AN EVALUATION OF ENVIRONMENTAL EFFECTS OF THE DOE HLW REPOSITORY SITING AND CHARACTERIZATION PROGRAM AT YUCCA MOUNTAIN, NEVADA

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ABSTRACT

This paper presents highlights of one of the Nevada Nuclear Waste Project Office (NWPO) environmental investigations in progress on the environmental effects of past and proposed activities of the Department of Energy (DOE) at the Yucca Mountain repository. The environmental investigations refer to those studies specifically related to resource evaluation, impact assessment and mitigation planning for the repository program; it is defined to exclude consideration of technical suitability determinations, socioeconomics and transportation.

This paper addresses the question:

What are the disturbances created by past and proposed DOE activities related to repository siting and characterization at Yucca Mountain?

It further discusses considerations in linking disturbance to the potential for significant adverse environmental impacts.

BACKGROUND

Since 1976, the DOE has conducted preliminary technical suitability studies related to siting and possible development of the nation's HLW repository at Yucca Mountain, Nevada. Those past investigations resulted in landscape disturbances and alterations of the environment which have not yet been defined. The DOE's statutory 1986 Environmental Assessment (EA) (1) found no significant environmental impacts related to its proposed Characterization activities, and the NWPA exempted those activities from additional National Environmental Policy Act (NEPA) requirements. The State of Nevada (2) contested the adequacy of the statutory EA on many grounds including the arguments that the existing environmental studies did not comprise an adequate baseline and DOE did not conduct sufficient analyses on which to base its determination.

The NWPO environmental program was established under provisions of the NWPA (Section 116) which guaranteed the State oversight of the DOE's program in Nevada for HLW repository siting, characterization, development, operation and closure. The NWPO identified in detail the overall need and purpose for an environmental program that is independent of the DOE's program. Environmental Science Associates, Inc., (ESA) of San Francisco was selected in 1988 as NWPO's prime contractor for the environmental investigations. The investigations are being conducted under a grant of the DOE to the State of Nevada.

IDENTIFICATION OF LANDSCAPE DISTURBANCE

The question posed by this paper is: what disturbance has been and will be created by past and proposed DOE activities related to repository siting and characterization at Yucca Mountain?

In order to address the question, it is necessary to break it into its component parts. These may be phrased as three questions germane to the environmental issues.

1) What elements of the project create environmental disturbance?

2) Where are the proposed activities that create disturbance located?

3) How can disturbances be identified?

The focus is on identification of disturbance related only to DOE's program for siting and characterization. Other elements related to disturbance will be reported in later publications.

What elements of the project create disturbance?

For an environmental evaluation to be meaningful, the project, as required by NEPA, must be defined by its totality of elements from its inception through its completing elements, i.e., from siting through facility closure and long-term maintenance. However, for this focused paper, I shall operationally restrict the term "project" to all siting and characterization activities carried out by DOE and its contractors. Thus, the benchmark is placed at about 1976 when the first disturbance activities were initiated by DOE, and it is bracketed on the future end at about 1997. The activities of greatest pertinence to environmental issues primarily are the investigations needed to answer geotechnical and hydrological questions about the suitability of the repository as well as issues of public health and safety and radionuclide migration. Other studies are related to meteorological monitoring, cultural resources and environmental studies themselves. Each of these activities has its own components that create disturbance of the environment.

The activities are too numerous and varied to describe here; see the DOE SCP (3) for descriptions. Those past and proposed activities related to the geotechnical investigations have the potential for the most surface disruption and

environmental impact. From an environmental viewpoint, the project is similar to a large mining project.

ESA reviewed the SCP in detail and categorized activities using a classification scheme that is functional for disturbance assessment. As envisioned at present, the combined siting and characterization programs create disturbances of the following primary types: drill holes; trenches and test pits; seismic surveys; monitoring stations; bladed use facilities; roads and corridors; various erosional features (such as the "pavements" created by washing away all overburden down to a bedrock surface to reveal faults, joints and fracture patterns); and structures.

Where are the proposed activities that create disturbances located?

The statutory EA included a study area of variable size, with detailed studies on a 27.5 square mile area centered on the repository block and nearby proposed surface facilities complex. The EA study area appears to have been too narrowly defined; this has been a key argument of the State with respect to adequacy of the statutory EA. Descriptions and maps produced by DOE contractors (4, 5, 6) include activities reaching far beyond Yucca Mountain, including, for example, seismic studies with associated disturbance features over 70 miles away in California.

The primary activity and disturbance area has been identified by ESA in three tiered levels: the Core Study Area, encompassing about 86 square miles, centered on Yucca Mountain in which the most intensive activities have occurred and are planned; the Cumulative Assessment Study Area, encompassing about 400 square miles in the vicinity of Yucca Mountain, in which many dispersed activities are mapped and which includes a broad area in which environmental impacts may be expected, and; 3) a Regional Study Area that encompasses the outlying areas in Nevada and California in which isolated disturbance activities or regional level impacts may be expected.

The tiered study areas contain other land uses (many of which are disturbance generators in their own right, e.g., mining, grazing, recreation, weapons testing) which must be considered in cumulative impact assessment. Impact significance and mitigation approaches cannot be identified until the issues of combined effects of DOE's repository related activities are added to the effects of other disturbances in the region and until compatibility of DOE's program with use of the resources by the other users are determined. This, for example, is the basis of the recent protest filed by the National Park Service to DOE's petition to obtain water rights because of a possible impact on water resources at Death Valley National Monument. In sum, disturbance related strictly to DOE's repository program must be identified, but consideration must also be given to other disturbances in the region which also impact environmental conditions and to resources which could be affected by it. A more comprehensive view is needed to encompass cumulative disturbance so that a measure of the DOE repository program's contribution to environmental impact can be ascertained. This aspect of ESA's disturbance assessment is in progress, but will not be reported in this paper so as to focus on those disturbances directly related to the HLW repository program.

How can disturbances be identified?

To obtain complete inventories of disturbances, ESA has pursued three routes of investigation. First, information sources on disturbance activities were ferreted from DOE's documents. DOE's SCP (3) and related atlases (4, 5, 6) provide the primary sources of information. While those sources are extensive and contain much information on activities, they are not complete and are subject to change. The DOE documents contain some conflicts of information. Data accuracy is not known - some information appears to be very accurate (refined description and precise mapping); other information is vague and unmapped. The U.S.Geological Survey has provided some very accurate large scale topographic maps (scale 1:5,000) of the Core Study Area.

DOE's environmental field investigations have been limited primarily to the approximately 27.5 square mile area Yucca Mountain study area of the EA and the resultant resource reports provide limited information for the cumulative and regional study areas.

The DOE SCP is not organized by functional classes related to disturbance types that are useful for impact evaluation. Thus, the activities described in the SCP required interpretation of their indicator characteristics and the nature of potential related disturbance.

Remote sensing techniques provide a considerable amount of information about past disturbances and existing conditions. ESA obtained historic aerial photography (1959, 1976 and 1978) to identify landscape features prior to repository siting investigations. Large scale (1:12,000) color aerial photography of the Core Study Area was taken in 1988 and has provided a primary source of data for accurate measurement of indicator characteristics. These have been supported by use of spectral remote sensing imagery from the Thematic Mapper and SPOT satellites. Merging of the spectral digital data sets allowed some forms of change detection in the landscape of the Cumulative Assessment Study Area and will be used for the regional study area later. Historic ground level photography also provided some useful information.

Field data collection to date has provided limited data on disturbance. ESA has not yet been given approval from DOE to collect information on the Nevada Test Site (NTS). ESA conducted site reconnaissance visits and collected some information from the surrounding area on lands managed by the U.S. Bureau of Land Management. However, without access to the NTS, field measurement of the key disturbance area of the Core Study Area has not been possible. Thus, DOE documents and interpretation of remote sensing imagery comprises the primary information sources form the bulk of information summarized in this paper.

To date, disturbance assessment has focused entirely on past disturbance features between 1976 and mid-1988. ESA's disturbance analysis has proceeded through a

TABLE I
Summary of Existing and Projected Disturbance Features (Number and Acreage) From Siting and Characterization, Yucca Mt., Nevada, and Vicinity.

Disturbance Type	Numbers Currently Identified	Average Acreage	Acreage Currently Disturbed	Additional Number Expected	Additional Acreage Expected	Estimated Total Disturbance
Drill Hole with Pad & Mud Pit	29	2.25	65.2	47	106	171 acres
Drill Hole with Pad, Mud Pit, & Spill	-	2.5	-	2	5	5
Drill Hole, No Pad	8	0.13	1.1	150	19.5	20.6
Drill Hole with Water Storage	1	2.25	2.25	-	-	2.25
Drill Hole with Pad, No Pit	24	0.98	23.5	20	19.6	43.1
Deep Trench	47	0.3	13.8	42	12.6	26.4
Test Pit	3	0.02	0.05	15	0.30	0.35
Infiltration Pit	2	0.61	1.2	6	3.6	4.8
Erosion Chain	-	0.1	-	3	0.3	0.3
"Pavement"	6	0.05	0.3	10	0.5	0.8
Reflective Survey Line*	10	1.08	10.8	?	19	30.0
Refractive Survey Line*	3	1.02	3.05	5	40	43
Refractive Shock Points	3	0.25	0.75	32	8	8.75
Met. Station with Pad	4	0.5	1.92	-	-	1.92
Met. Station, No Pad	2	0.1	0.18	4	0.4	0.58
Stream Gauge	-	0.1	-	15	1.5	1.5
Paved Parking	-	5	-	2	10	10
Bladed Parking	2	5	10	4	20	30
Bladed Bldg.	1	5.26	5.26	2	10	15
Flood Control Structures	1	0.5	0.47	-	-	0.5
Bladed Clearing/ Borrow Area	37	2.3	85.04	50	150	235
Paved Road*	4	-	62.92	-	-	62.92
Bladed Road*	106	-	233.0	30	60	293
4Trail*	207	-	117.1	150	35	152
TOTAL			638		522	1,158

* Linear Feature

SOURCE: D. Tersey, D. Rousseau, ESA, 1989

structured program to distinguish landscape features that have changed since 1976 as they appear on old and recent aerial photography or as they appear in spectral digital imagery. After feature identification was made, DOE documents were searched for correlation of the features with activities described by DOE. Not all features could be keyed to described activities. Each disturbance was identified by activity type, and associated disturbance characteristics (e.g., cut or fill area, waste handling, materials) were based on generic data derived from DOE documents. Features were accurately mapped with correction for photo distortion and map scale transfer. Measurements were made with use of a summarizing digital planimeter.

Table I provides a summary of disturbance type coverage for the Core Study Area and Cumulative Assessment Study Area. The primary sources of disturbance were bladed roads, trails, drill holes with pads and mud pits and bladed clearing/borrow areas. Within the study area, a total of 638 acres, i.e., about one square mile, may be characterized as existing "disturbed" land identified by ESA. DOE (SCP, Table 8.4.2-5) estimated that approximately 930 acres may be characterized as disturbed. DOE's estimates may be based on a somewhat different geographic area including areas to the east on the NTS for which photography was not available. Also, it is difficult to reconstruct the basis for DOE's estimates from the existing documents.

This type of disturbance assessment, landscape change identification, provides only one useful indicator of the magnitude of disturbance, i.e., total area disturbed. It falls far short of providing a comprehensive analysis of disturbance. Equally important, but more difficult to analyze, are volumes of cut and fill, relative location of disturbance defined by functional parameters related to environmental issues, materials involved (import/export, wastes, introduced hazardous materials, spills of toxic materials). The study is further limited by the inability to address sub-surface impacts, which have potentially profound impact on groundwater, soils and archaeological resources. Additionally, the analysis was limited to landscape feature identification and does not address event-related disturbances, such as traffic, noise, air quality emissions, etc. Studies of this nature are in progress by ESA, and will become further defined as the program progresses in the coming months.

An important application of the information will be in the development of disturbance models that can be applied to the activities described in the Site Characterization Plan. The data from past disturbance can be applied to proposed activities within the study area as reliable generic indicators of future disturbance. Given the assumed applicability of disturbance type average coverages for some features, as well as projected disturbance identified in the SCP, it is possible to project additional disturbance related to characterization of approximately 520 acres (Table I). The value is a very rough estimate because the SCP lacks good definition of many activities and their location. The combined past disturbance and proposed site characterization disturbance are indicated in Table I; the total is approximately 1,160 acres of landscape change.

To date, ESA has been able only to carry out limited measurements of past landscape disturbance features as evident on remote sensing imagery. It probably will be impossible to capture event-related, past disturbances, e.g., dust plumes, animal kills, pollution spills, noise. The State's environmental monitoring program will pay close attention to such event-related disturbances in the future.

Relating Disturbance to Environmental Impact Assessment

The crucial question, which has yet to be answered, is:

Do the identified disturbances create the potential for significant adverse environmental impacts?

Environmental impact assessment follows disturbance evaluation. The landscape disturbance assessment will yield much good information that can form the basis of environmental impact assessment of past siting, and proposed characterization activities and repository development plans. This is an ongoing part of the State's program; results will not be reported here. However, a brief discussion of approaches is merited.

Impact assessment is derived by relating disturbances, singly and in combination, to environmental conditions and trends. This requires the development of good baseline information and the application of meaningful impact models to the project at hand. Baseline development is just beginning and requires access to the NTS for collection of field data. ESA's goal is to obtain sufficient data on baseline conditions and measured effects to build impact models for each proposed activity. The impact models relate disturbance types to elements of the environment including the following:

- past and existing distribution and condition of the resources
- trends in the state of the resources
- established standards
- significance criteria
- cumulative impacts on resources
- maintenance of ecological integrity.

Impact significance identification must be related to site- and time-specific conditions and cumulative considerations of the relevant issues. For example, significance criteria for a specific species of animal cannot be identified until it is defined in relation to the broader distribution of the species, conditions of the habitat in the proposed activity area as well as in the broader range of the species, roles and niches in the ecosystem, sensitivities to disturbance and other considerations. A good example of this is the desert tortoise, which is a candidate listed species in California that occurs at Yucca Mountain and throughout the Mojave Desert. For California's LLRW facility, US Ecology, Inc., faced a similar issue and has had to conduct evaluations of tortoise populations, habitat condition and cumulative development impacts in an area of about 110 square miles in order to evaluate the significance of the impacts to the

tortoise population at the one-square mile proposed site near Needles, CA. Environmental impact investigations that incorporate consideration of regional perspectives on cumulative environmental issues are lacking in the DOE statutory EA and have been lacking to date in DOE's overall environmental program.

The question of impact significance is partly an issue of regulatory compliance. The relations between the HLW repository program, NWPA and NEPA are treated by Ulland and Winsor (7) in a separate paper in these proceedings and are only summarized here. While the statutory Environmental Assessment (1) determined that no significant environmental impacts were expected for characterization activities, the State questions whether that document was adequate in reaching that determination. Ulland and Winsor (7) concluded that from a regulatory compliance viewpoint: 1) the DOE program is multidisciplinary rather than interdisciplinary as required by NEPA; 2) it does not address cumulative impacts; and, 3)\it does not address the project in its totality of components. Given these limitations, the State's questioning of the program's compliance with NEPA requirements, as well as adequacy of the statutory EA, appears to have substantial justification.

One may additionally question whether the statutory EA of 1986 may have been premature considering that definition of many elements of the characterization plan have been supplied only in the most recent SCP revision and in light of the evolution of the plan. The character and location of many activities still remain unresolved. DOE has characterized the SCP as a "living document", which is a useful approach for a project as large and complex as this. By the same token, the State is justified in expecting the EA to also be a living document so that changes in the DOE program can be tied to projected disturbances and their related environmental impacts.

The SCP indicates the potential magnitude of the proposed studies and related disturbances, although there are still many gaps in the descriptions that make it impossible to come up with reliable estimates of disturbance. The recently released Environmental Monitoring and Mitigation Plan (8), Environmental Field Activity Plans (only partially completed) and Environmental Regulatory Compliance Plan (9) depict how DOE intends to deal with environmental issues. These documents appear to be narrow in focus.

Beyond the question of regulatory compliance remains the issue of whether environmental objectives are being adequately served by the DOE's characterization program. This is in fact the fundamental basis of significance determination. The problem here is that DOE has not established environmental objectives. In the SCP, response to DOE's Mission Plan Key Issue 3 (10), the environmental issue, was put off until EIS scoping. The DOE has no environmental management program; there are neither goals nor implementation plans for managing the environment and resources of the NTS and for the repository program which extends disturbances into resource areas far beyond the NTS. In the absence of defined objectives, it is difficult to see how DOE can assess impacts and identify significance criteria. This is an important flaw in DOE's environmental program at Yucca Mountain because an environmental management plan forms the foundation on which impact analysis proceeds and it is the "yardstick" for determining regulatory compliance.

Because of the preceding considerations, the State of Nevada is pursuing an independent program for evaluation of environmental issues, development of an environmental management plan, regulatory compliance assessment, and mitigation development, including reclamation strategies. The question of environmental impact significance determination for siting and characterization remains open to further inspection in the eyes of the State. Thus, the environmental program shall continue to pursue better identification of disturbances in the broader study area and link them to realistic assessments of environmental impact. This will occur in the context of environmental management objectives rather than repository development objectives.

REFERENCES CITED

1. U.S. Department of Energy Office of Civilian Radioactive Waste Management, "Environmental Assessment, Yucca Mt. Site, Nevada Research and Development Area," (1986).
2. State of Nevada Nuclear Waste Project Office, "State of Nevada Comments on the U.S. Department of Energy Draft Environmental Assessment for the Proposed High Level Nuclear Waste Site at Yucca Mountain," (1985).
3. U.S. Department of Energy Office of Civilian Radioactive Waste Management, "Site Characterization Plan, Yucca Mountain site, Nevada Research and Development Area, Nevada," (December 1988).
4. U.S. Department of Energy Nevada Operations Office, "Draft NNWSI Project Site Atlas, Vol 1," (June 1988).
5. U.S. Department of Energy, "Nevada Nuclear Waste Storage Investigations Atlas of Field Activities, Yucca Mountain, Nye County, Nevada", prepared by Holmes and Narver, Inc., (undated, 1988).
6. EG&G, Inc., "Surface Based Investigations," Maps (1987, 1988).
7. Ulland, L.M., & M.F. Winsor, "The Role of the State and Environmental Compliance in NWPA Implementation," Waste Management '89, Tucson, Arizona, (1989).
8. U.S. Department of Energy Office of Civilian Radioactive Waste Management, "Environmental Monitoring and Mitigation Plan for Site Characterization, Yucca Mountain Site, Nevada Research and Development Area, Nevada," (December 1988).
9. U.S. Department of Energy Office of Civilian Radioactive Waste Management, "Environmental Regulatory Compliance Plan for Site Characterization, Yucca Mountain site, Nevada Research and Development Area, Nevada," (December 1988).
10. U.S. Department of Energy Office of Civilian Radioactive Waste Management, "Mission Plan for the Civilian Radioactive Waste Management Program," (December 1985).

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