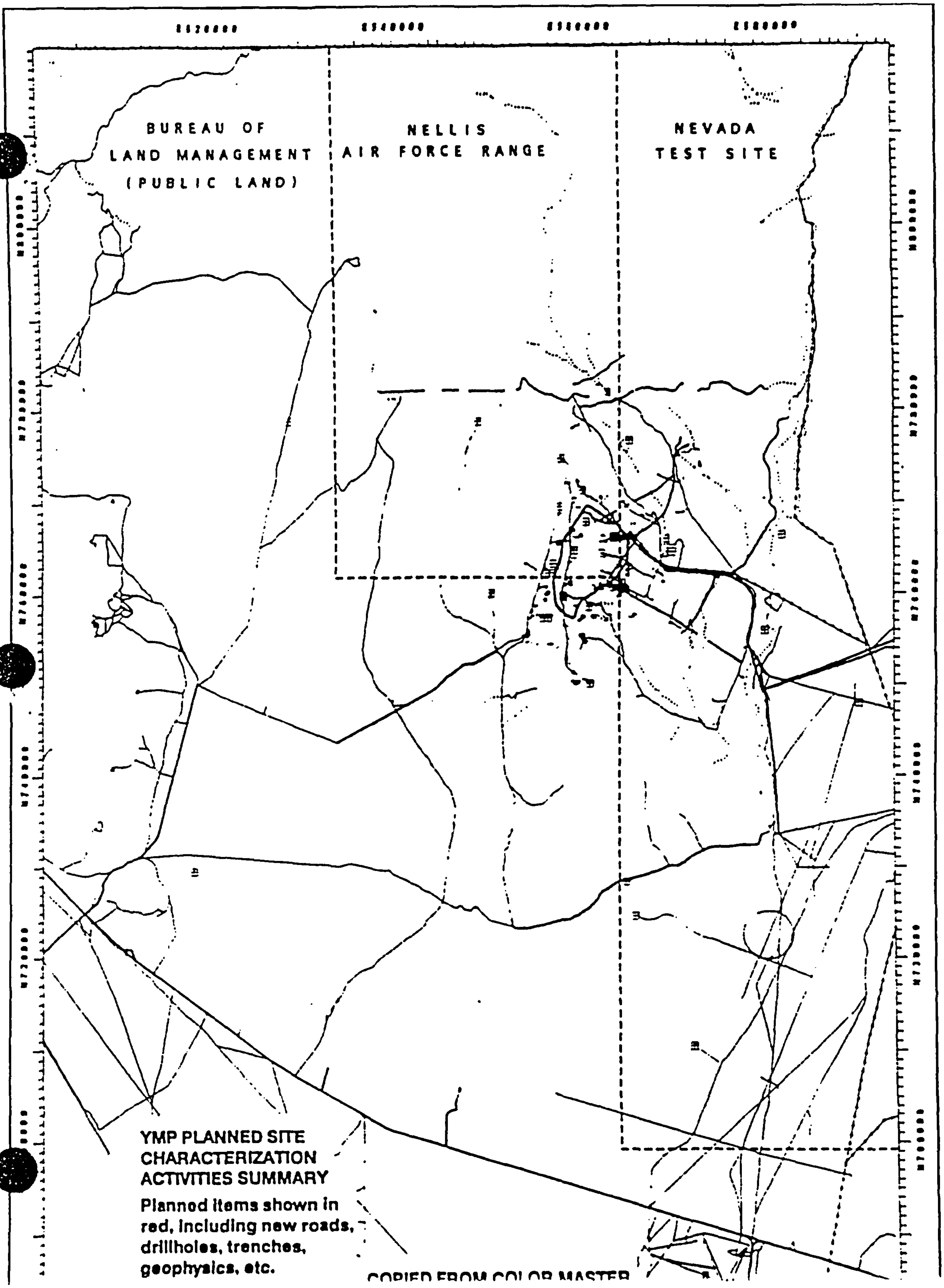
- MONITORING STATIONS HELP TO CHARACTERIZE LONG-TERM BEHAVIOR OF THE SURFACE AND GROUNDWATER HYDROLOGIC SYSTEMS, INFILTRATION PROCESSES, SEISMICITY AND GEODESY

- LABORATORY STUDIES ARE DESIGNED TO QUANTITATIVELY INVESTIGATE THE THERMOMECHANICAL, HYDROLOGIC, AND GEOCHEMICAL BEHAVIOR OF INDIVIDUAL ROCK SAMPLES

THE MAJOR PART OF THE SURFACE-BASED TESTING PROGRAM IS THE DRILLING PROGRAM

TYPES OF DRILLING PROGRAM	NUMBER OF HOLES	DIAMETER	DEPTH
DEEP UNSATURATED ZONE	17	7" - 12"	1500' - 2500'
SHALLOW UNSATURATED ZONE	279	3.98" - 6"	5' - 500'
SATURATED ZONE	6	6.25" - 8.75"	3000'
SYSTEMATIC DRILLING	12	3.98"	2000'
WATER TABLE	8	7" - 12"	1000' - 2000'
VOLCANIC	4	6.25"	1000'
GEOLOGIC COREHOLES	3	3.98"	5000'
TOTAL	329		

SBTPDRIL.CPG/10-26 88



YMP PLANNED SITE CHARACTERIZATION ACTIVITIES SUMMARY

Planned items shown in red, including new roads, drillholes, trenches, geophysics, etc.

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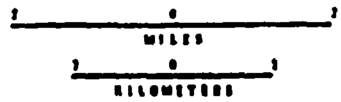
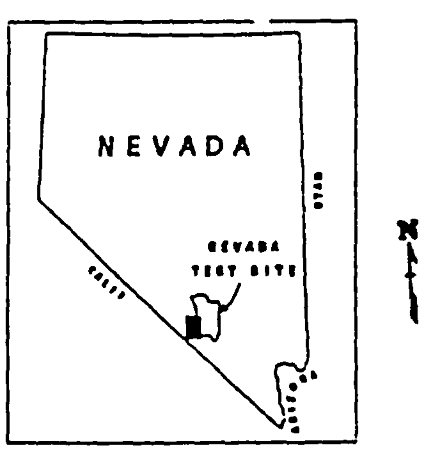
YUCCA MOUNTAIN PROJECT
PROPOSED ACTIVITIES
(SHOWN IN RED)
MAP 3



LEGEND

- DRILL PADS
- TRENCHES AND TEST PITS
- DRILL HOLES NOT REQUIRING PADS
- MONITORING STATIONS
- MEDIUM DUTY ROADS
- LIGHT DUTY ROADS
- UNIMPROVED ROADS
- UNIMPROVED ROADS (PROPOSED)
- TRAILS
- TRAILS (PROPOSED)
- SHALLOW SEISMIC REFLECTION LINES (PROPOSED)
- RAILROADS
- POWERLINES
- WATER PIPE LINES
- CONCEPTUAL PERIMETER DRIFT BOUNDARY



SOURCES:

[illegible] 1:24,000 USGS TOPOGRAPHIC MAPS
[illegible] 1:24,000 USGS ORTHOPHOTO MAPS
[illegible] 1:100,000 USGS TOPOGRAPHIC MAPS
[illegible] AND [illegible] 1:24,000 AERIAL PHOTOGRAPHY
PROPOSED ACTIVITY LOCATIONS FROM DRAFT SITE CHARACTERIZATION PLAN - AUGUST [illegible]
GRID TICKS BASED ON NEVADA STATE COORDINATE SYSTEM, CENTRAL ZONE
MAP COMPILED IN OCTOBER [illegible]

YMP-[illegible]-004.3

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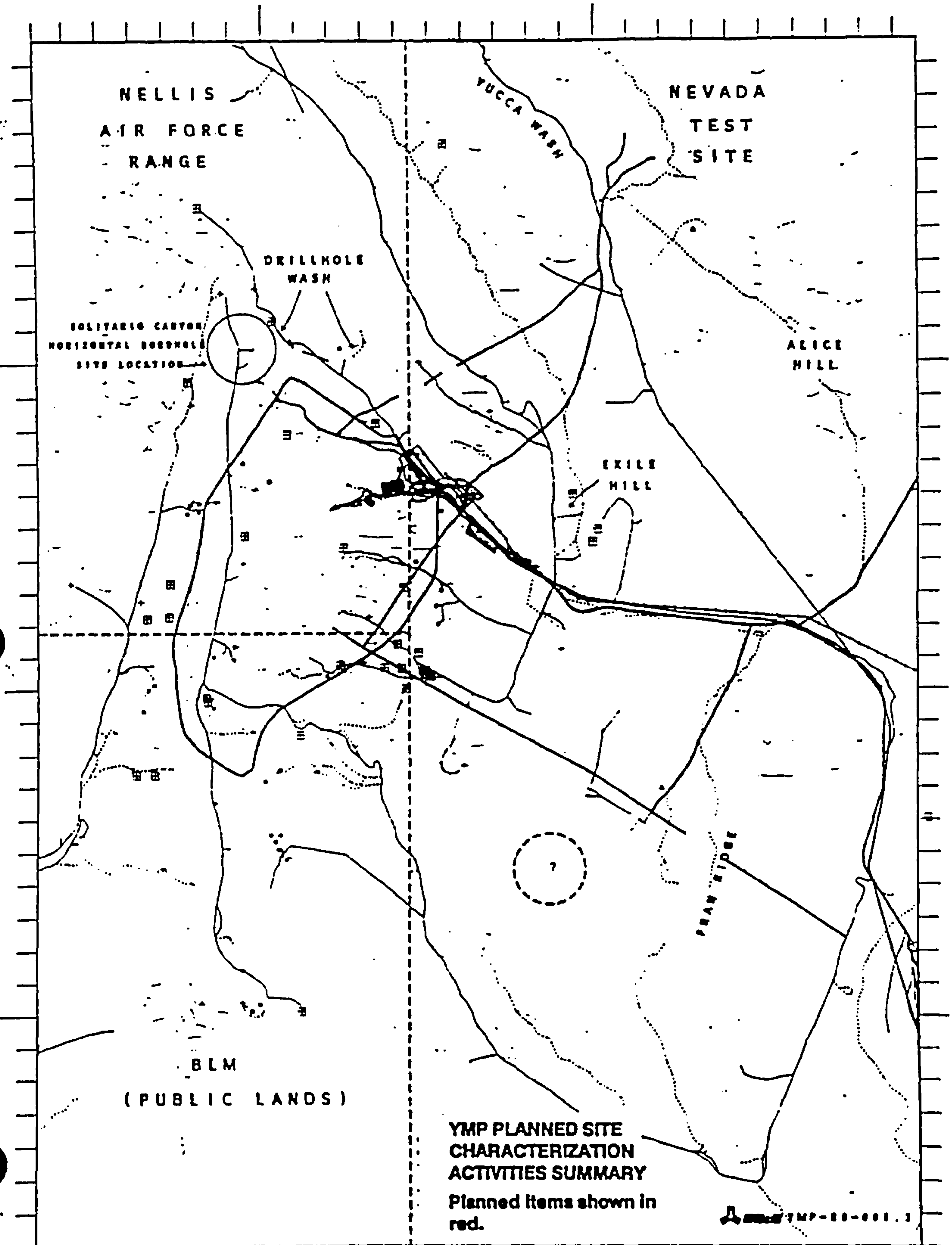

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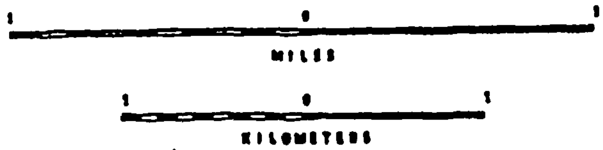
EXPANDED VIEW OF PROPOSED ACTIVITIES

MAP 4

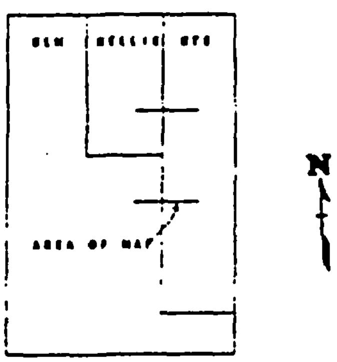


LEGEND

- DRILL PADS
- TRENCHES AND TEST PITS
- DRILL HOLES NOT REQUIRING PADS
- MONITORING STATIONS
- ? SOUTHERN TRACER COMPLEX

- LIGHT DUTY ROADS
- UNIMPROVED ROADS
- UNIMPROVED ROADS (PROPOSED)
- TRAILS
- TRAILS (PROPOSED)
- SHALLOW SEISMIC REFLECTION LINES (PROPOSED)
- POWERLINES
- WATER PIPE LINES

- EXPLORATORY SHAFT FACILITY (ESF)
- CONCEPTUAL PERIMETER DRIFT BOUNDARY



SOURCES:

1986 1:24,000 USGS TOPOGRAPHIC MAPS
1976 1:24,000 USGS ORTHOPHOTO MAPS
1983 1:100,000 USGS TOPOGRAPHIC MAPS
7/1986 AND 8/1987 1:24,000 AERIAL PHOTOGRAPHY
PROPOSED ACTIVITY LOCATIONS FROM DRAFT SITE CHARACTERIZATION PLAN - AUGUST 1987
GRID TICKS BASED ON NEVADA STATE COORDINATE SYSTEM, CENTRAL ZONE
MAP COMPILED IN OCTOBER 1988

YMP-89-005.3

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UNSATURATED ZONE DRILLING, TESTING AND MONITORING IS DESIGNED TO CHARACTERIZE THE HYDROLOGIC BEHAVIOR OF ROCK UNITS ABOVE THE WATER TABLE

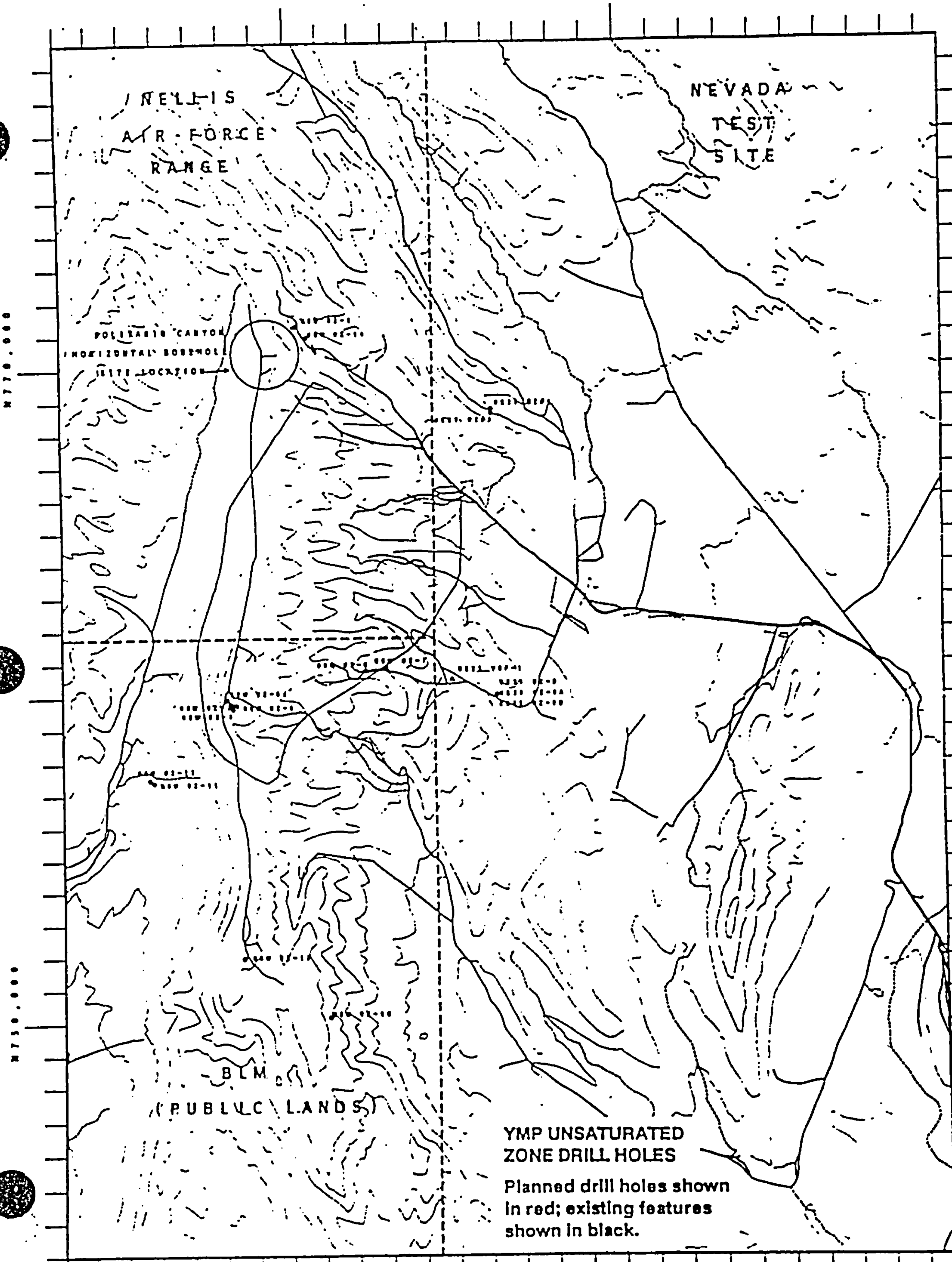
- IT IS NEEDED TO UNDERSTAND THE MOVEMENT OF BOTH LIQUID WATER DOWN TO THE WATER TABLE, AND WATER VAPOR AND AIR MOVEMENT WITHIN THE UNSATURATED ZONE

- IT INVOLVES DRILLING TO SAMPLE THE STATE OF MOISTURE IN THE UNSATURATED SECTION, TO TEST THE FLOW PROPERTIES OF FRACTERED ROCK UNITS PENETRATED, AND TO EMPLACE MONITORING INSTRUMENTS TO INVESTIGATE LONG-TERM BEHAVIOR OF THE HYDROLOGIC SYSTEM THROUGHOUT THE SITE AREA

UNSATURATED ZONE DRILLING, TESTING AND MONITORING IS DESIGNED TO CHARACTERIZE THE HYDROLOGIC BEHAVIOR OF ROCK UNITS ABOVE THE WATER TABLE

(CONTINUED)

- PLANNED EXPERIMENTS WILL ALSO SIMULATE RAINFALL EVENTS IN PREPARED TEST LOCATIONS DISTRIBUTED THROUGHOUT THE YUCCA MOUNTAIN AREA AS PART OF THE STUDY OF SURFACE INFILTRATION PROCESSES



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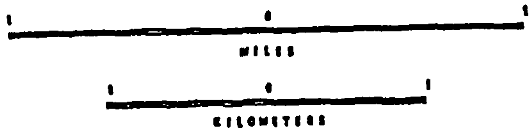
SURFACE BASED INVESTIGATIONS PLAN

UNSATURATED ZONE DRILLHOLES



LEGEND

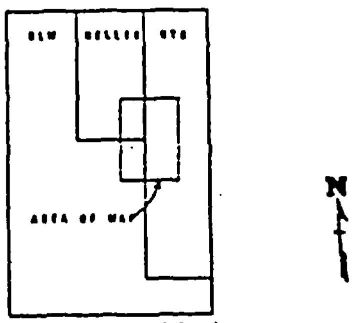
- UNSATURATED ZONE HYDROLOGIC - EXISTING
- UNSATURATED ZONE HYDROLOGIC - PROPOSED
- ▲ VERTICAL SEISMIC PROFILE SUPPORT HOLE PROPOSED

- LIGHT DUTY ROADS
- UNIMPROVED ROADS
- TRAILS

- PERIMETER DRIFT BOUNDARY

SOURCES:

10 FOOT ELEVATION CONTOURS - USGS 1:100,000 MAP
[illegible] 1:24,000 USGS TOPOGRAPHIC MAPS
[illegible] 1:24,000 USGS ORTHOPHOTO MAPS
[illegible] 1:100,000 USGS TOPOGRAPHIC MAPS
7/[illegible] AND [illegible]/[illegible] 1:24,000 AERIAL PHOTOGRAPHY
GRID TICKS BASED ON NEVADA STATE COORDINATE SYSTEM, CENTRAL ZONE
MAP COMPILED IN APRIL 1988



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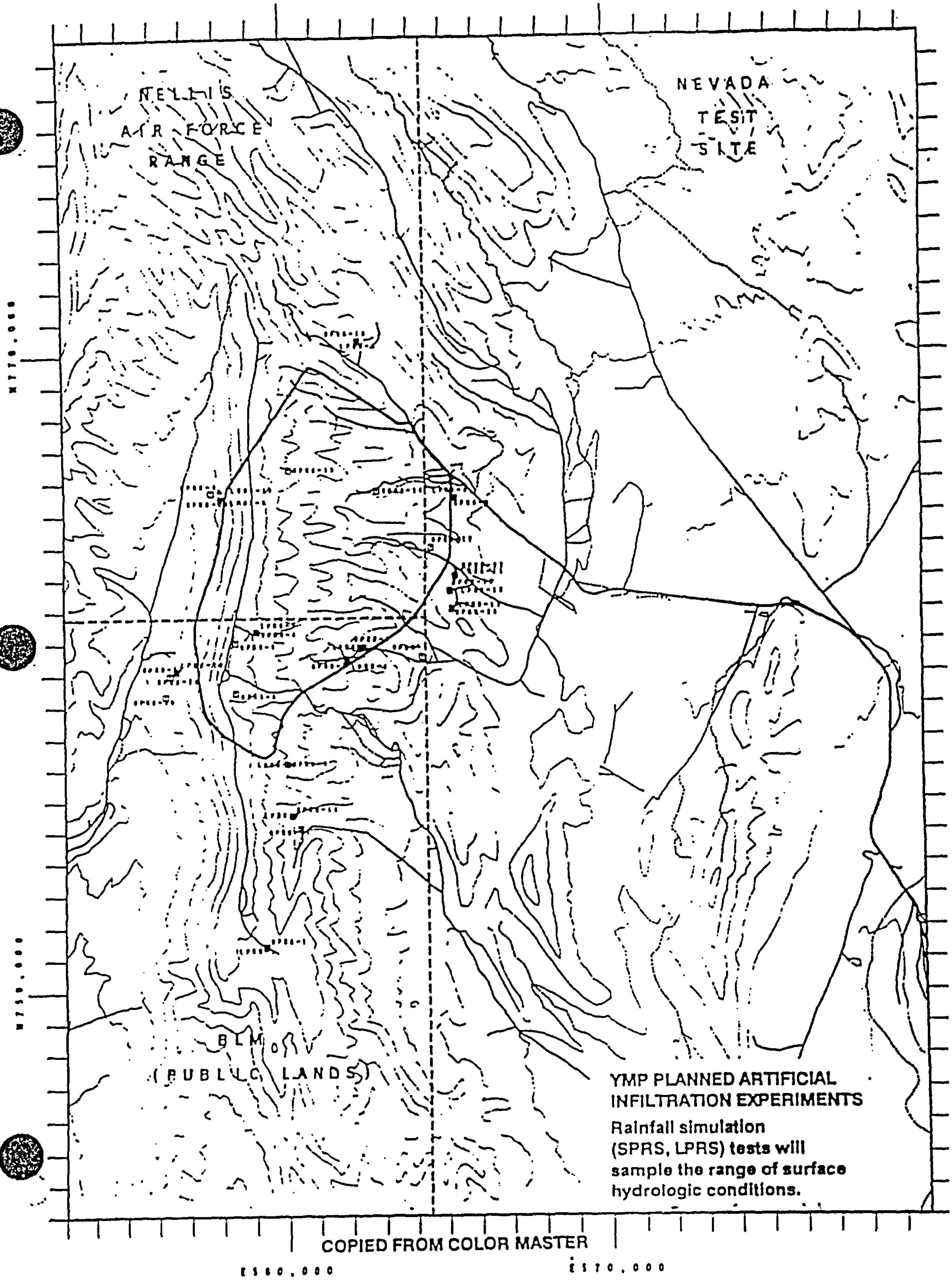

YMP PLANNED ARTIFICIAL INFILTRATION EXPERIMENTS

Rainfall simulation (SPRS, LPRS) tests will sample the range of surface hydrologic conditions.

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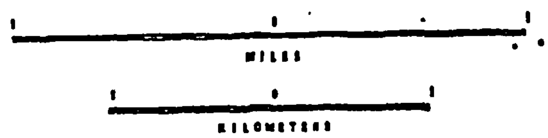
SURFACE BASED INVESTIGATIONS PLAN

PROPOSED RAINFALL SIMULATION STUDIES

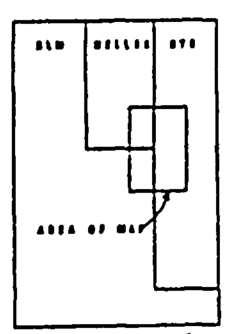


LEGEND

- ▲ LARGE-PLOT RAINFALL SIMULATION PROPOSED
- ▢ SMALL-PLOT RAINFALL SIMULATION PROPOSED
- LIGHT DUTY ROADS
- UNIMPROVED ROADS
- TRAILS
- PERIMETER DRIFT BOUNDARY

SOURCES:

[illegible] FOOT ELEVATION CONTOURS – USGS 1:[illegible] MAP
[illegible] 1:24,000 USGS TOPOGRAPHIC MAPS
[illegible] 1:24,000 USGS ORTHOPHOTO MAPS
[illegible] 1:[illegible] USGS TOPOGRAPHIC MAPS
7/[illegible] AND [illegible]/[illegible] 1:24,000 AERIAL PHOTOGRAPHY
GRID TICKS BASED ON NEVADA STATE COORDINATE SYSTEM, CENTRAL ZONE
MAP COMPILED IN APRIL [illegible]



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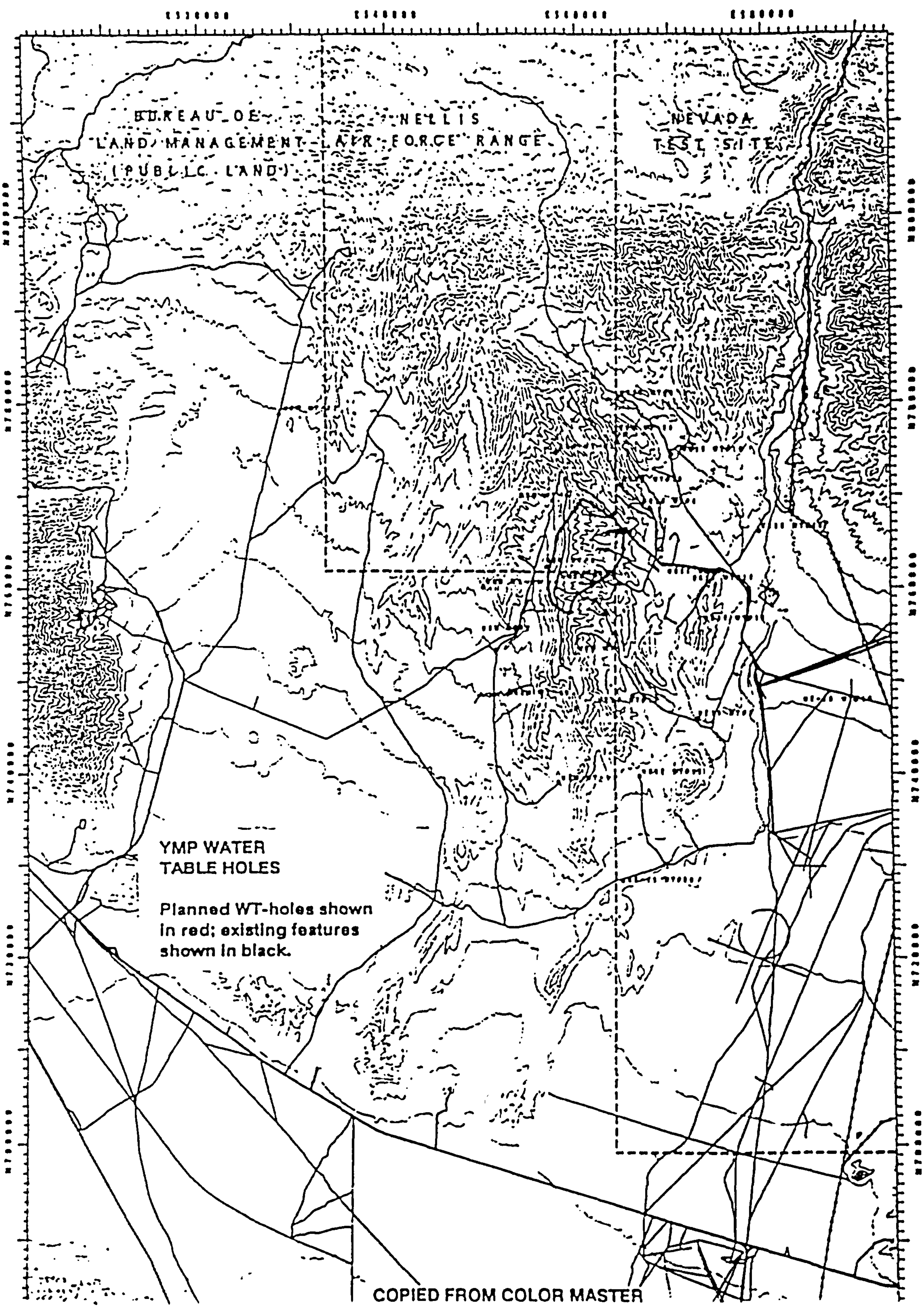
SATURATED ZONE DRILLING AND TESTING IS NEEDED TO UNDERSTAND THE MOVEMENT OF GROUNDWATER AND THE NATURE OF RADIONUCLIDE TRANSPORT BELOW THE WATER TABLE UNDER THE REPOSITORY

- IT INVOLVES DRILLING, SAMPLING, AND TESTING A SERIES OF DRILL HOLES. SINGLE-WELL AND MULTI-WELL FLOW TESTING WILL BE PERFORMED; CHEMICAL TRACERS WILL BE UTILIZED

WATER TABLE DRILLING, TESTING AND MONITORING IS DESIGNED TO CHARACTERIZE THE WATER TABLE ELEVATION AND MONITOR ITS FLUCTUATION OVER A BROAD AREA

- HOLES WILL BE USED TO SAMPLE THE GROUNDWATER FOR CHEMICAL ANALYSIS AND TO EMPLACE INSTRUMENTS TO MONITOR FLUCTUATION OF THE WATER TABLE



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SURFACE BASED INVESTIGATIONS PLAN

WATER TABLE HOLES

MILES

KILOMETERS

LEGEND

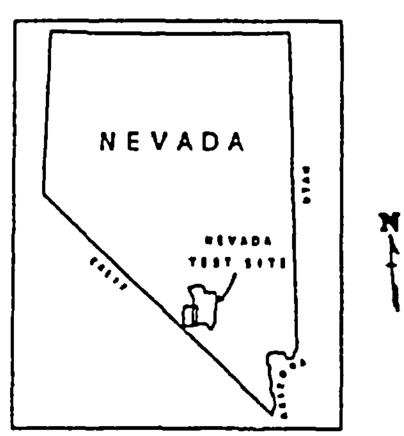
- WATER TABLE HOLES EXISTING
- WATER TABLE HOLES PROPOSED

- MEDIUM DUTY ROADS
- LIGHT DUTY ROADS
- UNIMPROVED ROADS
- TRAILS
- RAILROADS
- POWERLINES

- PERIMETER DRIFT BOUNDARY

SOURCES:

[illegible] FOOT ELEVATION CONTOURS – USGS 1:[illegible] MAP
[illegible] 1:[illegible] USGS TOPOGRAPHIC MAPS
[illegible] 1:[illegible] USGS ORTHOPHOTO MAPS
[illegible] 1:[illegible] USGS TOPOGRAPHIC MAP
[illegible] AND [illegible] 1:[illegible] AERIAL PHOTOGRAPHY
GRID TICKS BASED ON NEVADA STATE COORDINATE SYSTEM, CENTRAL ZONE
MAP COMPILED IN APRIL [illegible]



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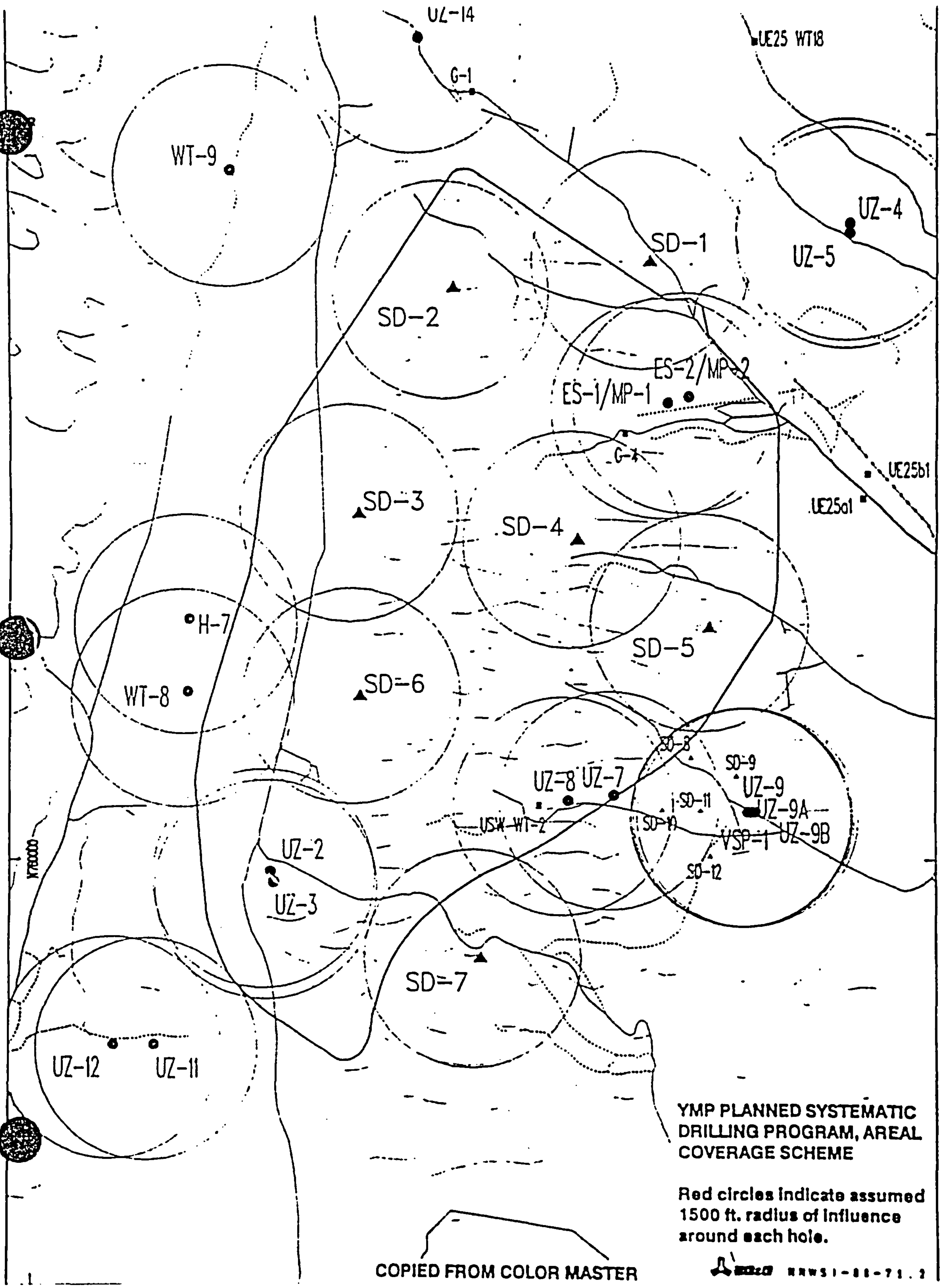
SYSTEMATIC DRILLING INVESTIGATES THE CHARACTER OF A LARGE BODY OF ROCK BY STATISTICAL ANALYSIS OF DATA FROM A LIMITED NUMBER OF DRILL HOLES

- A SERIES OF HOLES WILL BE DRILLED AT YUCCA MOUNTAIN TO CHARACTERIZE SYSTEMATIC, PREDICTABLE VARIATION IN THE STRATIGRAPHY, PHYSICAL PROPERTIES, AND OTHER PARAMETERS AS APPROPRIATE

- SYSTEMATIC DRILLING WILL HELP FILL IN GAPS IN THE SAMPLING COVERAGE OF THE SITE BY DRILL HOLES, AND WILL PROVIDE A BASIS FOR EVALUATING BIAS IN THE SAMPLING STRATEGY FOR YUCCA MOUNTAIN

- STATISTICAL MODELS OF PARAMETER VARIABILITY CAN BE READILY USED FOR PROBABILISTIC ASSESSMENT AND EVALUATION OF REPOSITORY PERFORMANCE

- DISTRIBUTION OF SORPTIVE MINERALS (e.g., ZEOLITES AND CLAYS) WILL BE INVESTIGATED



YMP PLANNED SYSTEMATIC DRILLING PROGRAM, AREAL COVERAGE SCHEME

Red circles indicate assumed 1500 ft. radius of influence around each hole.

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NNWSI PROJECT

SYSTEMATIC DRILLING PROGRAM
AREAL COVERAGE SCHEME

LEGEND

- SYSTEMATIC DRILLING PROGRAM
- FEATURE SAMPLING PROGRAM INTEGRATED WITH SYSTEMATIC PROGRAM
- EXISTING HOLES SUITABLE FOR RESAMPLING
- 1500 FOOT BUFFER
- LIGHT DUTY ROADS
- UNIMPROVED ROADS
- TRAILS
- POWERLINES
- PERIMETER DRIFT BOUNDARY

SOURCES:

10 M ELEVATION CONTOURS – USGS 1:100,000 BEATTY QUAD
1956 1:24,000 USGS TOPOGRAPHIC MAPS
1976 1:24,000 USGS ORTHOPHOTO MAPS
1983 1:100,000 USGS TOPOGRAPHIC MAPS
7/1986 AND 8/1987 1:24,000 AERIAL PHOTOGRAPHY
GRID TICKS BASED ON NEVADA STATE COORDINATE SYSTEM, CENTRAL ZONE
PERIMETER DRIFT BOUNDARY – SNL DRAWING R07003A
MAP COMPILED IN AUGUST 1988

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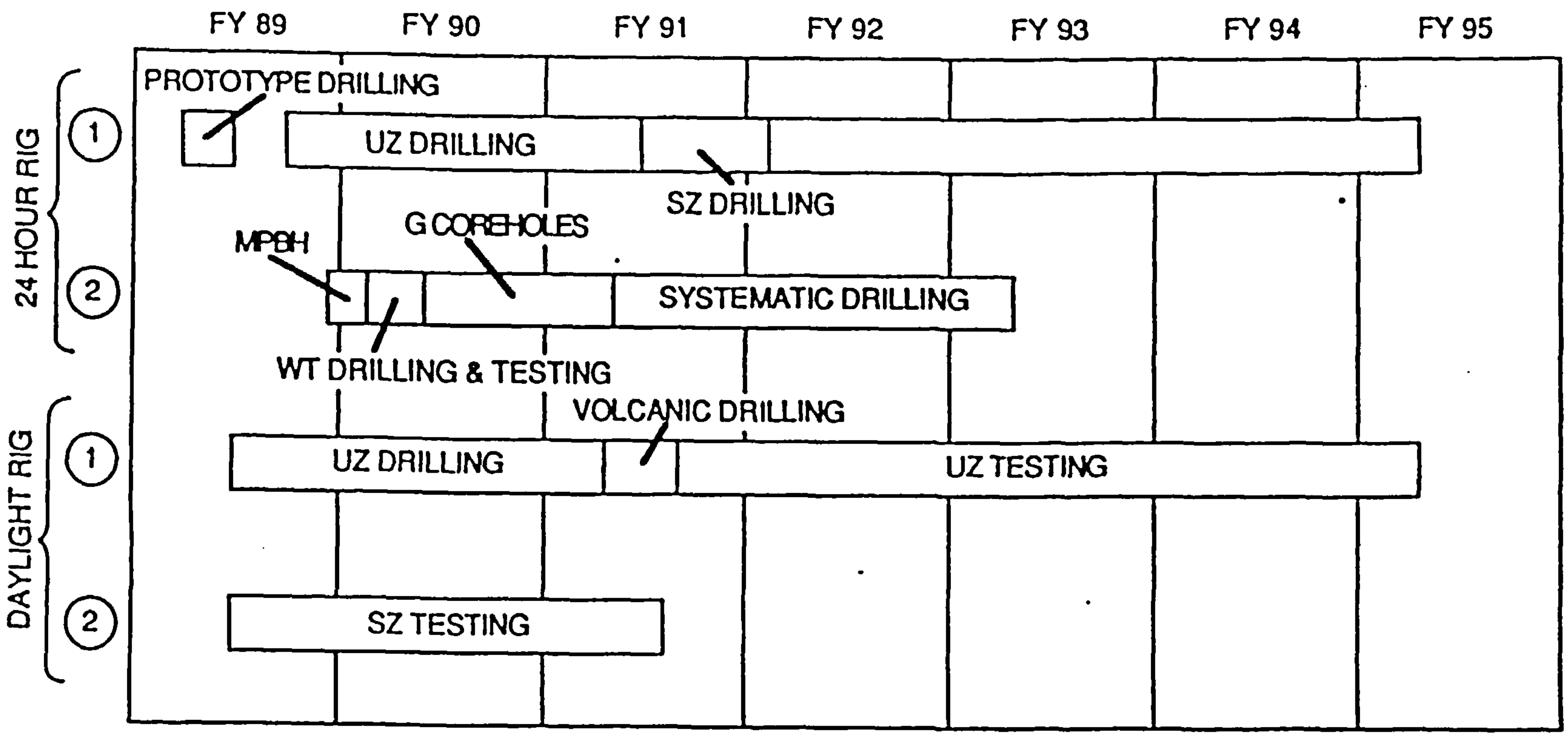
VOLCANIC HAZARDS ASSESSMENT DRILL HOLES

- ASSESSING FUTURE VOLCANIC HAZARDS IS, IN PART, BASED ON UNDERSTANDING THE PAST HISTORY OF VOLCANIC ACTIVITY IN A PARTICULAR AREA
  - SEVERAL BURIED INTRUSIONS OF IGNEOUS ROCK IN THE AMARGOSA VALLEY, DETECTED FROM GEOPHYSICAL INDICATIONS, WILL BE SAMPLED BY DRILL HOLES
- THREE NEW GEOLOGIC CORE HOLES ARE PLANNED TO AUGMENT HOLES DRILLED PRIOR TO SITE CHARACTERIZATION
  - THESE CORE HOLES WILL PROVIDE ADDITIONAL DATA TO CHARACTERIZE THE STRATIGRAPHY, PHYSICAL PROPERTIES AND GEOLOGIC HISTORY OF VOLCANIC ROCK UNITS, INCLUDING THE HOST ROCK, THROUGHOUT THE SITE AREA

SOUTHCENTRAL YUCCA MOUNTAIN, UNSATURATED ZONE UZ-6 DRILL RIG

PROPOSED YUCCA MOUNTAIN PROJECT DRILLING SCHEDULE

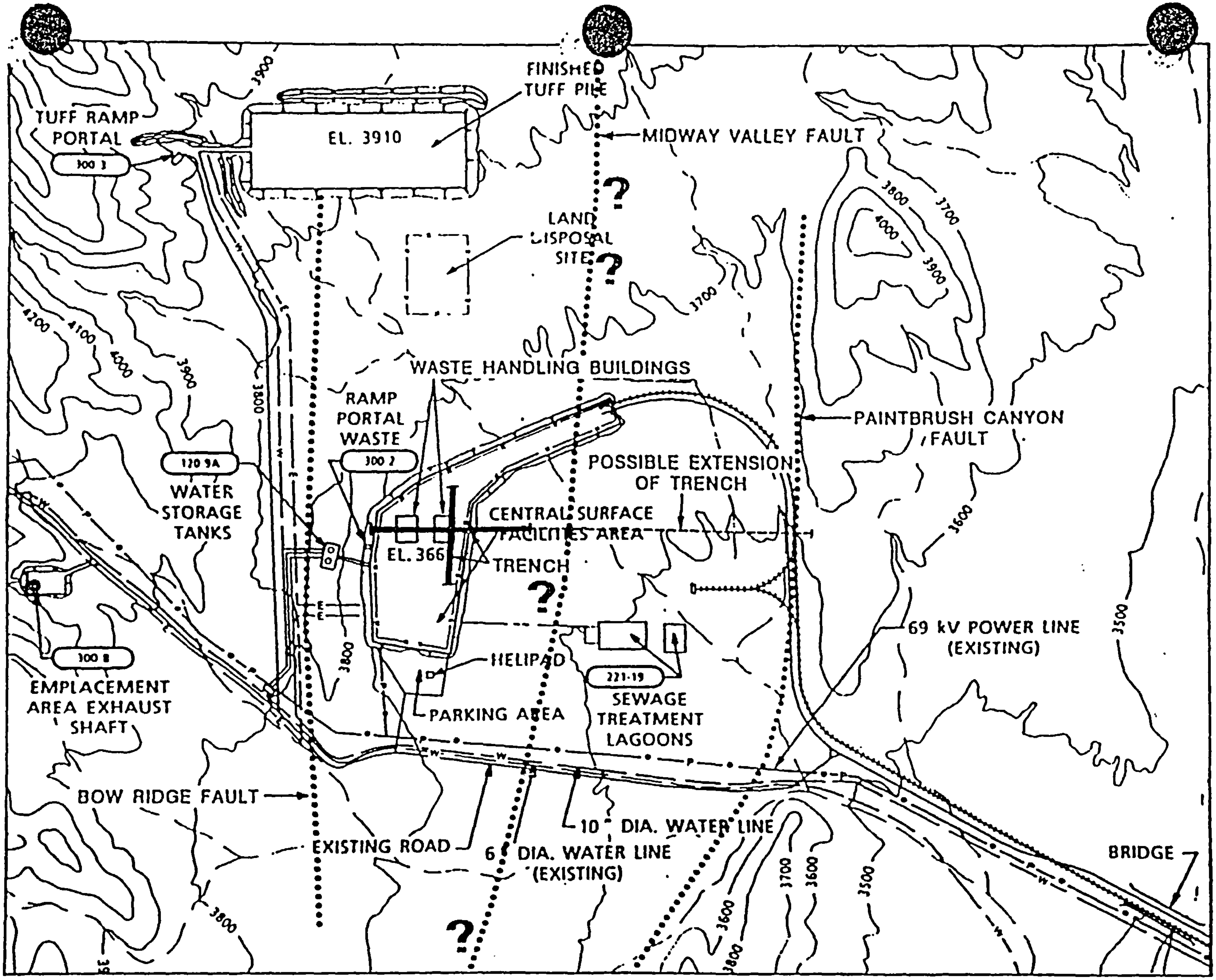


TWO MAJOR TRENCHING PROGRAMS ARE PLANNED FOR THE SITE CHARACTERIZATION PROGRAM

- DATA FROM TRENCHES WILL CHARACTERIZE MAGNITUDE AND HISTORY OF PAST MOVEMENT ON FAULTS THROUGHOUT THE SITE AREA THAT MAY HAVE BEEN ACTIVE WITHIN THE LAST 10,000 TO 2,000,000 YEARS

- AN ADDITIONAL OBJECTIVE OF THIS ACTIVITY WILL BE TO INVESTIGATE THE MINERALS FOUND IN THESE FAULT ZONES. TRENCHES ON THE BOW RIDGE FAULT WILL BE SUPPLEMENTED BY AN ARRAY OF SHALLOW BORINGS TO CHARACTERIZE THE SUBSURFACE DISTRIBUTION OF THESE FAULT DEPOSITS

- THE NATURE OF POTENTIAL FAULTING AND SURFACE MATERIALS WILL BE INVESTIGATED IN MIDWAY VALLEY, THE PROPOSED SITE OF REPOSITORY SURFACE FACILITIES



PRELIMINARY LOCATION OF MIDWAY VALLEY TRENCHES
FOR CONCEPTUAL SURFACE FACILITY LOCATION

VIEW TO EAST OF
TRENCHES OVER BOWRIDGE FAULT
ON WEST SIDE OF EXILE HILL,
REPOSITORY SURFACE FACILITY AREA

ASLSBT5P.A06/12-13-88

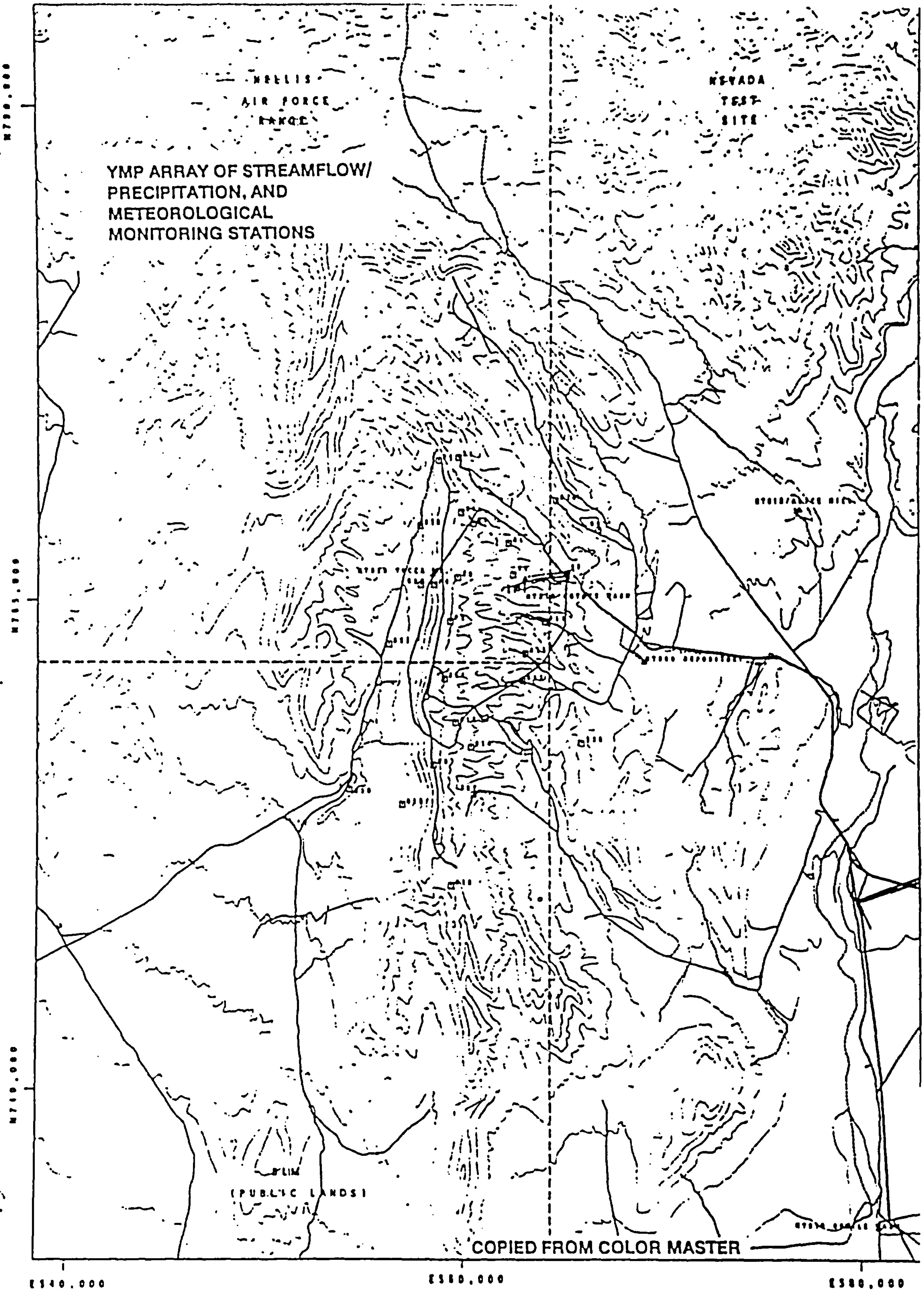
MONITORING ACTIVITIES

- SOUTHERN GREAT BASIN SEISMIC NETWORK; 54 STATIONS TELEMETERED TO USGS/DENVER, PLUS A PORTABLE ARRAY DEPLOYED INTERMITTENTLY AT YUCCA MOUNTAIN. PROVIDES INFORMATION ON ACTIVE PROCESSES FOR THE TECTONIC MODEL OF YUCCA MOUNTAIN AND VICINITY, AND SITE-SPECIFIC DATA FOR EVALUATION OF PRECLOSURE SEISMIC HAZARDS ASSOCIATED WITH A REPOSITORY

- METEOROLOGICAL, PRECIPITATION AND STREAMFLOW MONITORING FOR CHARACTERIZATION OF SURFACE HYDROLOGIC PROCESSES

- WATER TABLE MONITORING AND PIEZOMETRY IN ABOUT 25 DRILL HOLES AT OR NEAR YUCCA MOUNTAIN FOR CHARACTERIZING TEMPORAL STABILITY OF GROUNDWATER FLOW SYSTEM

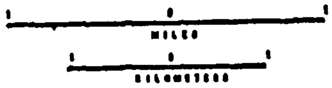
- NATURAL INFILTRATION OF PRECIPITATION WILL BE MONITORED USING GEOPHYSICAL LOGGING TECHNIQUES, AND AN ARRAY OF ABOUT 100 SHALLOW BORINGS DISTRIBUTED ACROSS THE SITE AREA


NELLIS AIR FORCE RANGE
NEVADA TEST SITE
YMP ARRAY OF STREAMFLOW/ PRECIPITATION, AND METEOROLOGICAL MONITORING STATIONS
(PUBLIC LANDS)
COPIED FROM COLOR MASTER
E540,000
E560,000
E580,000

NNWSI PROJECT

SURFACE BASED INVESTIGATIONS PLAN

METEOROLOGICAL AND STREAMFLOW MONITORING SITE NETWORK



LEGEND

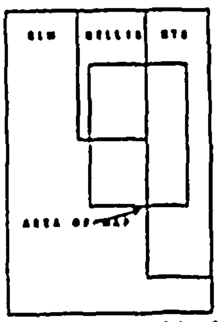
- STREAMFLOW AND PRECIPITATION MONITORING SITES - PROPOSED
- ▲ METEOROLOGICAL MONITORING TOWERS EXISTING

- LIGHT DUTY ROADS
- UNIMPROVED ROADS
- TRAILS

- PERIMETER DRIFT BOUNDARY

SOURCES:

50 FOOT ELEVATION CONTOURS - 1:100,000 USGS MAP
[illegible] 1:24,000 USGS TOPOGRAPHIC MAPS
[illegible] 1:24,000 USGS ORTHOPHOTO MAPS
[illegible] 1:100,000 USGS TOPOGRAPHIC MAPS
7/[illegible] AND 8/[illegible] 1:24,000 AERIAL PHOTOGRAPHY
GRID TICKS BASED ON NEVADA STATE COORDINATE SYSTEM, CENTRAL ZONE
MAP COMPILED IN APRIL [illegible]



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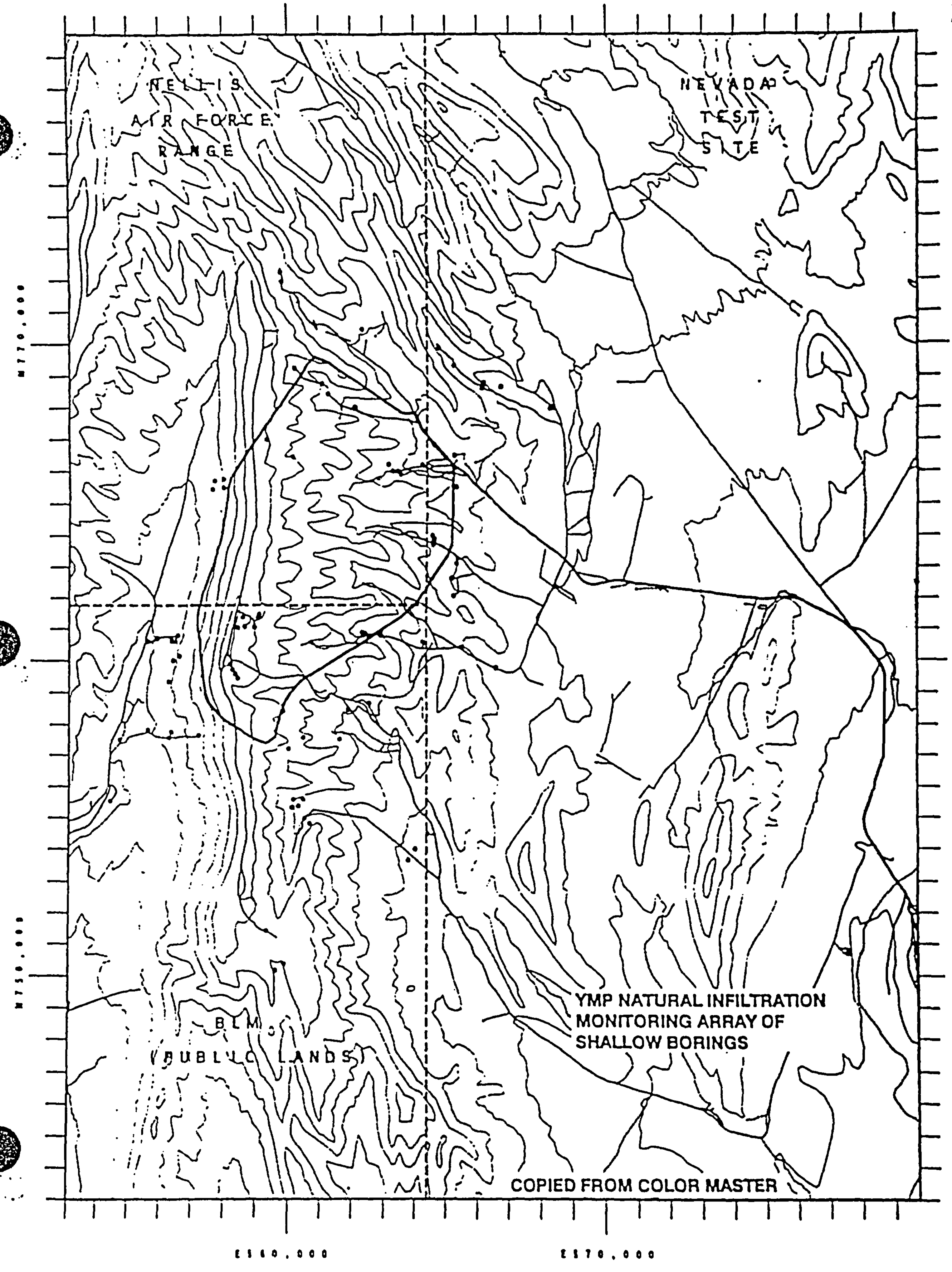
NELLIS
AIR FORCE
RANGE
NEVADA
TEST
SITE
YMP NATURAL INFILTRATION
MONITORING ARRAY OF
SHALLOW BORINGS
BLM
(PUBLIC LANDS)
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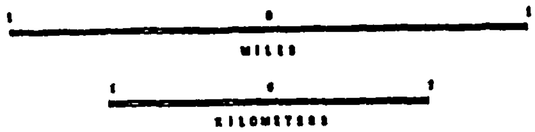
SURFACE BASED INVESTIGATIONS PLAN

NATURAL INFILTRATION MONITORING



LEGEND

- NATURAL INFILTRATION MONITORING (UNSATURATED ZONE NEUTRON ACCESS HOLES) - EXISTING
- NATURAL INFILTRATION MONITORING (UNSATURATED ZONE NEUTRON ACCESS HOLES) - *PROPOSED*

LIGHT DUTY ROADS

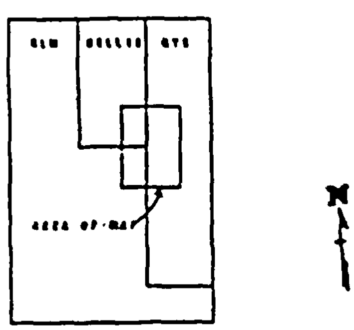
UNIMPROVED ROADS

TRAILS

PERIMETER DRIFT BOUNDARY

SOURCES:

10 FOOT ELEVATION CONTOURS - USGS 1:100,000 MAP
1961 1:24,000 USGS TOPOGRAPHIC MAPS
1976 1:24,000 USGS ORTHOPHOTO MAPS
1983 1:100,000 USGS TOPOGRAPHIC MAPS
7/1986 AND 8/1987 1:24,000 AERIAL PHOTOGRAPHY
GRID TICKS BASED ON NEVADA STATE COORDINATE SYSTEM, CENTRAL ZONE
MAP COMPILED IN APRIL 1988



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LABORATORY STUDIES

- MANY TYPES OF LABORATORY MEASUREMENTS AND BENCH-SCALE SIMULATIONS OF NATURAL PROPERTIES AND PROCESSES ARE PLANNED

- A DRILLING TECHNOLOGY PROGRAM IS UNDERWAY TO PROTOTYPE CANDIDATE METHODS FOR DRY DRILLING AND CORING IN THE DEEP UNSATURATED ZONE AT YUCCA MOUNTAIN

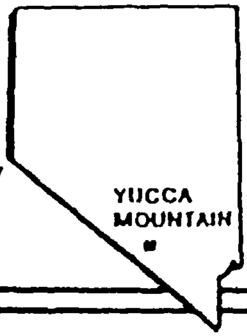
- ACQUISITION OF APPROXIMATELY 70,000 FEET OF CORE, A SIMILAR QUANTITY OF DRILL CUTTINGS, AND > 1,000,000 lb. OF BULK SAMPLES IS ANTICIPATED

- A 28,000 SQ. FT. YMP SAMPLE MANAGEMENT FACILITY HAS BEEN CONSTRUCTED ON THE NEVADA TEST SITE NEAR YUCCA MOUNTAIN

- FIELD LABORATORIES HAVE BEEN SET UP FOR TIMELY MEASUREMENT OF SENSITIVE HYDROLOGIC PROPERTIES

U.S. DEPARTMENT OF ENERGY

OCRWM



EXPLORATORY SHAFT DESIGN

PRESENTED BY

LARRY SKOUSEN
DIRECTOR, ENGINEERING AND DEVELOPMENT DIVISION
YUCCA MOUNTAIN PROJECT
U.S. DEPARTMENT OF ENERGY

DECEMBER 13, 1988
UNITED STATES DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE/YUCCA MOUNTAIN PROJECT OFFICE

U.S. DEPARTMENT OF ENERGY

OCRWM

YUCCA MOUNTAIN

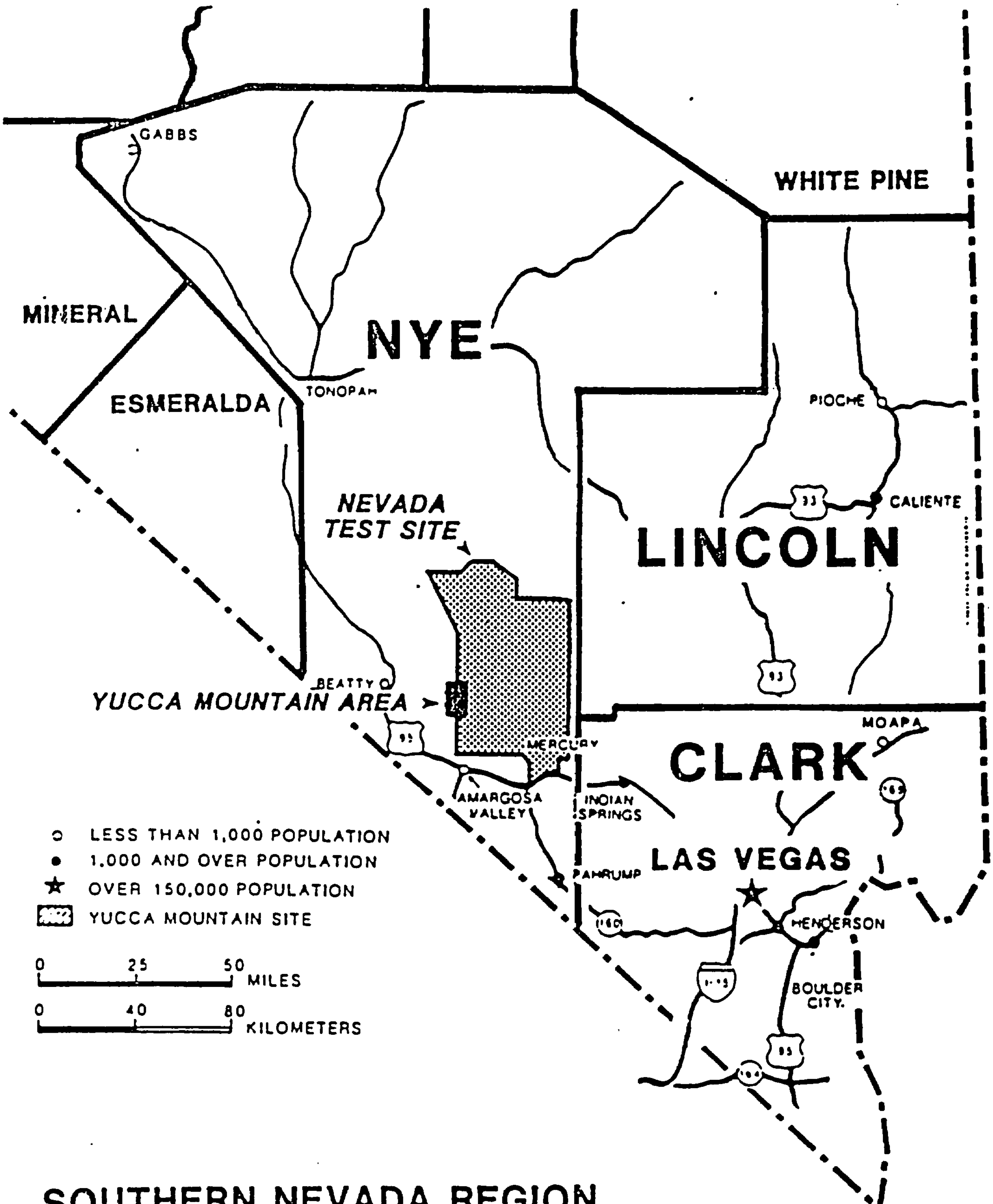
EXPLORATORY SHAFT DESIGN

PRESENTED BY

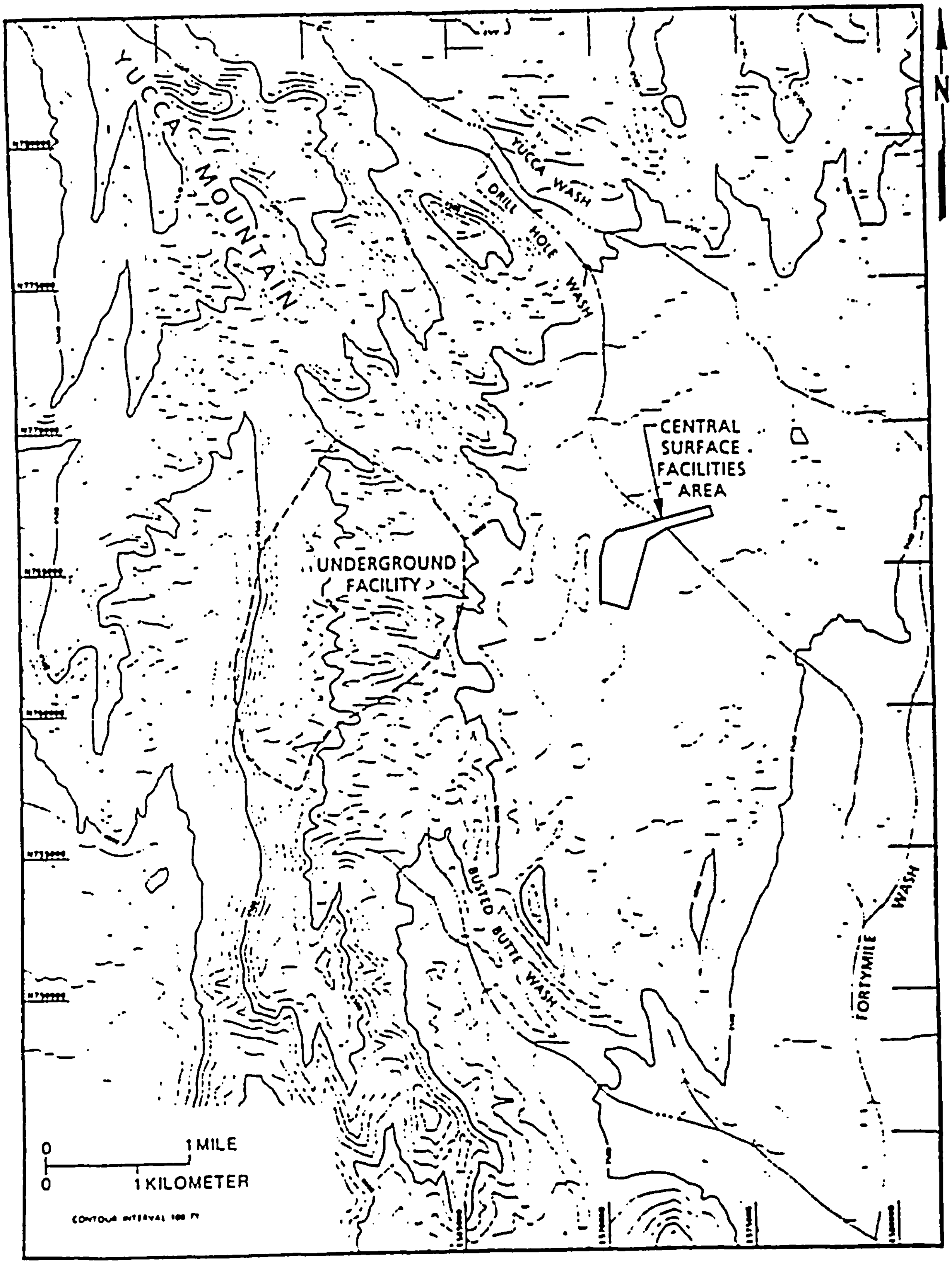
LARRY SKOUSEN
DIRECTOR, ENGINEERING AND DEVELOPMENT DIVISION
YUCCA MOUNTAIN PROJECT
U.S. DEPARTMENT OF ENERGY

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

DECEMBER 13, 1988
UNITED STATES DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE/YUCCA MOUNTAIN PROJECT OFFICE



SOUTHERN NEVADA REGION

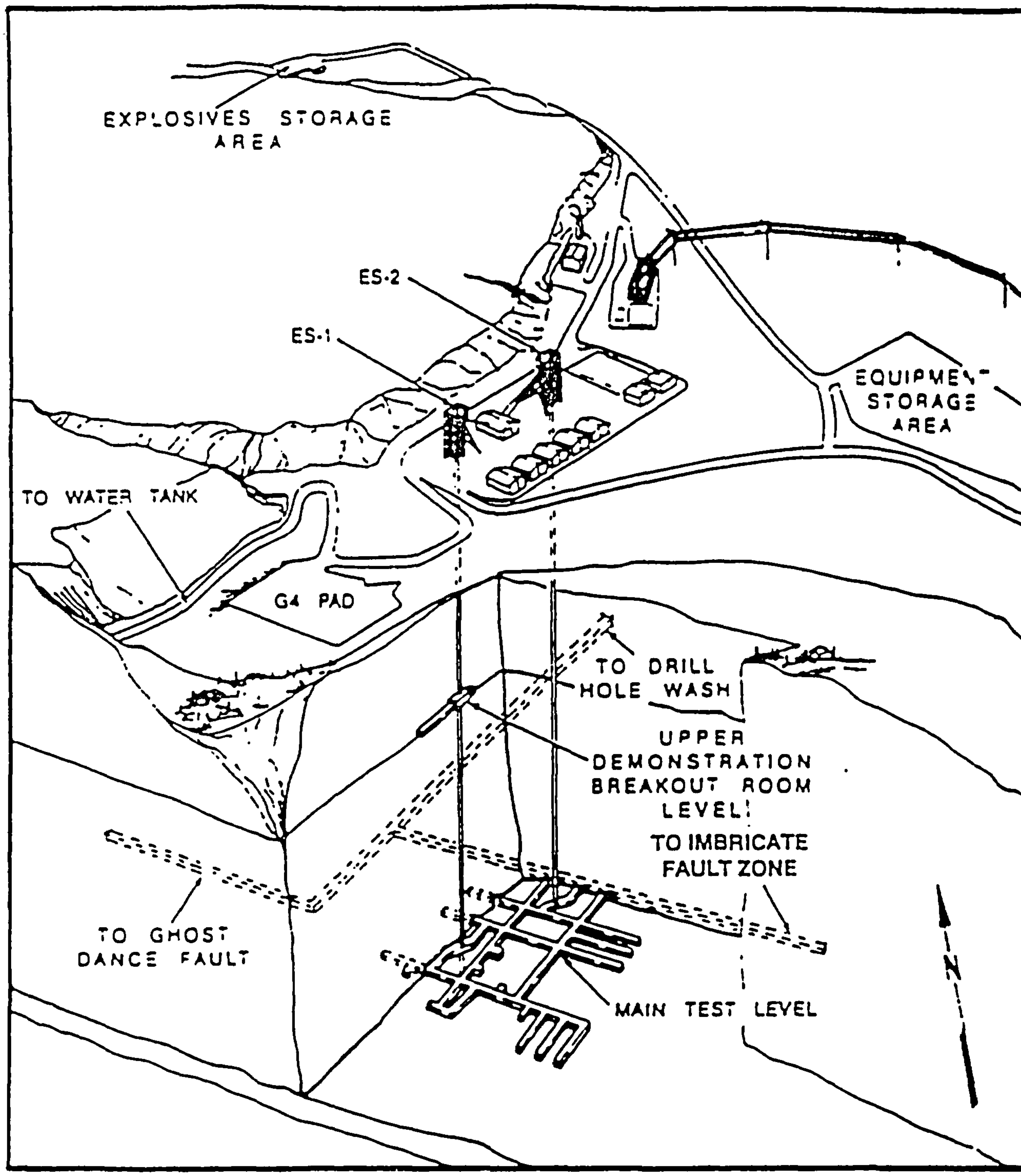


YUCCA MOUNTAIN
YUCCA WASH
DRILL HOLE WASH
CENTRAL SURFACE FACILITIES AREA
UNDERGROUND FACILITY
BUSTED BUTTE WASH
FORTYMILE WASH
N
0 1 MILE
0 1 KILOMETER
CONTOUR INTERVAL 100 FT

AERIAL SITE PHOTO

- THE SITE OF THE ESF IS 85 MILES NORTHWEST OF LAS VEGAS

- LOCATIONS OF THE EXPLORATORY SHAFT FACILITY AND THE PERIMETER DRIFT OF THE REPOSITORY AS WELL AS THE REPOSITORY SURFACE FACILITIES ARE SHOWN ON THE PHOTO

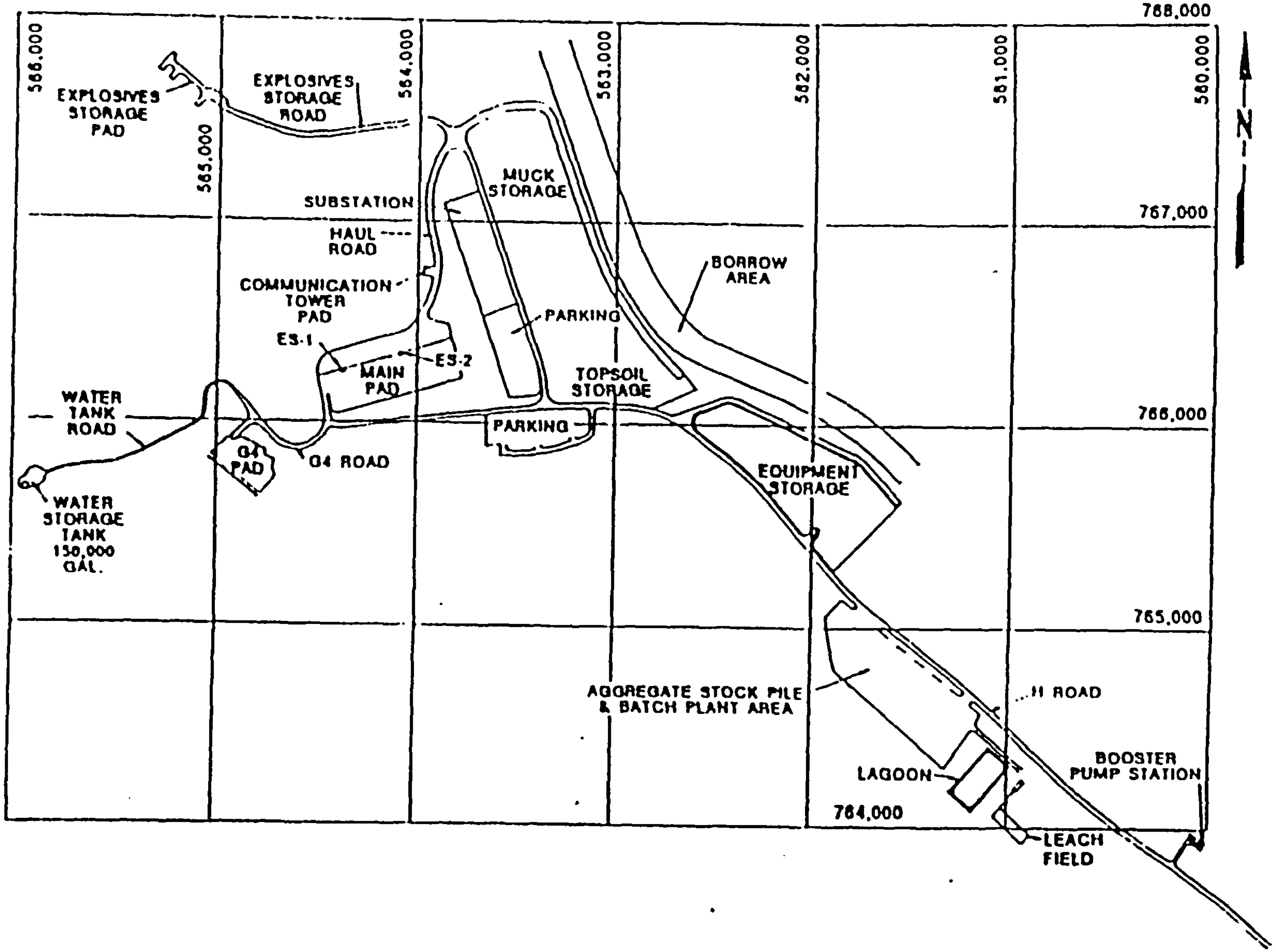


CONCEPTUAL ILLUSTRATION OF THE EXPLORATORY SHAFT FACILITY

SURFACE AND UNDERGROUND INTERFACE

- CUTAWAY OF THE ESF FACILITIES DEPICTS
  - THE SHAFT DEPTHS
  - THE UNDERGROUND LAYOUT
  - THE EXPLORATORY DRIFTS TO THE DRILL HOLE WASH FAULT, THE IMBRICATE FAULT ZONE, AND THE GHOST DANCE FAULT

ESF SITE PLAN



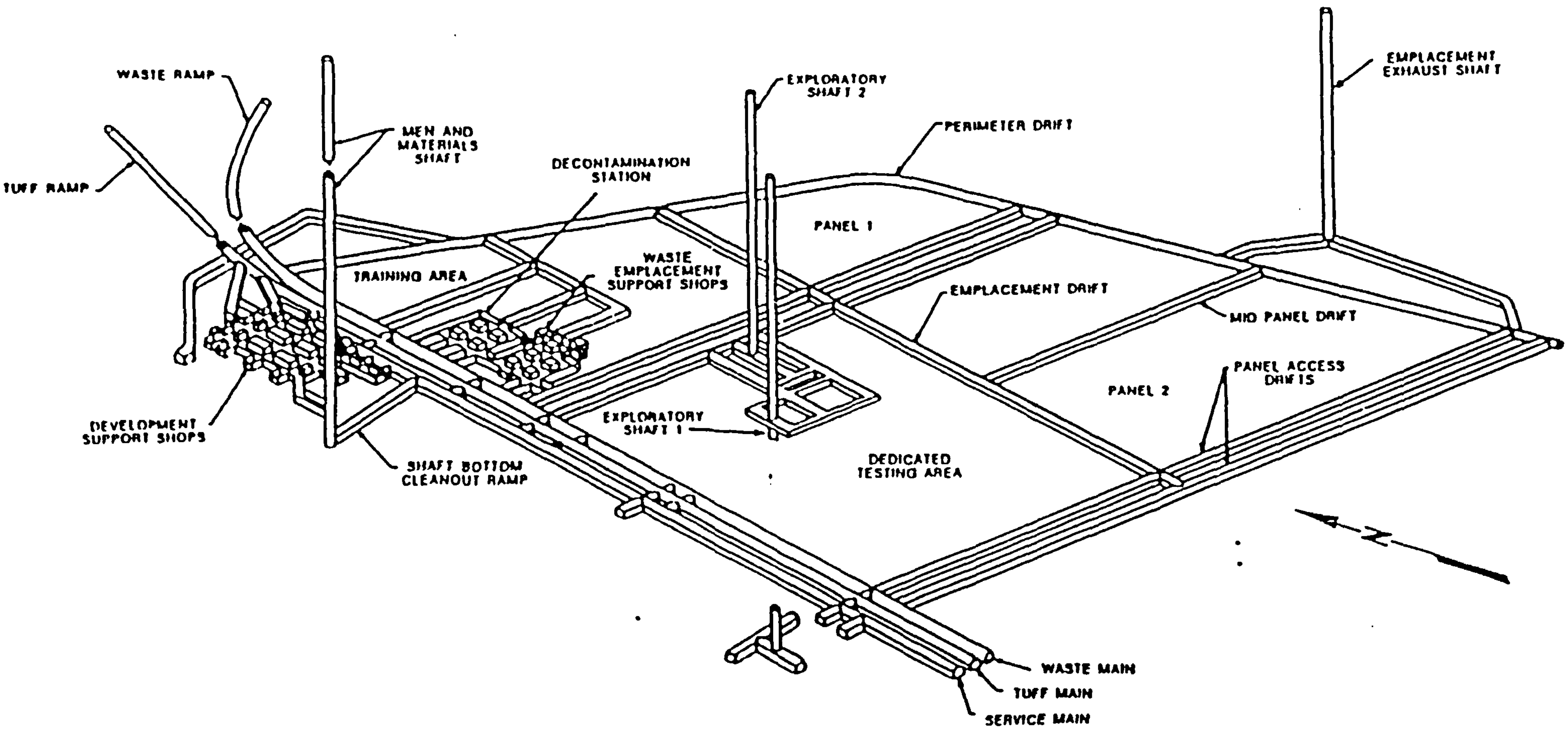
SURFACE LAYOUT

- THE SURFACE FACILITIES LAYOUT FOR THE ESF COVERS APPROXIMATELY 5 ACRES

THE MAIN PAD INCLUDES:

- ES-1 HOIST AND HEADFRAME
- ES-2 HOIST AND HEADFRAME
- HOIST HOUSE FOR BOTH HOISTS
- UTILITIES
- TRAILER FACILITIES FOR OFFICES AND LABORATORIES

RESPOSITORY/EXPLORATORY SHAFT COMPLEX



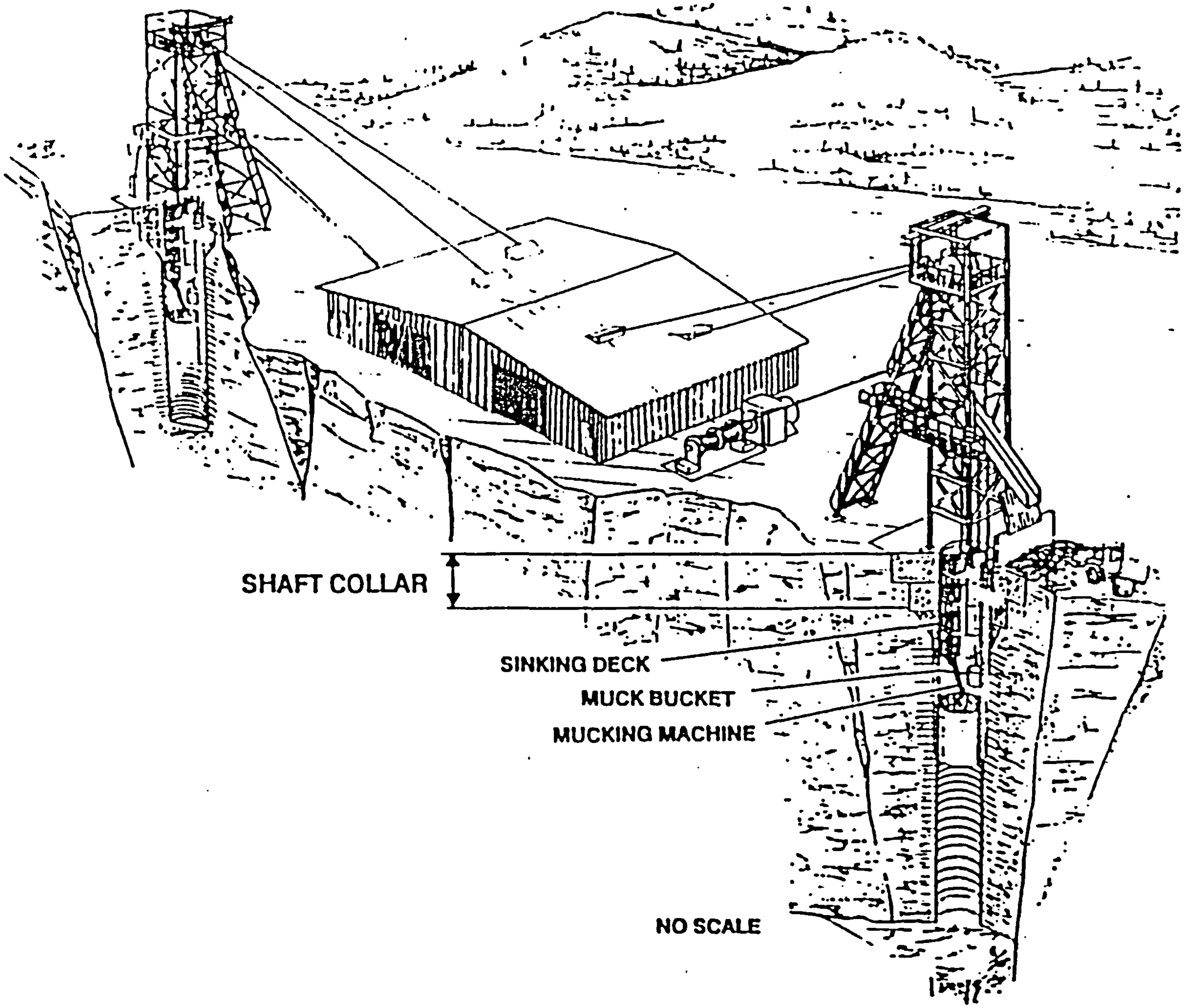
SHAFT CROSS SECTION

- THE ES-1 AND THE ES-2 SHAFTS SERVE DIFFERENT FUNCTIONS

- THE ES-1 IS THE TESTING SHAFT AND HAS BREAKOUTS AT THE 600 LEVEL, WHERE TESTING WILL BE PERFORMED ON THE TOP OF THE REPOSITORY BLOCK, THE MAIN TEST LEVEL (1050 LEVEL), WHERE TESTING AT THE REPOSITORY LEVEL WILL BE PERFORMED

- THE ES-2 IS THE CONSTRUCTION SHAFT WHICH EXTENDS FROM THE SURFACE TO THE MAIN TEST LEVEL

TYPICAL MINING LAYOUT



NNWSI DESIGN REQUIREMENTS FOR EXPLORATORY SHAFTS, LINERS, AND COLLARS

COLLAR

- EXPLORATORY SHAFT COLLARS ARE FOUNDED IN ROCK
- REINFORCED TO SERVE AS HEADFRAME FOUNDATION
- STRUCTURALLY ISOLATED FROM THE LINING
- DESIGNED TO SURFACE DESIGN CODES

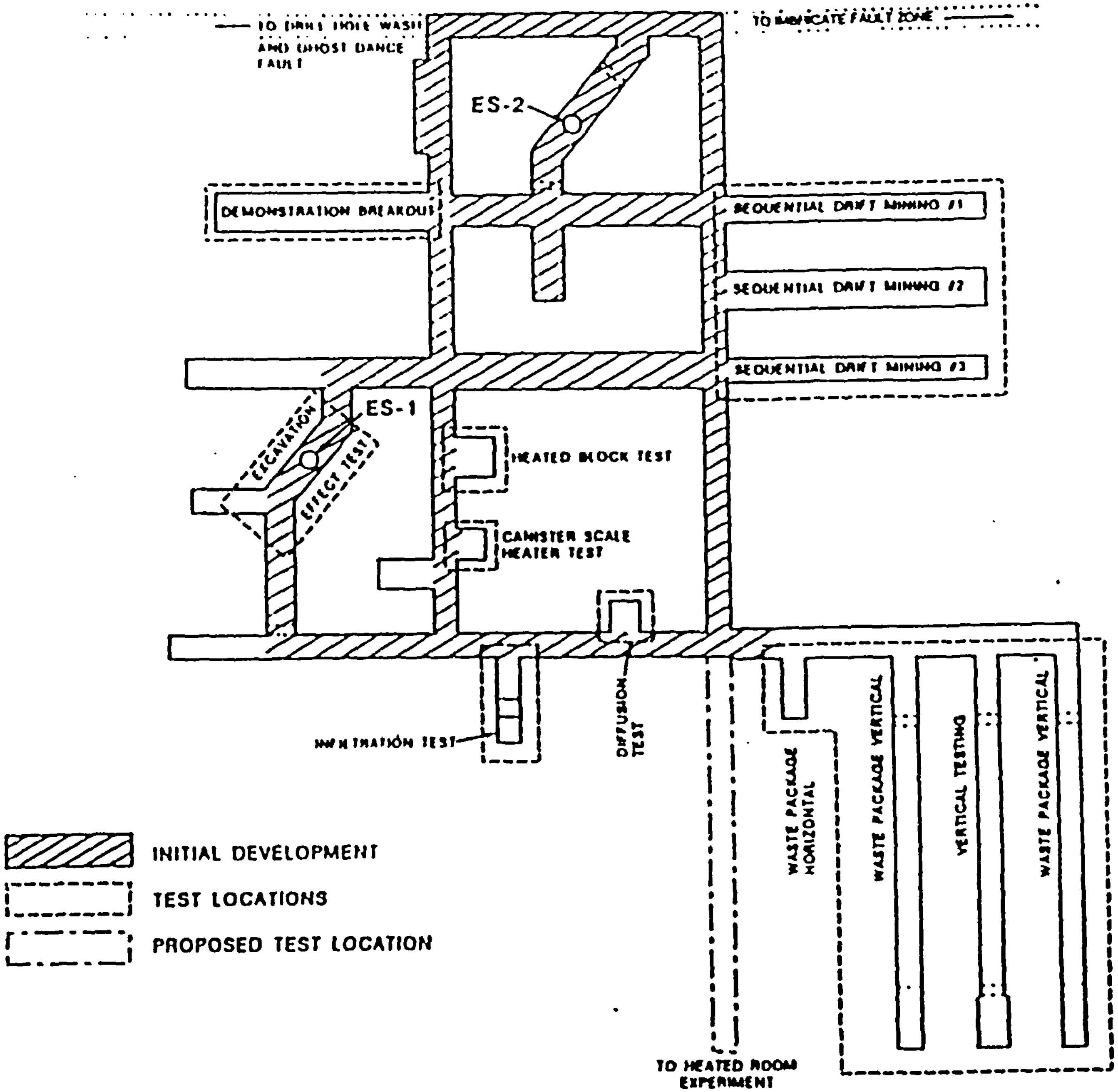
NNWSI DESIGN REQUIREMENTS FOR EXPLORATORY SHAFTS, LINERS, AND COLLARS

(CONTINUED)

LINING

- MINIMUM OF 12 INCHES THICK
- CAST DIRECTLY AGAINST THE ROCK
- JOINTS ARE ALLOWED BETWEEN SECTIONS OF THE LINER
- PERMANENT EMBEDMENTS ARE CONSIDERED TO BE PART OF THE LINER
- BROW STRUCTURE IS REINFORCED AS REQUIRED FOR SUPPORT

GENERAL ARRANGEMENT OF THE MAIN TEST LEVEL AREA



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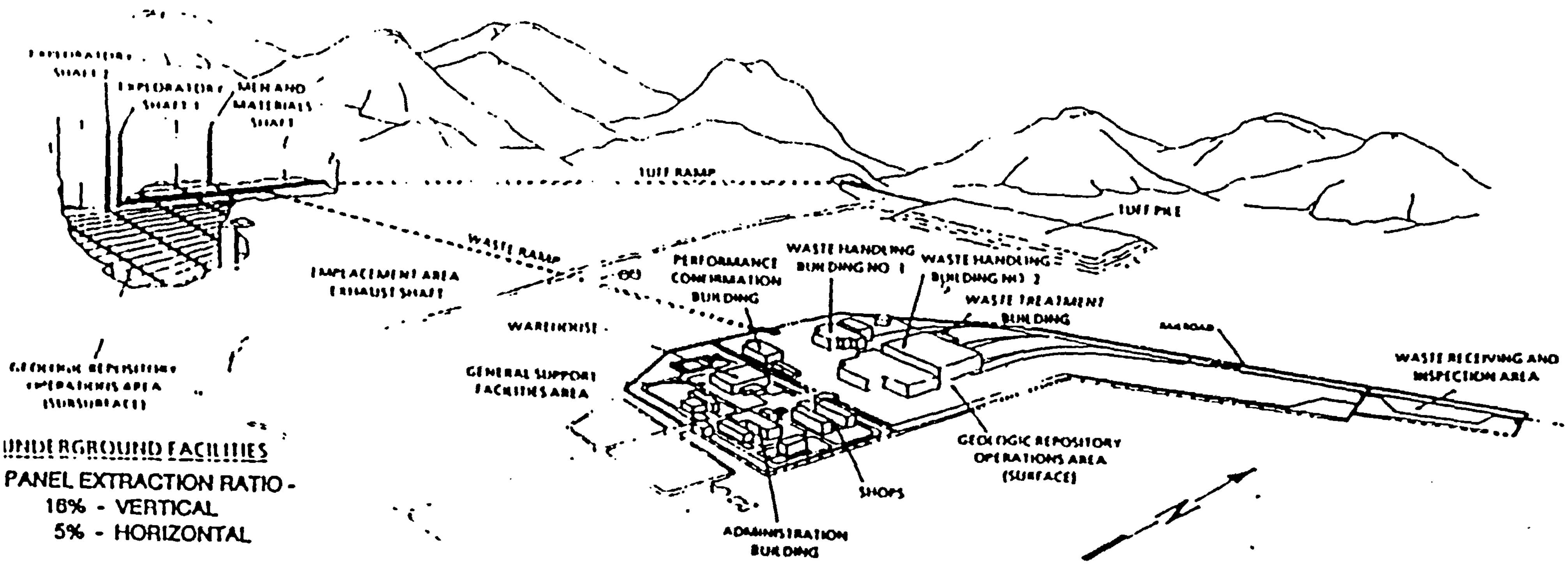
MAIN TEST LEVEL
LAYOUT/REPOSITORY

- THE MAIN TEST LEVEL IS WHERE THE MAIN TESTING ACTIVITIES OF SITE CHARACTERIZATION WILL TAKE PLACE

- THIS TEST AREA IS BASED ON AN OPERATIONAL CORE AREA SURROUNDED BY TEST ALCOVES AND TAKEOFFS FOR THE LONG EXPLORATORY DRIFTS WHICH WILL PROVIDE ACCESS TO THE GEOLOGIC FAULTS OF INTEREST: THE GHOST DANCE FAULT, THE IMBRICATE FAULTS, AND THE DRILL HOLE WASH FAULT

PRELIMINARY DRAWING OF REPOSITORY COMPLEX



UNDERGROUND FACILITIES

PANEL EXTRACTION RATIO -
16% - VERTICAL
5% - HORIZONTAL

RAMP FOR WASTE DELIVERY

SEPERATE EMPLACEMENT & DEVELOPMENT VENTILATION

SLOPE FROM DRIFTS TO EMPLACEMENT EXHAUST SHAFT

DESIGN LIFETIME 100 YEARS

ACCESS DRIFT TEMPERATURE -
<50° C FOR 50 YEARS

CENTRAL SURFACE FACILITIES

COMPARTMENTALIZATION OF FACILITIES

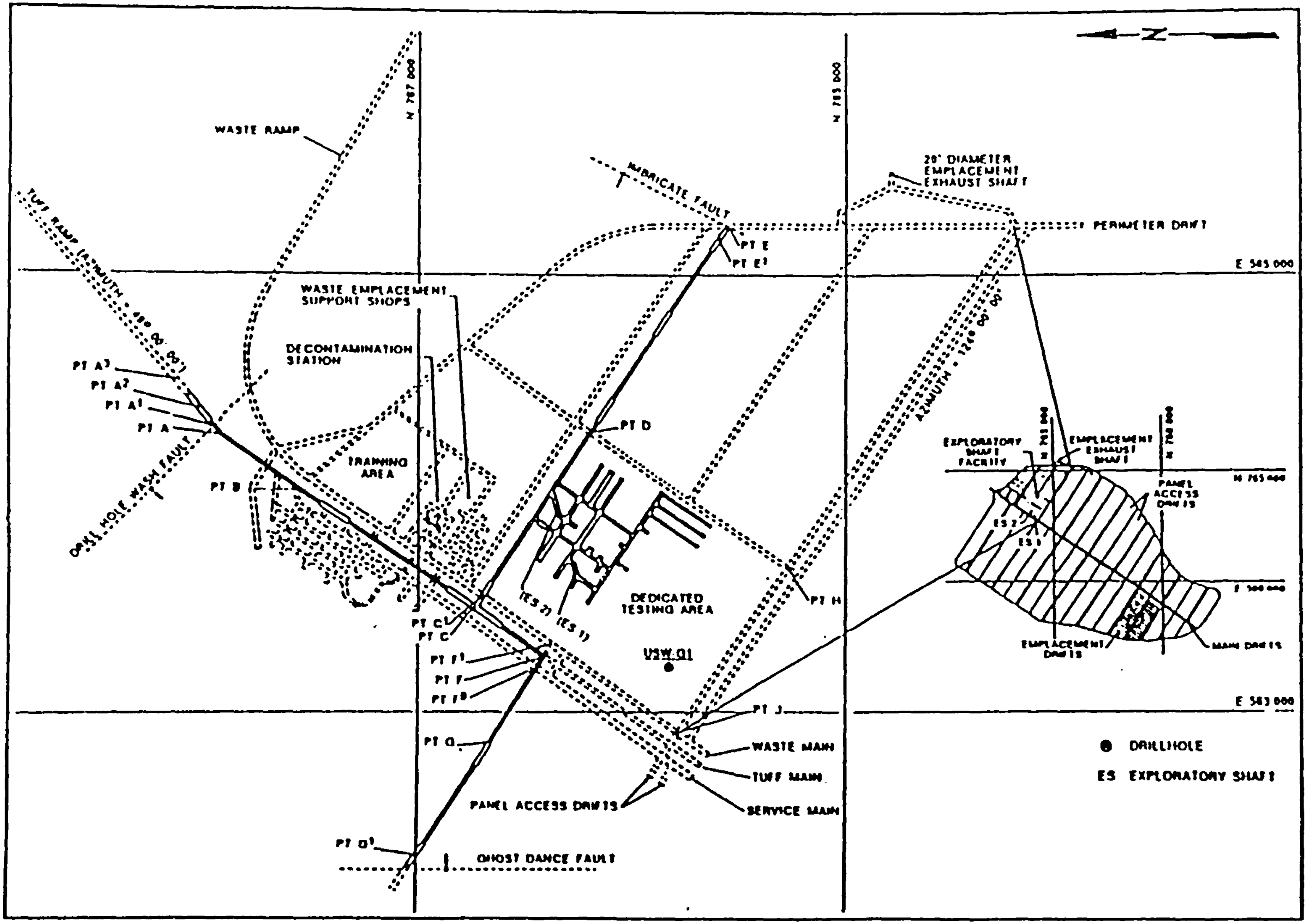
ZONED VENTILATION SYSTEMS

LOW-PROFILE BUILDINGS

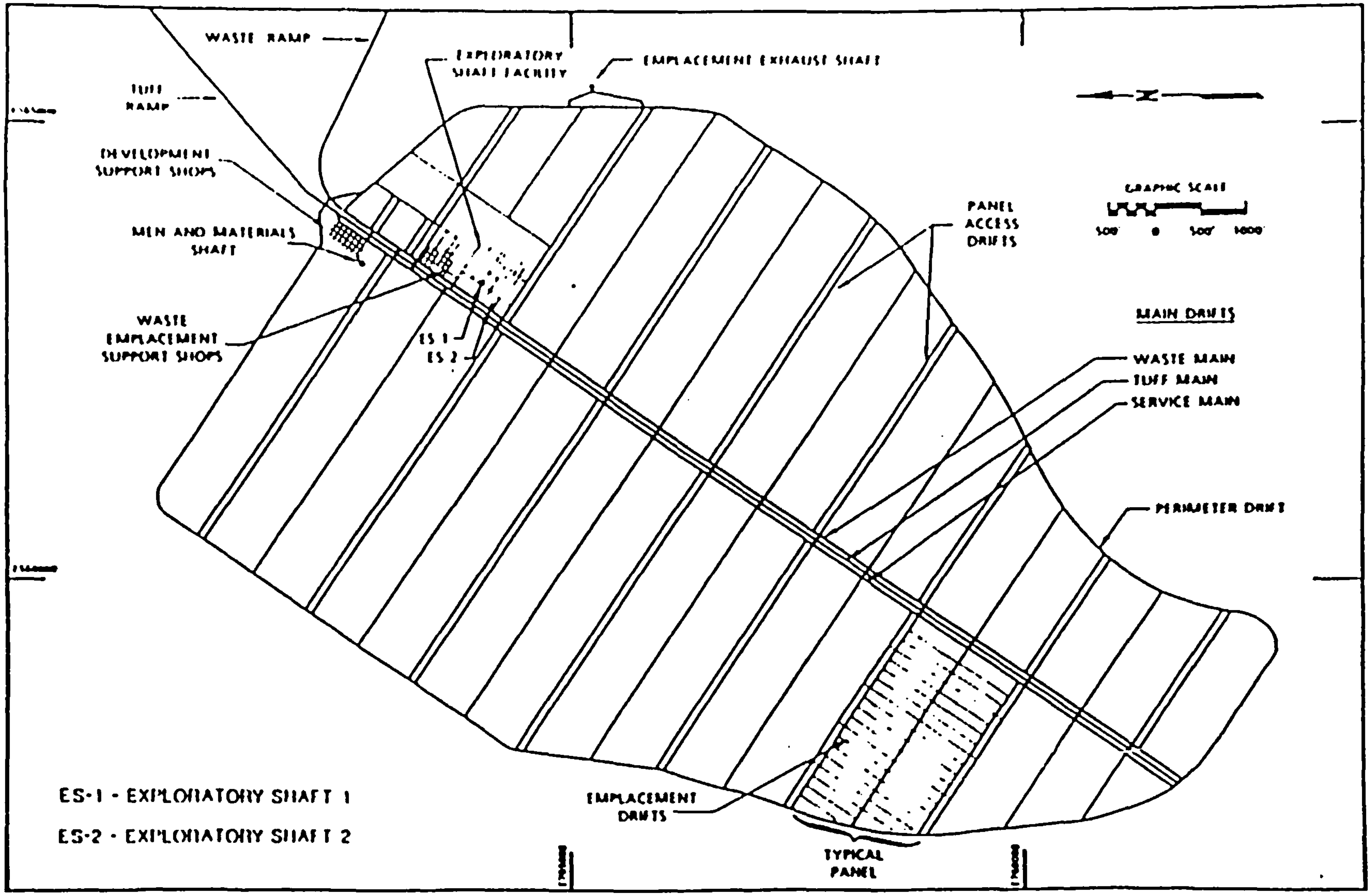
NEGATIVE PRESSURE HOT CELLS

AVOID FAULTS WITH SIGNIFICANT DISPLACEMENT POTENTIAL

ESF LAYOUT WITHIN PLANNED REPOSITORY SETTING



CONCEPTUAL REPOSITORY LAYOUT



OCRWM

...RTMENT OF ENERGY

YUCCA MOUNTAIN

EXPLORATORY SHAFT TESTING

PRESENTED BY

M. D. VOEGELE
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

DECEMBER 13, 1988
UNITED STATES DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE/YUCCA MOUNTAIN PROJECT OFFICE

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

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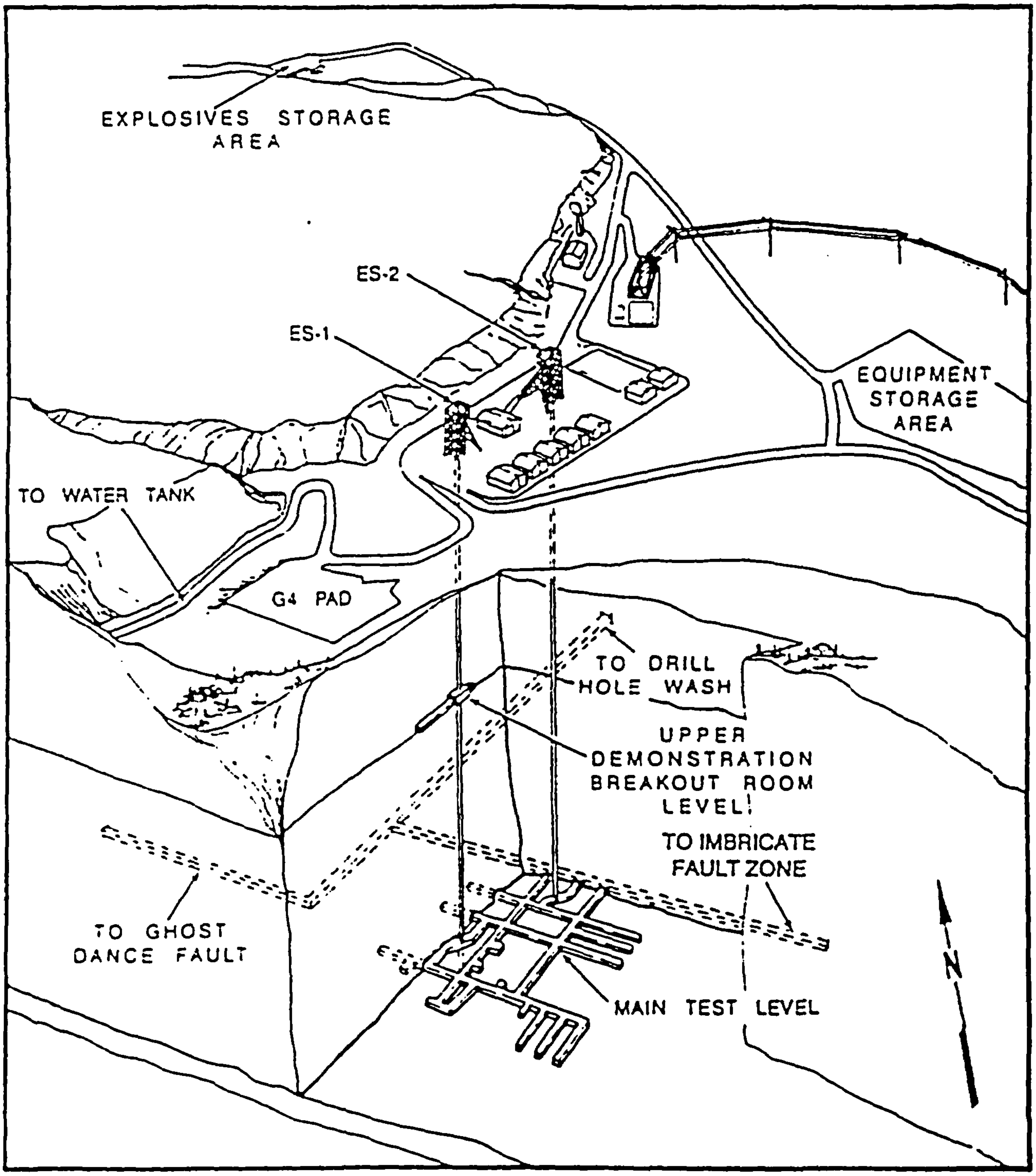

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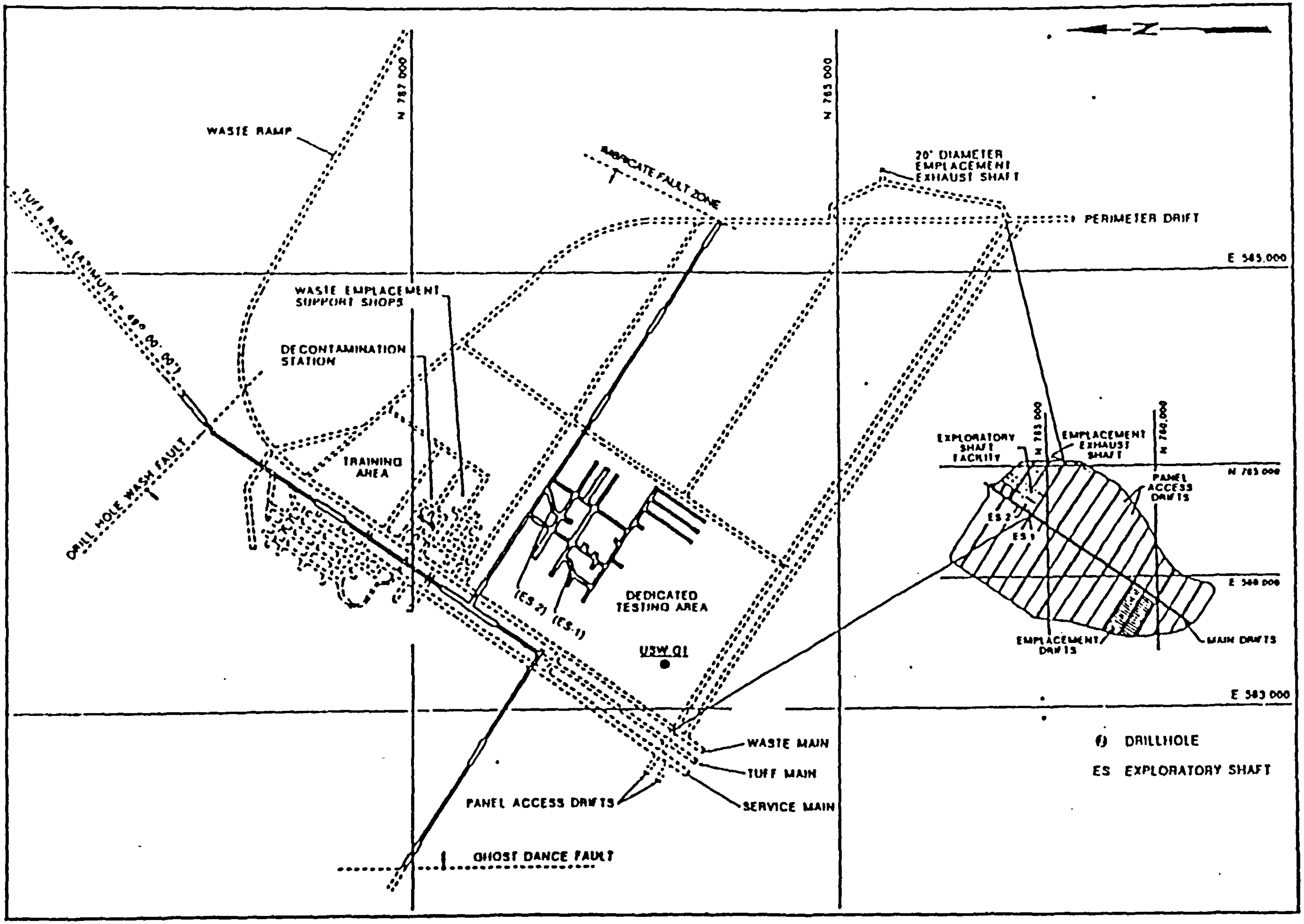
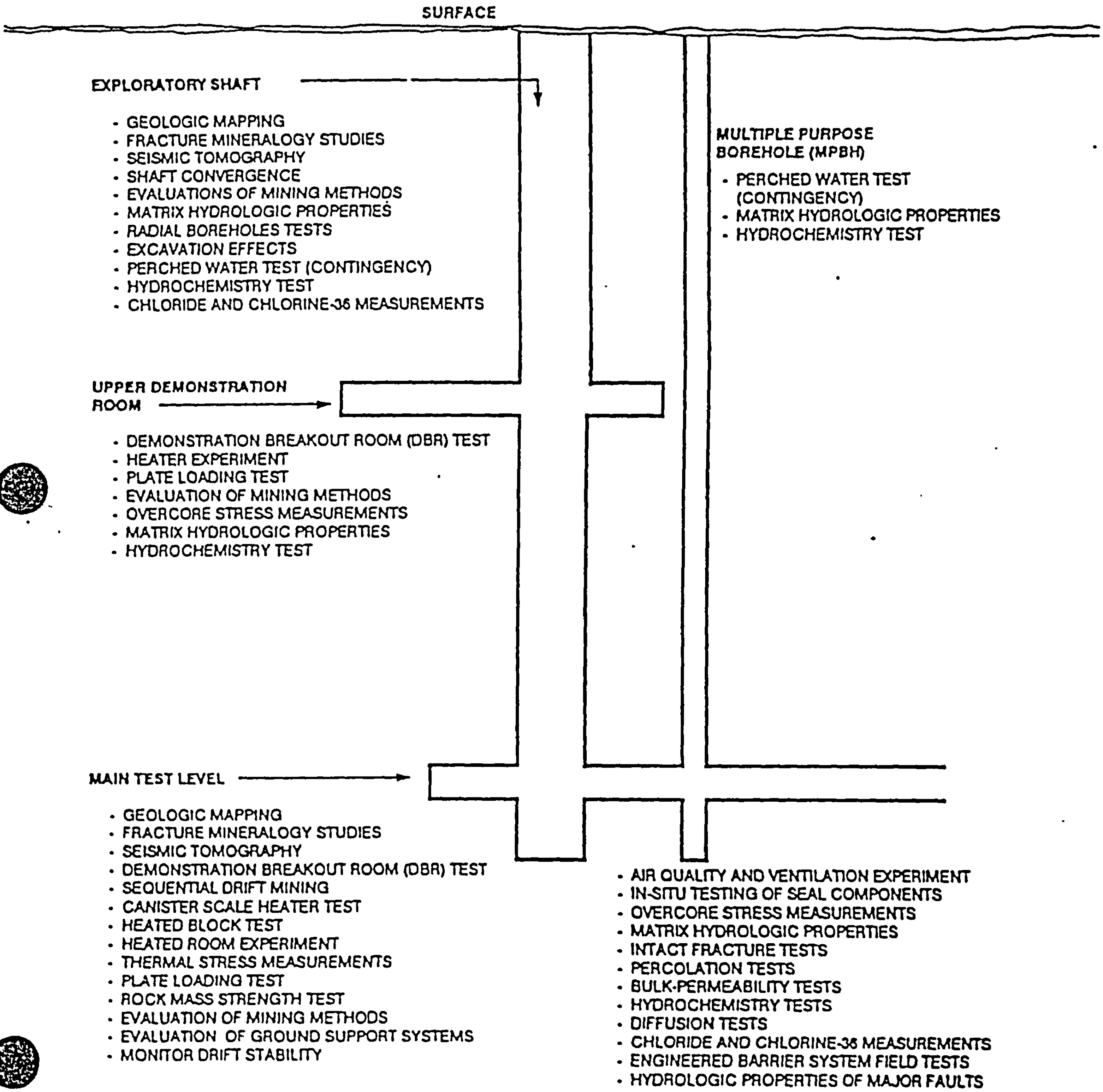


WASTE RAMP
TUFF RAMP (AZIMUTH = 48° 00' 00")
N 767 000
N 765 000
IMBRICATE FAULT ZONE
20' DIAMETER EMPLACEMENT EXHAUST SHAFT
PERIMETER DRIFT
E 565,000
WASTE EMPLACEMENT SUPPORT SHOPS
DECONTAMINATION STATION
TRAINING AREA
DRILL HOLE WASH FAULT
(ES-2)
(ES-1)
DEDICATED TESTING AREA
USW G1
EXPLORATORY SHAFT FACILITY
EMPLACEMENT EXHAUST SHAFT
PANEL ACCESS DRIFTS
ES 2
ES 1
EMPLACEMENT DRIFTS
MAIN DRIFTS
E 583 000
WASTE MAIN
TUFF MAIN
SERVICE MAIN
PANEL ACCESS DRIFTS
GHOST DANCE FAULT
DRILLHOLE
ES EXPLORATORY SHAFT

LOCATION AND TYPE OF TEST IN THE EXPLORATORY SHAFT FACILITY



SCTPCH.CPG 12/8/88

EVALUATIONS OF ESF IMPACTS

- THE SITE CHARACTERIZATION PROGRAM HAS BEEN EVALUATED CONCERNING ISOLATION IMPACTS, REPRESENTATIVENESS AND INTERFERENCES, INCLUDING THOSE RELATED TO TESTING, CONFIGURATION, CONSTRUCTION AND OPERATIONS

- THOSE EVALUATIONS ARE BASED ON LIMITED DATA AND CONSERVATIVE ASSUMPTIONS. THE CHARACTERIZATION PROGRAM HAS BEEN DEVELOPED TO MONITOR POTENTIAL CHANGES TO SITE CONDITIONS DURING CHARACTERIZATION TO PERMIT ASSESSMENTS ABOUT DATA VALUES AND ASSUMPTIONS

ESF PROGRAM CONSIDERS POTENTIAL IMPACTS ON ISOLATION CAPABILITY OF SITE AND CHARACTERIZATION

- DETAILED EVALUATIONS TO ENSURE THAT SITE CHARACTERIZATION ACTIVITIES ARE CONDUCTED SO AS TO LIMIT ADVERSE EFFECTS ON LONG-TERM PERFORMANCE OF THE REPOSITORY TO THE EXTENT PRACTICABLE (10 CFR 60.15(d)(1))

- DETAILED EVALUATIONS TO ENSURE THAT SITE CHARACTERIZATION-RELATED ACTIVITIES DO NOT LIMIT THE ABILITY TO ADEQUATELY CHARACTERIZE THE SITE

ESF PROGRAM CONSIDERS POTENTIAL FOR INTERFERENCE BETWEEN TESTS

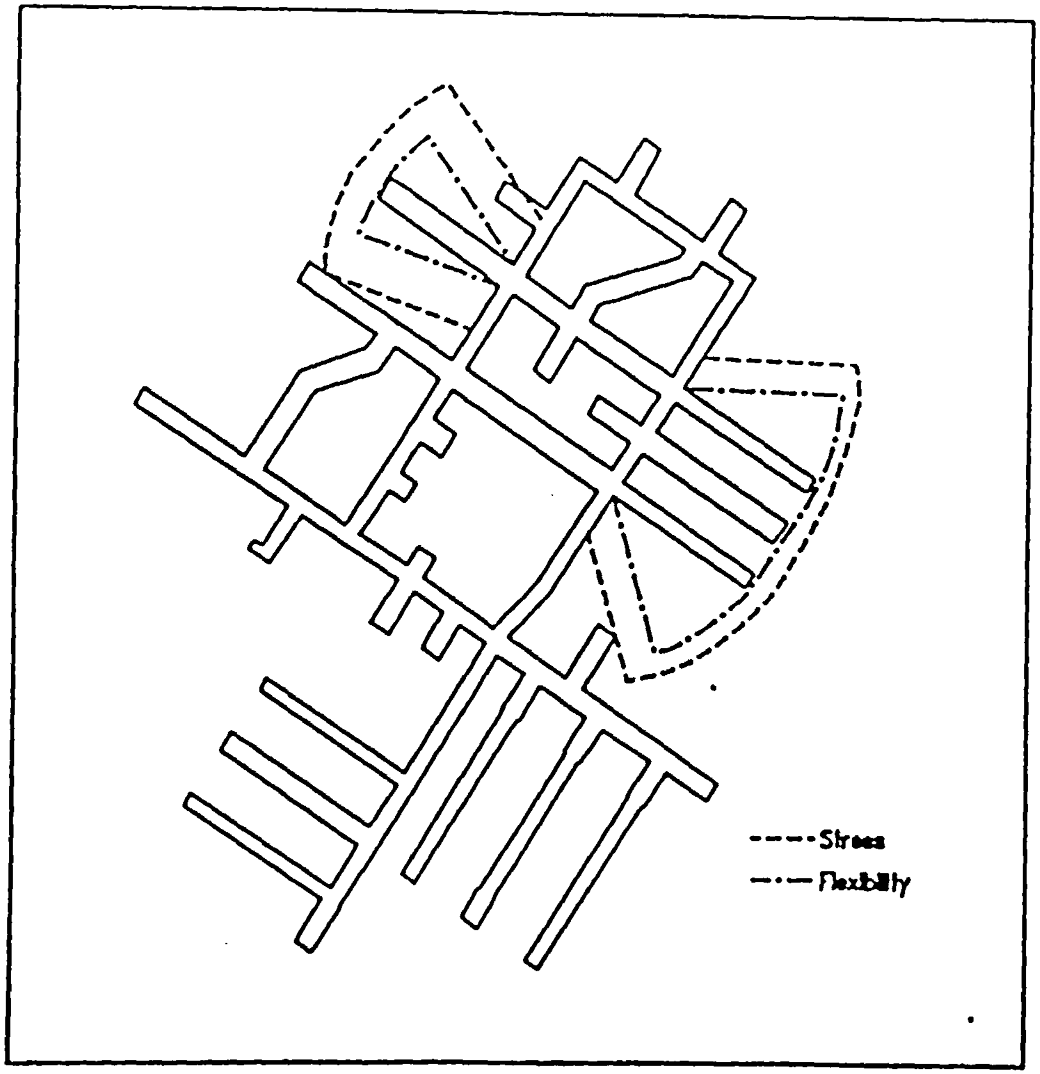
ESF TEST LAYOUT CONSTRAINTS

- FOR EACH ES TEST, ASSESS PRINCIPAL CONSTRAINTS RELATED TO ESF LAYOUT
  - SEQUENCING
  - PHYSICAL LAYOUT
  - CONSTRUCTION AND OPERATION

ZONES OF INFLUENCE FOR ES TESTS

- FOR EACH ES TEST, EVALUATE PRINCIPAL FACTORS THAT COULD AFFECT OTHER TEST ENVIRONMENTS
  - MECHANICAL
  - THERMAL
  - HYDROLOGICAL
  - CHEMICAL

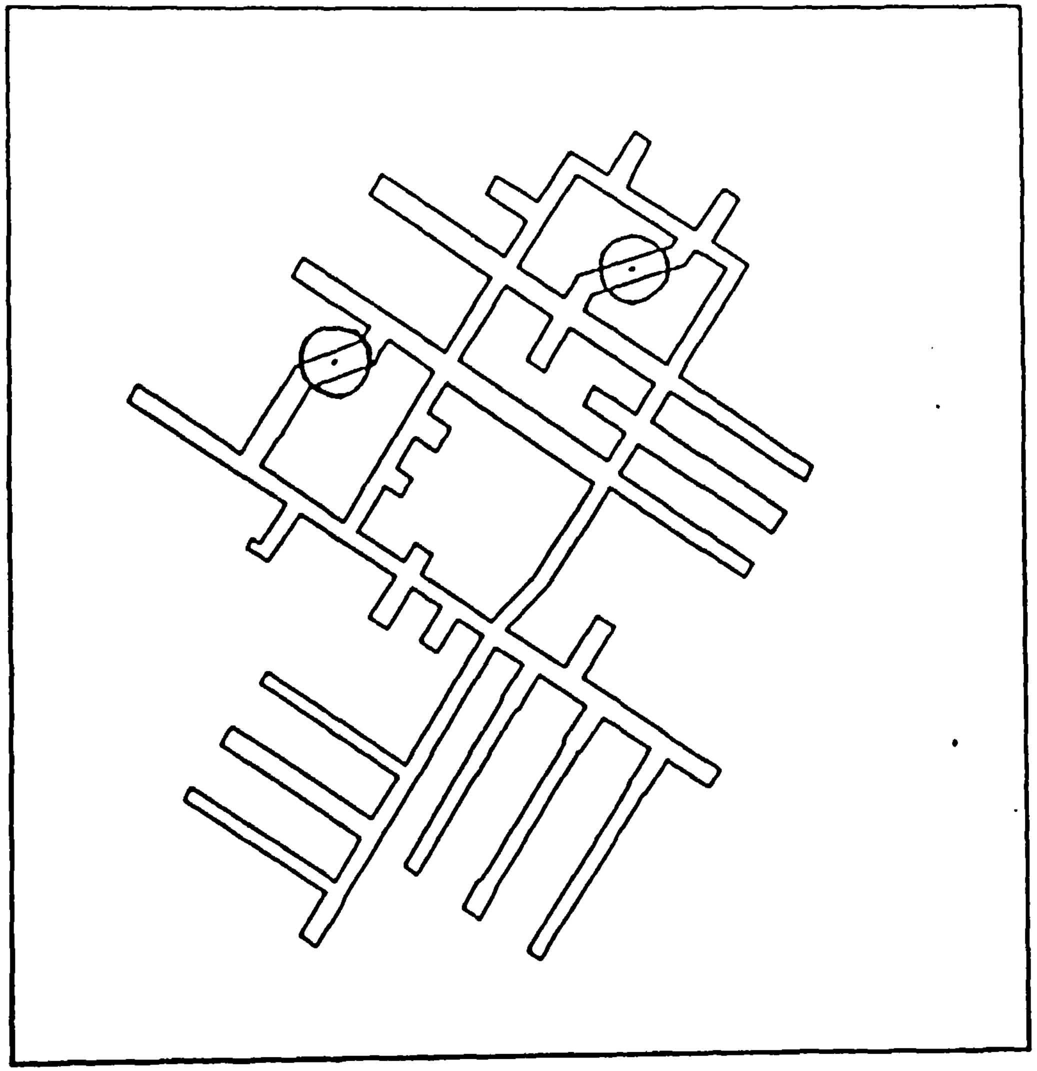
EXAMPLE OF MECHANICAL INTERFERENCE CONSIDERATIONS



- DEMONSTRATION BREAKOUT ROOM
  - CONSTRAINTS - NEED 100 FT STANDOFF FROM OTHER MINING WHILE MEASUREMENTS IN PROGRESS (DOTTED LINE) BECAUSE OF DISPLACEMENT GAUGE ANCHORS. LARGE AREA REQUIRED BECAUSE OF NEED FOR FLEXIBILITY IN ORIENTATION
  - ZONE OF INFLUENCE - STRESS ALTERED REGION EXTENDS APPROX. 2 DRIFT DIA. (50 FT) (SOLID-DOT LINE)

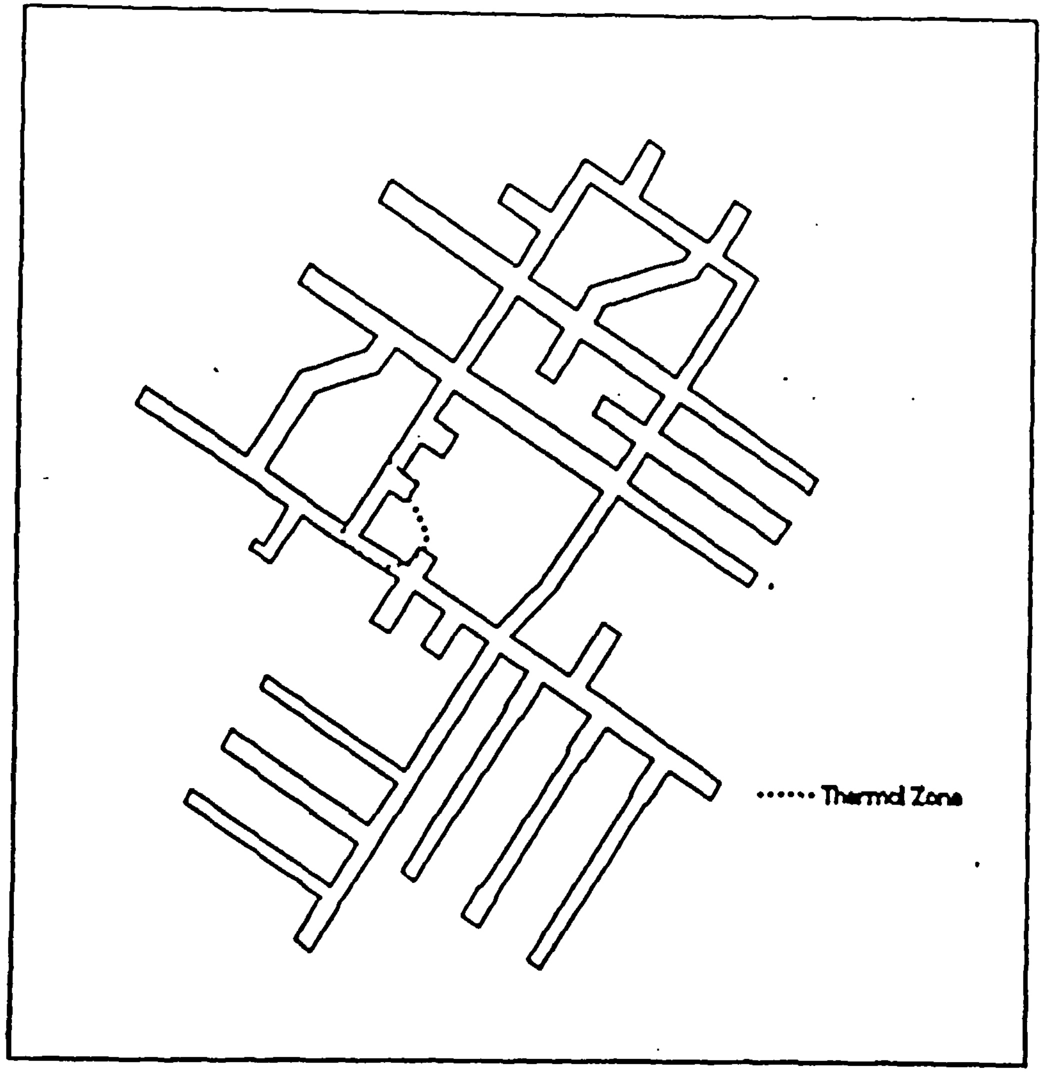
- SEQUENTIAL DRIFT MINING
  - CONSTRAINT - NO OTHER MINING WITHIN 50 FT OF OUTER DRIFTS (INSTRUMENTS DO NOT EXTEND BEYOND OUTER DRIFT)
  - ZONE OF INFLUENCE - 2 DIA.

EXAMPLE OF HYDROLOGIC INTERFERENCE CONSIDERATIONS



- HYDROLOGIC ZONE OF INFLUENCE AROUND SHAFTS
- IF 10% CONSTRUCTION WATER GOES INTO FORMATION
  - SATURATION CHANGE IN MP2 IS 0.08
  - AFTER 2 YEARS, ALTERED ZONE IS APPROX. 8 M FROM SHAFT CENTERLINE
  - VERY LOW CHANGES IN SATURATION IF WATER FLOWS LATERALLY IN FRACTURES
- EXPECTED ZONE OF GENERAL INFLUENCE IS LESS THAN 10 M

EXAMPLE OF THERMAL INTERFERENCE CONSIDERATIONS



- CANISTER SCALE HEATER TEST
- CONSTRAINTS-CANISTER SHOULD BE LOCATED A MINIMUM OF 30 FT FROM LATERAL DRIFT TO LIMIT INFLUENCE OF DRIFTS ON NEAR FIELD
- ZONE OF INFLUENCE-THERMAL FIELD WILL EXTEND 45 FT RADIALLY AND 60 FT ALONG AXIS OF HEATER

ACTIVITIES THAT MONITOR EFFECTS OF SITE CHARACTERIZATION

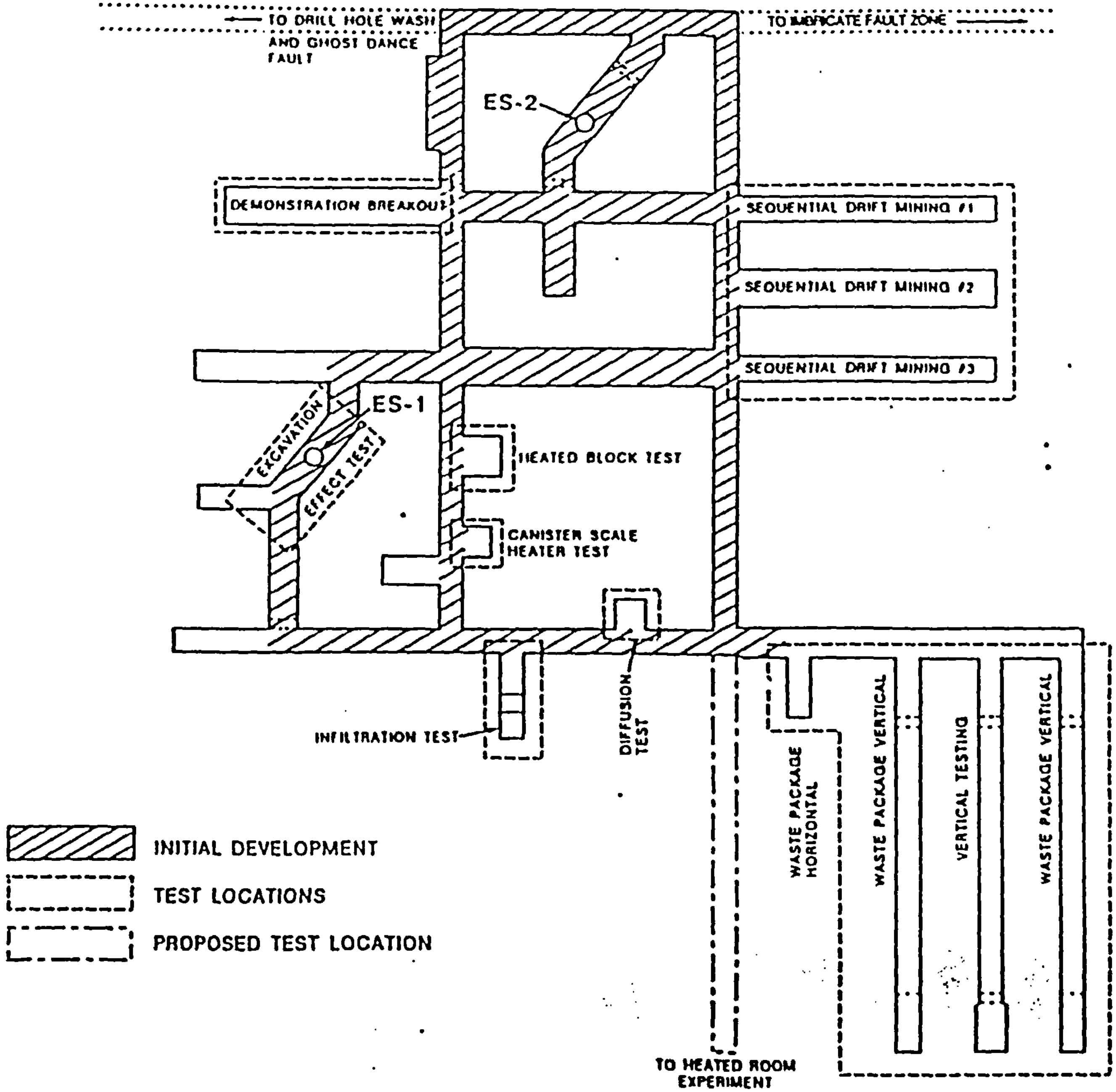
TITLE OF ACTIVITY	DESCRIPTION
• ARTIFICIAL RECHARGE; MATRIX HYDROLOGIC PROPERTIES; SITE BOREHOLES	• MONITOR INFILTRATION RATE AND TRACERS IN WATER
• RADIAL BOREHOLE TESTS; EXCAVATION EFFECTS; PLATE LOAD	• MONITOR EXCAVATION EFFECTS ON PROPERTIES
• PERCHED WATER; HYDRO-CHEMISTRY; MPBH; HYDRO-CHEMICAL SATURATED ZONE	• MONITOR PERCHED WATER, DRILLING FLUID CONTAMI-NATION IN SATURATED AND UNSATURATED ZONE
• GEOLOGIC MAPPING; OVERCORE STRESS	• MONITOR EXCAVATION EFFECTS ON SITE CONDITIONS

ACTIVITIES THAT MONITOR EFFECTS OF SITE CHARACTERIZATION

(CONTINUED)

TITLE OF ACTIVITY	DESCRIPTION
• HEAT CAPACITY; THERMAL CONDUCTIVITY AND EXPANSION; AIR QUALITY	• CONFIRM DATA VALUES FOR CALCULATING RESPONSES
• VARIABLE CONDITIONS ON MECHANICAL PROPERTIES AND FRACTURES	• INVESTIGATE EFFECTS OF VARIABLE ENVIRONMENTAL CONDITIONS ON SAMPLES AND FRACTURES
• SHAFT CONVERGENCE; DBR; SEQUENTIAL DRIFT MINING; HEATER (TSw1); CANISTER SCALE HEATER, HEATED BLOCK, THERMAL STRESS, HEATED ROOM	• ROOM SCALE MONITORING OF STABILITY, DEFORMATION AND THERMAL AND MECHANICAL RESPONSE
• MINING METHODS, GROUND SUPPORT, DRIFT STABILITY	• MONITORING EFFECTS OF MINING OPERATIONS

GENERAL ARRANGEMENT OF THE MAIN TEST LEVEL AREA



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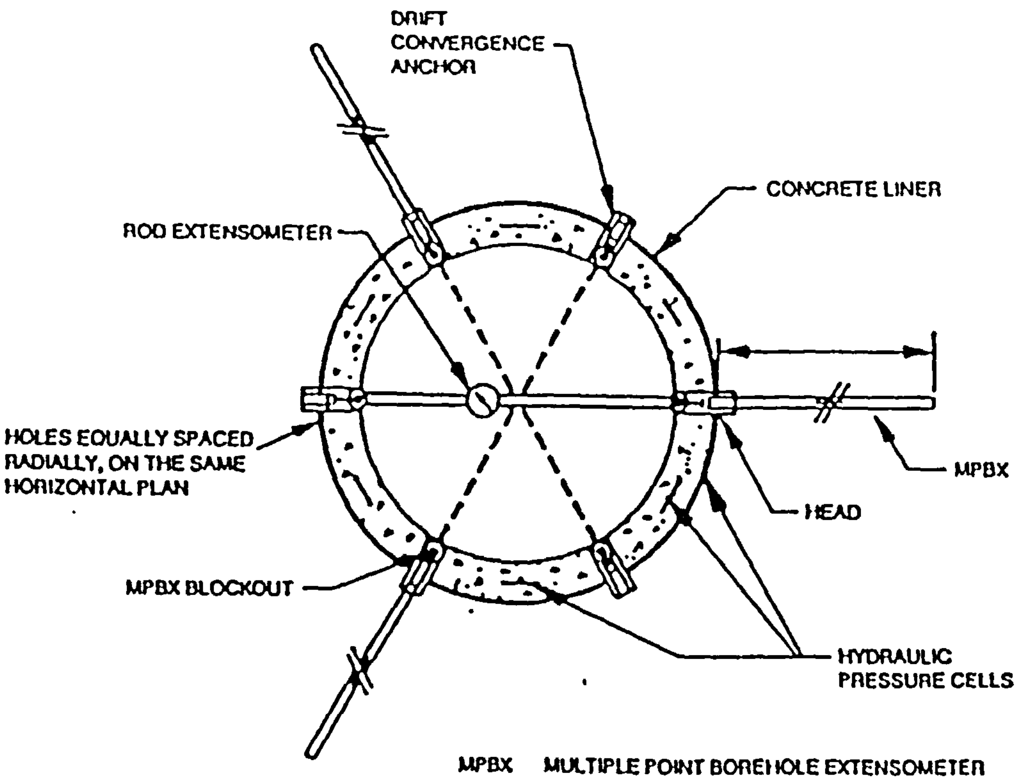
MULTIPURPOSE BOREHOLE TEST

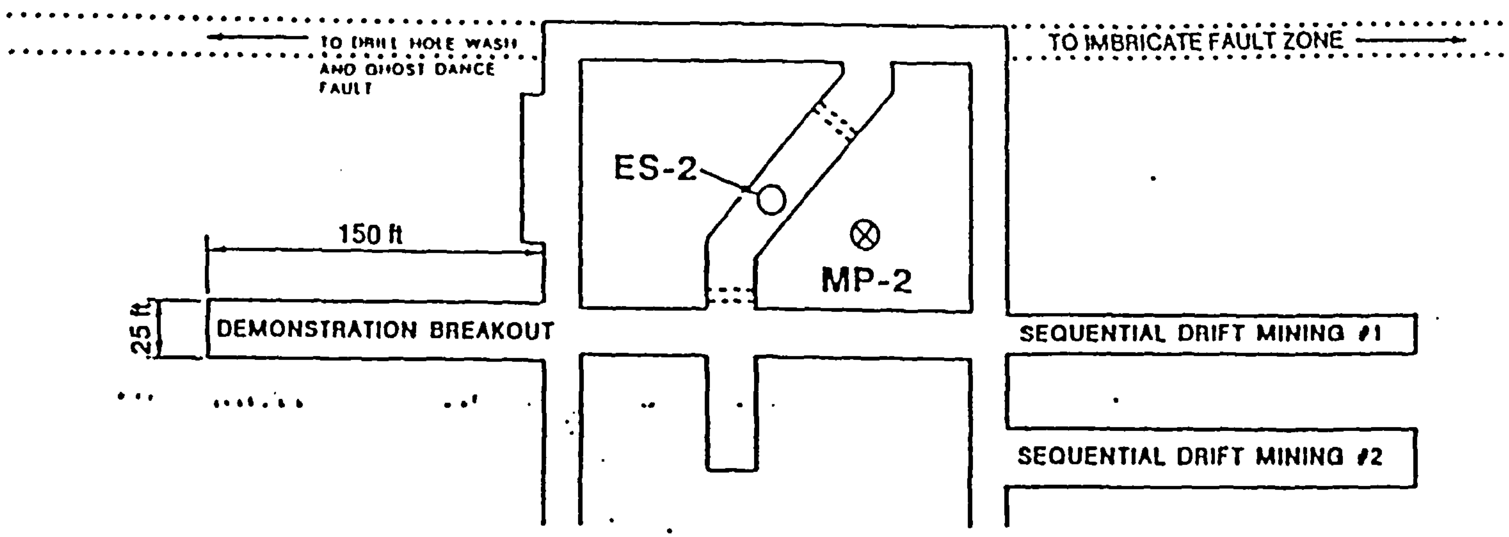
- INVESTIGATE FOR PERCHED WATER
- OBTAIN STRATIGRAPHIC AND ROCK QUALITY INFORMATION BEFORE SHAFT CONSTRUCTION
- ESTABLISH BASELINE DATA ON HYDROLOGIC PROPERTIES BEFORE SHAFT CONSTRUCTION
- MONITOR FOR POTENTIAL DISTURBANCES CAUSED BY SHAFT MINING ACTIVITIES

SHAFT CONVERGENCE TEST



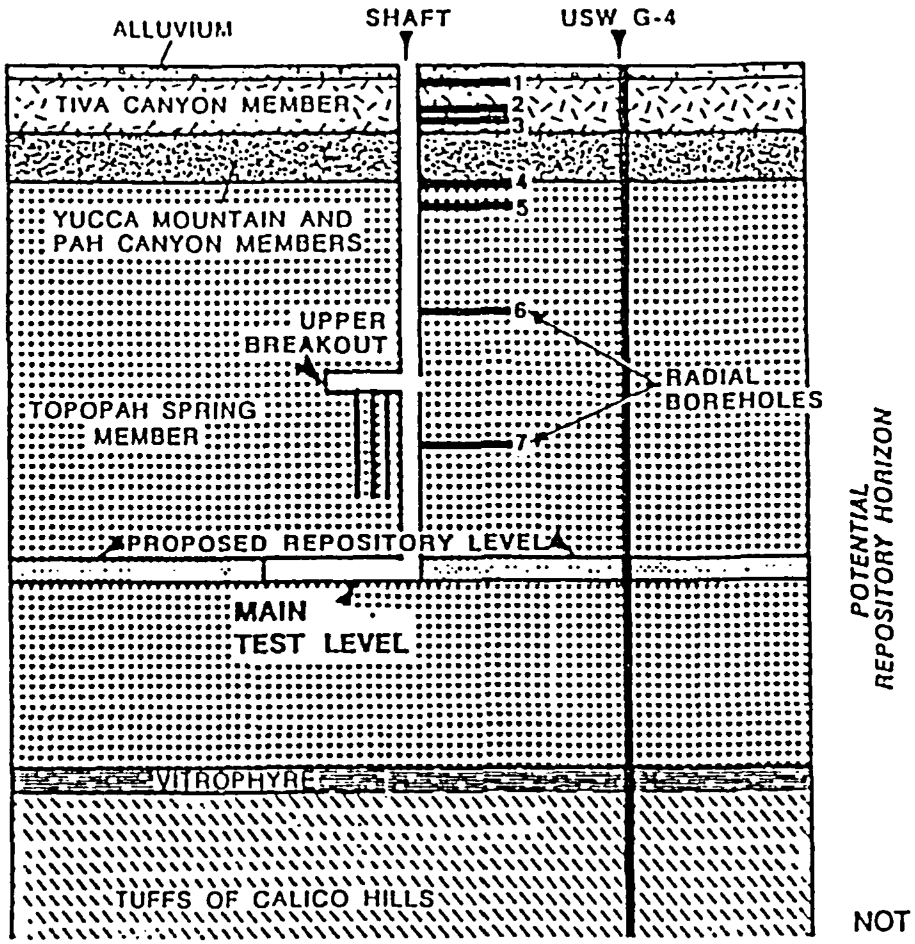
- MONITOR ROCK-MASS DEFORMATION AROUND SHAFT OPENING
- MEASURE IN SITU STRESSES
- MONITOR RADIAL STRESS IN LINER

DEMONSTRATION BREAKOUT ROOMS



- MINED OPENING WILL BE SIZED TO BE CONSISTENT WITH THE MAXIMUM WIDTH PLANNED FOR REPOSITORY DRIFTS
- BLASTING METHODS AND ROCK STABILIZATION REQUIREMENTS AND TECHNIQUES WILL BE DETERMINED IN EACH DBR HORIZON
- ROCK MASS RESPONSE WILL ALSO BE MEASURED IN THE DBR EXCAVATIONS BY USING EXTENSOMETERS AND CONVERGENCE ANCHORS

RADIAL BOREHOLE TESTS AND EXCAVATION EFFECTS TEST IN THE EXPLORATORY SHAFT FACILITY



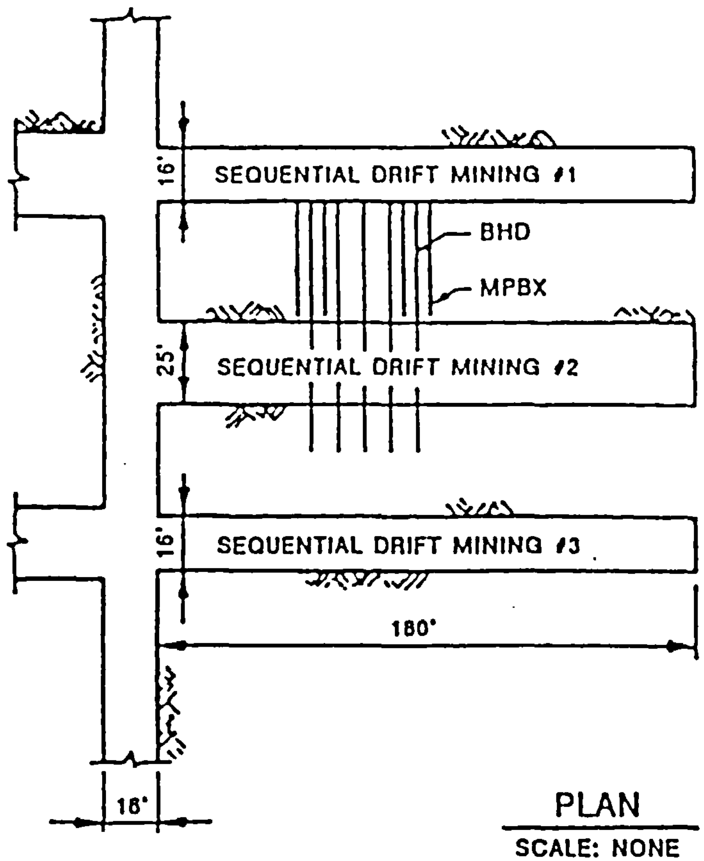
NOT TO SCALE

- INVESTIGATE VERTICAL AND LATERAL MOVEMENT OF GAS, WATER, AND VAPOR ON AND ACROSS HYDROGEOLOGIC CONTACTS AND WITHIN THE TOPOPAH SPRING UNIT UNDER MINIMALLY DISTURBED CONDITIONS .

- EVALUATE NEAR-FIELD EXCAVATION EFFECTS ON HYDROLOGIC PROPERTIES

NRCVG5P.A08/12-8 88

SEQUENTIAL DRIFT MINING TEST

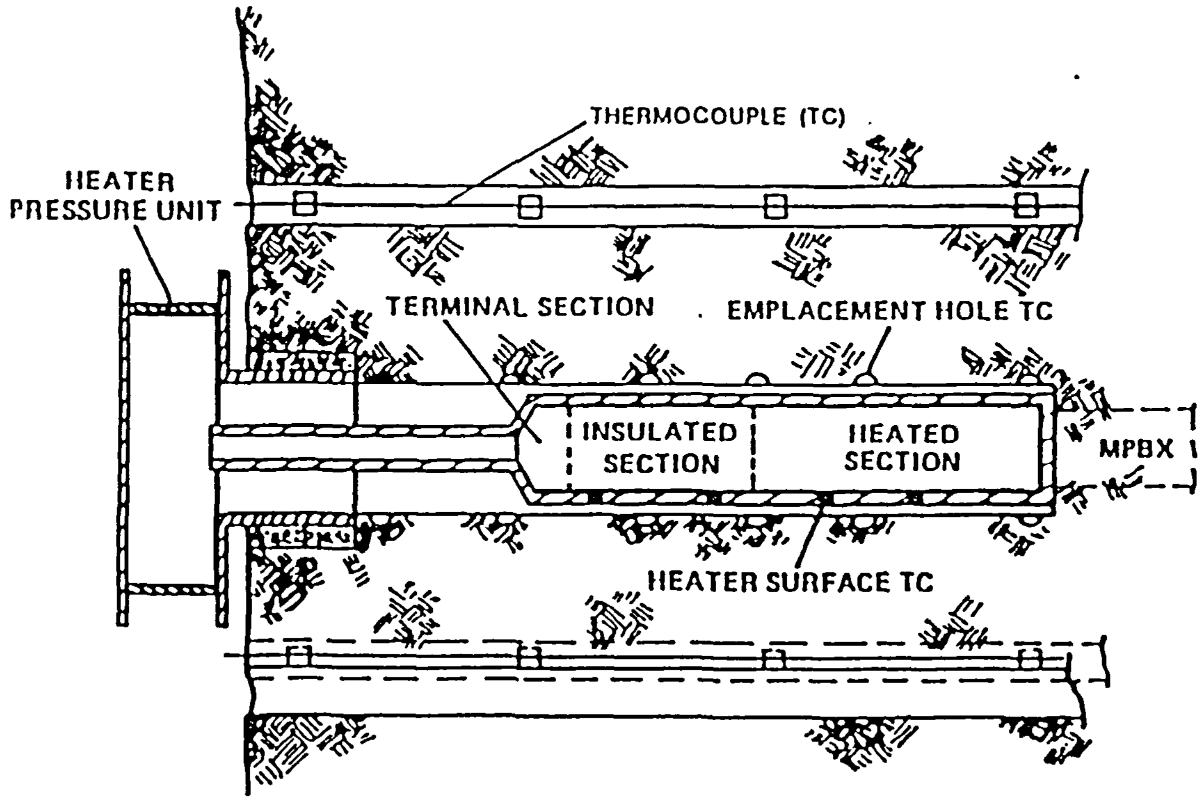


BHD - BOREHOLE DEFORMATION

MPBX - MULTIPOINT BOREHOLE EXTENSOMETER

- OBTAIN DEFORMATION RESPONSE DATA IN ROCK SURROUNDING A REPOSITORY-SIZE DRIFT OPENING AS IT IS BEING MINED IN THE DEDICATED TEST AREA
- BOREHOLE SENSORS WILL BE INSTALLED TO MONITOR STRESS RELEASE, BULK PERMEABILITY CHANGES, AND DEFORMATION
- AIR AND WATER PERMEABILITY IN BOREHOLES ADJACENT TO THE NEW DRIFT OPENING WILL BE MEASURED AFTER MINING

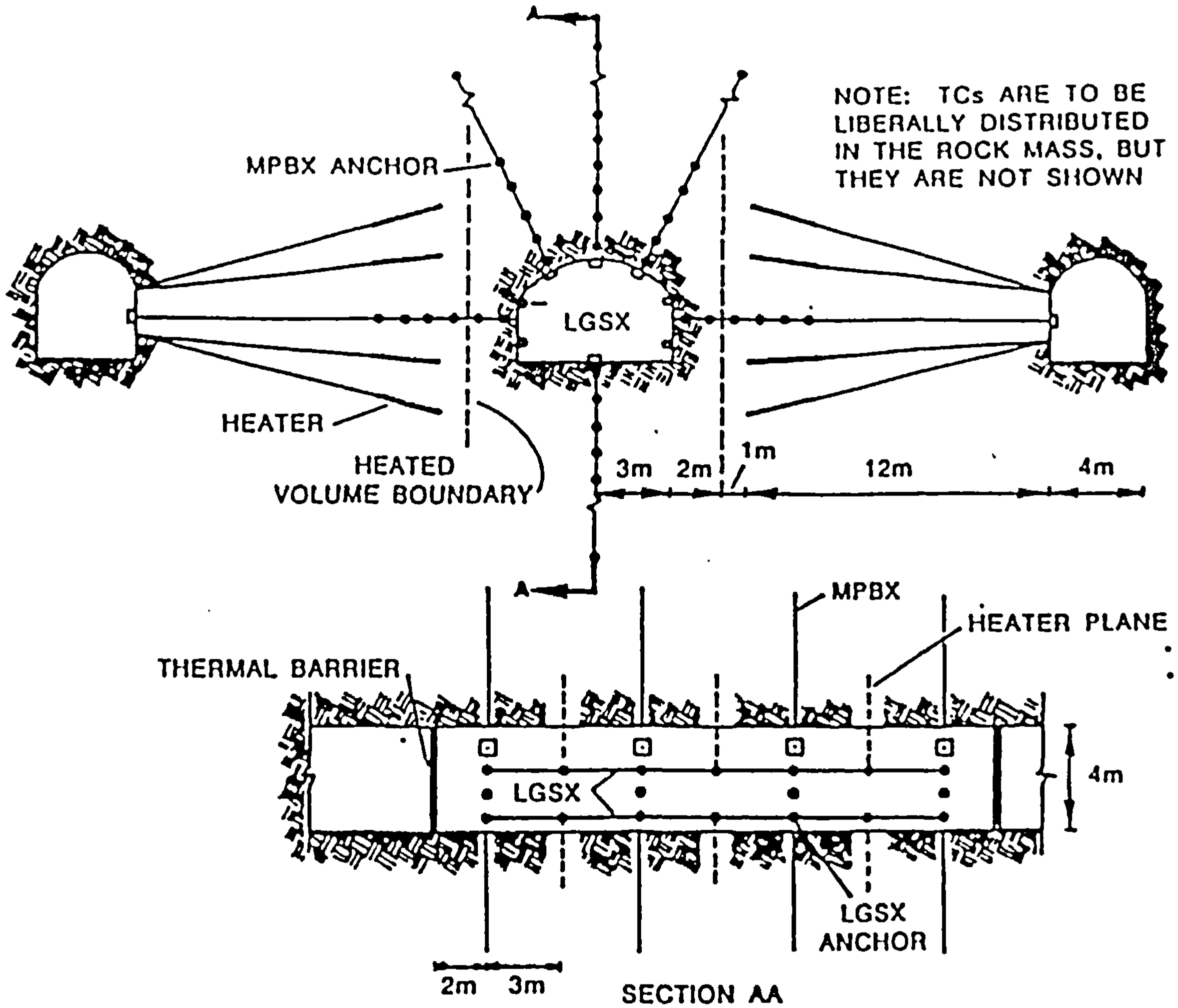
HEATER EXPERIMENT (TSwl)



- ESTABLISH THERMOMECHANICAL AND THERMALLY INDUCED HYDROLOGIC RESPONSES IN HIGH-LITHOPHYSAL-CAVITY ROCK TO VERIFY SCALING RELATIONSHIPS NEEDED FOR REPOSITORY DESIGN AND PERFORMANCE CALCULATIONS

- THE ROCK RESPONSE TO THERMAL LOADING, HEAT FLOW, AND MOISTURE CHANGES WILL BE MONITORED

HEATED ROOM EXPERIMENT



- MEASURE THERMOMECHANICAL RESPONSES IN FRACTURED WELDED TUFF AT A DRIFT-SIZE SCALE TO ACQUIRE DATA FOR EVALUATING BOTH PRE - AND POST- CLOSURE DESIGN

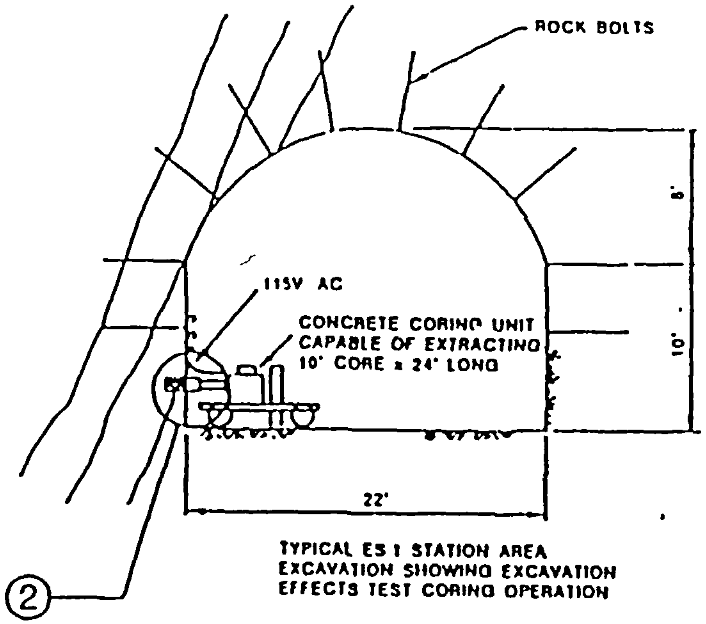
PERCOLATION TESTS IN THE EXPLORATORY SHAFT FACILITY

- OBSERVE AND MEASURE FLUID FLOW THROUGH A NETWORK OF FRACTURES UNDER CONTROLLED CONDITIONS IN ORDER TO CHARACTERIZE AND QUANTIFY IMPORTANT FLOW PROCESSES IN FRACTURED WELDED TUFF

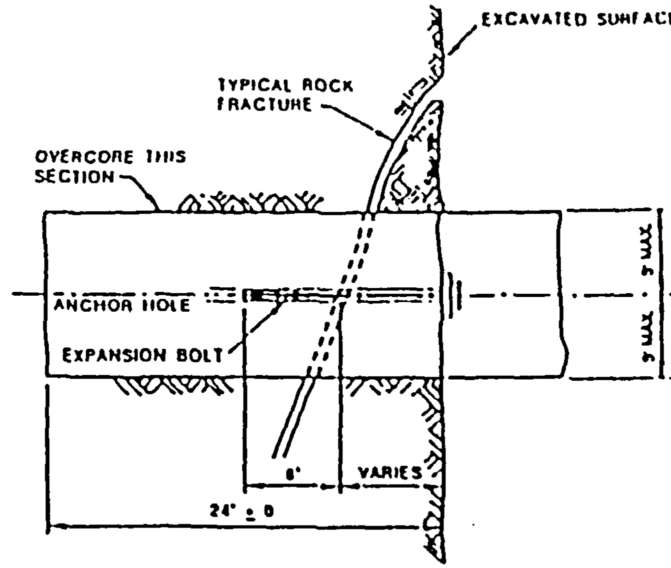
BULK-PERMEABILITY TEST IN THE EXPLORATORY SHAFT FACILITY

- DETERMINE AIR AND WATER PERMEABILITY AND HYDRAULIC CONDUCTIVITY VALUES IN RELATIVELY LARGE VOLUMES OF MINIMALLY DISTURBED TOPOPAH SPRING WELDED TUFF

INTACT FRACTURE TEST



TYPICAL ES 1 STATION AREA
EXCAVATION SHOWING EXCAVATION
EFFECTS TEST CORING OPERATION



DETAIL (2)
SCALE: NONE

AC ALTERNATING CURRENT
ES EXPLORATORY SHAFT

- EVALUATE FLUID-FLOW AND CHEMICAL TRANSPORT PROPERTIES AND MECHANISMS IN RELATIVELY UNDISTURBED AND VARIABLY STRESSED FRACTURES TO ENHANCE UNDERSTANDING OF PHYSICS OF FLOW AND FOR FLOW MODELING

NRCVG5P.A08/11-28 88

SHAFT AND BOREHOLE SEALS TESTS

THE NEED FOR THE FOLOWING CATEGORIES OF FIELD TESTS WILL BE EVALUATED:

- VERIFICATION OF EMPLACEMENT TECHNIQUES
- SATURATION OR INFILTRATION TESTS, INCLUDING THE EFFECTS OF FINES ON DRAINAGE POTENTIAL
- SEAL BEHAVIOR UNDER MINIMALLY DISTURBED HYDROGEOLOGICAL CONDITIONS

SUMMARY

- CURRENTLY DOING PROTOTYPE TESTS IN SIMILAR ROCK AT G-TUNNEL

  - DEMONSTRATE TEST CONCEPTS
  - DEVELOP QUALITY TESTING PROCEDURES

GEOLOGIC MAPPING OF EXPLORATORY SHAFTS AND DRIFTS

GEOLOGIC MAPPING AND PHOTOGRAMMETRY WILL BE USED TO DOCUMENT LITHOLOGY AND FRACTURE VARIABILITY THROUGHOUT THE VERTICAL AND HORIZONTAL EXTENT OF UNDERGROUND EXCAVATIONS, TO INVESTIGATE STRUCTURAL FEATURES, AND TO PROVIDE SITING DATA TO CONFIRM (OR MODIFY) PLANNED TEST LOCATIONS WITHIN THE UNDERGROUND EXCAVATIONS

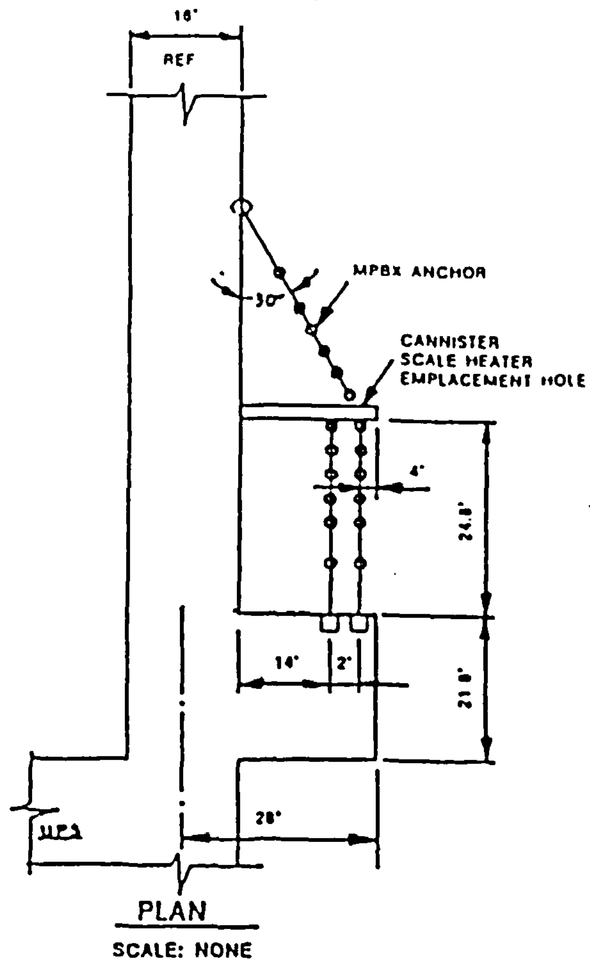
FRACTURE MINERALOGY STUDIES OF EXPLORATORY SHAFT AND DRIFTS

THE FRACTURE MINERALOGY STUDIES WILL BE CONDUCTED TO DETERMINE MINERALOGIC VARIABILITY THROUGHOUT THE VERTICAL SECTION OF ES-1, TO ESTABLISH THE TIME AND CONDITIONS OF FRACTURE MINERALOGY DEPOSITION ALTERATION, AND TO IDENTIFY FRACTURE-COATING MINERAL TYPES, SORPTIVE CHARACTERISTICS, AND HEALTH HAZARD POTENTIAL OF FIBROUS ZEOLITES.

SEISMIC TOMOGRAPHY AND VERTICAL SEISMIC PROFILING

THE PURPOSE OF SEISMIC TOMOGRAPHY AND VERTICAL SEISMIC PROFILING TESTS IS TO EVALUATE OR DEVELOP A METHOD FOR REMOTE CHARACTERIZATION OF SUBSURFACE FRACTURE NETWORKS USING THE ESF TESTS AS A MEANS TO CALIBRATE AGAINST MAPPED FRACTURE NETWORKS

CANISTER SCALE HEATER TEST



- MONITOR THERMOMECHANICAL AND HYDROTHERMAL RESPONSES IN THE REPOSITORY HOST ROCK AT CANISTER SCALE FOR:
  - DESIGN AND PERFORMANCE MODELING
  - INVESTIGATION OF RETRIEVABILITY
  - MONITORING OF RADON EMANATION AS A FUNCTION OF HEAT LOADING

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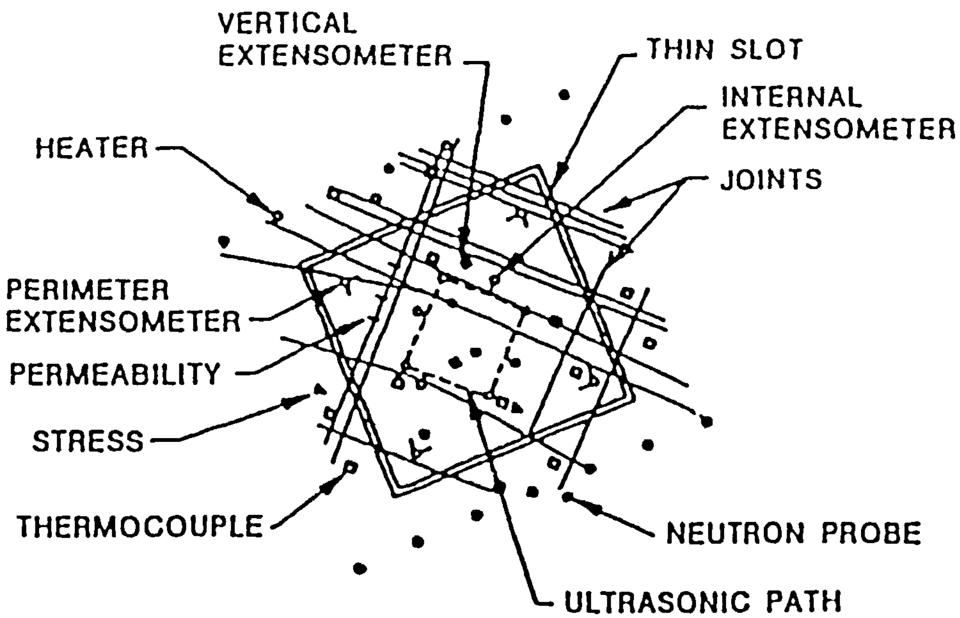
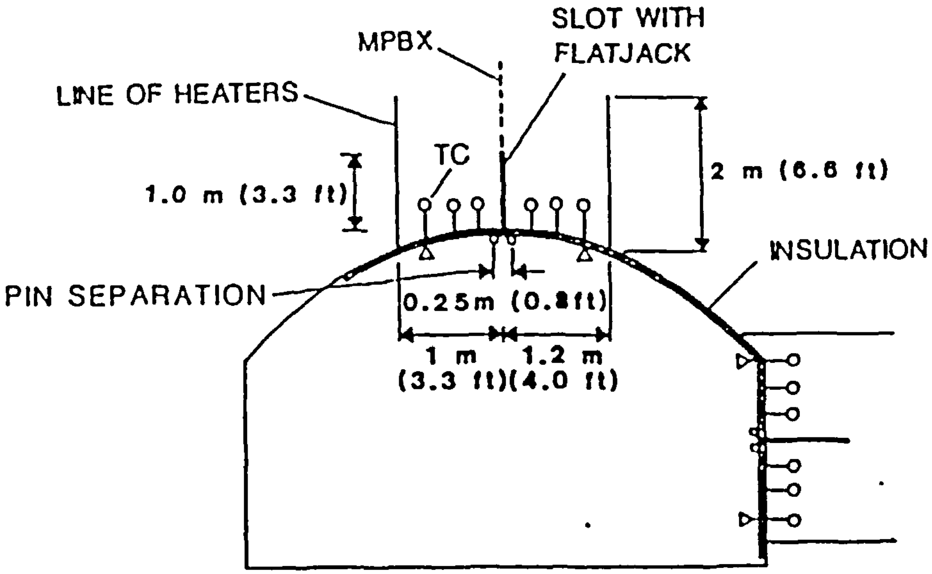
HEATED BLOCK EXPERIMENT



- MEASURE THREE-DIMENSIONAL DEFORMATION AND TEMPERATURE CHANGES FOR MODELING
- MEASURE RELATIONSHIPS AMONG FRACTURE PERMEABILITY, STRESS, AND TEMPERATURE
- MONITOR MOISTURE MOVEMENT RELATIVE TO TEMPERATURE
- EVALUATE CROSS-HOLE MEASUREMENT METHODS IN LARGE BLOCKS OF WELDED TUFF

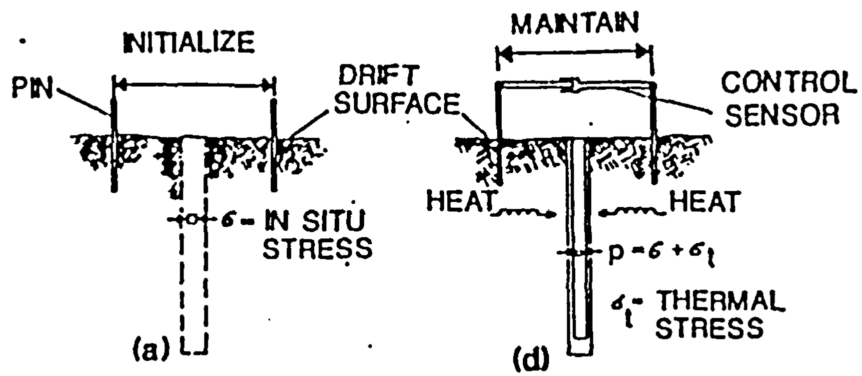
NRCVG5P.A06/11-28 88

THERMAL STRESS MEASUREMENTS



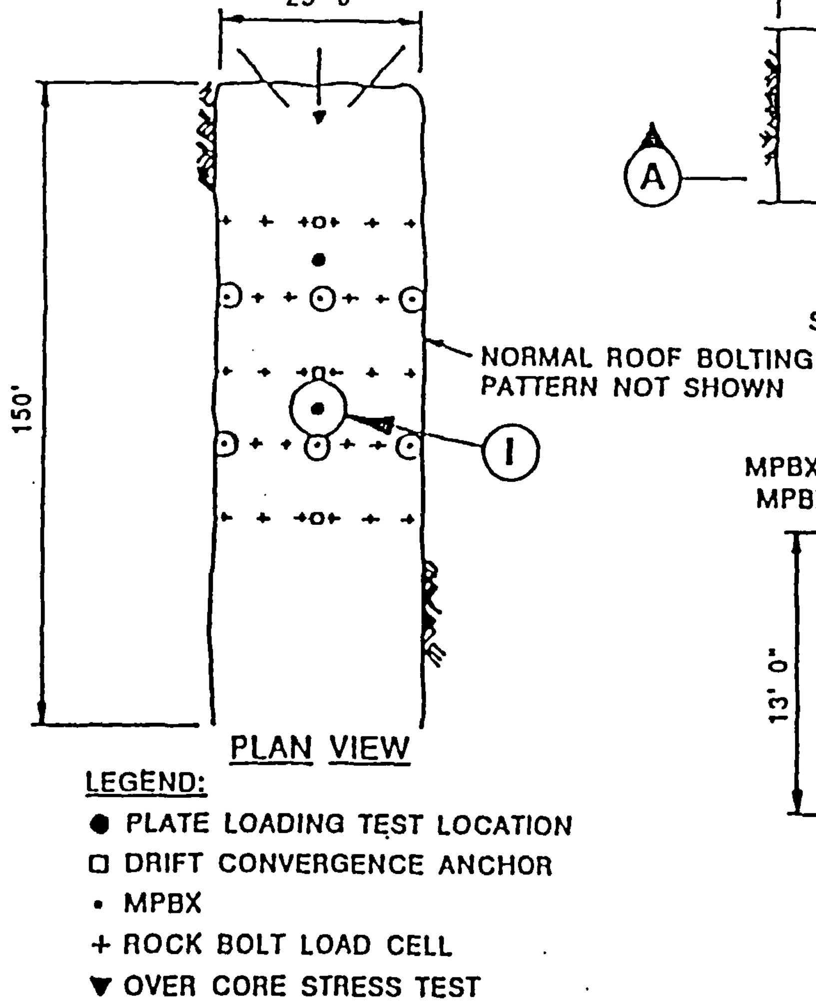
DRIFT SECTION VIEW

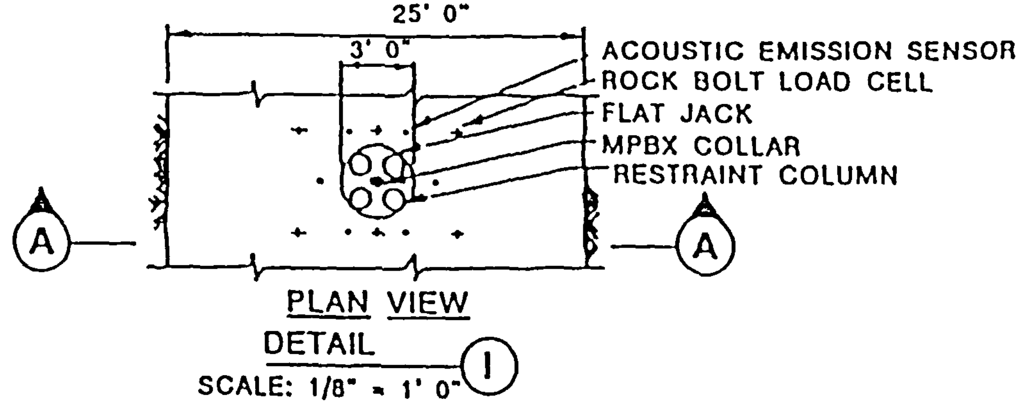
MPBX – MULTIPOINT BOREHOLE EXTENSOMETER
TC – THERMOCOUPLE

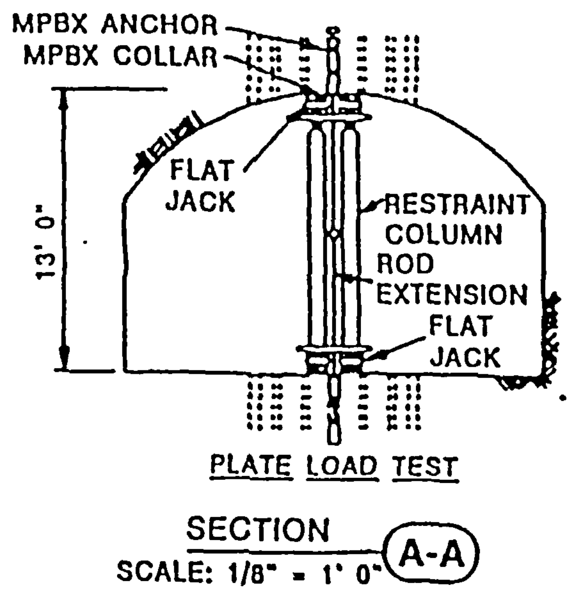


- MEASURE THERMAL STRESSES IN A RELATIVELY LARGE VOLUME OF JOINTED ROCK AND RELATE THE STRESS CHANGES TO THERMOMECHANICAL DISPLACEMENT FOR NUMERICAL MODELING

PLATE LOADING TESTS







- MEASURE THE ROCK-MASS DEFORMATION MODULUS WITH A MULTIPOINT BOREHOLE EXTENSOMETER AND EVALUATE THE FRACTURE ZONE ADJACENT TO THE MINED OPENINGS

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DEVELOPMENT AND DEMONSTRATION OF REQUIRED EQUIPMENT

- EVALUATE THE HORIZONTAL BORING TECHNOLOGY AND EQUIPMENT PERFORMANCE IN THE TOPOPAH SPRING WELDED UNIT BY DRILLING, LINING, AND INSTRUMENTING TWO WASTE EMPLACEMENT-SIZE HOLES

EVALUATION OF MINING METHODS

- DEVELOP RECOMMENDATIONS FOR MINING IN THE REPOSITORY BY MONITORING AND EVALUATING MINING ACTIVITIES IN THE ESF, AND BY CONDUCTING MINING INVESTIGATIONS

- INVESTIGATE MINING METHODS IN ES-1 AND IN THE LONG EXPLORATORY DRIFTS THROUGH PARTICLE VELOCITY MEASUREMENTS SEGMENTED BLASTING OF ROUNDS, AND EXAMINATION OF BLAST-INDUCED DAMAGE IN BOREHOLES

EVALUATION OF GROUND-SUPPORT SYSTEMS

- SELECTION, INSTALLATION, AND PERFORMANCE OF THE SUPPORT SYSTEMS USED IN THE ESF WILL BE MONITORED

- EXPERIMENTATION WITH GROUND SUPPORTS WILL INCLUDE PULL TESTS ON ROCK BOLTS, OBSERVATION OF UNSUPPORTED ROCK, STRENGTH MEASUREMENTS ON SHOTCRETE CORES, AND TRIALS OF ALTERNATE GROUND-SUPPORT CONFIGURATIONS

- DEVELOP RECOMMENDATIONS FOR A GROUND-SUPPORT METHODOLOGY TO BE USED IN DRIFTS IN THE REPOSITORY

MONITORING DRIFT STABILITY

- MONITOR DRIFT CONVERGENCE THROUGHOUT THE ESF TO UNDERSTAND POTENTIAL INSTABILITIES AND PROVIDE DATA FOR EMPIRICAL EVALUATIONS

- ROCK-MASS RELAXATION WILL BE INVESTIGATED IN THE REPOSITORY-SCALE PORTIONS OF THE LONG DRIFTS USING MULTI-POINT BOREHOLE EXTENSOMETERS

AIR QUALITY AND VENTILATION EXPERIMENT

- ASSESS THE IMPACT OF SITE CHARACTERISTICS ON VENTILATION REQUIREMENTS TO ENSURE A SAFE WORKING ENVIRONMENT

  - MEASUREMENTS OF RADON EMANATION
  - SURVEYS OF AIRFLOW AND PRESSURE, TEMPERATURE, AND HUMIDITY
  - DETERMINATIONS OF AIR RESISTANCE FACTORS
  - DUST CHARACTERIZATION

ROCK-MASS STRENGTH EXPERIMENT

- ESTIMATE THE SHEAR STRENGTH OF JOINTED ROCK MASSES AT VARIOUS SCALES, AT SEVERAL IN SITU LOCATIONS, AND IN THE LABORATORY FOR USE IN JOINTED-ROCK MODELING

OVERCORE STRESS EXPERIMENTS IN THE EXPLORATORY SHAFT FACILITY

- DETERMINE THE IN SITU STATE OF STRESS ABOVE AND WITHIN THE REPOSITORY HORIZON
- DETERMINE THE EXTENT OF EXCAVATION-INDUCED STRESS CHANGES
- RELATE STRESS PARAMETERS TO ROCK-MASS HETEROGENEITIES

LABORATORY TESTS (THERMAL AND MECHANICAL) USING SAMPLES OBTAINED FROM THE EXPLORATORY SHAFT FACILITY

- PROVIDE BULK, THERMAL, AND MECHANICAL PROPERTIES DATA FOR EVALUATION OF OPENING STABILITY AND RELATED DESIGN AND PERFORMANCE STUDIES AND/OR MODELING

MATRIX HYDROLOGIC PROPERTIES TESTING

- DEVELOP A COMPREHENSIVE DATA BASE ON MATRIX FLUX PROPERTIES IN THE UNSATURATED-ZONE TUFFS AT YUCCA MOUNTAIN USING MINIMALLY DISTURBED SAMPLES

HYDROLOGICAL PROPERTIES OF MAJOR FAULTS ENCOUNTERED IN THE MAIN TEST LEVEL OF THE EXPLORATORY SHAFT FACILITY

- PROVIDE HYDROLOGIC INFORMATION IN PARALLEL WITH GEOLOGIC MAPPING OF THE EXPLORATORY SHAFTS AND DRIFTS

- FAULTS ENCOUNTERED IN THE LONG EXPLORATORY DRIFTS ON THE MAIN TEST LEVEL WILL BE CHARACTERIZED GEOLOGICALLY UNDER THE GEOLOGIC MAPPING ACTIVITY

DIFFUSION TESTS IN THE EXPLORATORY SHAFT FACILITY

- DETERMINE DIFFUSIVITY COEFFICIENTS FOR NONSORBING IONS IN THE TOPOPAH SPRING WELDED TUFF UNDER MINIMALLY DISTURBED CONDITIONS

CHLORIDE AND CHLORINE-36 MEASUREMENTS OF PERCOLATION AT YUCCA MOUNTIAN

- DETERMINE THE RATE OF WATER MOVEMENT DOWNWARD THROUGH THE UNSATURATED-ZONE TUFFS USING THE CHLORINE-36/CHLORIDE CONCENTRATION RATIO

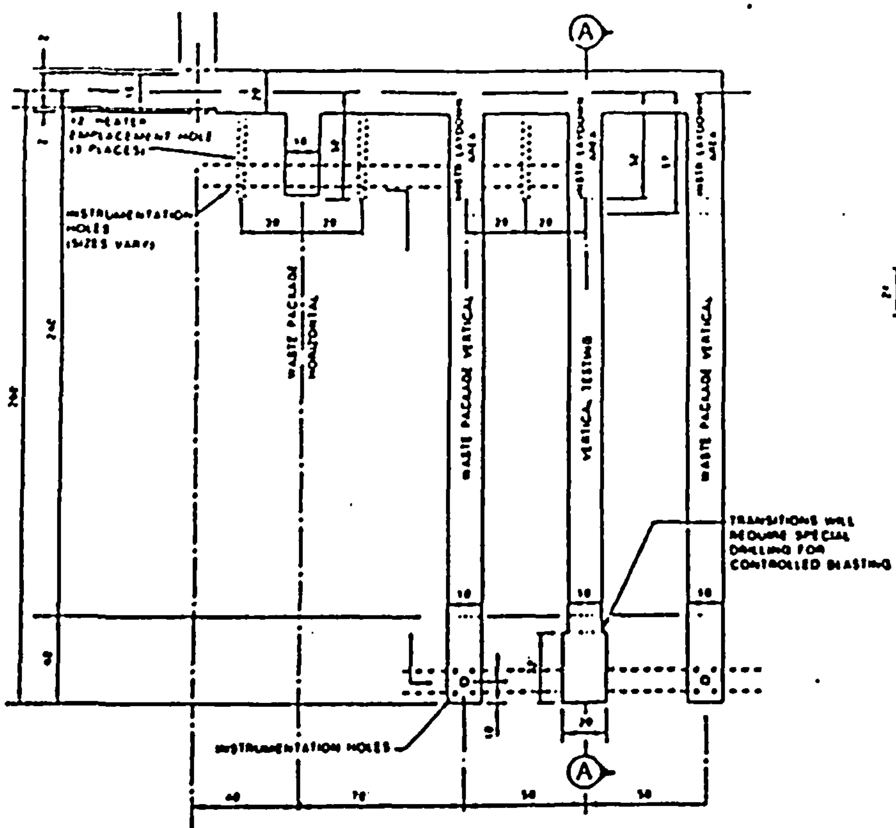
PERCHED-WATER TEST IN THE EXPLORATORY SHAFT FACILITY

- DETECT THE OCCURENCE AND DELINEATE THE LATERAL AND VERTICAL EXTENT OF PERCHED-WATER ZONES DURING SHAFT EXCAVATION
- IDENTIFY PERCHING MECHANISM(S)
- SAMPLE THE WATER FOR CHEMICAL ANALYSES

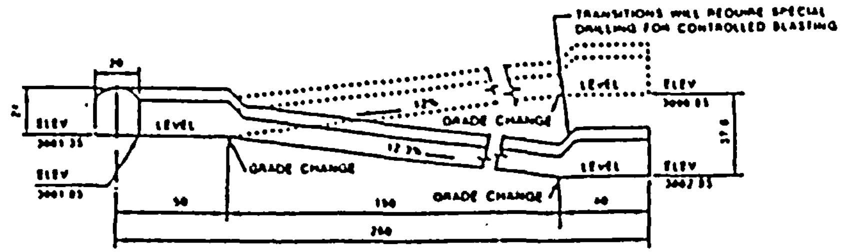
HYDROCHEMISTRY TESTS IN THE EXPLORATORY SHAFT FACILITY

- DETERMINE THE CHEMICAL COMPOSITION, REACTIVE MECHANISMS, AGE OF WATER AND GAS IN PORES, FRACTURES, AND PERCHED-WATER ZONES WITHIN THE UNSATURATED TUFFS ACCESSIBLE FROM THE ESF AND/OR AFFILIATED CORE HOLES

ENGINEERED BARRIER SYSTEM FIELD TESTS

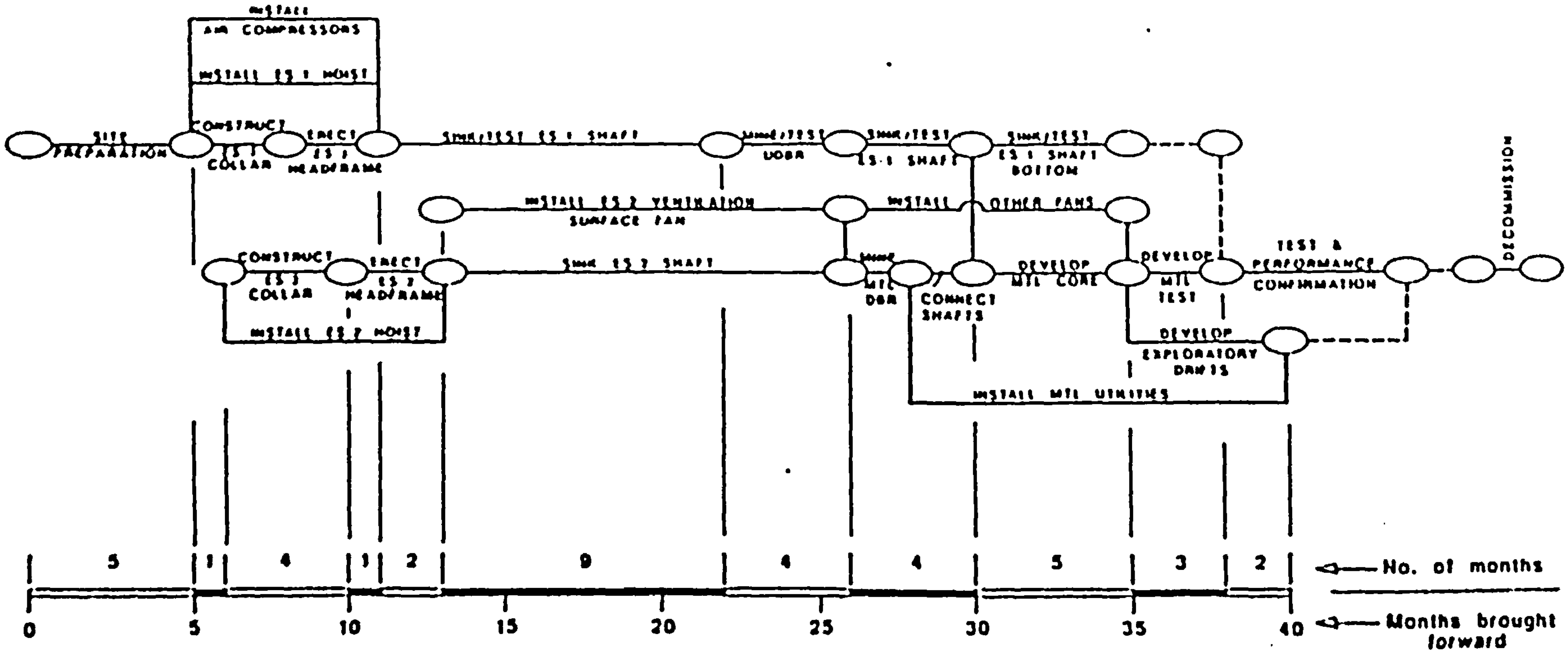


PLAN



SECTION (A-A)

- DETERMINE THE HYDROLOGIC TRANSPORT PROPERTIES IN ROCK AT THE REPOSITORY HORIZON UNDER MINIMALLY DISTURBED CONDITIONS
- DETERMINE THE EFFECT ON WATER CHEMISTRY OF NEAR-FIELD THERMAL PERTURBATION



ES EXPLORATORY SHAFT
MTL MAIN TEST LEVEL
UDBR UPPER DEMONSTRATION BREAKOUT ROOM

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U.S. DEPARTMENT OF ENERGY

OCRWM

YUCCA MOUNTAIN

STRATEGY FOR USE OF TESTING INFORMATION

PRESENTED BY

MAXWELL B. BLANCHARD
DIRECTOR, REGULATORY & SITE EVALUATION DIVISION
YUCCA MOUNTAIN PROJECT
U.S. DEPARTMENT OF ENERGY

DECEMBER 13, 1988

UNITED STATES DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE/YUCCA MOUNTAIN PROJECT OFFICE

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WASTE ISOLATION DEPENDS ON PERFORMANCE OF THE NATURAL AND ENGINEERED BARRIERS

- **ENGINEERED BARRIERS**
  - DESIGNED AND CONSTRUCTED USING AVAILABLE TECHNOLOGY
  - DEGRADATION (PERFORMANCE) DEPENDS ON NATURAL CONDITIONS

- **NATURAL BARRIERS**
  - CANNOT BE DESIGNED
  - NEED TO UNDERSTAND HOW PROCESSES ACT TO CHANGE NATURAL BARRIERS
  - NEED TO PREDICT MAGNITUDE OF CHANGES AND CONSEQUENCES ON WASTE ISOLATION

OVERVIEW OF DOE STRATEGY FOR DEVELOPMENT AND USE OF SITE TESTING INFORMATION

- UNDERSTAND REGULATORY REQUIREMENTS FOR SITE SUITABILITY AND REPOSITORY LICENSING
- TRANSLATE REGULATORY REQUIREMENTS INTO "ISSUES" (OGR-B-10 - DOE ISSUES HIERARCHY)

OVERVIEW OF DOE STRATEGY FOR DEVELOPMENT AND USE OF SITE TESTING INFORMATION

(CONTINUED)

- DEVELOP STRATEGY FOR RESOLUTION OF EACH ISSUE
- IDENTIFY SITE DATA NEEDS AS ONE STEP IN THE STRATEGY FOR RESOLVING EACH ISSUE

THE ISSUES HIERARCHY

AN ORGANIZING TOOL THAT LINKS THE REGULATIONS WITH THE CHARACTERIZATION PROGRAMS THROUGH ISSUES

REGULATORY REQUIREMENTS

- DOE GUIDELINES
- NRC TECHNICAL CRITERIA
  - PERFORMANCE OBJECTIVES
  - SITING CRITERIA
  - DESIGN CRITERIA
- EPA STANDARDS

ISSUES

- PERFORMANCE ISSUES
- DESIGN ISSUES

CHARACTERIZATION PROGRAMS

- GEOHYDROLOGY
- GEOCHEMISTRY
- ROCK CHARACTERISTICS
- EROSION
- DISSOLUTION
- TECTONICS
- HUMAN INTERFERENCE
- POPULATION DENSITY
- LAND OWNERSHIP
- METEOROLOGY
- OFFSITE INSTALLATIONS
- SURFACE CHARACTERISTICS

DEFINE ISSUES

KEY ISSUE 1: POSTCLOSURE PERFORMANCE

PERFORMANCE ISSUES

1.1 TOTAL SYSTEM PERFORMANCE
1.2 INDIVIDUAL DOSE REQUIREMENTS
1.3 GROUNDWATER PROTECTION REQUIREMENTS
1.4 WASTE PACKAGE CONTAINMENT
1.5 ENGINEERED BARRIER RELEASES
1.6 1,000 YR TRAVEL TIME
1.7 PERFORMANCE CONFIRMATION
1.8 FAVORABLE AND POTENTIALLY ADVERSE CONDITIONS (10CFR60)
1.9 HIGHER LEVEL FINDINGS ON SYSTEM AND TECHNICAL GUIDELINES

DESIGN ISSUES

1.10 WASTE PACKAGE DESIGN
1.11 UNDERGROUND FACILITY DESIGN
1.12 SEAL DESIGN

KEY ISSUE 2: PRECLOSURE RADIOLOGICAL SAFETY

PERFORMANCE ISSUES

2.1 RELEASE TO HIGHLY POPULATED & UNRESTRICTED AREAS - NORMAL OPERATION
2.2 RADIOLOGICAL SAFETY OF WORKERS - NORMAL OPERATION
2.3 RELEASE TO RESTRICTED & UNRESTRICTED AREAS - CREDIBLE ACCIDENTS
2.4 WASTE RETRIEVAL
2.5 HIGHER LEVEL FINDINGS ON SYSTEM & TECHNICAL GUIDELINES

DESIGN ISSUES

2.6 CHARACTERISTICS & CONFIGURATIONS OF WASTE PACKAGE
2.7 CHARACTERISTICS & CONFIGURATIONS OF REPOSITORY

KEY ISSUE 3: HEALTH, SAFETY, ENVIRONMENT, SOCIOECONOMICS, TRANSPORTATION

KEY ISSUE 4: PRECLOSURE PERFORMANCE

PERFORMANCE ISSUES

4.1 HIGHER LEVEL FINDINGS ON SYSTEMS & TECHNICAL GUIDELINES

DESIGN ISSUES

4.2 INDUSTRIAL SAFETY REQUIREMENTS
4.3 AVAILABILITY OF TECHNOLOGY FOR WASTE PACKAGE DESIGN
4.4 AVAILABILITY OF TECHNOLOGY FOR REPOSITORY DESIGN
4.5 REASONABLE COSTS FOR TOTAL SYSTEM

UNDERLYING PURPOSE OF ISSUE RESOLUTION STRATEGY

1. DEFINE MEASURES TO BE USED TO EVALUATE SUITABILITY OF THE YUCCA MOUNTAIN SITE FOR DEVELOPMENT AS A REPOSITORY

2. DEVELOP PLANS FOR MEETING PERFORMANCE AND DESIGN REQUIREMENTS IN 10 CFR PART 60

UNDERLYING PURPOSE OF ISSUE RESOLUTION STRATEGY
(CONTINUED)

3. USE PRELIMINARY MEASURES AND PLANS FROM (1) AND (2) TO DETERMINE WHAT, AND HOW MUCH, INFORMATION IS NEEDED ABOUT NATURAL SITE PROCESSES AND CONDITIONS

4. DEVELOP SYSTEMATIC PROCESS FOR DETERMINING STATUS OF EVALUATIONS OF SITE SUITABLITY AND EVALUATING PROGRESS TOWARD MEETING REGULATORY REQUIREMENTS*

* MEASURING STICK FOR "REASONABLE ASSURANCE"

ROLE OF PERFORMANCE ALLOCATION IN FOCUSING SITE DATA NEEDS

- PERFORMANCE ALLOCATION IS THE PROCESS THAT WAS USED TO DEFINE THE NATURAL AND ENGINEERED BARRIERS THAT ARE EXPECTED TO BE RELIED UPON TO MEET THE REGULATORY REQUIREMENTS

- PERFORMANCE ALLOCATION WAS USED TO PRIORITIZE THE TESTS AND EXPERIMENTS TO BE CONDUCTED DURING SITE CHARACTERIZATION

ROLE OF PERFORMANCE ALLOCATION IN FOCUSING SITE DATA NEEDS

(CONTINUED)

- SITE INFORMATION FOR THOSE BARRIERS PROVIDING THE PRIMARY CONTRIBUTION TO MEETING REGULATORY REQUIREMENTS WERE GIVEN HIGHEST PRIORITY

---SEVERAL EXAMPLES OF PERFORMANCE ALLOCATION WILL BE PRESENTED LATER IN THIS PRESENTATION---

OVERVIEW OF SITE PROGRAM

- EMPHASIS IS PLACED ON CHARACTERIZING THE NATURAL GEOLOGIC SETTING THAT PROVIDES THE MAJOR LONG-TERM BARRIER TO RADIONUCLIDE MOVEMENT

- SITE TESTING ADDRESSES BOTH THE EXPECTED RANGE OF VARIATION IN CURRENT SITE CONDITIONS OVER THE NEXT 10,000 YEARS AND THE POTENTIALLY DISRUPTIVE EVENTS (LOWER PROBABILITY) THAT COULD OCCUR OVER THE NEXT 10,000 YEARS

OVERVIEW OF SITE PROGRAM

(CONTINUED)

- "REASONABLE ASSURANCE" CALLED FOR IN THE REGULATORY REQUIREMENTS FOR LONG-TERM REPOSITORY PERFORMANCE IS EXPECTED TO BE MET THROUGH

  - REDUNDANT TESTING TO GAIN CONFIDENCE IN CONCLUSIONS ABOUT SITE CONDITIONS

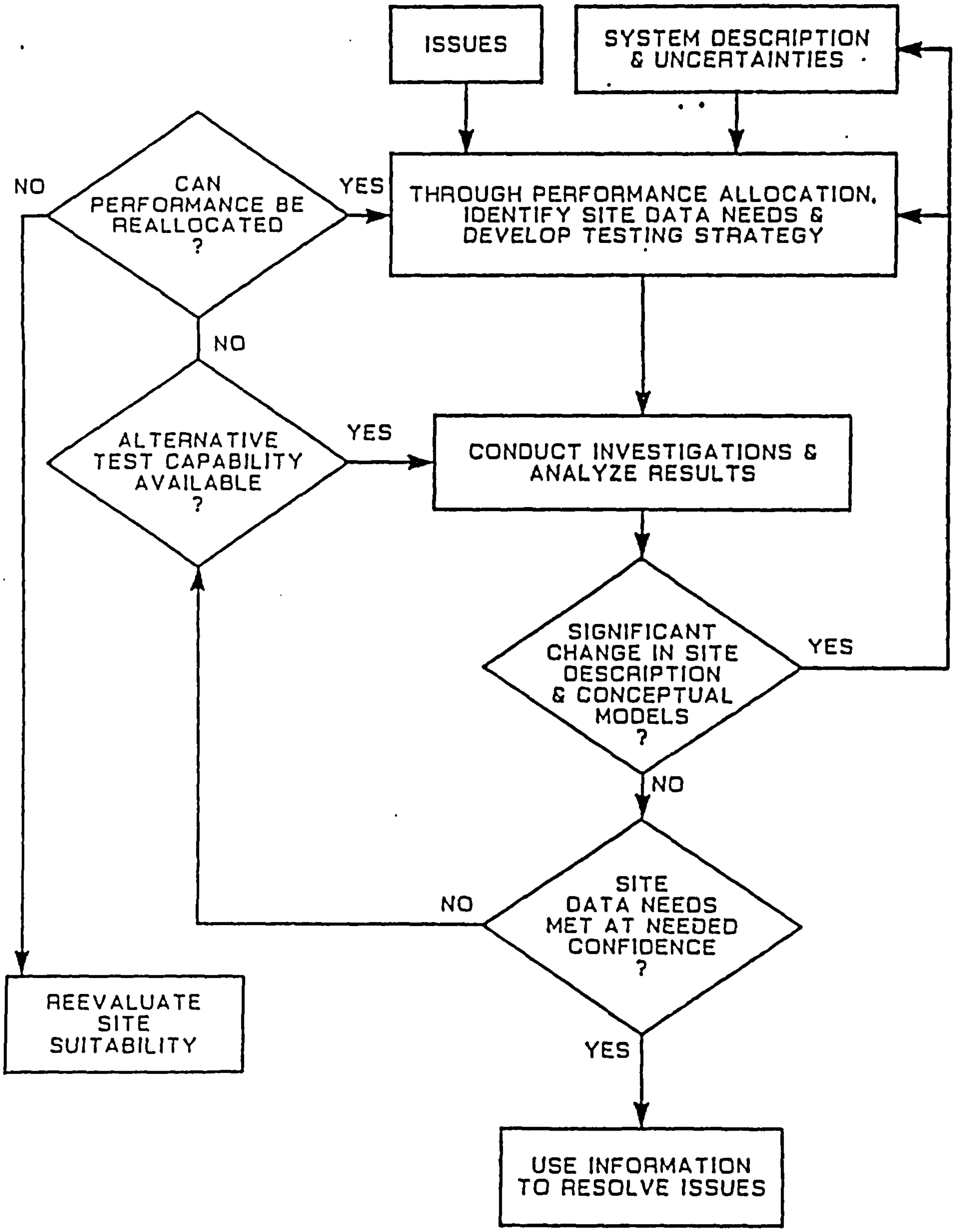
  - BOUNDING CALCULATIONS FOR CONDITIONS WITH HIGH UNCERTAINTY

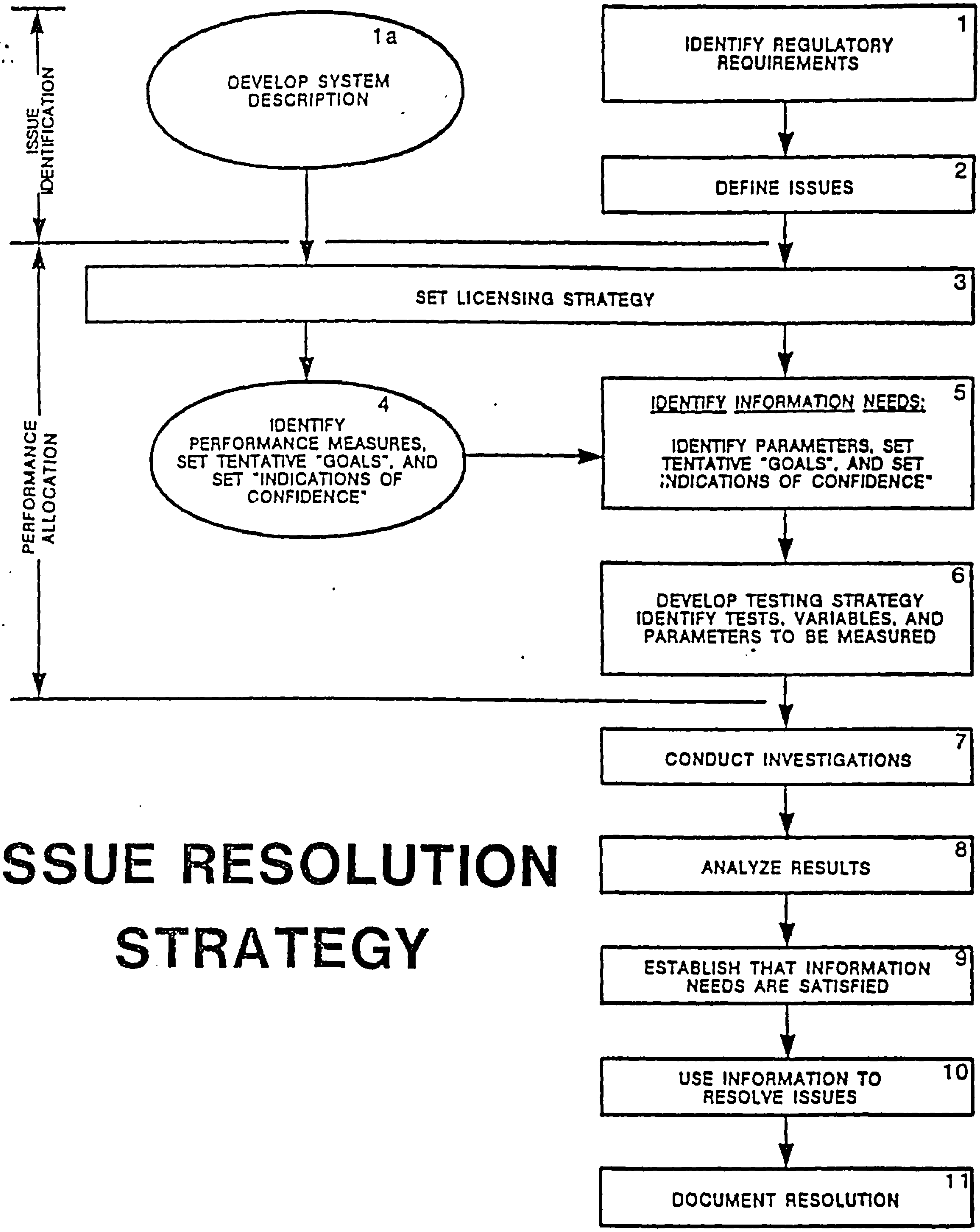
  - RELIANCE ON MULTIPLE AND SECONDARY BARRIERS

COMPONENTS OF THE SITE CHARACTERIZATION PROGRAM

AREA OF INVESTIGATION	STUDIES	ACTIVITIES
GEOHYDROLOGY	16	54
GEOCHEMISTRY	16	31
ROCK CHARACTERISTICS	5	16
CLIMATE	8	24
EROSION	4	5
TECTONICS	30	102
HUMAN INTERFERENCE (MINERAL RESOURCES)	5	11
METEOROLOGY	4	2
SURFACE CHARACTERISTICS	3	8
THERMAL AND MECHANICAL ROCK PROPERTIES	10	25
SURFACE HYDROLOGY	3	6

STRATEGY FOR THE CONDUCT OF THE SITE PROGRAM

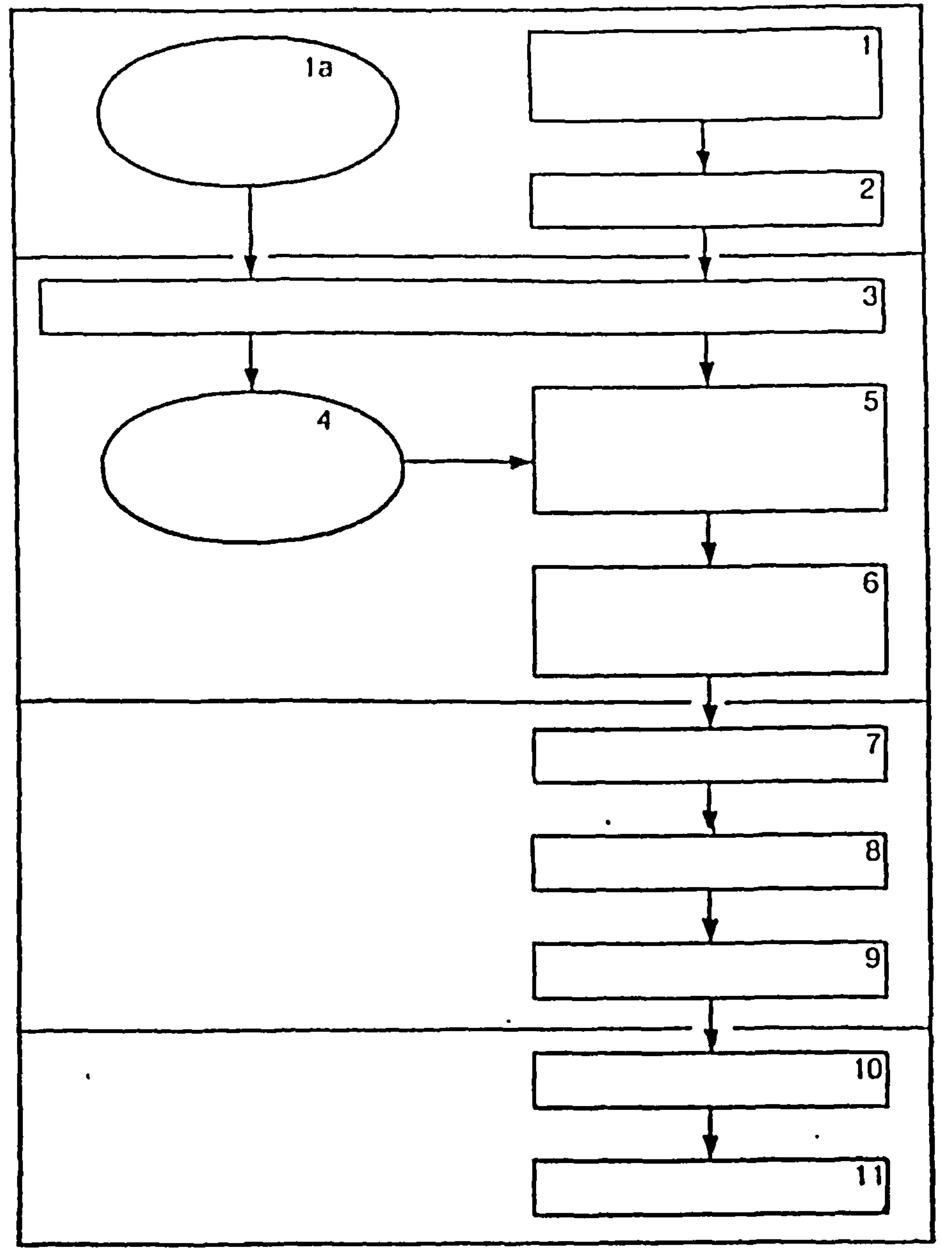




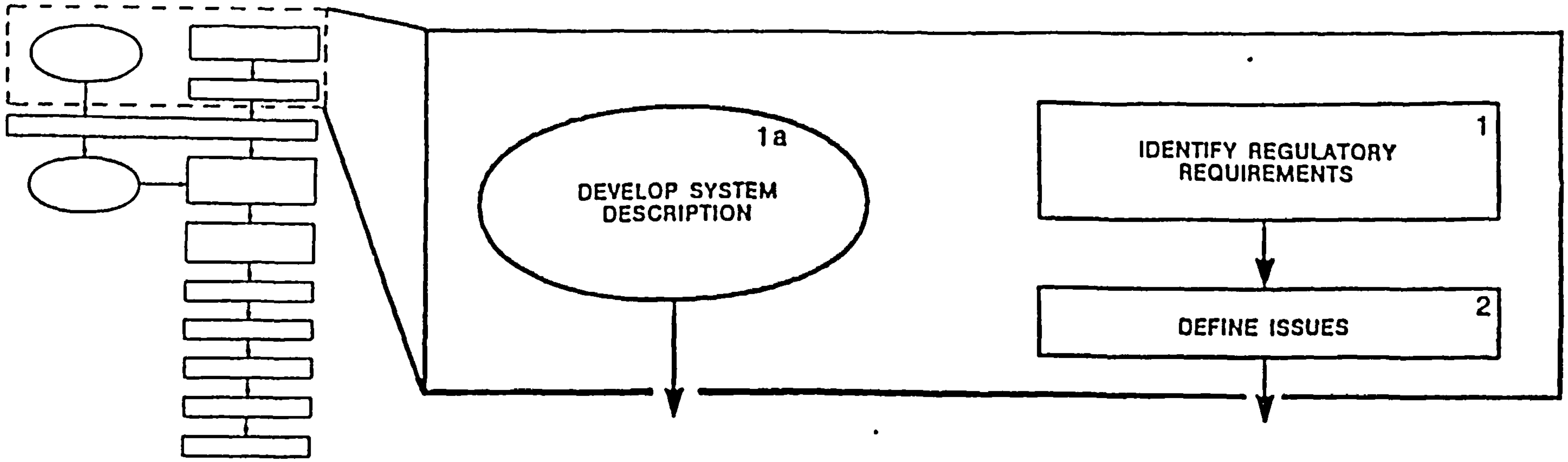
ISSUE RESOLUTION STRATEGY

ISSUE RESOLUTION STRATEGY

- ISSUE IDENTIFICATION
  (DISCUSSED IN SCP)
- PERFORMANCE ALLOCATION
  (DESCRIBED IN DETAIL IN SCP)
- DATA COLLECTION AND ANALYSES
- ISSUE RESOLUTION

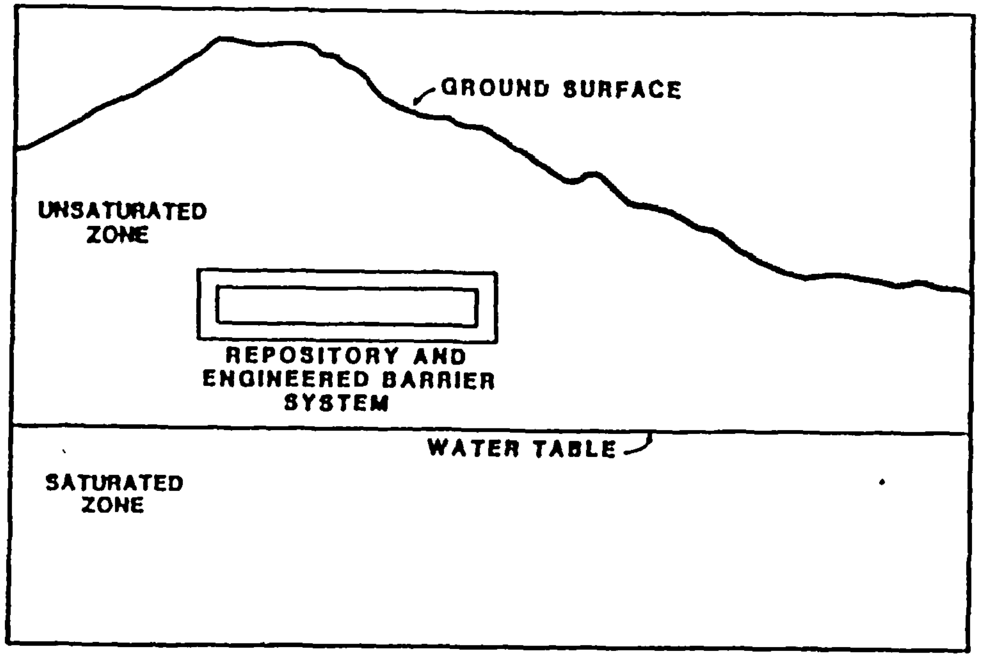


ISSUE RESOLUTION STRATEGY: ISSUE IDENTIFICATION



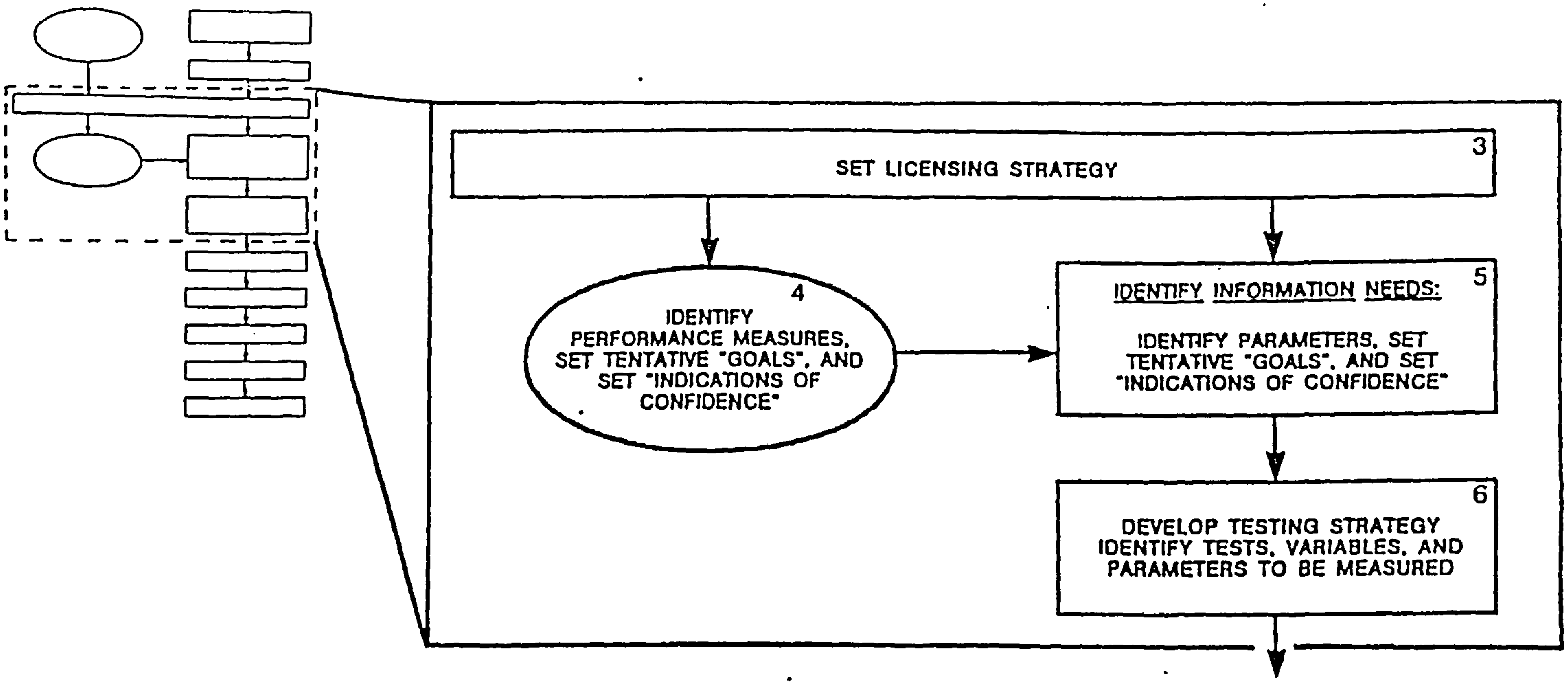
1a
DEVELOP SYSTEM DESCRIPTION

- DEVELOP CONCEPTUAL SITE MODELS
- DEVELOP CONCEPTUAL DESIGNS
- DEFINE SYSTEM ELEMENTS

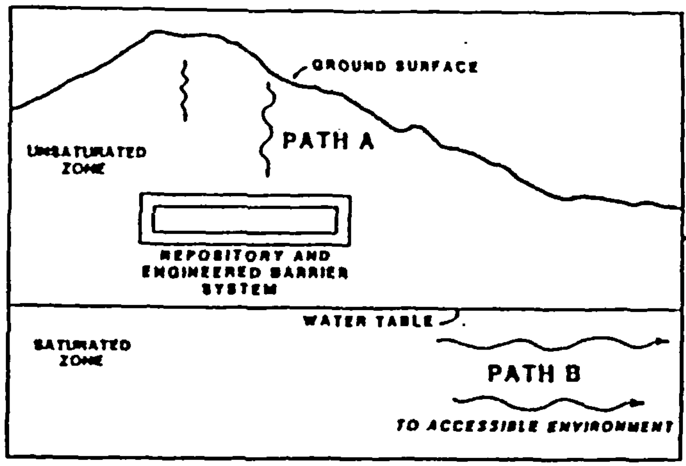


- SITE ELEMENTS
    - UNSATURATED ZONE
        - ---
        - ---
        - ---
    - SATURATED ZONE
        - ---
        - ---
        - ---
- ENGINEERED BARRIER ELEMENTS
    - AIR GAP
    - CONTAINER
    - WASTE FORM

ISSUE RESOLUTION STRATEGY: PERFORMANCE ALLOCATION



SET LICENSING STRATEGY



→ SELECT MAJOR SYSTEM ELEMENTS WITH HIGH LIKELIHOOD TO MEET OR EXCEED CRITERIA

→ **SITE**
UNSATURATED ZONE
- •
- •
- •
- •

EBS
AIR GAP
CONTAINER
- •
- •
- •
- •

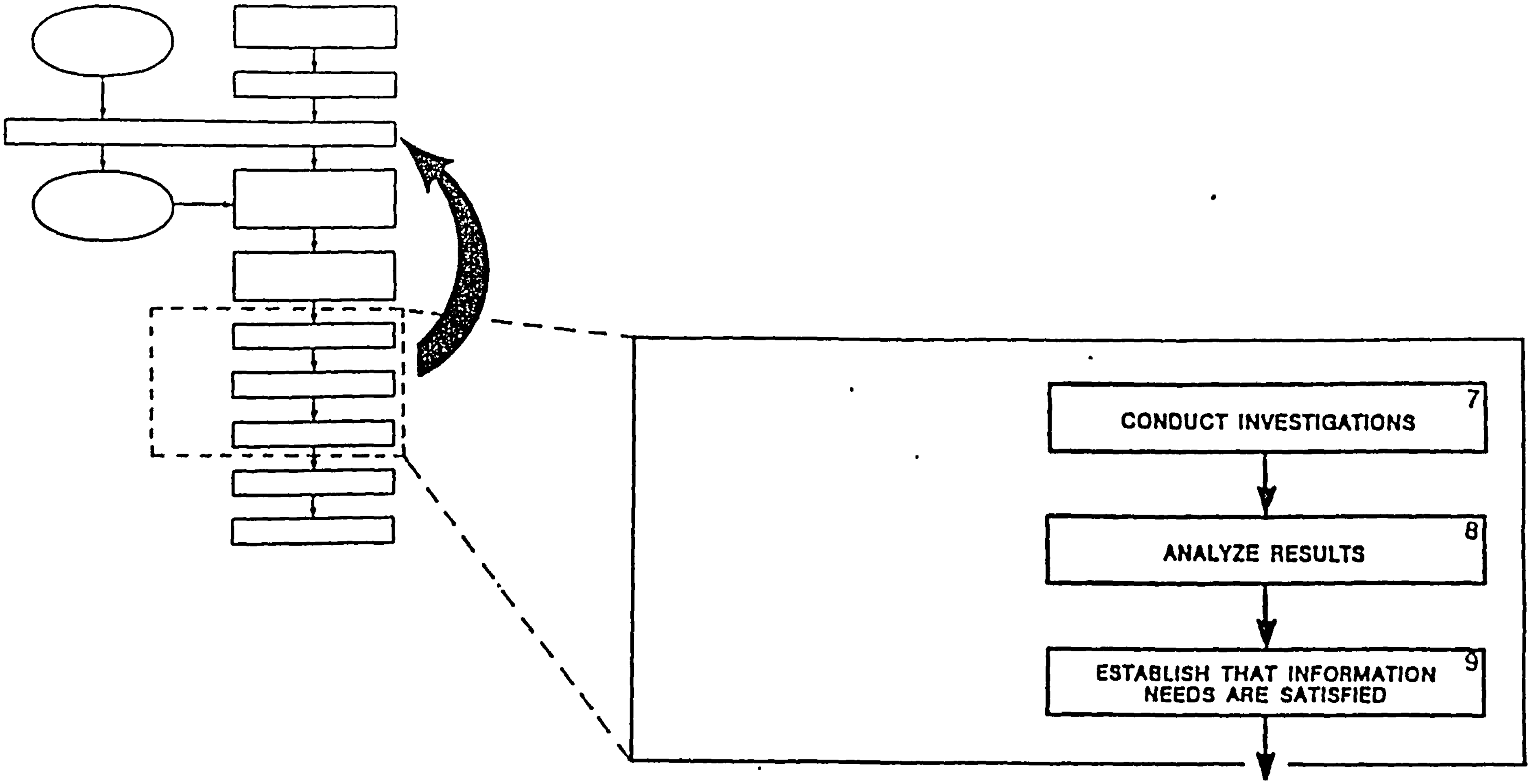
↓ SET PRELIMINARY TESTING EMPHASIS

4

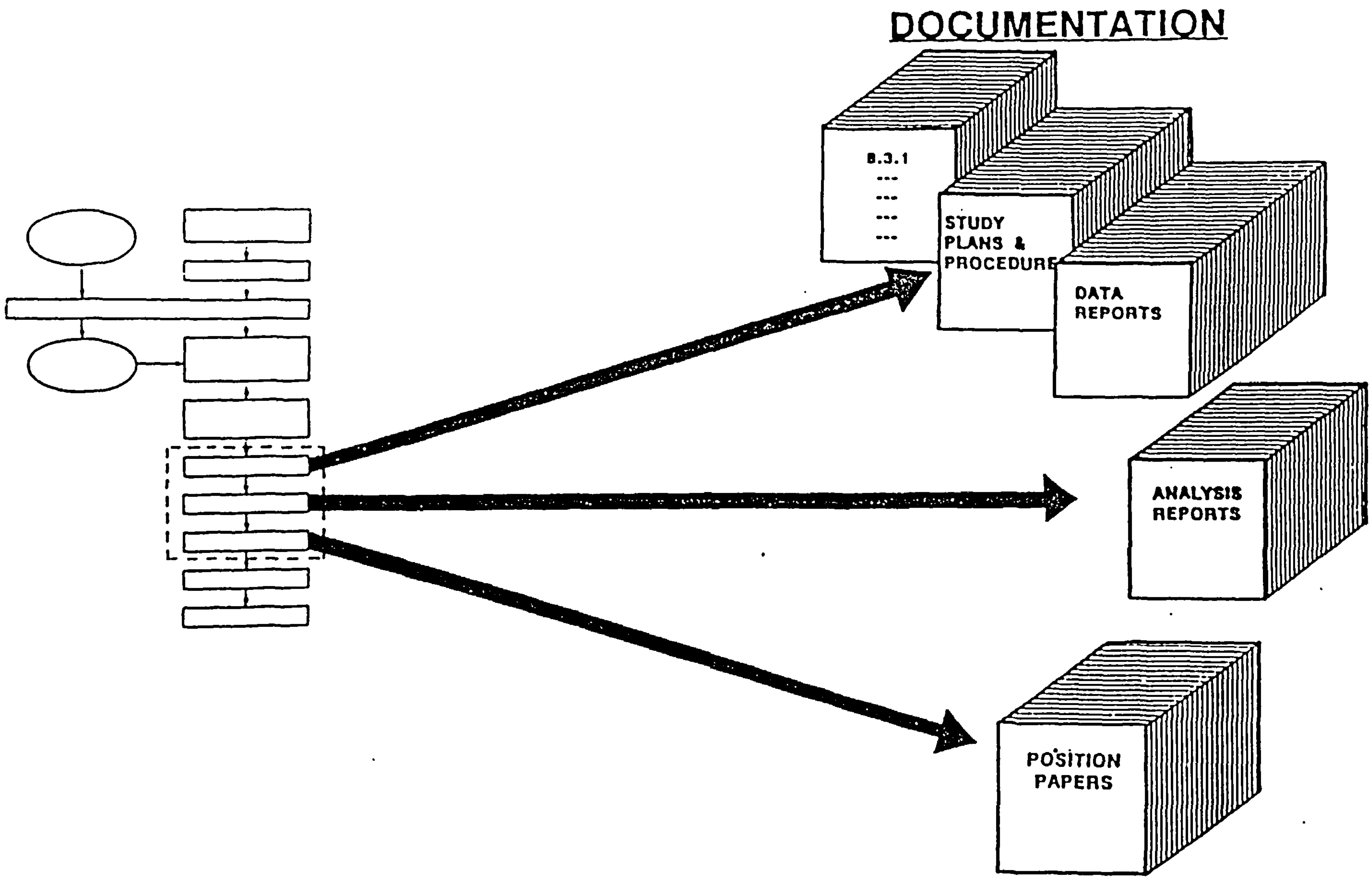
IDENTIFY
PERFORMANCE MEASURES
SET TENTATIVE "GOALS" AND
SET "INDICATIONS OF
CONFIDENCE"

- PERFORMANCE MEASURE
  - BASIS OR STANDARD USED TO ASSESS THE PERFORMANCE OF A SYSTEM ELEMENT
- TENTATIVE GOAL
  - IS A VALUE OR LIMIT TOWARD WHICH THE SITE TESTING EFFORT IS DIRECTED
  - DOES NOT REPRESENT REGULATORY LIMITS
  - ARE CONSERVATIVELY SET WITH RESPECT TO REGULATORY LIMITS
  - SERVES AS A GUIDE FOR TESTING
- "INDICATIONS OF CONFIDENCE"
  - JUDGEMENT OF HOW WELL THE CURRENT VALUE WILL MATCH THE MEASURED VALUE

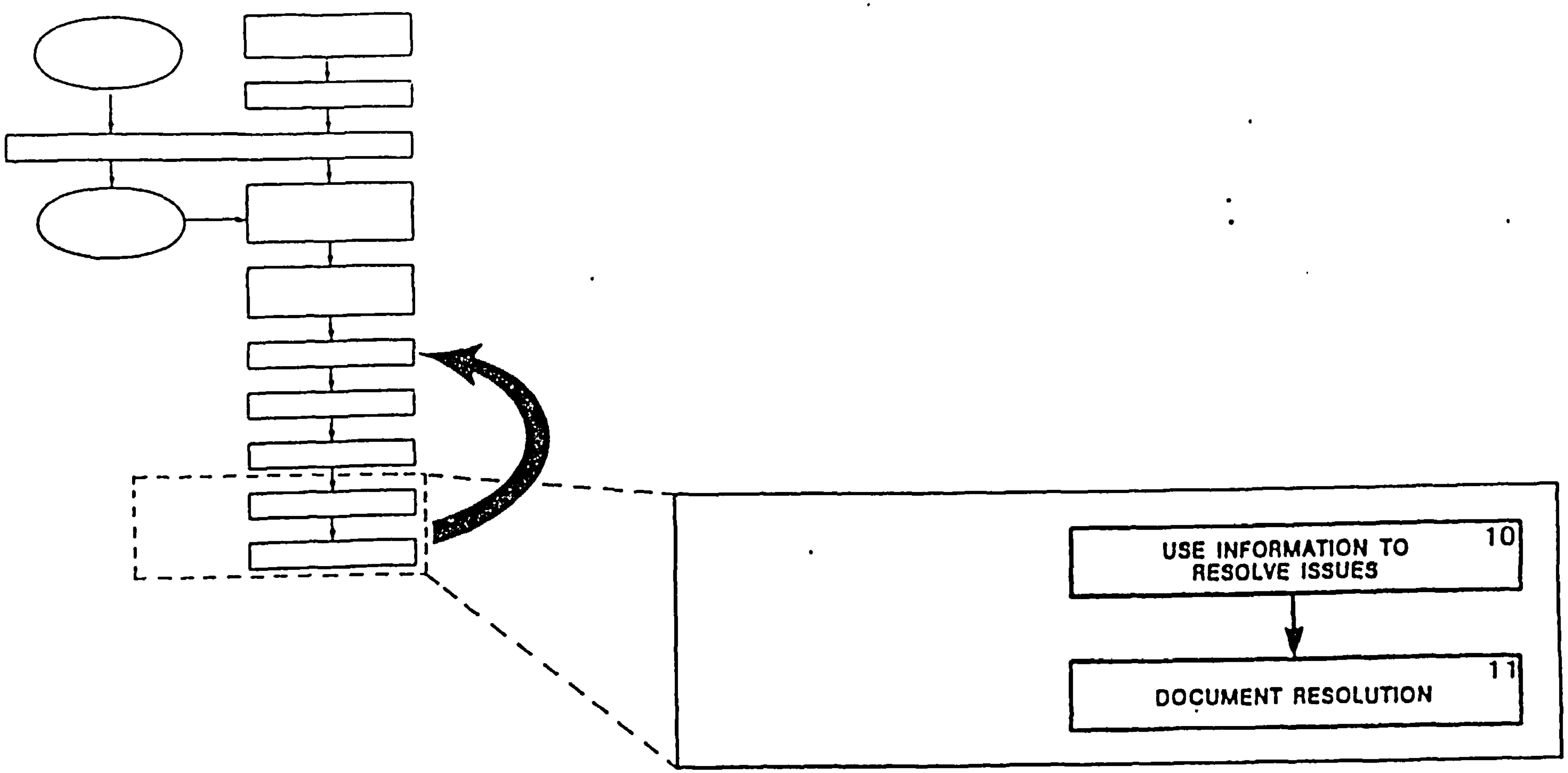
ISSUE RESOLUTION STRATEGY: DATA COLLECTION AND ANALYSES



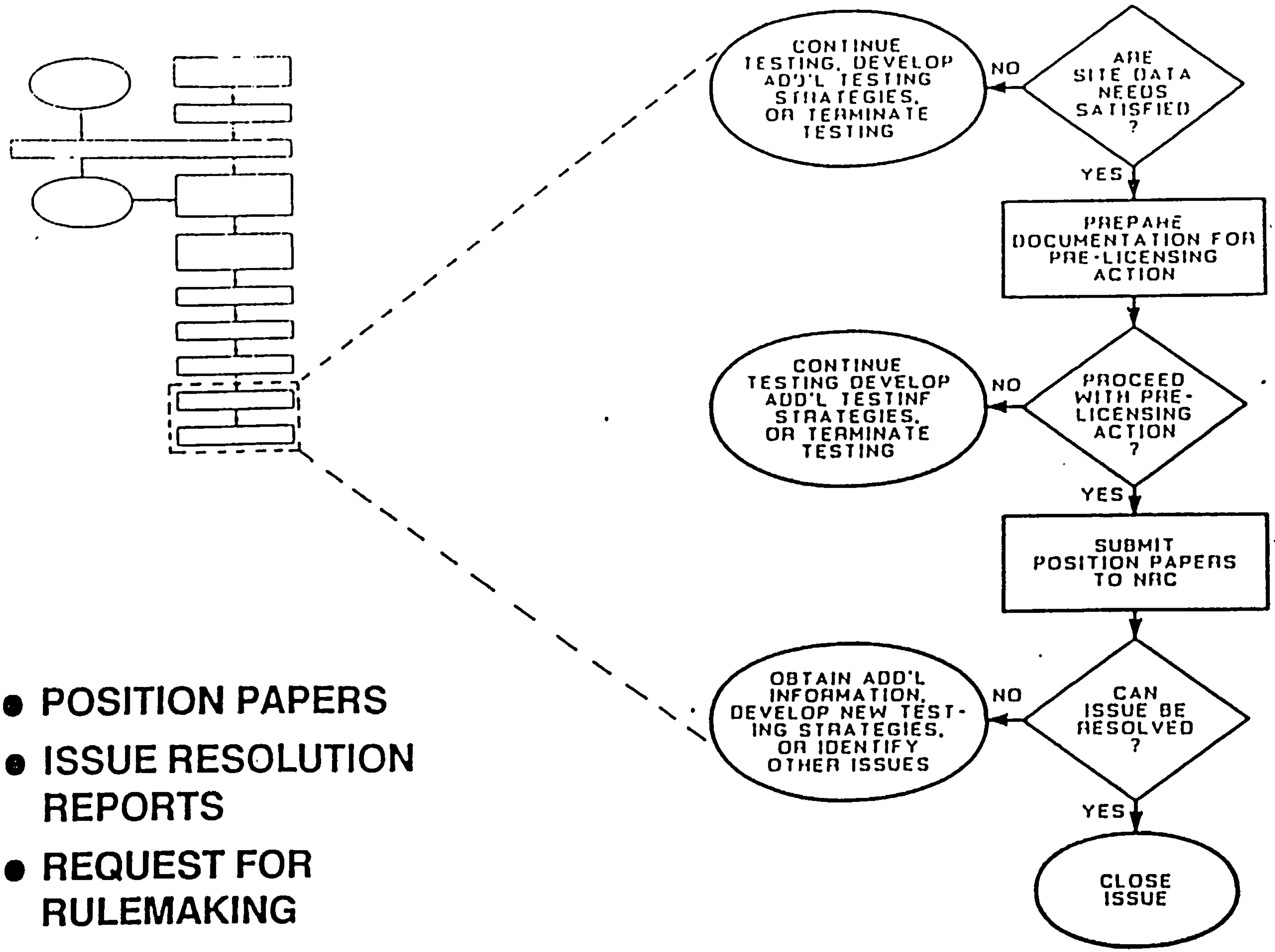
DATA COLLECTION AND ANALYSES



ISSUE RESOLUTION STRATEGY: ISSUE RESOLUTION



ISSUE RESOLUTION



- POSITION PAPERS
- ISSUE RESOLUTION REPORTS
- REQUEST FOR RULEMAKING
- OTHER

NEXT PORTION OF BRIEFING PROVIDES:

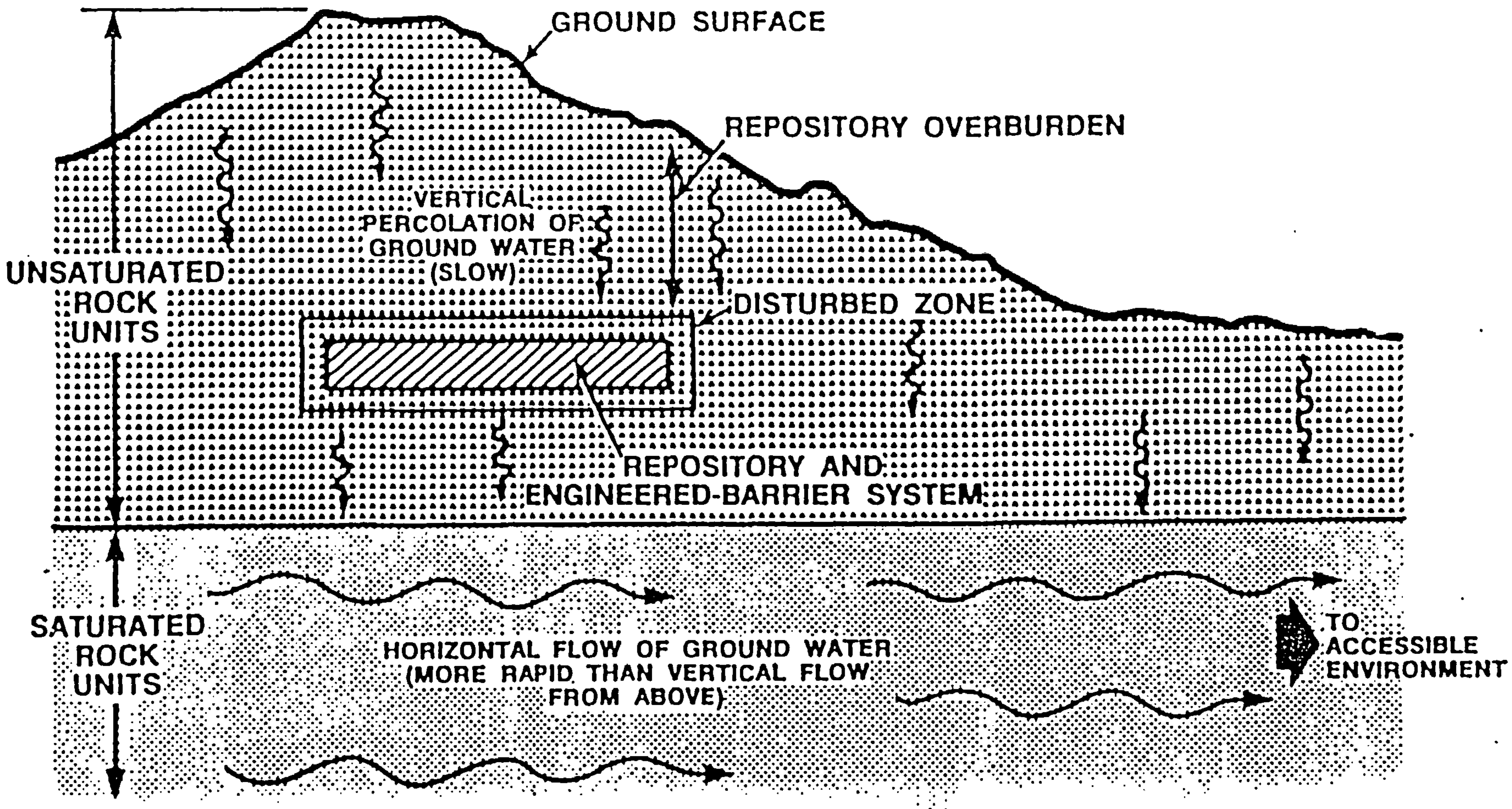
- AN EXAMPLE OF PERFORMANCE ALLOCATION FOR
  - MEETING 10,000 YEAR CUMULATIVE RADIONUCLIDE RELEASE REQUIREMENTS

- EXAMPLES OF TWO SITE TESTING PROGRAMS DEFINED THROUGH PERFORMANCE ALLOCATION

EXAMPLE OF
PERFORMANCE ALLOCATION

10,000 - YEAR CUMULATIVE
RELEASE REQUIREMENTS

ELEMENTS OF THE REPOSITORY SYSTEM



ELEMENTS AND FEATURES TO BE RELIED ON FOR THE 10,000 YEAR CUMULATIVE RELEASE LIMIT

ELEMENT	FEATURE TO BE RELIED ON
UNSATURATED ROCK UNITS	SMALL AMOUNT OF GROUND WATER
	LONG AVERAGE TRANSPORT TIME IN GROUND WATER
	CONFINEMENT OF WATER TO ROCK MATRIX
	GEOCHEMICAL RETARDATION
SATURATED ROCK UNITS (BACKUP BARRIER)	FLOW TIME TO ACCESSIBLE ENVIRONMENT
	GEOCHEMICAL RETARDATION
ENGINEERED-BARRIER SYSTEM (BACKUP BARRIER)	LIMITED RATE OF RELEASE OF RADIONUCLIDES

EXAMPLE PERFORMANCE MEASURES FOR NOMINAL (EXPECTED) CASE

TRANSPORT MEDIUM ALONG PATHWAY	SYSTEM ELEMENTS	FUNCTION/PROCESS	PERFORMANCE MEASURE	TENTATIVE GOAL	NEEDED CONFIDENCE
WATER	UNSATURATED ZONE ROCK UNITS	LIMIT RADIONUCLIDE TRANSPORT	CALCULATED RELEASE / EPA STANDARD	<.01	HIGH
	ENGINEERED BARRIER SYSTEM*				
	SATURATED ROCK UNITS*				
GAS	ENGINEERED BARRIER SYSTEM	LIMIT RELEASE OF CARBON-14	CALCULATED RELEASE / EPA STANDARD	<0.2	MEDIUM
	OVERBURDEN*				

* SECONDARY BARRIER

EXAMPLE PERFORMANCE PARAMETERS FOR NOMINAL (EXPECTED) CASE

SYSTEM ELEMENT	PERFORMANCE PARAMETER	TENTATIVE GOAL	NEEDED CONFIDENCE
UNSATURATED ZONE (UZ) (PRIMARY BARRIER)	AVERAGE FLUX	<0.5mm/YR	HIGH
	AVERAGE EFFECTIVE MATRIX POROSITY	>0.1	HIGH
	AVERAGE CHEMICAL RETARDATION FACTOR FOR ITH SPECIES	≥1	HIGH
	AVERAGE THICKNESS BETWEEN REPOSITORY AND WATER TABLE	>100m	HIGH
SATURATED ZONE (SZ) (BACKUP BARRIER)	AVERAGE FLUX	<32mm/YR	MEDIUM
	AVERAGE LENGTH OF FLOW PATH	>5000m	MEDIUM
ENGINEERED-BARRIER SYSTEM (BACKUP BARRIER)	FRACTIONAL MASS RELEASE RATE FOR EACH SPECIES	$<10^{-4}$	MEDIUM

GEOHYDROLOGY PROGRAM

EXAMPLE OF PERFORMANCE ALLOCATION REQUESTS FOR SITE GEOHYDROLOGY DATA

GEOHYDROLOGY DATA IS BEING PROVIDED TO DESIGN, PERFORMANCE AND CHARACTERIZING PROGRAMS

GEOHYDROLOGY PROGRAM 8.3.1.2

DESIGN ISSUES

1.11 CONFIGURATION OF UNDERGROUND FACILITIES (POSTCLOSURE) (SECTION 8.3.2.2)
1.12 SEAL CHARACTERISTICS (SECTION 8.3.3.2)
4.2 NONRADIOLOGICAL HEALTH AND SAFETY (SECTION 8.3.2.4)
4.4 PRECLOSURE DESIGN AND TECHNICAL FEASIBILITY (SECTION 8.3.2.5

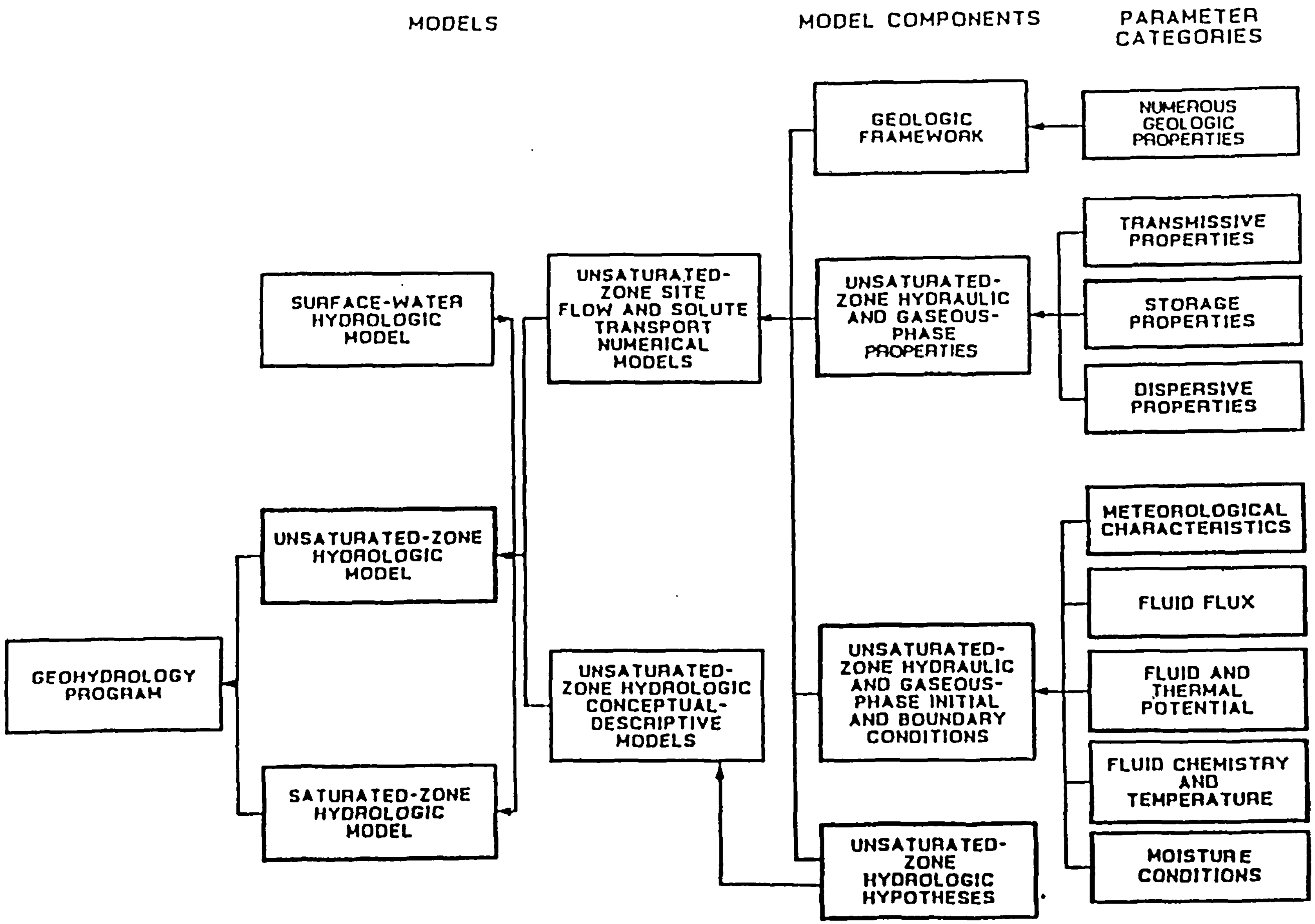
PERFORMANCE ISSUES

1.1 TOTAL SYSTEM PERFORMANCE (SECTION 8.3.5.13)
1.3 GROUND-WATER PROTECTION (SECTION 8.3.5.15)
1.4 WASTE PACKAGE CONTAINMENT (SECTION 8.3.5.9)
1.5 ENGINEERED BARRIER SYSTEM RELEASES (SECTION 8.3.5.10)
1.6 GROUND-WATER TRAVEL TIME (SECTION 8.3.5.12)
1.8 NRC SITING CRITERIA (SECTION 8.3.5.17)
1.9 HIGHER LEVEL FINDINGS--POSTCLOSURE SYSTEM AND TECHNICAL GUIDELINES (SECTION 8.3.5.18)

CHARACTERIZATION PROGRAMS

8.3.1.3 GEOCHEMISTRY PROGRAM
8.3.1.4 ROCK CHARACTERISTICS PROGRAM
8.3.1.5 CLIMATE PROGRAM
8.3.1.6 EROSION PROGRAM
8.3.1.8 POSTCLOSURE TECTONICS PROGRAM
8.3.1.9 HUMAN INTERFERENCE PROGRAM
8.3.1.12 METEOROLOGY PROGRAM
8.3.1.14 SURFACE CHARACTERISTICS PROGRAM
8.3.1.15 THERMAL AND MECHANICAL ROCK PROPERTIES PROGRAM
8.3.1.16 PRECLOSURE HYDROLOGY PROGRAM
8.3.1.17 PRECLOSURE TECTONICS PROGRAM

UNSATURATED-ZONE HYDROLOGY COMPONENT OF THE GEOHYDROLOGY PROGRAM



ACTIVITY PARAMETERS PROVIDED BY THE UNSATURATED ZONE GEOHYDROLOGY PROGRAM

CALLS BY PERFORMANCE AND DESIGN ISSUES			RESPONSE BY GEOHYDROLOGY CHARACTERIZATION PROGRAM	
ISSUE	SCP SECTION	PARAMETER CATEGORY	ACTIVITY PARAMETER	SCP ACTIVITY
1.1, 1.5, 1.6, 1.12	8.3.5.13, 8.3.5.10, 8.3.5.12, 8.3.3.2	FLUID FLUX	FLUX, LIQUID AND GASEOUS PHASE GHOST DANCE FAULT ZONE	8.3.1.2.2.6.1
			FLUX, VOLUMETRIC, THROUGH FRACTURE/MATRIX NETWORKS	8.3.1.2.2.4.2
			FLUX, VOLUMETRIC, THROUGH THE TOPOPAH SPRINGWELDED UNIT	8.3.1.2.2.4.3
1.1, 1.4, 1.6, 4.4, 1.8, 1.9 1.5, 4.2	8.3.5.13 8.3.5.9, 8.3.5.12, 8.3.2.5, 8.3.5.17, 8.3.5.18, 8.3.5.10, 8.3.2.4	SYNTHESIS CHARACTER-ISTICS	FLOW PATHS, MOISTURE IN UNSATURATED ZONE	8.3.1.2.2.10.2
			GROUND-WATER TRAVEL TIME, FRACTURE/MATRIX ZONE	8.3.1.2.2.4.2
			MOISTURE FLUXES, FLOW PATHS, AND TRAVEL TIMES WITHIN THE UNSATURATED ZONE	8.3.1.2.2.10.1

ACTIVITY PARAMETER TRACKED INTO APPROPRIATE STUDY

8.3.1.2.2.4 STUDY:	CHARACTERIZATION OF YUCCA MOUNTAIN PERCOLATION IN THE UNSATURATED ZONE--EXPLORATORY SHAFT FACILITY STUDY
8.3.1.2.2.4.1 ACTIVITY:	INTACT FRACTURE TEST IN THE ESF
8.3.1.2.2.4.2 ACTIVITY:	INFILTRATION TESTS IN THE ESF

ACTIVITY PARAMETER	SCP ACTIVITY
FLUX, VOLUMETRIC THROUGH FRACTURE/MATRIX NETWORKS	8.3.1.2.2.4.2

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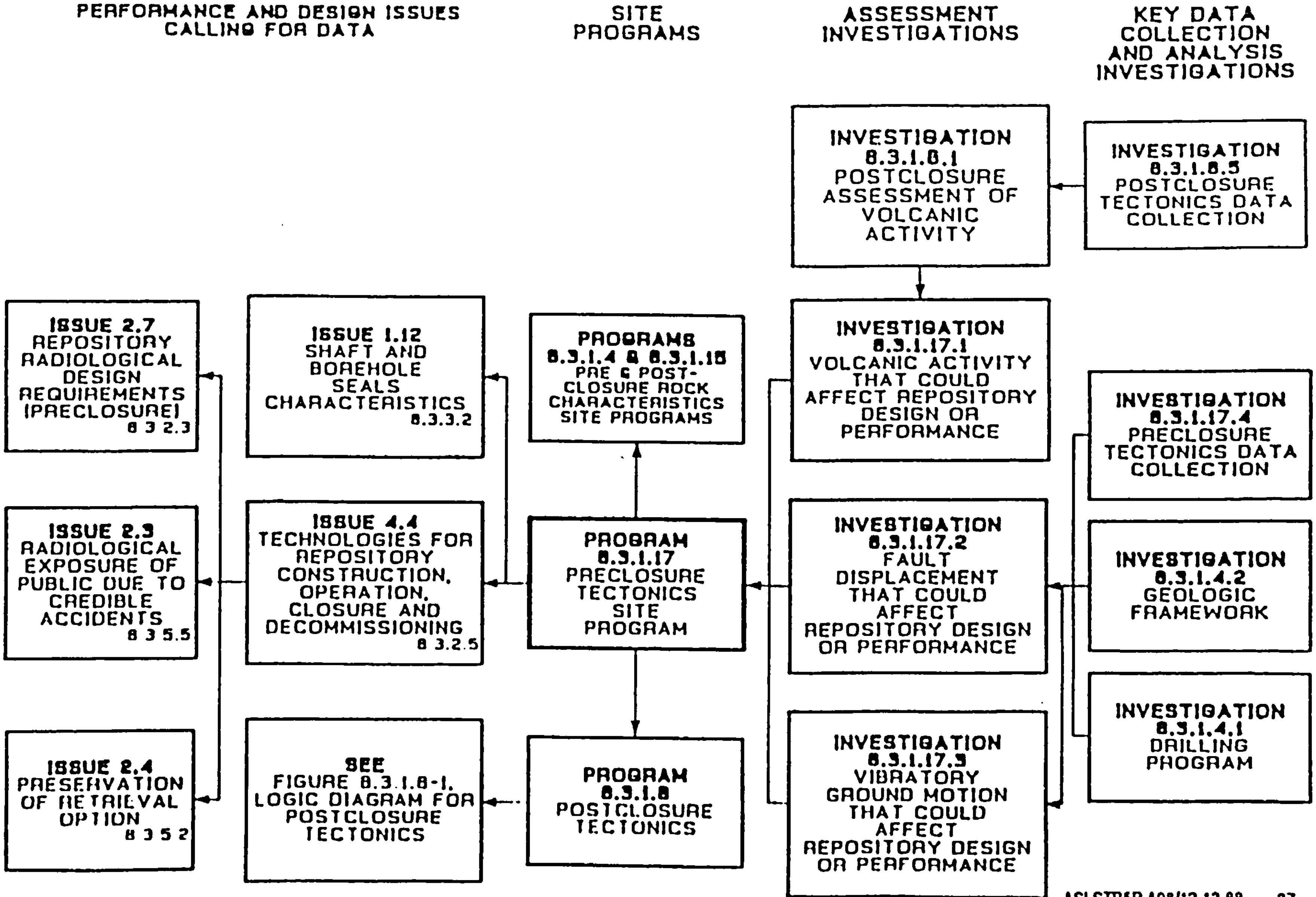
TECTONICS PROGRAM EXAMPLE

EXAMPLE OF PERFORMANCE ALLOCATION REQUESTS FOR TECTONICS DATA

LOGIC DIAGRAM FOR THE PRECLOSURE TECTONICS SITE PROGRAM



TECTONICS PROGRAM EXAMPLE

PRECLOSURE DESIGN OF SURFACE FACILITIES IMPORTANT TO SAFETY (FITS)

SYSTEM ELEMENT	FUNCTION/ PROCESS	PERFORMANCE/DESIGN MEASURE	TENTATIVE GOAL	NEEDED CONFIDENCE
SITE-SURFACE	PROVIDE FACILITY LOCATION NOT JEOPARDIZED BY NATURAL OR MAN-MADE PHENOMENA	ACCEPTABILITY OF LOCATION OF SURFACE FACILITIES • • •	FITS NOT LOCATED OVER HAZARDOUS FAULT	HIGH
			ACCEPTABLE POTENTIAL FOR GROUND SHAKING • • •	HIGH • • •

PERFORMANCE/DESIGN PARAMETER	TENTATIVE GOAL	NEEDED CONFIDENCE	
PROBABILITY OF EXCEEDING 5 cm OF DISPLACEMENT UNDER FITS	< 0.01 PER 100 YEARS	HIGH	
PROBABILITY OF EXCEEDING DESIGN BASIS GROUND MOTIONS AT FITS	< 0.1 PER 100 YEARS	MEDIUM TO HIGH	TEST BASIS FROM—CHARACTERIZATION PROGRAM CONTINUED

TECTONICS PROGRAM EXAMPLE

(CONTINUED)

CHARACTERIZATION PARAMETERS FEEDING PROBABILITY OF EXCEEDING DESIGN BASIS GROUND MOTIONS AT FITS

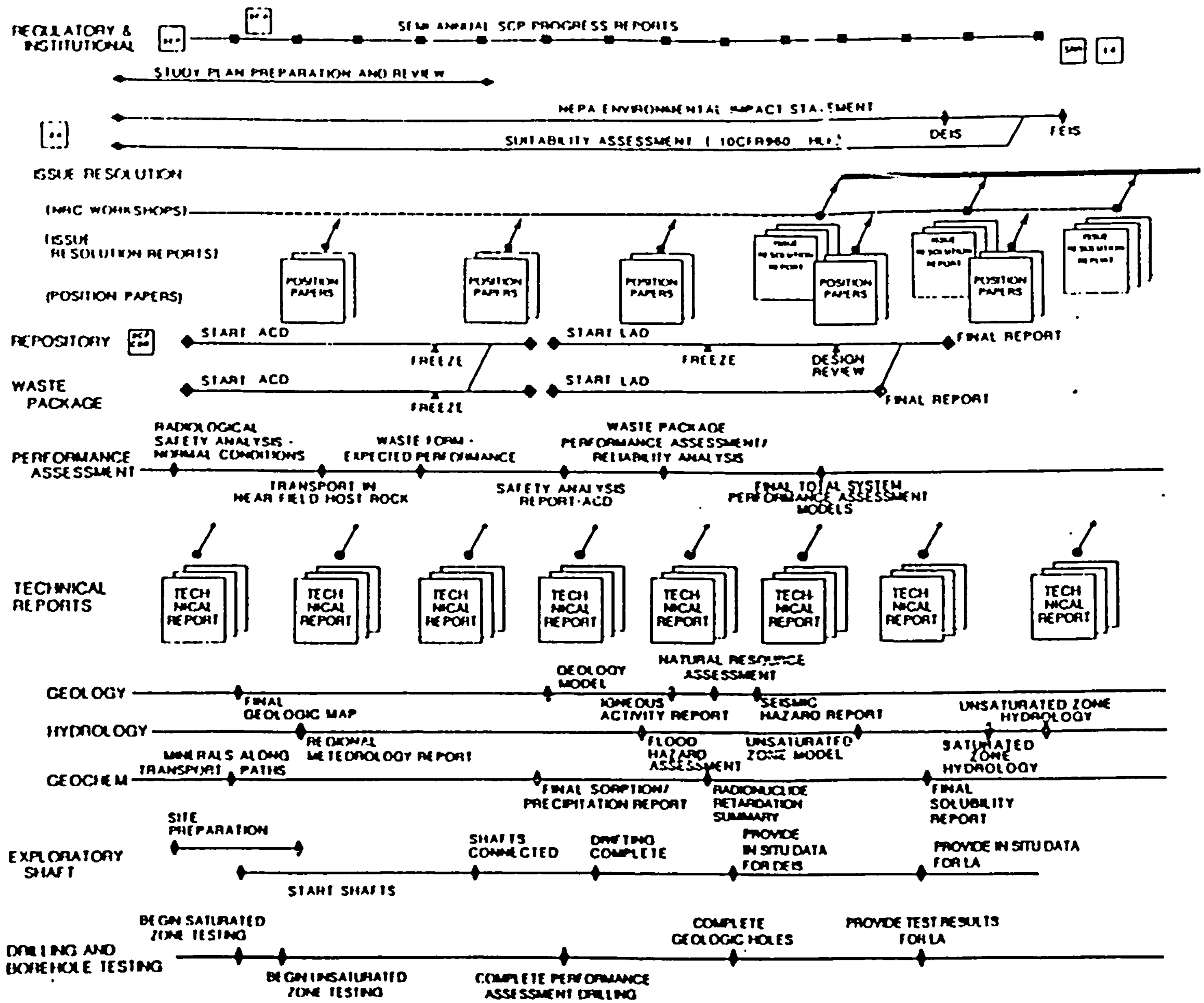
CHARACTERIZATION PARAMETER	CURRENT ESTIMATE	CONFIDENCE IN CURRENT ESTIMATE	NEEDED CONFIDENCE
RELEVANT EARTHQUAKE SOURCES	PAINTBRUSH CANYON BOW RIDGE SOLITARIO CANYON	MEDIUM	MEDIUM TO HIGH
GROUND MOTION ATTENUATION WITH DISTANCE	PUBLISHED MODELS FOR CA & W.U.S.	LOW TO MEDIUM	MEDIUM
TIME HISTORIES FOR CONTROLLING EVENT(S)	PGA 0.4 - 0.6G	LOW TO MEDIUM	MEDIUM TO HIGH
GROUND MOTION EXCEEDENCE PROBABILITIES	1-5 x 10^{-4}/ YR FOR 0.5G	LOW TO MEDIUM	MEDIUM

CHARACTERIZATION PARAMETER TRACKED INTO APPROPRIATE STUDY

8.3.1.17.3.1 STUDY: RELEVANT EARTHQUAKE SOURCES

8.3.1.17.3.1.1 ACTIVITY: IDENTIFY RELEVANT EARTHQUAKE SOURCES

8.3.1.17.3.1.2 ACTIVITY: CHARACTERIZE 10,000 YEAR CUMULATIVE SLIP EARTHQUAKE FOR RELEVANT SEISMOGENIC SOURCES


REGULATORY & INSTITUTIONAL
SEMI ANNUAL SCP PROGRESS REPORTS
STUDY PLAN PREPARATION AND REVIEW
NEPA ENVIRONMENTAL IMPACT STATEMENT
DEIS
FEIS
ISSUE RESOLUTION
(NRC WORKSHOPS)
(ISSUE RESOLUTION REPORTS)
(POSITION PAPERS)
POSITION PAPERS
REPOSITORY
START ACD
FREEZE
START LAD
DESIGN REVIEW
FINAL REPORT
WASTE PACKAGE
PERFORMANCE ASSESSMENT
RADIOLOGICAL SAFETY ANALYSIS - NORMAL CONDITIONS
WASTE FORM - EXPECTED PERFORMANCE
WASTE PACKAGE PERFORMANCE ASSESSMENT/ RELIABILITY ANALYSIS
TRANSPORT IN NEAR FIELD HOST ROCK
SAFETY ANALYSIS REPORT-ACD
FINAL TOTAL SYSTEM PERFORMANCE ASSESSMENT MODELS
TECHNICAL REPORTS
TECHNICAL REPORT
GEOLOGY
FINAL GEOLOGIC MAP
GEOLOGY MODEL
NATURAL RESOURCE ASSESSMENT
IGNEOUS ACTIVITY REPORT
SEISMIC HAZARD REPORT
UNSATURATED ZONE HYDROLOGY
HYDROLOGY
REGIONAL METEOROLOGY REPORT
FLOOD HAZARD ASSESSMENT
UNSATURATED ZONE MODEL
SATURATED ZONE HYDROLOGY
GEOCHEM
MINERALS ALONG TRANSPORT PATHS
FINAL SORPTION/ PRECIPITATION REPORT
RADIONUCLIDE RETARDATION SUMMARY
FINAL SOLUBILITY REPORT
EXPLORATORY SHAFT
SITE PREPARATION
START SHAFTS
SHAFTS CONNECTED
DRIFTING COMPLETE
PROVIDE IN SITU DATA FOR DEIS
PROVIDE IN SITU DATA FOR LA
DRILLING AND BOREHOLE TESTING
BEGIN SATURATED ZONE TESTING
BEGIN UNSATURATED ZONE TESTING
COMPLETE PERFORMANCE ASSESSMENT DRILLING
COMPLETE GEOLOGIC HOLES
PROVIDE TEST RESULTS FOR LA