CONTAMINATION AT THE BEATTY, NEVADA, RADIOACTIVE WASTE DISPOSAL FACILITY

JANUARY 1996

COMMITTEE TO BRIDGE THE GAP

LOS ANGELES, CALIFORNIA

The Committee to Bridge the Gap

The Committee to Bridge the Gap is a non-profit public interest organization specializing in issues related to nuclear safety, environmental protection, and the prevention of nuclear terrorism and nuclear weapons proliferation. Committee to Bridge the Gap provides technical assistance to communities near current or proposed nuclear facilities. Donations to Committee to Bridge the Gap are tax deductible. For further information about the Ward Valley controversy or Committee to Bridge the Gap, please call (310) 478-0829 or write:

Committee to Bridge the Gap
1637 Butler Avenue, Suite 203
Los Angeles, California 90025

Executive Summary

Contaminants have recently been discovered outside US Ecology's radioactive waste facility near Beatty, Nevada. In this report, we find that:

- Conflicts of interest apparently exist for researchers involved in the United States Geological Survey (USGS) review of the Beatty data.

- The California Department of Health Services (DHS) claims that the Beatty finding has no relevance to Ward Valley. This claim contradicts a formal legal finding issued by DHS prior to the discovery of contaminants outside the Beatty facility. In its finding, DHS concluded that "the Beatty site provides a good analog for the Ward Valley facility."

- At the urging of Ward Valley contractor US Ecology, DHS relied upon Beatty for support that contaminants would move slowly, if at all, at Ward Valley.

- Radioactive and chemical contaminants have been found in monitoring well water at the Beatty facility.

- DHS made contradictory and erroneous statements about the discovery of contaminants in Beatty monitoring well water.

- In an internal memorandum, US Ecology admitted, "Any rapid migration of radionuclides at the site abetted by natural site characteristics, would be of significant concern and relevant to the Ward Valley project."

- The USGS researcher who discovered contamination outside the Beatty facility said that he could not explain the findings.

- US Ecology illegally dumped approximately 270,000 to 700,000 gallons of liquid waste at Beatty over 14 years, or up to 50,000 gallons per year.

- Nearly 2 million gallons of water from rainfall falls onto the Beatty trenches during a typical year.

- Liquid waste dumping could have had only an insignificant impact on the migration of radioactive wastes at Beatty.

- When compared to rainfall, there wasn't enough liquid waste dumped at Beatty to make any real difference in the migration of waste at the site.

- The findings at Beatty invalidate DHS and US Ecology's theories about the movement of contaminants in arid environments, and support the warnings offered by former USGS scientist Dr. Howard Wilshire. Wilshire predicted that preferential pathways and lateral subsurface flow of contaminants could enhance radionuclide migration at Ward Valley and threaten the Colorado River.

Background

The nuclear industry wants to build a radioactive waste facility in Ward Valley, California. The proposed facility is located less than 20 miles from the Colorado River, the primary source of drinking water for millions of people in California, Arizona, and Mexico. If approved, large quantities of nuclear power plant wastes will be dumped into unlined trenches. These wastes include plutonium, strontium, and cesium. Plutonium-239 is one of the most toxic substances ever discovered. It remains dangerous for upwards of 500,000 years.

The company chosen to operate Ward Valley has a very troubled history. The firm, mis-named "US Ecology," has engaged in dumping operations at five radioactive waste sites, all of which have leaked. In Illinois, it abandoned its leaking dump. The State of Illinois had to go to court to force US Ecology to return to the site and attempt to stabilize the leaking waste. The United States Environmental Protection Agency designated their Kentucky facility a Superfund clean-up site (*i.e.*, among the most polluted places in the country) after radioactive migration, predicted to take thousands of years, occurred in 10 years.

Contaminants have recently been discovered outside US Ecology's radioactive waste facility near Beatty, Nevada, and all the way down to groundwater. In this report, we evaluate this discovery and its relevance to the proposal to dispose of radioactive waste at Ward Valley.

Suppressed Data About Contamination at Beatty

In October 1995, we obtained and released measurements by the United States Geological Survey (USGS) about the discovery of contaminants outside the US Ecology radioactive waste disposal facility located near Beatty, Nevada. The discovery raised new questions about the proposed Ward Valley radioactive waste facility since Beatty and Ward Valley share a similar climate, geologic features, and the same contractor.

Supporters of the proposed Ward Valley facility, pointing to Beatty, claim that contaminants cannot migrate at arid sites. Their theory is that virtually all rain evaporates or gets used by plants, so none is available to pick up soluble radioactive materials from the waste and carry those materials down to groundwater. The soil, referred to as the "vadose" or "unsaturated" zone, has an "upward hydraulic gradient," they say. As a result, they claim, water purportedly moves up through the soil in what is called "a net upward flux of soil moisture." If rain doesn't get to groundwater, or takes many thousands of years to get to groundwater, there's no way for contaminants to move at arid disposal sites.

Measurements taken by David Prudic, a researcher with USGS, suggest otherwise. Prudic received his first results in July 1994. He chose not to release his findings until Committee to Bridge the Gap made inquiries in October 1995. Prudic's decision to withhold the information for more than a year is a matter of controversy. In early July 1994, Prudic told a National Academy of Sciences (NAS) panel that it takes thousands of years for moisture at Beatty and Ward Valley to move a few inches. About two weeks later, Prudic received his test results.[1] They established that radioactive contaminants migrated in only 30 years at the Beatty facility, which opened in 1962. Prudic did not report these results to the NAS. Instead, in August 1994, he published a report reiterating the claims he made to the NAS panel prior to receiving his test results.[2]

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[1] Personal communication, October 30, 1995.

[2] Prudic, D. C., 1994, "Estimates of percolation rates and ages of water in unsaturated sediments at two Mojave Desert sites, California–Nevada," United States Geological Survey, Water-Resources Investigations Report 94-4160. Carson City, NV: U.S. Department of the Interior.

United States Department of the Interior

U.S. GEOLOGICAL SURVEY

Water Resources Division
Nevada District
333 West Nye Lane, Room 203
Carson City, Nevada 89706

October 27, 1995

Dr. Joseph K. Lyou
Executive Director
Committee To Bridge The Gap
1637 Butler Avenue
Los Angeles, California

Dear Dr. Lyou:

As per your telephone request on October 25, 1995, please find enclosed a copy of a paper that is in press titled "Water-vapor movement through unsaturated alluvium in Amargosa Desert near Beatty, Nevada-- Current understanding and continuing studies" by David E. Prudic. The paper was presented at a joint U.S. Geological Survey-U.S. Nuclear Regulatory Commission workshop on research related to disposal of low-level radioactive waste held May 1993. The report is part of the proceedings, which are in the process of being published. The paper describes the objectives for collecting gas samples in the unsaturated zone at the Beatty research site.

With respect to your request regarding recent work and sampling at the U.S. Geological Survey research site adjacent to the low-level radioactive-waste burial site near Beatty, Nevada, please find enclosed a table of tritium and carbon-14 analyses of gas samples that were collected in April 1994 and July 1995. The general location of sampling sites is shown on two maps attached to the table. The analyses include all tritium values and the carbon-14 analyses from samples collected in April 1994 at test hole UZB-2 and from samples collected in June 1992 at the test hole 2 miles south of the site. The sampling in April 1994 was limited to test hole UZB-2, which was drilled south of our shaft facility. The test hole was drilled in September 1993 for the purpose of studying the natural distribution of gases in the unsaturated zone in relation to water movement through the very dry sediments.

We installed ten one-foot long piezometers in test hole UZB-2; all above the ground-water table. Depth to the midpoint of each piezometer is about 18, 39, 59, 79, 112, 157, 189, 309, 348, and 357 feet below land surface. Depth to ground water at a nearby well is about 367 feet. The piezometers in the test hole are separated with a bentonite grout. The hole was drilled with an air hammer attached to casing which followed behind the hammer as the hole was drilled. The casing was needed to prevent the hole from collapsing and most was removed (a 100-foot section of casing was left at a depth from 200 to 300 feet because it broke off) as the hole was backfilled with the piezometers and bentonite grout.

We did not sample the well until April 1994 because we were pumping gas from the piezometers to remove air injected into the sediments while drilling. We waited to sample for tritium and carbon-14 until we had a stable profile of carbon dioxide in piezometers. In April 1994, we sampled the water vapor in the gas from each piezometer for tritium and stable isotopes of

deuterium and oxygen-18, and the carbon dioxide from seven piezometers for carbon-14 and carbon-13. The gas samples were collected by slowly pumping (pump rates of about 1 liter per minute or less) gas from each piezometer and freezing the water vapor as the gas past through a glass freeze trap immersed in a mixture of alcohol and dry ice. After removing the water vapor, we stripped carbon dioxide from seven samples by bubbling the soil gas through a gas-wash bottle containing potassium hydroxide.

Analyses of the water vapor for tritium were done by the National Research Program, Tritium Laboratory of the U.S. Geological Survey and analyses for carbon-14 were done by the Radiocarbon Laboratory, Desert Research Institute, Las Vegas, Nevada. The carbon-14 analyses were completed in May 1995 and I received a copy on May 24, 1995. Because of the unexpectedly high concentrations of tritium and carbon-14 in samples collected in the upper 100 feet of sediments, we requested funding to resample the test hole and surrounding area in June 1995. In July 1995, we resampled the five shallowest piezometers in test hole UZB-2; three air ports in our research shaft; two air piezometers at a site two miles south of our research site; and from two shallow probes driven 5.5 feet into the sediments next to the fence enclosing the waste-burial area.

A water sample was collected from test hole UZB-2 in September 1993 at the time the well was drilled. The test hole was drilled a few feet into the water table. This sample was analyzed for tritium at the same time that the condensed water vapor was analyzed, and the concentration of tritium in the sample is less than the detection limit (about 3 tritium units or about 9.6 picocuries per liter).

A colleague and I presently are writing a report describing the sampling and distribution of gases in the unsaturated zone at our research facility.

Sincerely,

David E. Prudic

David E. Prudic
Hydrologist

Enclosures

cc: Carol Boughton, U.S. Geological Survey, Nevada District, Carson City, Nevada
Jon Nowlin, U.S. Geological Survey, District Chief, Nevada District, Carson City, Nevada
John Klein, U.S. Geological Survey, Assistant Regional Hydrologist, Sacramento, California
John Conomos, U.S. Geological Survey, Regional Hydrologist, Menlo Park, California
William Alley, U.S. Geological Survey, Chief, Office of Ground Water, Reston, Virginia
John Fischer, U.S. Geological Survey, Assistant Chief Hydrologist, Reston, Virginia
Stanley Marshall, Department of Human Resources, Nevada State Division of Health, Carson City, Nevada
Verne Ross, Nevada Department of Environmental Protection, Carson City, Nevada

DEP:lkn
/files/opm/projects/nv172/deprudic.gap.prm.doc10/27/95

Table 1: Concentrations of tritium and carbon-14 in soil gas samples collected near the burial area for low-level radioactive wastes, south of Beatty, Nevada

		Tritium		Carbon-14	
Location [1] and depth below land surface	Date sampled	Tritium Units[2]	1 sigma[3]	Percent modern carbon	1 sigma[4]
UZB-2: 18 feet	4/15-20/94	199	± 5	1,696.	± 18.8
UZB-2: 18 feet	7/10/95	249	± 8		
UZB-2: 18 feet	7/11/95	253	± 8		
UZB-2: 18 feet	7/12/95	240	± 8		
UZB-2: 18 feet	7/13/95	247	± 8		
UZB-2: 18 feet	7/14/95	243	± 8		
UZB-2: 39 feet	4/15-20/94	737	± 10		
UZB-2: 39 feet	7/12/95	883	± 12		
UZB-2: 59 feet	4/15-20/94	581	± 8		
UZB-2: 59 feet	7/10/95	723	± 11	297.	± 3.48
UZB-2: 59 feet	7/13/95	640	± 12		
UZB-2: 79 feet	4/15-20/94	762	± 10	199.	± 2.59
UZB-2: 79 feet	7/11/95	1,100	± 14		
UZB-2: 112 feet	4/15-20/94	266	± 10	80.9	± 1.21
UZB-2: 112 feet	7/12/95	437	± 9		
UZB-2: 112 feet	7/13/95	372	± 9		
UZB-2: 157 feet	4/15-20/94	198	± 5		
UZB-2: 189 feet	4/15-20/94	215	± 5	28.4	± 0.69
UZB-2: 309 feet	4/15-20/94	143	± 5		
UZB-2: 348 feet	4/15-20/94	133	± 5	22.1	± 0.17
UZB-2: 357 feet	4/15-20/94	162	± 6		
Probe A - 5.5 feet	7/10/95	8,980	± 70		

Table 1: Concentrations of tritium and carbon-14 in soil gas samples collected near the burial area for low-level radioactive wastes, south of Beatty, Nevada

		Tritium		Carbon-14	
Location [1] and depth below land surface	Date sampled	Tritium Units[2]	1 sigma[3]	Percent modern carbon	1 sigma[4]
Probe B - 5.5 feet	7/11/95	29,450	±210		
Shaft- 20 feet	7/12/95	92	±6		
Shaft- 20 feet	7/13/95	92	±6		
Shaft- 36 feet	7/11/95	619	±10		
Shaft- 36 feet	7/13/95	615	±10		
Shaft- 43 feet	7/13/95	229	±7		
Fischer's green- 34 feet?	6/09/92			100.	0.76
Fischer's red- 41 feet?	6/09/92			90.4	0.72
Fischer's purple- 61 feet	6/09/92			78.0	0.67
Fischer's white- 93 feet	6/09/92			55.2	0.75
Fischer's green- 34 feet?	7/11/95	3	±6		
Fischer's green- 34 feet?	7/12/95	0	±6		
Fischer's red- 41 feet?	7/10/95	5	±6		
Fischer's red- 41 feet?	7/11/95	-1	±6		

[1] UZB-2 is a test hole about 150 feet south of experimental shaft; Shaft is a 5.5-feet diameter caisson near the southwest corner of the burial area for low-level radioactive wastes; Fischer's test hole is about 2 miles south of the burial area; depth of green and red tubes is not precisely known.

[2] Tritium units can be converted to picocuries per liter by multiplying tritium units with 3.2. (From Fritz, P., and J.Ch. Fontes, eds., 1980, Handbook of environmental isotope geochemistry: Elsevier Scientific Publishing Company, New York, New York, page 14.)

[3] Error associated with each tritium value represents the counting error at one standard deviation and is reported in tritium units. Values from Fischer test hole are less than the reported error and are below detection limits.

[4] Error associated with each carbon-14 value represents the counting error at one standard deviation and is reported in percent of modern carbon. Thus, the value at a depth of 19 feet in test hole UZB-2 is between 1,677 and 1,715 percent of modern carbon.

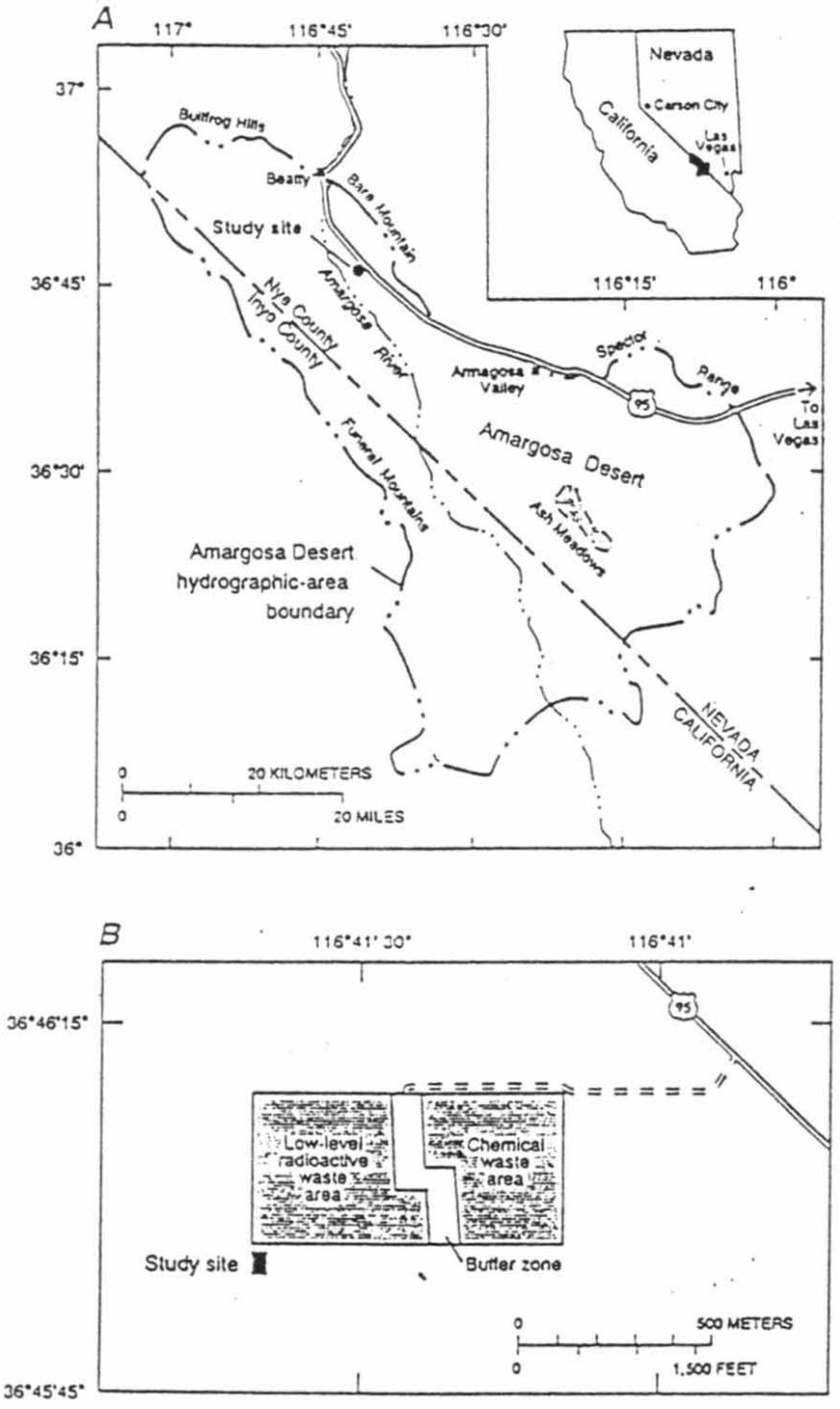
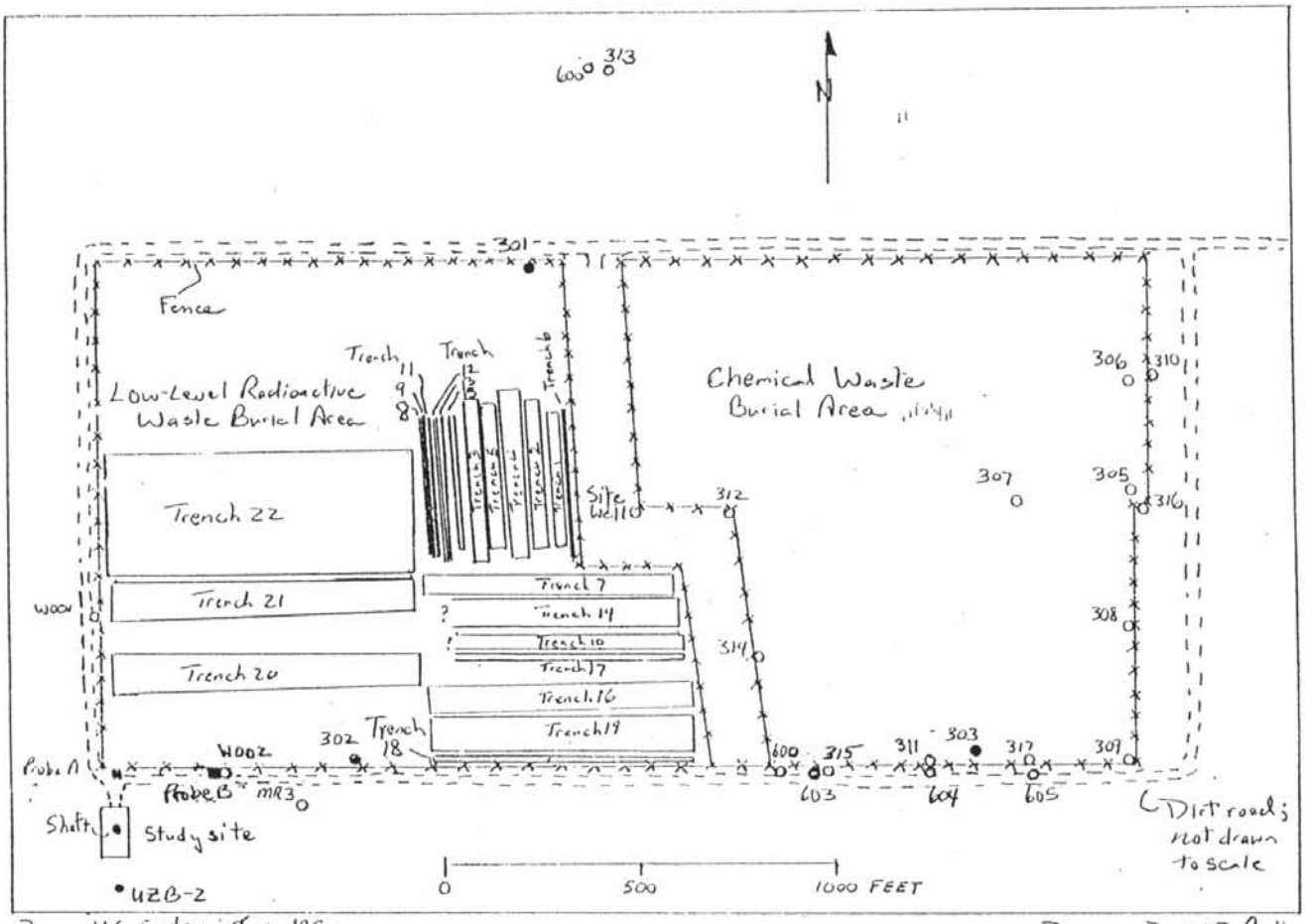


Figure 1. Location of (A) waste-disposal facility in Amargosa Desert and (B) study site in relation to disposal facility.



Base U.S. Ecology, Inc., 1990

Drawn by David E. Prudic

BLM Asks USGS to Review the Beatty Data

In response to the release of the Beatty data, we wrote Interior Secretary Bruce Babbitt and requested that he initiate a formal public review of the new information as required by federal environmental law.[1] In reply, Mr. Ed Hastey, the Director of the California State Office of the United States Bureau of Land Management (BLM) wrote to inform us that they had requested USGS review the Beatty data and its relationship to Ward Valley.

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[1] Letter from Daniel Hirsch, Committee to Bridge the Gap, to Secretary Bruce Babbitt, United States Department of the Interior, dated October 29, 1995.

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
California State Office
2800 Cottage Way, Room E-2845
Sacramento, California 95825-1889

2700
CA-930.7

NOV 28 1995

Daniel Hirsch, President
Committee to Bridge the Gap
1637 Butler Ave., Suite 203
Los Angeles, CA 90025

Dear Mr. Hirsch:

Secretary Babbitt has asked us to reply to your letter of October 29, 1995. In that letter you suggested that new information, in the form of a U. S. Geological Survey report on the low-level radioactive waste disposal site at Beatty, Nevada, had been released. Based on that report you requested the Bureau of Land Management prepare a supplemental environmental impact statement.

We, too, have received this report. Because the Geological Survey has expertise related to hydrogeologic issues, generated the Beatty data, and is familiar with both the Beatty and Ward Valley sites, we have requested their evaluation of that data and its relationship to the Ward Valley site.

After we have received and analyzed their response to our request, we will answer your letter more fully.

Sincerely,

Ed Hastey

Ed Hastey
State Director

cc: DM, CDD
AM, Needles
CDD, Romoli
Nawi, Rgl. Sol.

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United States Department of the Interior

BUREAU OF LAND MANAGEMENT
California State Office
2800 Cottage Way, Room E-2845
Sacramento, California 95825-1889

NOV 03 1995

IN REPLY REFER TO:
2700
CA-930.7

Memorandum

To: Gordon P. Eaton, Director
U.S. Geological Survey

From: State Director

Subject: Beatty, Nevada Test Results

We have received information regarding tritium and carbon-14 analyses of gas samples collected by the U.S. Geological Survey (USGS) adjacent to the low-level radioactive waste disposal site in Beatty, Nevada. This memorandum is to request your evaluation of the Beatty data and the relation of the data to the Ward Valley site in California.

The Bureau of Land Management (BLM) is presently considering transfer of the federally-owned Ward Valley lands to the State of California for use as a low-level radioactive waste disposal facility. The environmental impacts of the proposed facility have been considered in a final environmental impact statement/ environmental impact report (EIS/EIR) jointly issued by the State of California Department of Health Services and BLM in 1991. A supplemental EIS (SEIS) was issued by BLM in 1993. Operation of the Beatty site by US Ecology, the State of California's licensed operator for the Ward Valley facility, is addressed in the FEIR/EIS and SEIS. See, e.g., FEIS/EIR, Responses to Comments at 11.44, 79.2, 95.1, Appendix 1 and SEIS at pp. 15-16.

In May of 1995, a panel of the National Academy of Sciences/National Research Council (NAS) issued a report, with which I assume you are familiar, entitled "Ward Valley: An Examination of Seven Issues in Earth Sciences and Ecology." An important issue addressed in the NAS report (both by the panel majority and in two dissenting statements) concerns the transfer of contaminants through the unsaturated zone and the potential for contamination of groundwater. In this connection, the NAS report considered the reported presence of tritium found in the unsaturated zone at the Ward Valley site, and it recommends that additional testing for tritium and sampling for chlorine-36 be performed. (Report, pp. 5, 116.)

The report also considered the Beatty Nevada site as an analog for the Ward Valley site and concluded that it "may be useful in understanding some natural processes, but it is limited in evaluating the behavior of the Ward Valley site because of historical uncertainties." (Report, p. 23.)

Because USGS has expertise related to hydrogeologic issues, generated the Beatty data, and is familiar with both the Beatty and Ward Valley sites, BLM requests your evaluation of the Beatty data and the relation of the data to the Ward Valley site, and of whether and to what extent the data bears on the conclusions and recommendations in the environmental documentation on Ward Valley and in the NAS report.

We have attached correspondence from Committee To Bridge The Gap which we have recently received on the issue. We would also be pleased to provide you with copies of any portions of the environmental documentation on Ward Valley which you may not have. Please contact Richard Johnson or Jack Mills of my staff at 916-979-2850 for further information regarding this matter.

Al Wright

Acting

Attachments
As stated

cc: (w/o attachs)
Elisabeth C. Brandt
Deputy Director and Chief Counsel
Department of Health Services

SOL/JMILLS:mw:USGS-BLM.4
11/3/95

Alleged Retribution Against Whistle-Blower Makes Criticism Unlikely

The acknowledgment that the USGS had been asked to review the relevance of the Beatty data to Ward Valley raised questions and concerns. One of the key concerns involved the subject of alleged retribution taken by USGS against geologists who had criticized the safety of the proposed Ward Valley facility. Joined by other USGS whistle-blowers, these geologists filed a lawsuit accusing the USGS of wrongful termination. If the USGS fired those who were critical of Ward Valley, how could they be trusted to conduct a fair review of the Beatty data? The USGS "party line" on Ward Valley had already been forcefully established.

PUBLIC EMPLOYEES FOR ENVIRONMENTAL RESPONSIBILITY

for further information:
Jeff Ruch/Howard Wilshire (202) 265-PEER
Mary Dryovage (415) 981-1923
Bob Schaeffer (617) 489-0461

for immediate release Thursday morning, November 9, 1995

"POLITICAL PURGE" ALLEGED AT U.S. GEOLOGICAL SURVEY; RULES MANIPULATED TO OUST DISSIDENTS, WHISTLEBLOWERS

Thirty-seven federal scientists today filed legal challenges to a reduction-in-force (RIF) at the U.S. Geological Survey (USGS), charging Interior Department managers with retaliation against outspoken employees through falsification of position descriptions and manipulation of merit system rules. The challenges were filed through Public Employees for Environmental Responsibility (PEER), a national advocacy organization of resource management staff. The lead attorney is Mary Dryovage, Chair of the National Employment Lawyers Association Federal Employee Rights Committee.

Over 500 USGS employees recently lost their jobs in a massive RIF, or layoff, the largest in agency history. All the cuts took place in the Geologic Division, which produced reports on such politically charged topics as the value of minerals on federal lands and the suitability of Ward Valley, California as a nuclear waste dump site. The division also investigates earthquakes and other earth processes.

PEER General Counsel Jeffrey Ruch charged, "This RIF has little to do with budgets and a lot to do with political agendas. Ninety percent of agency whistleblowers -- employees who had publicly aired internal agency reports or disclosed evidence of waste, fraud, threats to public safety, or other violations of law -- were targeted."

Ruch added, "The issue here is whether federal agency scientists can practice with independence and integrity or whether they all have to practice 'political science' in order to survive."

The legal challenges will be heard by the U.S. Merit Systems Protection Board within 120 days. Attorney Dryovage explained, "The Survey has broken the fundamental precept governing reductions in force: selection of employees must be done by merit through comparing the records of employees at the same competitive level. Just before this RIF, however, USGS rewrote the position descriptions of employees to place many in heretofore nonexistent and unique competitive levels so that the agency could literally pick and choose which specific persons it wished to retain."

. . . . more

For example, Howard Wilshire, a USGS geologist with 34 years of service who had written a controversial report raising concerns about the Ward Valley, California nuclear waste site, was reclassified immediately prior to the RIF so that the only way he could retain employment was to "bump" his wife, also a USGS geologist, into unemployment. Wilshire, who is now leading the fight against the RIF, declared, "Interior Department managers are trashing the premier science agency in the world in order to quiet so-called 'troublemakers' who persist in raising inconvenient facts. The real national tragedy is that vital capabilities of the Survey will be lost -- and for no good reason."

The RIF comes at a time when the USGS budget for the current fiscal year has not yet been adopted by Congress. But figures before the budget conference committee suggest that the USGS will actually receive a slight increase. In addition, about 400 USGS staff have already opted for early retirement buyouts this year.

Among those hurt by the RIF:

* Gene Foord is regarded as one of the world's top mineralogists despite his deafness. Last year he was diagnosed with terminal cancer. Because he is too young to qualify for early retirement, Foord sought a hardship exemption from the RIF so his wife and two young children would qualify for survivor benefits. USGS denied his application.

* Maxine Ovetz was terminated seven and a half months short of retirement eligibility. Treated for breast cancer a year ago, Ovetz now lacks medical benefits and is in jeopardy should the cancer reoccur.

Based on cases such as these, Wilshire concluded, "It was very clear that the managers in charge of the RIF had their orders. Nothing could stay their predetermined actions."

Only one manager was separated by the RIF, but women in research and technical positions were disproportionately represented. In the USGS Menlo Park, California, office, 41% of separated scientists and technicians were women in a workforce that was less than 27% female.

Earlier this year, the Merit Systems Protection Board invalidated mass layoffs by the U.S. Postal Service because that agency failed to follow proper procedures.

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Prudic Reviewing Data He Suppressed

On January 11, 1996, Prudic called our office and requested information about documents referenced in a Committee to Bridge the Gap report. He said that he is involved in the USGS review of the Beatty data requested by BLM. This news raised conflict of interest concerns. Prudic had the data well in advance of the publication of the NAS study. In order to find that the Beatty data had relevance to Ward Valley, Prudic would have to admit that he withheld important information from the NAS. In addition, he would have to acknowledge that he misled the panel when he told them that moisture moves slowly, if at all, at Beatty and Ward Valley.

Prudic informed us that others at USGS are involved in the review. These reviewers, however, also have apparent conflicts. One reviewer, Robert Striegl, helped design and perform the measurements used to discover contamination at Beatty, which were not disclosed to the NAS panel or the public. He and Prudic co-authored the USGS report of the Beatty findings.[1]

Although it appears Prudic and Striegl are the primary authors of the review, Prudic said that the reviewers also include Ed Weeks and Rick Healy of USGS. Weeks and Healy have their own potential conflicts. They co-authored, along with former USGS employee and current US Ecology contractor Eric Lappala, the key computer program used by US Ecology to predict no migration could occur at the proposed Ward Valley radioactive waste facility for thousands of years. The Beatty data directly challenge the validity of this computer program. If the Beatty data are relevant to Ward Valley, then their computer program erred in concluding that Ward Valley wouldn't leak. In addition, their association with US Ecology's Lappala is troubling.

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[1] Prudic, D. E., & Striegl, R. G., 1995, Tritium and Radioactive Carbon (^{14}C) Analyses of Gas Collected From Unsaturated Sediments Next to a Low-Level Radioactive-Waste Burial Site South of Beatty, Nevada, April 1994 and July 1995, USGS Open-File Report 95-741. Carson City, NV: U.S. Department of the Interior.

Tritium and Radioactive Carbon (^{14}C) Analyses of Gas Collected From Unsaturated Sediments Next to a Low-Level Radioactive-Waste Burial Site South of Beatty, Nevada, April 1994 and July 1995

By David E. Prudic and Robert G. Striegl

U.S. GEOLOGICAL SURVEY

Open-File Report 95-741

Carson City, Nevada
1995

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Report Prepared for

US Ecology, Inc.
1600 Dove Street, Suite 408
Newport Beach, California 92660

GROUNDWATER FLOW AND TRANSFER MECHANISM REPORT WARD VALLEY, CALIFORNIA

HLA Job Nos. 17160,060.11
and 17160,061.11

by

Grant L. Ohland
Geologist - 4678

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January 11, 1990

6.2.1 Model Selection Criteria

The computer codes selected to simulate moisture movement and radionuclide transport at the Ward Valley site were required to have a number of capabilities. These capabilities varied depending on which case was being evaluated and whether the case addressed the disposal trench zone, the near-surface unsaturated zone, or the deep unsaturated zone. All variably saturated flow simulations required that the model have the capability to adequately simulate moisture movement into very dry soil, including, in some cases, an initially sharp wetting front. The numerical model used to simulate moisture movement in the disposal trench zone and near-surface unsaturated zone needed to have the capability to:

- Simulate near-surface phenomena such as infiltration, bare soil evaporation, and plant transpiration, and
- Account for, in some cases, the effects of horizontal layering.

The numerical model employed to simulate the deep unsaturated zone moisture movement and radionuclide transport had to also have the capability to:

- Simulate transport of a solute and account for related phenomena such as dispersion and retardation, and
- Account for the radioactive decay of the source and the transported radionuclides.

Two numerical models were selected from those available to HLA: VS2D and ATLAS-SOLUTE. The description and verification of these codes follows.

6.2.2 VS2D Description and Verification

VS2D is a public domain computer code distributed by the U.S. Geological Survey (*Lappala et al. 1987*) It uses a finite-difference solution algorithm and has the capabilities outlined above for modeling moisture movement in the disposal trench zone. It is a flow code and does not simulate solute mass transport. Additional details regarding the model grids and their purposes are presented in Section 6.3.

Verification of the VS2D code is presented in the user manual (*Lappala, et al., 1987*). One of the example problems from the manual that simulates infiltration, evaporation,

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and transpiration was presented to the California Department of Health Services (DHS) during the initial phase of the numerical analysis effort (*HLA 1989*).

6.2.3 ATLAS-SOLUTE Description and Verification

The ATLAS-SOLUTE computer code was selected for use in simulating moisture movement and radionuclide flux in the deep unsaturated zone, although some of the simulations also included the disposal trench zone. ATLAS-SOLUTE is a proprietary computer code developed by HLA. It uses a finite-element scheme to solve the equations governing fluid flow and solute mass transport. The solution algorithm can account for dispersion, retardation, and radioactive decay. All ATLAS-SOLUTE simulations were performed using a 1-D vertical model. ATLAS-SOLUTE was used for the numerical evaluation of Infiltration Cases 5, 6, and 7, and for radionuclide transport simulations. Section 6.3.4 contains additional details regarding the model grid and its specification.

As verification of the ATLAS-SOLUTE code, HLA presented the following items to the DHS: a user's manual (*HLA 1988b*), a theoretical manual (*HLA 1988c*), and several validation examples verifying the code's ability to simulate the required phenomena (*HLA 1988a*). A DHS contractor reviewed these items and provided comments (*Serie 1989*) which HLA subsequently addressed (*Lappala 1989a*).

6.3 MODEL INPUT PARAMETERS

Infiltration through the disposal trench and deep unsaturated zones was evaluated using four distinct numerical models. The disposal trench zone was evaluated using a 2-D cross-sectional VS2D models. The near-surface unsaturated zone was evaluated using a 1-D column model and a 2-D axisymmetric VS2D model. The deep unsaturated zone was simulated using a 1-D cross-sectional ATLAS-SOLUTE model. Figure 6151.A-20 illustrates the location of these model domains relative to the disposal trenches and the saturated zone.

Model input parameters for the 2-D VS2D, 1-D VS2D, 2-D axisymmetric and 1-D ATLAS-SOLUTE models are described below. Model input parameters consist of:

HLA, 1988c. SOLUTE, A general purpose finite-element program for heat transfer, fluid flow, and solute transport in porous media, ATLAS System, Theoretical Manual, Revision 3, November, 1988.

Harr, M.E., 1962. Groundwater and seepage, McGraw-Hill Book Co., New York.

Hely, A.G., and Peck, E.L., 1964. Precipitation, runoff, and water loss in the Lower Colorado River - Salton Sea Area, U. S. Geological Survey Professional Paper 486-B, 16 p.

Krauskopf, K.B., 1988. Radioactive waste disposal and geology, Chapman and Hall, New York, 145 p.

Laliberte, G.E., Corey, A.T., and Brooks, R.H., 1966, Properties of unsaturated porous media, Fort Collins, CSU Hydrology Paper No. 17, 40 p.

Langmuir, D., 1981. Phase II Report. Exploratory geochemical techniques to be used during site selection and characterization: application to the six geologic media, Appendix F-2, 38 p.

Lappala, E.G. - HLA, 1989. Letter to S. Romano, T. Hanrahan, and R. Gaynor (US Ecology), Resolution of 019/027 response by Roy F. Weston, Inc., on Simulation methods for preparing license application, dated May 2, 1989.

Lappala, E.G., Healy, R.W., and Weeks, E.P., 1987, Documentation of computer program VS2D to solve the equations of fluid flow in variably saturated porous media, U.S. Geological Survey Water-Resources Investigations Report 83-4099, 184 p.

Lyman, W.J., Reehl, W.F., and Rosenblatt, D.H., 1982. Handbook of chemical property estimation methods, McGraw-Hill Book Co., New York.

Mehuys, G.R., Stolzy, L.H., Lefey, J., and Weeks, L.V., 1975, Effects of stones on the hydraulic conductivity of relatively dry desert soils, Soil Science Society of America Proceedings, v. 39, pp. 37-42.

Mualem, Y., 1976. A catalogue of the hydraulic properties of unsaturated soils, Israel Institute of Technology, 100 p.

Nichols, W.D., 1986. Geohydrology of the unsaturated zone at the burial site for low-level radioactive waste near Beatty, Nye County, Nevada, U.S. Geological Survey, Open-File Report 85-198, 85 p.

Nichols, W.D., 1987. Geohydrology of the unsaturated zone at the burial site for low-level radioactive waste near Beatty, Nye County, Nevada, U.S. Geological Survey Water Supply Paper WSP-2312, 57 p.

Nyhan, J.W., 1989. Development of technology For The Long-term Stabilization And Closure Of Shallow Land Burial Sites In Semiarid Environments, Los Alamos National Laboratory Report LA-11283-MS, 77 p.

024

Beatty: A "Good Analog" to Ward Valley

When the data about leakage at Beatty became public, Ward Valley proponents immediately dismissed the findings as irrelevant to Ward Valley. The *Los Angeles Times* quoted Elisabeth Brandt, the State of California's leading Ward Valley advocate, as saying, "The Beatty site had considerably different disposal practices." The *San Diego Union Tribune* quoted Brandt as saying, "I don't think someone finding tritium underground next to a disposal site in another state is relevant."

This position, however, directly contradicted a formal legal finding issued by the State of California prior to the discovery of contamination at Beatty. On June 22, 1994, the California Department of Health Services issued a legal finding that "the Beatty site provides a good analog for the Ward Valley facility."

JUN 2 2 1994

SUPPLEMENTAL FINDINGS
PURSUANT TO COURT ORDER ON THE
LOW-LEVEL RADIOACTIVE WASTE DISPOSAL FACILITY PROJECT

STATE OF CALIFORNIA

I. BACKGROUND OF SUPPLEMENTAL FINDINGS

1. Authority of the State Department of Health Services

The State Department of Health Services (Health Services) is designated by the Radiation Control Law (Health and Safety Code, section 25800, et seq.) as the agency responsible for the issuance of licenses to, among other things, transfer, receive, acquire or possess radioactive material. The Radiation Control Law directs Health Services to commence a process to identify regions within the state which would be suitable for the disposal by land burial of low-level radioactive waste, and to identify a license designee capable to receive radioactive materials from other persons for disposal on land, for the purpose of submitting an application for a license to receive low-level radioactive waste for disposal by land burial.

2. Health Services as Lead Agency

Health Services served as the lead agency under the California Environmental Quality Act (Public Resources Code, section 21000 et seq.)(CEQA) for a proposed project to construct, operate, close and maintain a facility to receive radioactive materials for disposal on land located at Ward Valley in San Bernardino County. An Environmental Impact Report (EIR) was prepared by Health Services as part of a joint document which also served as the Environmental Impact Statement (EIS) prepared by the federal Bureau of Land Management to meet its obligation under the National Environmental Policy Act (NEPA) relating to the proposed transfer of federal land to California for purposes of the Ward Valley facility.

3. Responsibility of the Director

Health Services is under the control of the Director of Health Services (Director). The Director, or his or her designee, is the final decision-maker for Health Services on all matters related to the proposed project to construct, operate, close and maintain the facility to receive radioactive materials for disposal on land.

4. Certification of Final Environmental Impact Report

On September 16, 1993, the Director's designee certified the Final Environmental Impact Report (EIR) for the project to construct, operate, close and maintain a facility to receive radioactive materials for disposal on land. The Final EIR was presented to the

J. USE OF THE BEATTY SITE AS AN ANALOG

149. Wilshire Report - Recommendation - Use of the Beatty Site as an Analog

The Wilshire Report recommends that the low-level radioactive waste site in Beatty, Nevada, can be a good analog for the Ward Valley project.

150. Dames & Moore Analysis - Recommendation - Use of the Beatty Site as an Analog

The Dames & Moore Analysis reviewed the recommendation related to the use of the Beatty site as an analog, and responded that:

(1) the Beatty site is indeed a good analog;

(2) USGS studies of the Beatty site were relied upon to study the Ward Valley facility.

151. Finding - Recommendation - Use of the Beatty Site as an Analog

Based upon the Administrative Record for the project and the Dames & Moore Analysis of the Wilshire Report, I find that the Beatty site provides a good analog for the Ward Valley facility.

K. POSSIBILITY OF COLORADO RIVER CONTAMINATION

152. Order - Questions About Contamination of the Colorado River

The order of the Los Angeles Superior Court stated that "the questions of most concern to all parties and the public generally are: will the Colorado River be contaminated?, is it threatened to be contaminated?, is it likely to be contaminated?, etc." (Order, page 5, lines 12-18.)

153. Dames & Moore Analysis - Questions About Contamination of the Colorado River.

The Dames & Moore Analysis reviewed the questions presented in the court order, and responded that contamination of the Colorado River due to releases from the disposal facility is neither probable nor likely, and is, for all practical purposes, impossible. This conclusion is based upon the following;

(1) Contact of the waste with liquids would be necessary for radionuclides to migrate;

disposal facility at Barnwell, South Carolina, the last available disposal facility in the nation;

(3) generators of LLRW will be compelled to store LLRW at the point of generation, which is often located in heavily populated areas of the state;

(4) a natural disaster, such as a fire or earthquake, could result in radiation exposures to the public;

(5) delay in commencing disposal operations at the Ward Valley facility increases the possibility that such exposures could occur;

(6) a hearing under CEQA would inevitably delay the project and thereby increase the risk to the public health and safety.

167. Finding - Project Approval

I find that the previous project approval was suspended pending reconsideration in light of the Wilshire Report and, based upon the Administrative Record including the Final EIR as well as the other documents referenced in these findings including the Dames & Moore Report as an EIR Addendum, shall be confirmed upon the confirmation and ratification by Health Services of the license issued on September 16, 1993.

168. Finding - Ratification of License

Having reconsidered the approval of the project in light of the Wilshire Report, I hereby confirm and ratify the Radioactive Materials License issued to US Ecology, Inc. on September 16, 1993.

6/22/94
Date

RON JOSEPH, Chief Deputy Director
Department of Health Services

US Ecology Uses Beatty to Make Assurances About Ward Valley

Relying on information from its Beatty site, US Ecology claimed that rainwater moves very slowly through soil toward groundwater at Ward Valley. US Ecology wrote that Beatty and Ward Valley share "generally similar geologic settings" and similar soil. If natural site characteristics at Beatty prevent the rapid movement of water, US Ecology argued, similar characteristics at Ward Valley would offer the same protections.

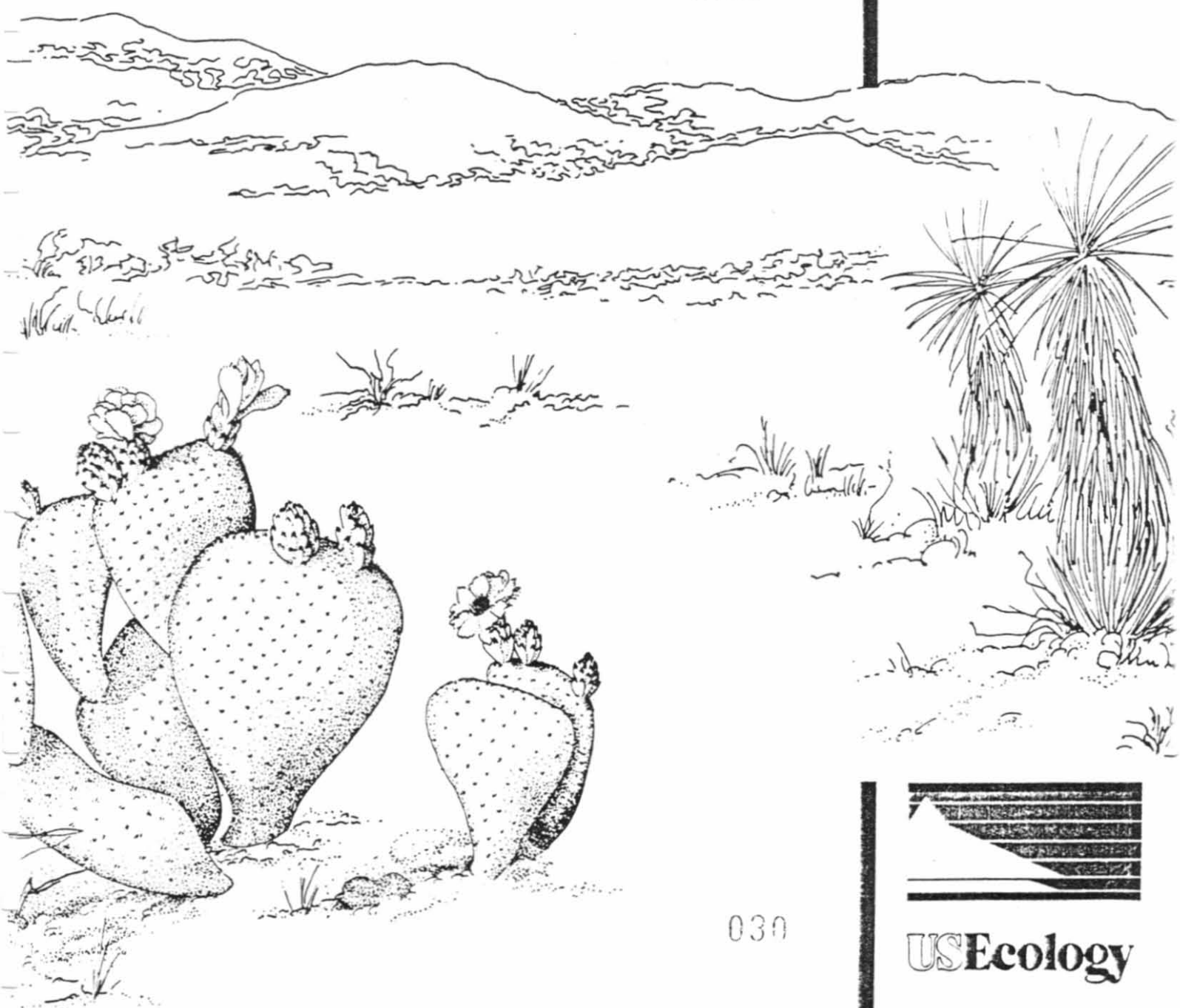
It is, however, important to note that the corollary to US Ecology's argument must also be true: If evidence shows that water (and radionuclides) move rapidly at Beatty, then the same would happen at Ward Valley.

CALIFORNIA

LOW-LEVEL RADIOACTIVE WASTE DISPOSAL FACILITY

LICENSE APPLICATION

CERTIFIED COMPLETE
DECEMBER 1989



030

USEcology

To ensure that all waste is buried beneath the deepest projected scouring action caused by a Probable Maximum Flood (PMF) all wastes are buried at least 20 feet below the original ground surface at the time of completion. Trench dimensions at the original ground surface depend on the depth and side slope. Based on experience at the Beatty, Nevada, disposal facility, which is in a generally similar geologic setting, soil stability may allow side slopes of one horizontal to one vertical (1:1). The trench design plan is drawn conservatively, however, at 1 1/2 horizontal to one vertical (1.5:1). In practice, the steepest slope considered safe for employees working in the trenches is employed to maximize space utilization and minimize surface disturbance. The slope of the trench floors is parallel to the average surface grade, which slopes about 2.2 percent to the east.

Waste placement proceeds from west to east, which allows rainfall runoff within the trench to drain away from disposed waste while keeping the overall trench depth uniform. The four Class A trenches are approximately 1,546 feet long by 290 feet wide at grade by 60 feet deep. A 40-foot-wide space separates each completed trench at the surface. This distance, assuming 1.5:1 side slopes and 20-foot cover between buried waste and the ground surface, maintains a minimum of 100 feet of in-situ undisturbed earth between wastes in adjacent trenches. As noted, the Class A trenches are developed on a continuous, progressive basis. The bottom of the initial excavation will be 110 feet wide by 250 feet long, with a ramp extending roughly 600 feet eastward. An initial excavation of this size provides the space needed for safe maneuvering of heavy equipment and waste shipments into the trench as well as unloading, placement, and backfill. (See Section 4200 for an expanded description of waste handling). A safe working distance is maintained between disposal of waste and excavation activity to ensure worker safety and to provide sufficient room for excavation and backfilling operations.

The single BC30 Trench is 1,546 feet long by 226 feet wide at the surface and 42 feet deep. A shallower excavation is used to ensure that any moisture accumulation in Class A trenches does not migrate into the Class BC30 trench. Like the Class A trenches, the entire trench is not open at any one time but is excavated as needed and backfilled as waste is placed. To allow for truck turning and a conservatively safe distance between emplaced waste and the progressive excavation face, the initial BC30 trench excavation is 100 feet by 250 feet. An access ramp extends roughly 420 feet eastward from the trench bottom to the surface. The BC30 Trench is located farthest away from the facility shop and Operations Buildings.

1200.4.5 Trench Covers

The final trench cover, constructed as a monolithic structure covering the entire site, protects disposed wastes from the effects of erosion by wind and water. This cover is constructed within the flood-control

Calculations based upon information presented in Wilson, et al. (1980) indicate that there is sufficient head difference between the basins to induce inflow from the north, perhaps on the order of 2,000 acre-feet per year. Numerical modeling results presented in Appendix 6151.A indicate a likely range of about 200 to 2,200 acre-feet per year of groundwater underflow from the Lanfair Valley.

Stormwater runoff from mountainous areas surrounding the Ward Valley could infiltrate in dry washes and surface channels on the valley floor. Homer Wash is the largest of these features, and it extends nearly the length of Ward Valley. Based upon 0.5 inches per year (Healy and Peck 1964) for the Ward Valley area, the mountain front runoff from the mountainous area (190 square miles) is about 5100 acre-feet per year. Most or all of this runoff is probably lost to evaporation from the bare soil prior to infiltration and to plant transpiration following infiltration. Therefore, recharge to the Ward Valley aquifer from mountain front runoff probably ranges is between 0 to 5,100 acre-feet per year (see Section 2.3.4, Appendix 6151.A).

Recharge through the alluvium probably is small. A discussion regarding groundwater recharge through the alluvium at the Beatty, Nevada, and the Nevada Test Site is presented in Section 2420.1.1.2. Since the Ward Valley site is located in a desert environment and is situated on alluvial soil materials similar to those found at these sites, methods for estimating the amounts of groundwater recharge and deep percolation presented by Nichols (1986) may be applicable to the Ward Valley. The average annual rainfall there is about 16 centimeters per year, and Nichols estimates that about 3 percent of the rainfall becomes deep percolation. For Ward Valley, deep percolation is estimated at about 0.45 centimeters per year. Nichols estimated that about 1.7 percent of deep percolation becomes groundwater recharge for the Beatty site. An estimate of groundwater recharge for the alluvium at Ward Valley using this method is about 0.08 millimeters per year (mm/yr). This value falls within the range of about 0.05 mm/yr (Nichols 1986) to about 0.5 mm/yr (Montazer and Wilson 1984) for alluvium recharge values estimated for other alluvial basins in this region. Over the 875 square mile basin, 0.5 mm/year equates to about 900 acre-feet per year, a small fraction of recharge from other sources.

The regional information summarized above compares with results of infiltration model analyses at the Ward Valley site. Analyses of infiltration during 20-year cycles of average annual precipitation described in Section 2420.4 indicate that about 0.14 inches of moisture per year moved through a soil column model with bare-soil evaporation. No moisture moved through the model when reasonable estimates of plant transpiration were included in the model. Numerical simulations of groundwater conditions in the saturated zone in the Ward Valley, described in Section 2420.3, best reproduced observed piezometric

State Regulatory Agency Questions US Ecology's Qualifications

Through an agreement with the United States Nuclear Regulatory Commission, the California Department of Health Services (DHS) has assumed the responsibility for licensing and regulating the proposed Ward Valley radioactive waste facility. Four companies applied for the contract to build and operate a radioactive waste facility in California. After receiving the applications, DHS reviewed each of the companies. They ranked US Ecology last among the four applicants.

In its evaluation, DHS wrote, "The past history of US Ecology's operations cast doubts on their ability to perform future activities. The applicant strictly adheres to minimum standards. . . . US Ecology has shown repeatedly throughout its application and operations of this type, that they will do only what is necessary to keep operating."

Source: Memorandum from the Environmental Health Division, California Department of Health Services, to Kenneth W. Kizer, M.D., M.P.H., Director, DHS, dated 11/21/85

U.S. Ecology

The past history of U.S. Ecology's operations casts doubts on their ability to perform future activities. The applicant strictly adheres to minimum standards. As a corporation, they have operated or are currently operating low-level radioactive waste disposal sites in Maxey Flats, Kentucky; Sheffield, Illinois; Richland, Washington and Beatty, Nevada. The sites in Maxey Flats and Sheffiled are no longer in operation.

The Maxey Flats location has failed, radioactive waste has mitgrated off-site, with remedial action being performed by Westinghouse. The Sheffield site has been closed by U.S. Ecology and the State of Illinois has pending $97 million law suit and seeks injunctive releif including a request that U.S. Ecology remove all or parts of the radioactive waste disposed of at Sheffield. U.S. Ecology's adjacent chemical disposal site is closed to chemical waste shipments and this operation is under litigation, as to fines and possible removal of chemical waste.

The Richland, Washington and Beatty Nevada low-level disposal sites are presently being operated by U.S. Ecology.

U.S. Ecology's Beatty Nevada license was revoked by the state in 1980 and the intervening period has been marked by litigation. However, by agreement to both parties, the site has continued operation on a limited scale. Additionall operations at the Beatty site have resulted in a $10,000 fine for unauthorized opening of containered waste.

U.S. Ecology's Richland operations is currently under regulatory fire in that stability of the trench caps is in question.

There is concern as to the ability of U.S. Ecology to maintain an adequately trained staff, in that they are a small corporation with limited resources (financial, technical and training personnel).

U.S. Ecology's operational procedures (including disposal techniques) design criteria, quality control and environmental monitoring are minimal. Their application indicated that they expected to operate the California site in the same manner as the existing Washington site. There is concern as to the ability of company to provide and maintain important elements necessary to a successful site operation.

U.S. Ecology has shown repeatedly throughout its application and operations of this type, that they will do only what is necessary to keep operating. This may not be appropriate for a highly controversial issue such as the disposal of low-level radioactive waste.

US Ecology Instructs DHS to Rely on Beatty

The top-ranked companies dropped out of the process, apparently because of concerns about their potential liability should the new facility leak. DHS was then forced to accept US Ecology as its "license designee."

In the meantime, US Ecology got a copy of DHS's evaluation. The company wrote DHS to argue against DHS's conclusions. US Ecology asked DHS to emphasize the US Ecology track record at the company's arid climate facilities in Richland, Washington, and Beatty, Nevada, where US Ecology claimed there was no evidence of contamination.

US Ecology Consultants
1600 Dove Street, Suite 408
Newport Beach, California 92660
Phone 714/955-1201

10.4.2.1.11

Please file
No answer
Needed

January 27, 1986

USEcology Consultants

A Division of US Ecology, Inc

Dr. Harvey F. Collins, Chief
State of California
Environmental Health Division
Department of Health Services
714 P Street
Sacramento, CA 95814

Dear Dr. Collins:

Since we have agreed to be the license designee for developing California's low-level radioactive waste disposal site, we find it desirable to comment on the Department's evaluation of our application. Having been ranked last among the candidates, it is likely that the evaluation may become the subject of some criticism.

We are not challenging the actual ranking of the applications. All four applicants are stable, well-qualified firms, and a ranking among them is difficult and arguable. We do, however, take exception to some of the elemental evaluations, particularly where subjective judgments are presented which clearly exhibit personal bias.

We disagree with many of the itemized evaluations where our competition received higher ratings. It is apparent from the explanations that important information in US Ecology's application or available from our regulators has been overlooked or misunderstood by the reviewers. While a point by point rebuttal of the evaluation would serve no purpose, the following comments are provided in reference to statements we feel most disconcerting. Hopefully, these comments will be useful in clarifying our company's capabilities, character and attitudes.

Technical Qualifications of the Applicant

One of the applicants was rated above US Ecology because of "its thirteen years of operation of the Barnwell, South Carolina disposal site." It is clearly stated in US Ecology's application that we have almost 25 years experience in operating the Beatty, Nevada, and Richland, Washington, disposal sites. It is also readily available public information that US Ecology's safety record with respect to radiation exposure is superior to that of our competitors.

Maintenance of Trained Cadre

One of the applicants was rated above US Ecology because it "plans to transfer experienced personnel from the Barnwell, South Carolina site..." when necessary. Our application not only makes a similar statement, but we have personnel at 5 operating facilities available for this purpose.

Methods of Disposal Unit Construction Including Codes to be Followed

US Ecology was judged "does not meet requirements" because it "did not list any codes which would be followed." In fact, the application does refer, in appropriate places, to regulations and codes that will be followed. The other applicants, who were rated "meets requirements", also listed codes; however, the codes listed were not identical in any of the applications.

"The past history of US Ecology's operations casts doubts on their ability to perform future activities. The applicant strictly adheres to minimum standards."

These statements and the subsequent discourse obviously indicate personal bias and are not accurate characterizations of US Ecology. They represent very shallow investigation into what are complex issues and are principally based on events which are more than ten years in the past. We recognize that the Department had limited time and resources for this review; however, subjective and biased remarks such as these are entirely out of place.

US Ecology has over 75 site-years of experience in low-level radioactive waste disposal. Of the other applicants, only one has 13 site-years experience, the others have none. Our radiation safety record is the best in the industry. In all our history, we have had only one instance of serious non-compliance, and it was related to employee theft and misconduct. That incident occurred over 10 years ago. Over the past several years, US Ecology has enjoyed excellent cooperative relationships with its regulators and local support from the communities near its operating sites. The State of Kentucky, on the other hand, has had no regulatory role with US Ecology since 1979 and is not even familiar with our current management personnel or operations.

Since our low-level radioactive waste disposal operations have been confined to Beatty, Nevada, and Richland, Washington, for the last six years, it is reasonable that our record at those facilities should be the primary basis for the evaluation. US Ecology has been operating the desert sites at Richland and Beatty for almost 25 years with no signs of environmental contamination. We have been handling almost all of California's low-level radioactive waste in Richland for several years. The Department's evaluation ranked us high with respect to site selection procedures and we expect to locate a suitable arid site, similar to Beatty and Richland, in California. As demonstrated in our application, US Ecology also has the technical capability and the intention to add engineering enhancements or waste treatment processes as they are justified through public involvement and environmental studies in the development process.

We hope you will find this information useful in this continuing process. We look forward to working closely with you to develop a disposal facility in California that will serve as a model for the nation.

Sincerely yours,

Ronald K. Gaynor

Ronald K. Gaynor, P.E.
Vice President

cc: Mr. Joseph O. Ward, Dept. of Health Services
Ms. Goldie Eng, Dept. of Health Services

202-00471

DHS Completes Transformation From Regulator to Advocate

Having been forced to accept US Ecology as its license-designee, DHS quickly forgot about its initial reservations about the company's qualifications. Less than eight months after concluding that "[t]he past history of US Ecology's operations casts doubts on their ability to perform future activities," DHS wrote US Ecology to coordinate a meeting to discuss "the best way to 'defend' USE's license designee status." By July 1986, DHS had completed its transition from regulator to advocate.

E

C -- hold for 16th

STATE OF CALIFORNIA—HEALTH AND WELFARE AGENCY

GEORGE DEUKMEJIAN, Governor

DEPARTMENT OF HEALTH SERVICES

714/744 P STREET
SACRAMENTO, CA 95814

Mr. Steve Romano
Assistant Project Manager
U. S. Ecology, Incorporated
1600 Dove Street, Suite 408
Newport Beach, California 92660

July 11, 1986

Dear Steve:

Some topics for discussion Wednesday are listed in no particular priority order. Some are questions, some are comments, some are concerns. Not all of them grow out of Round 1 meetings. We will collectively think of others I'm sure.

1. What is the best way to "defend" USE's license designee status? — Summary of Decision Making Process in Selecting a Lic Designee
2. How many people will be employed at the site?
3. Round 2 and 3 public comment opportunities should be improved over Round 1.
4. Will the site be located over unpotable water?
5. Will DHS be able to electronically access USE/ESA/etc. data?
6. When will the on-site inspector be employed? What are the requirements? — ???
7. Are we all right regarding the question about other agencies' permits etc.? — No answer
8. How do we resolve the mixed waste issue?
9. How is the content of a waste container to be verified? — Varies from State to State!
10. There is some confusion over the EIR and the environmental assessments. — only 1 site will have EIR
11. Are we OK for the Riverside and Blythe meetings?
12. How can we deal with the issue of <u>less than</u> low-level radioactive waste?

We'll see you in Harvey's office at 10:30 on July 16, 1986.

Sincerely,

Don J. Womeldorf, Chief
Vector Surveillance
and Control Branch

202-00482

DHS Adopts US Ecology's Argument About Beatty

In response to public comments on US Ecology's dismal track record, DHS adopts US Ecology's argument about Richland and Beatty. In the Final Environmental Impact Report/Statement (FEIR/S) on Ward Valley, DHS wrote, "The experience with desert disposal sites in the states of Nevada and Washington is more relevant to California's effort than experience in eastern sites with high rainfall and shallow groundwater. . . . Neither of the western LLRW [low-level radioactive waste] disposal sites has contaminated groundwater."

DHS repeated this argument in response to comments on its FEIR/S, "The Department considers US Ecology's operating record at its Beatty, Nevada, and Richland, Washington, facilities to be most pertinent to the California facility. . . . There has been no release of radiation that has contaminated groundwater."

DHS's conclusions about groundwater contamination at Beatty were not, however, supported by monitoring data collected at the site. Tritium had been detected in groundwater. Contradicting itself, DHS admits this in the very next paragraph, "In 1983, elevated tritium levels were observed in two monitoring wells associated with the [Beatty, Nevada] disposal facility."

In an attempt to explain the findings, DHS wrote, "The elevated concentrations were greater up-gradient than down-gradient, and gradually dissipated. There was no recurrence." Both of these claims are wrong.

STATE OF CALIFORNIA INDEMNITY SELECTION

&

LOW-LEVEL RADIOACTIVE WASTE FACILITY

Final Environmental Impact Report/Statement

Appendix - Responses to Comments on Draft EIR/S

SCH 80052308

April 1991

Prepared For:

State of California
Department of Health Services
714 P Street, Room 616
Sacramento, California 95814

Bureau of Land Management
California Desert District
6221 Box Springs Boulevard
Riverside, California 92507

Prepared By:

Dames & Moore
6 Hutton Centre Drive, Suite 700
Santa Ana, California 92707

fya:14886d0.228

Act as amended. Another purpose is to provide a basis for establishing regulations for near surface land disposal of specified radioactive wastes.

11.42 Only wastes falling within the concentration limits set forth in 10 CFR Part 61.55 for Class A, B, and C LLRW will be accepted for disposal (this may include transuranic elements up to 100 nanocuries per gram in the waste). The description of the facility is accurate.

11.43 Consistent with the Memorandum of Understanding between BLM and DHS, Dames & Moore was hired through a competitive bid process by DHS to prepare the EIR/S. Information in the PEA and EIR/S includes data developed by USE and its consultants and independently reviewed by responsible agency staff, BLM, DHS, and consultants hired by DHS to conduct technical review, including Dames & Moore. Separate evaluations in the EIR/S were also completed by Dames & Moore. Prior to public issuance, the Draft EIR/S was reviewed by BLM and DHS staff. Additions and changes were made to the Draft as a result of this review. This approach reflects an independent assessment of the project; no conflict of interest is involved. The preparation of the EIR/S is consistent with Section 15084 of the CEQA Guidelines.

11.44 DHS issued a report of findings on USE's past record and the company's qualifications and capabilities to develop and operate California's LLRW disposal facility. This report, issued in 1986 and made available to the public, concluded that USE is fully qualified to undertake this task, and that the problems that have occurred in the past at other company disposal facilities can be avoided based on experience gained in the past twenty-five years and by diligent enforcement of the stringent new LLRW disposal regulations in effect since 1982. Subsequent to the selection of USE and in response to this comment, the states of Tennessee, Illinois, Nevada, Texas, and Washington were contacted for updated information on USE's environmental record. Their responses to requests for updated information support the DHS's 1986 conclusion that USE is qualified to construct and operate the disposal facility under appropriate regulatory oversight. Appendix 1 provides documentation of USE's history and the information obtained to evaluate that history in 1986.

With respect to USE disposal sites in Kentucky and Illinois, a review of appropriate documents confirms that no member of the public has ever been exposed to radiation as a result of off-site releases from buried waste. The $97 million lawsuit for closure of the Illinois site was actually settled by USE and the State of Illinois for approximately $12 million. Closure of the Kentucky site will be based on approval of clean-up plans by the U.S. Environmental Protection Agency (EPA). USE is only one of numerous Potentially Responsible Parties involved in evaluating remediation of the Kentucky site. While the precise cost is unknown, based on the alternatives now under consideration by EPA, it will certainly not begin to approach $154 trillion.

The experience with desert disposal sites in the states of Nevada and Washington is more relevant to California's effort than experience with eastern sites with high rainfall and shallow groundwater. Opened in 1962 and 1963 respectively, the two western facilities are, in fact, the nation's two oldest commercial LLRW disposal sites. Neither of the western LLRW disposal sites has contaminated groundwater.

Also see response to comment 63.6 regarding incorporation by reference.

SUMMARY OF COMMENTS
FROM JUNE-AUGUST, 1991, COMMENT PERIOD ON
FINAL ENVIRONMENTAL IMPACT REPORT/STATEMENT
AND DEPARTMENT RESPONSES TO
STATE OF CALIFORNIA INDEMNITY SELECTION
AND
LOW-LEVEL RADIOACTIVE WASTE FACILITY
CALIFORNIA DEPARTMENT OF HEALTH SERVICES

LOW-LEVEL WASTE PROGRAM

AUGUST, 1993

All of these found US Ecology to be acceptable. The company is currently working under contract to develop the low-level waste disposal facility for the Central Interstate Compact.

The Department considers US Ecology's operating record at its Beatty, Nevada, and Richland, Washington, facilities to be most pertinent to the California facility. These sites share desert conditions of low rainfall and deep groundwater, and are currently required to operate under the conditions of title 10, Code of Federal Regulations, part 61. Opened in 1962 and 1963, respectively, these two facilities are the oldest commercial low-level waste disposal sites in the United States. Based on recent consultation with state and federal regulators and review of available documentation, the Department has confirmed that there have been no significant health and safety infractions at those facilities. There has been no release of radiation that has contaminated groundwater. Infractions noted over the years of operation have been resolved to the satisfaction of the licensing agencies through changes in procedures and policies, with subsequent regulatory follow-up. The license for the Washington facility was recently renewed, indicating that US Ecology is considered qualified to safely operate the disposal facility. Audits in recent years by both Nevada and the State of Washington revealed no conditions endangering public health and safety.

There has been no tritium detected in Beatty wells in 1991 or the recent past. In 1983, elevated tritium levels were observed in two monitoring wells associated with the disposal facility. One was up-gradient and one was down-gradient. Investigations by both the licensee and Nevada regulators were not able to ascertain the specific cause. The elevated concentrations were greater up-gradient than down-gradient, and gradually dissipated. There was no recurrence.

Elevated cesium 137 levels were discovered in soil at Beatty during a routine debrushing operation in the on-site buffer zone. The area was completely surveyed, and the contamination was packaged and disposed. While the exact source of contamination is not known, it is the result of operations over a decade ago. It is possible that when the spill originally occurred, it was cleaned up to the regulatory standard then applicable and was subsequently covered with clean fill. During a recent debrushing operation, the covering fill was removed, prompting the cleanup.

There is no known record of airborne releases of plutonium at Maxey Flats. The Department has been unable to confirm any increased incidence of cancer in connection with the Sheffield, Illinois low-level radioactive waste disposal facility.

Monitoring Data Show Tritium in Beatty Groundwater

For more than two years, data from monitoring wells at Beatty showed evidence of tritium in groundwater at the site. Tritium is a radioactive isotope of hydrogen. As with other radioisotopes, tritium is measured in terms of radioactive units known as curies. One curie is the amount of nuclear material that undergoes 37 billion disintegrations per second. Each disintegration releases ionizing radiation of one form or another (usually gamma rays, alpha or beta particles). Tritium emits beta particles. Small amounts of radioactive material are measured in picocuries. A picocurie is a millionth of a millionth of a curie.

Tritium concentrations in the Beatty well water reached as high as 410,000 picocuries per liter of water (pCi/L). The legal drinking water standard for tritium is 20,000 pC/L. Thus, tritium in the Beatty well water was as much as 20 times the legal drinking water standard.

DHS claimed that, "[t]he elevated concentrations were greater up-gradient than down-gradient."[1] While not explicit in its explanation, DHS appears to support the contention that the contamination resulted from a disgruntled US Ecology employee "spiking" the wells. (From the standpoint of protecting water resources, this explanation, if correct, is not reassuring.) The highest concentrations of tritium were found in Well 302; lower concentrations of tritium were found in Well 301. Maps of the contour of groundwater at the site show that Well 302 is down-gradient of the radioactive waste disposal trenches. Thus, contrary to DHS's assertion, the highest concentrations of tritium were found in the down-gradient well. This is the result one would expect if the tritium found in the well water resulted from the rapid migration of contaminants from the waste disposal trenches. This finding raises serious questions about the validity of the theory that contaminants move slowly, if at all, in arid environments.

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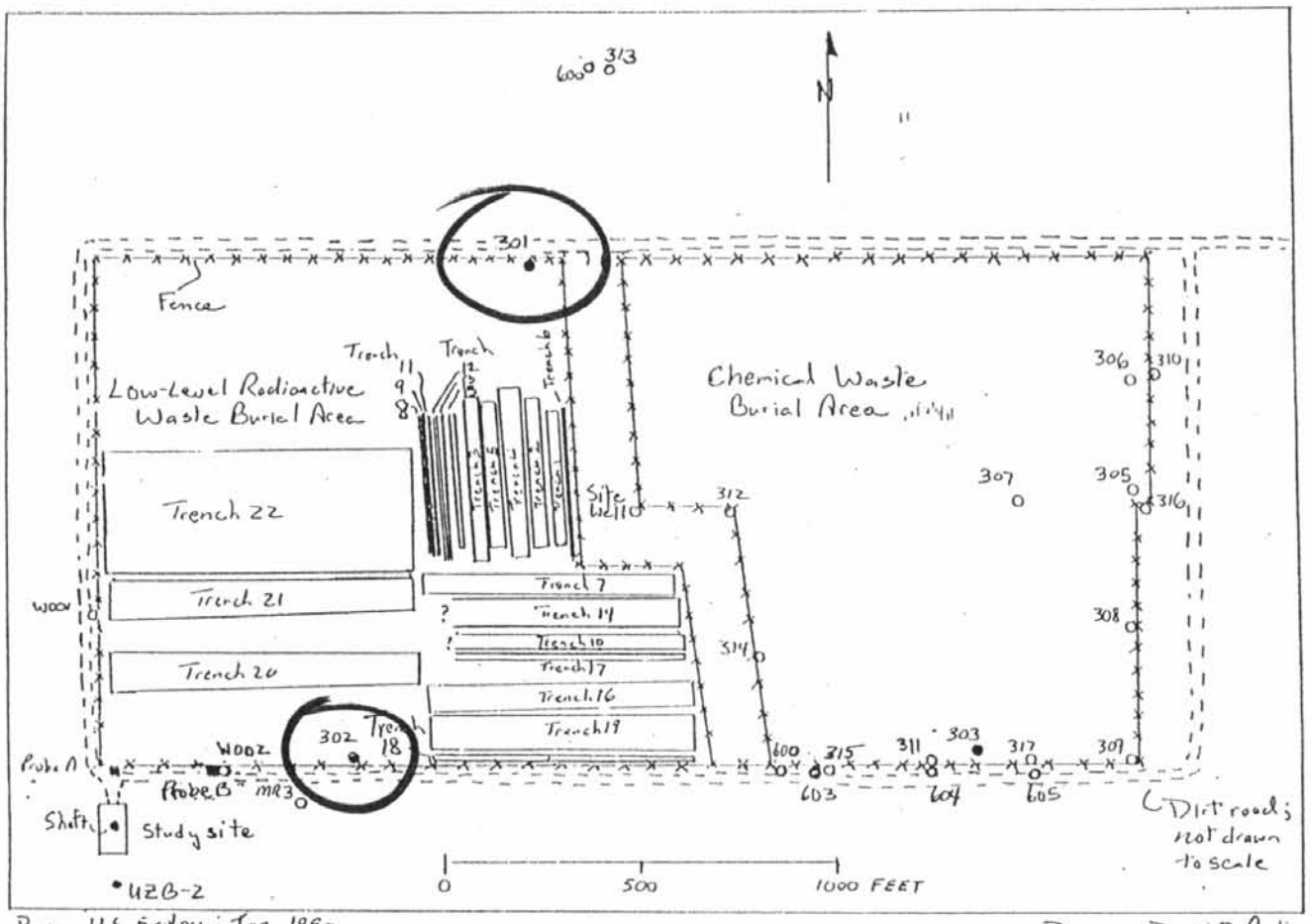
[1] DHS, 1993, Summary of Comments From June-August, 1991, Comment Period on Final Environmental Impact Report/Statement and Department Responses to State of California Indemnity Selection and Low-Level Radioactive Waste Facility, p. 27.

Table 1. Beatty, Nevada, Well Water Sampling Results

Well	Date Sampled	Tritium, pCi/L	Analyzer
301	* 6-28-82	0.0 ± 1,000	Eberline
	* 9-09-82	24,000 ± 1,000	Eberline
	* 10-26-82	< 1,000	Teledyne
	* 2-03-83	200 ± 70	Teledyne
	* 3-03-83	< 2,000	Teledyne
	3-30-83	< 200	EAL
	3-30-83	< 200	USGS
	4-07-83	< 200	USGS
	7-11-83	< 200	USGS
	7-11-83	< 220	EPA
	7-11-83	< 200	EAL
	8-02-83	0 ± 200	EAL
	8-22-83	500	CEP
	9-02-83	500	CEP
	9-30-83	500	CEP
	10-27-83	300 ± 200	EAL
	11-30-83	< 200	EAL
	12-21-83	0 ± 200	EAL
	1-26-84	0 ± 200	EAL
302	* 10-26-82	410,000 ± 10,000	Eberline
	* 2-03-83	48,900 ± 3,000	Teledyne
	* 3-03-83	65,200 ± 6,520	Teledyne
	3-11-83	50,100	EPA
	3-30-83	30,700	USGS
	3-30-83	31,000	USGS
	4-07-83	30,000	USGS
	5-03-83	46,700	EPA
	5-03-83	47,000 ± 2,000	EAL
	6-03-83	13,000 ± 600	EAL
	6-29-83	11,000 ± 600	EAL
	7-11-83	10,000	EAL
	7-11-83	18,200 ± 900	EAL
	8-02-83	13,200 ± 700	EAL
	8-22-83	< 500	CEP
	9-30-83	2,800 ± 750	CEP
	10-27-83	5,800 ± 300	EAL
	11-30-83	4,200 ± 200	EAL
	12-21-83	3,000 ± 300	EAL
	1-26-84	3,600 ± 200	EAL
	3-02-84	2,900 ± 100	EAL
	4-14-84	2,100 ± 200	EAL
	5-31-84	1,600 ± 200	EAL
	6-29-84	1,000 ± 200	EAL
	7-31-84	1,000 ± 200	EAL
	8-30-84	1,400 ± 200	EAL
	9-27-84	800 ± 200	EAL
	10-30-84	500 ± 200	EAL
	11-30-84	300 ± 200	EAL
	12-28-84	500 ± 200	EAL
	1-31-85	0 ± 200	EAL

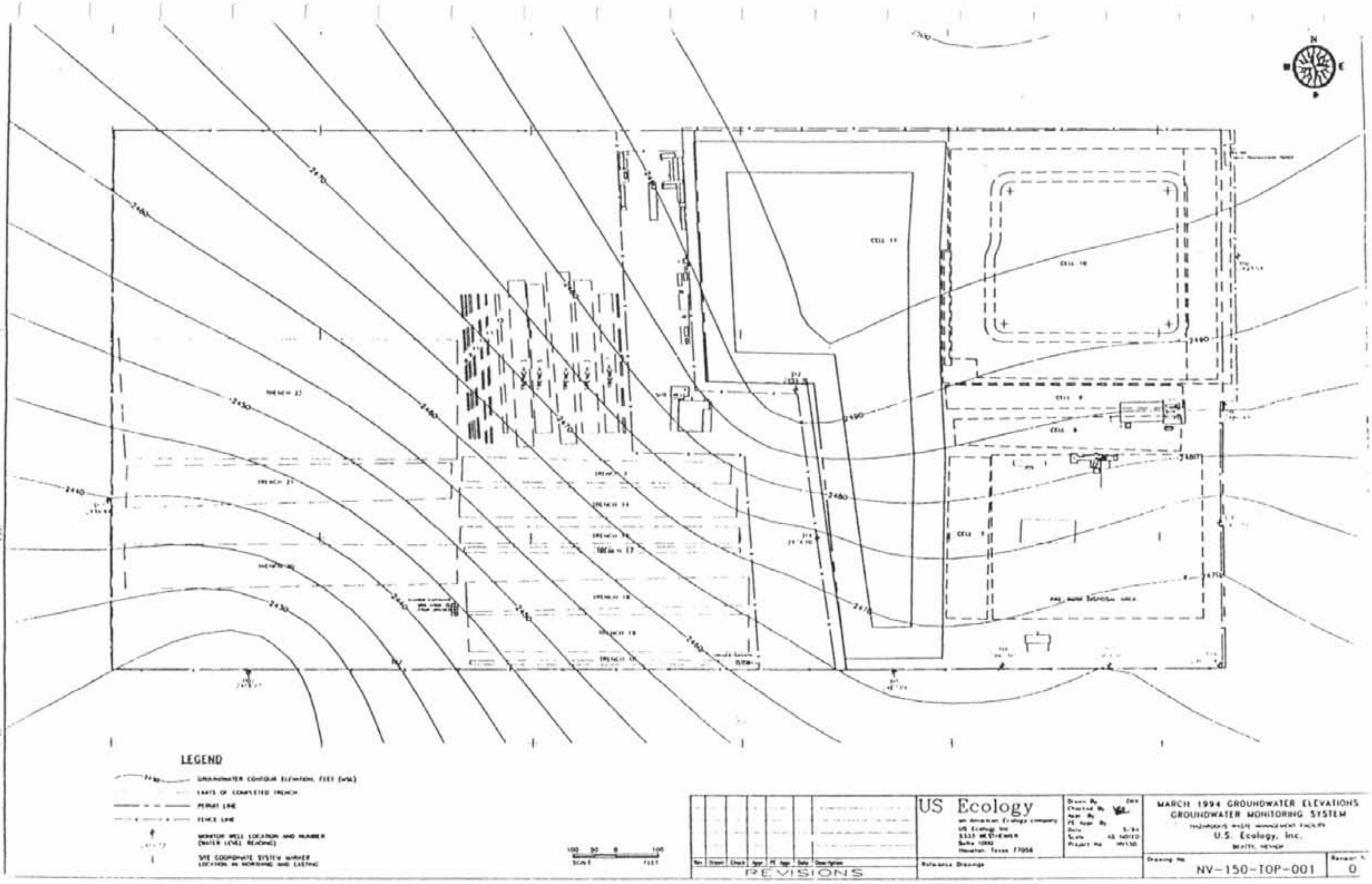
* Samples collected and analyzed by US Ecology contractor. Rest of samples collected by State and analyzed by different agencies or contractors.

Source: Ward Valley Administrative Record, 123-00190 to 123-00191.



Base U.S. Ecology, Inc., 1990

Drawn by David E. Prudic



LEGEND
GROUNDWATER CONTOUR ELEVATION, FEET (MSL)
LIMITS OF COMPLETED TRENCH
PERMIT LINE
FENCE LINE
MONITOR WELL LOCATION AND NUMBER (WATER LEVEL READING)
SITE COORDINATE SYSTEM MARKER LOCATION IN NORTHING AND EASTING
SCALE FEET
REVISIONS
US Ecology
Houston, Texas 77056
Reference Drawings
MARCH 1994 GROUNDWATER ELEVATIONS
GROUNDWATER MONITORING SYSTEM
U.S. Ecology, Inc.
Drawing No
NV-150-TOP-001
0

C4

USGS Discovers Recurrence of Tritium in Beatty Groundwater

Regulators continued to find tritium in groundwater at Beatty from September 1982 through December 1984. Members of the public concerned about the safety of Ward Valley raised questions about these findings. DHS responded to these concerns in August 1993. It claimed, "There was no recurrence."[1]

DHS, however, failed to acknowledge data collected four years earlier by David Prudic of the USGS showing a recurrence of elevated levels of tritium in well water at the site. As with the initial discovery of tritium in groundwater, this finding constituted evidence of rapid migration of contaminants at Beatty. Prudic dismissed his finding as being invalidated by "remnant drilling fluid." If, however, the measurements came from groundwater, there would be direct evidence rejecting the theory that radioactive contaminants move slowly, if at all, in arid environments.

Prudic took measurements from five wells at the site. Four of the wells were either up-gradient of the radioactive waste burial trenches or off to the side of the trenches. Prudic found elevated concentrations of tritium in well water in Well MR-3, the only down-gradient trench he tested. This well is, in fact, only about 200 feet from Well 302, where tritium had been discovered in 1982. Thus, Prudic's measurements were consistent with the earlier discovery of tritium in down-gradient groundwater. Both findings indicate that it took less than 35 years for tritium to migrate from the trenches down more than 350 feet to the aquifer beneath the disposal site.

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[1] DHS, 1993, Summary of Comments From June-August, 1991, Comment Period on Final Environmental Impact Report/Statement and Department Responses to State of California Indemnity Selection and Low-Level Radioactive Waste Facility, p. 27.

Source: Letter from D. Prudic, USGS, to J. Lyou, Committee to Bridge the Gap, dated December 20, 1993.

Table 4.--Data on ground-water quality near low-level radioactive-waste disposal site, Beatty, Nevada for August, 1989 (Continued). Concentrations of dissolved radionuclides.
[Abbreviations are pCi/l = picocuries per liter; ug/l is micrograms per liter; -- means not determined. Except where noted, analyses are by U.S. Geological Survey Laboratory, Arvada, Colorado.

Well Name	Tritium (pci/l)	Gross Alpha (ug/l as Uranium)	Gross Alpha (pCi/l as Uranium)	Gross Beta (piC/l as Strontium-90)	Gross Beta (piC/l as Cesium-137)	Gamma Scan (piC/l) Potassium-40	Gamma Scan (piC/l) Radium-224	Gamma Scan (piC/l) Thorium-2
SUPPLY	1.3 ± 1.9	5.3 ± 0.9	5.8 ± 1.0	15.6 ± 2.2	17.4 ± 2.5	--	2.11 ± 0.51	32.5 ± 3
MW 313	1.3 ± 1.9	7.9 ± 1.2	8.6 ± 1.3	16.8 ± 2.4	18.6 ± 2.7	--	1.05 ± 0.44	14.8 ± 3
MR-3	12.2 ± 1.9[a] 6.4 ± 1.9	9.2 ± 1.3	10.0 ± 1.5	15.3 ± 2.3	17.2 ± 2.5	53.2 ± 7.8	2.83 ± 0.77	45.6 ± 4
MR-3[b]	--	--	--	--	--	--	--	--
MW 315	1.9 ± 1.9	9.6 ± 1.4	10.5 ± 1.5	14.1 ± 2.1	15.7 ± 2.4	--	2.23 ± 0.52	35.4 ± 4
MW 314	2.9 ± 2.6	10.0 ± 1.5	11.0 ± 1.6	13.6 ± 2.2	15.8 ± 2.5	24.0 ± 4.3	3.17 ± 0.63	--
MW 316	2.2 ± 1.9	13.3 ± 1.8	14.6 ± 2.0	17.5 ± 2.5	19.7 ± 2.8	--	1.08 ± 0.46	--

[a] Replicate tritium analyses. Suspect above background tritium concentration is caused by remnant drilling fluid e though more than 2,000 gallons were pumped from well prior to sampling.

[b] Analyses by Nevada State Health Laboratory (Reno, Nevada) of sample collected by Bert Gray, Nevada State Health Department. Dashes mean constituent not determined.

Independent Review Finds Additional Evidence of Groundwater Contamination at Beatty

In October 1994, an independent group of radioactive waste facility regulators released a draft report in which they reviewed the historic monitoring record at Beatty and disposal sites. This appears to be the first undertaking of a long-term perspective of Beatty groundwater monitoring records. The reviewers, known as the Conference of Radiation Control Program Directors (CRCPD), found that groundwater measurements had exceeded action levels repeatedly over a 31-year period. Regulators establish these "action levels" to serve as warning mechanisms that trigger further review and analyses.

Beginning in 1962, US Ecology tested groundwater at the site for evidence of radionuclide migration. Initially, US Ecology tested for "gross alpha" and "gross beta," two different types of radioactivity. In 1979, they added a test for tritium.

Their measurements of gross alpha exceeded the established action levels eight times during the 31-year monitoring period reviewed by the CRCPD. Their measurements of gross beta exceeded action levels seven times during this period. Their measurements of tritium exceeded action levels in 4 of 13 years of monitoring.

These findings represent further evidence that radioactive contaminants have migrated to groundwater at the Beatty facility.

DRAFT

Conference of Radiation Control Program Directors, Inc. Environmental Monitoring Report for Commercial Low-Level Radioactive Waste Disposal Sites

Report prepared by the CRCPD E-5 Committee

Conference of Radiation Control Program Directors, Inc.
205 Capital Avenue
Frankfort, KY 40601

October 1994

Table 4-3. Gross alpha, gross beta, and tritium activity in ground water.

Year	Gross alpha[a] pCi/l	Gross beta[a] pCi/l	Tritium pCi/l
1962	3 ± 2	54 ± 4	no data
1963	no data	no data	no data
1964	8 ± 3	50 ± 26	no data
1965	20 ± 5	60 ± 31	no data
1966	10 ± 5	60 ± 34	no data
1967	10 ± 4	40 ± 28	no data
1968	14 ± 5	52 ± 3	no data
1969	6 ± 3	41 ± 41	no data
1970	39 ± 7	94 ± 30	no data
1971	no data	no data	no data
1972	10 ± 4	9 ± 4	no data
1973	46 ± 7	549 ± 47	no data
1974	16 ± 10	132 ± 77	no data
1975	47 ± 9	173 ± 55	no data
1976	12 ± 5	40 ± 32	no data
1977	< 3	< 30	no data
1978	3 ± 2	< 20	no data
1979	10 ± 5	< 20	3,800 ± 1,100
1980	< 5	10 ± 4	1,700 ± 900
1981	21 ± 7	31 ± 4	0
1982	710 ± 183	340 ± 49	24,000 ± 1,000
1983	140 ± 98	930 ± 150	49,000 ± 29,000
1984	63 ± 29	140 ± 24	5,000 ± 4,000
1985	25 ± 18	26 ± 10	1,100 ± 600
1986	15 ± 9	14 ± 5	< 500
1987	no data	no data	no data
1988	31 ± 11	10 ± 3	< 500
1989	20 ± 14	30 ± 23	1,548 ± 508
1990	78 ± 24	63 ± 11	< 500
1991	10 ± 6	11 ± 5	1,079 ± 551
1992	7 ± 3	13 ± 3	< 500

Action Levels: gross alpha = 30.0 pCi/l; gross beta = 90.0 pCi/l; tritium = 2,000 pCi/l

a. Indicates highest value for each year.

EPA Study Identifies Chemical Contaminants in Beatty Groundwater

US Ecology operates a chemical waste disposal facility adjacent to its radioactive waste disposal facility in Beatty. Monitoring records from the chemical waste dump indicate a wide variety of chemical contaminants in groundwater at the site.[1] The discovery of chemical waste contaminants in well water at Beatty prompted the United States Environmental Protection Agency (EPA) to undertake a review. In 1990, the EPA issued its findings. The author of their report concluded, "Groundwater chemical analysis data from wells 308-316 indicates that groundwater contamination in the upper unit is wide-spread."

The discoveries of tritium in groundwater, the repeated findings of elevated radioactivity in groundwater revealed in the CRCPD report, and the evidence of widespread chemical contaminants in monitoring well water at Beatty combine to establish overwhelming evidence challenging the validity of the theory that contaminants migrate slowly, if at all, at waste facilities in arid environments.

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[1] See, for example, letter from Nancy Alvarez, Nevada Bureau of Waste Management, to Ina Alterman, National Research Council, dated November 3, 1994.

A REVIEW OF ORGANIC CONTAMINANTS IN THE UNSATURATED ZONE AND GROUNDWATER ZONES AT THE BEATTY, NEVADA TSD SITE

Prepared for

U.S. EPA
Region IX

By

Richard L. Johnson, Ph.D.
Department of Environmental Science and Engineering
Oregon Graduate Institute
Beaverton, Oregon 97006

27 September, 1990

A. Introduction

This report examines the possibility of vapor transport as a mechanism for groundwater contamination the U.S. Ecology TSD site at Beatty, Nevada. Vapor and shallow groundwater samples collected from around the site indicate widespread contamination by volatile organic compounds. In addition, groundwater samples from well 307 suggest contamination may be present in the lower water-bearing zone. The two questions to be explored here are: 1) What are the likely mechanisms of transport to the upper water-bearing unit; and 2) What are the mechanisms for contamination of the lower water-bearing unit.

A central issue in the discussions between U.S. EPA (EPA) and U.S. Ecology (USE) is the USE conclusion that:

> "...it now appears even more likely that the 330 foot gravel pack at Well 307 has circumvented the natural isolation of the disposal cells, allowing organic vapors to migrate through both the unsaturated zone and the uppermost saturated deposits. The concentration of these denser vapors in both the well and its gravel pack has resulted in low levels of groundwater contamination of the lower gravel aquifer at Well 307."

It is my conclusion that this statement is either incorrect or only partially correct. Firstly, it is unlikely that dense vapor transport via Well 307 is the mechanism which caused the wide-spread contamination in the upper water-bearing unit. Secondly, the extent of groundwater contamination in the lower water-bearing unit is not well known at this time, thus while Well 307 is likely to have provided a conduit to the lower unit, it may not represent the only available pathway. These conclusions will be discussed in detail in the following sections.

B. The Distribution of Contaminants.

Groundwater chemical analysis data from wells 308-316 indicates that groundwater contamination in the upper unit is wide-spread (Figure 1). This data argues against a single source of contamination (e.g., vapors from well 307) for two reasons:

1) If spreading is by radial flow from a small point source, then a very-large volume would be required to distribute mass over a cylinder which is many tens of feet high and hundreds of feet in diameter. It is unlikely that the Well 307 well bore could be such a source, although it is possible

US Ecology Acknowledges Importance of Beatty to Ward Valley

In November 1994, a year before the new data about offsite migration of contaminants outside the Beatty facility became public, a US Ecology employee wrote an internal memorandum on the CRCPD findings. While the memo dealt directly with inconsistencies in US Ecology's explanation of the CRCPD report of tritium in well water, the author wrote prophetically about the rapid migration of radioactive contaminants at Beatty, and the implications of such a finding on the proposed Ward Valley facility:

> In statements and representations regarding the performance of the Ward Valley site we have relied, in part, on comparison with the Beatty site because it has been studied extensively by USGS and has many characteristics similar to Ward Valley. Any rapid migration of radionuclides at the site abetted by natural site characteristics, would be of significant concern and relevant to the Ward Valley project.

US ECOLOGY, INC.

M E M O R A N D U M

TO: Art Palmer, CRC and SO DATE: November 7, 1994

FROM: Jim Shaffner REF:

SUBJECT: Tritium in Groundwater Monitoring Well's at Beatty CC:

==========

Recently a predecisional draft report entitled Conference of Radiation Control Program Directors, "Environmental Monitoring Report for Commercial Low-Level Radioactive Waste Disposal Sites, October 1994", was distributed to members of a CRCPD working group and others. Page 4-15 (attachment 1) of the report contains the following explanation for elevated tritium concentrations detected a decade ago in a downgradient well at the Beatty, NV facility.

"The most probable hypothetical cause for the presence of tritium in groundwater includes the migration of tritiated water down to the groundwater from disposed waste as either a liquid or vapor (Reference 1)."

While I believe the statement to be incorrect based on the factual evidence presented in the report and other information I've seen, the annotated reference, Beatty Site Environmental Reports 1962-1987, (portions attached) (attachment 2) was prepared and disseminated by one of your predecessors, Mr. Steven R. Adams. Review of the reference document (page 9) suggests a logical source for the quotation in the CRCPD report. However, in an earlier document, a memo to T.A. Semones from Mr. Adams dated December 15, 1988 (attachment 3) on the subject, a completely different, and I believe more accurate, conclusion was drawn from the same factual data.

To add to the confusion, much of the text from Mr. Adam's earlier memo has been lifted verbatim into the 1990 report. Furthermore the text, as I read it, supports the conclusion in the earlier memo rather than the conclusion in the 1990 report. In fact, where the 1988 memo seems to be logical and internally consistent, parallel portions of the 1990 report are not.

Satisfactory resolution of this matter is imperative to the Ward Valley project for two reasons:

1) We have averred to the California Department of Health Services that the tritium levels found in wells at Beatty in the mid 1980's were <u>not</u> as a result of migration either as a liquid or vapor. The fact that tritium was found in groundwater wells at Beatty has been well known for many years. While the exact cause for the sudden occurrence can probably never be definitively established, all evidence and analysis by ourselves, our consultants and USGS, that I am aware of, suggests that the cause was something other than migration. If we have reasons to believe otherwise, I must immediately inform California DHS. If we have reasons to believe that the CRCPD draft report and the US Ecology statement in the 1990 monitoring report are incorrect, I must also inform California DHS of the reasons we believe they are in error.

2) In statements and representations regarding the performance of the Ward Valley site we have relied, in part, on comparison with the Beatty site because it has been studied extensively by USGS and has many characteristics similar to Ward Valley. <u>Any rapid migration of radionuclides at the site abetted by natural site characteristics, would be of significant concern and relevant to the Ward Valley project</u>.

This is a request for you to review the two conflicting reports, attached, in conjunction with available environmental monitoring data and recent pathway analyses in order to clarify this confusing situation.

I await your early reply.

The Attempt to Explain the Findings at Beatty

Two key questions arose from David Prudic's discovery of radioactive contaminants outside the Beatty facility: How did it happen? and is it relevant to Ward Valley? Prudic told the *Los Angeles Times* that he could not explain why Beatty leaked:

> In an interview Monday, Prudic said he was puzzled by the findings and, consequently, slow to reveal them.
>
> "The significance of the Beatty findings is that we don't understand how the tritium moved as far as it did," he said. "Something happened that we are not aware of. . . . Some process that we cannot explain caused significant concentrations to migrate well beyond the area of the waste trenches.
>
> "If we can't understand it at one particular place, it becomes difficult to make predictions about what will happen somewhere else that is similar," Prudic said, adding that the terrain at Beatty and Ward Valley is similar.[1]

Supporters of the proposed Ward Valley facility have offered their own explanation of why Beatty leaked. Elisabeth Brandt of DHS blamed the problem on US Ecology's disposal of liquid waste at Beatty. Brandt said, "The Beatty site had considerably different disposal practices. That may have included pouring of liquid tritium directly onto the ground and allowing the disposal of unpackaged waste."[2]

Regulators first discovered that US Ecology had disposed of liquid waste at Beatty in 1976. This revelation came out of an in-depth review of disposal practices at the Beatty facility after it was discovered that company employees had illegally opened radioactive waste containers, sold and given away their contents, and poured cement from a

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[1] "New Data Clouds (*sic*) Ward Valley Plan," Los Angeles Times, October 31, 1995.

[2] Ibid.

contaminated cement mixer at a neighborhood bar and at the town jail. During the investigation, regulators discovered that US Ecology had also illegally disposed of liquid wastes at the site. This alarmed investigators, who cited US Ecology for violating the prohibition against the disposal of liquid wastes in its operating license.

This is an important point as Prudic, DHS, and US Ecology appear to be relying on "different disposal practices" (i.e., the illegal dumping of liquid wastes) as the distinguishing difference between Beatty and Ward Valley. This explanation must be considered in the context that the same prohibition against liquid waste dumping will exist at Ward Valley. *It was illegal for US Ecology to dispose of liquid wastes at Beatty, just as it would be illegal for them to dispose of liquid wastes at Ward Valley.*

As a result of their investigation, regulators discovered that US Ecology had illegally dumped liquid wastes for at least 10 years. Beginning in or before 1966 and continuing through 1975, US Ecology did not, as required in their license, solidify liquid waste received at the site. In fact, during this time, the liquid waste solidification system was inoperable. US Ecology got away with this practice in part because they had set up piping to make it appear as if liquid wastes were being solidified.

Ward Valley facility proponents contend that the same company that violated its license in a way that caused the Beatty facility to fail should now be trusted to construct and operate an unlined nuclear waste dump less than 20 miles from the Colorado River in a geologically similar site at Ward Valley.

The shortcomings in this logic notwithstanding, the argument that liquid waste disposal resulted in the failure at Beatty rests upon the assumption that enough liquid waste had been dumped to account for the rapid offsite migration of radioactive contaminants. From their investigation, regulators documented that, at minimum, US Ecology appeared to have disposed of approximately 165,000 gallons of liquid waste at Beatty over a 10-year period.

MIKE O'CALLAGHAN
GOVERNOR

ROGER S. TROUNDAY
DIRECTOR

STATE OF NEVADA
DEPARTMENT OF HUMAN RESOURCES
CAPITOL COMPLEX
ROOM 600, KINKEAD BUILDING
505 E. KING STREET
CARSON CITY, NEVADA 89710
TELEPHONE (702) 885-4730

March 31, 1976

DEPARTMENTAL DIVISIONS
AGING SERVICES
CHILD CARE SERVICES
HEALTH
MENTAL HYGIENE-MENTAL RETARDATION
REHABILITATION
WELFARE
YOUTH SERVICES AGENCY

MEMO #91

TO: GOVERNOR MIKE O'CALLAGHAN

ATTN: CHRIS SCHALLER

FROM: ROGER S. TROUNDAY

SUBJECT: PROBLEM AT BEATTY

Yesterday I met with Bob Engelken and representatives from his staff including an attorney from Nuclear Regulatory Commission.

They reported to us that they have had eight residents of Beatty take a whole body count and so far the evaluations have proven to be negative. However, the blood and urine analysis on these individuals have not been completed, but so far it looks good. Their investigation has gone into other states, mainly Washington and California, and they have interviewed several former employees including site managers and the former president. Their investigation has shown that the former president, Mr. Jim Harvey, was involved rather extensively in the exodus of equipment and materials off of the burial site. NRC has signed statements by various individuals stating that he knew about the materials taken off and, in fact, in some instances negotiated the sale of the equipment that was removed.

They are still putting together all of the reports they have from their various investigators, and since this has gotten to be such an involved case, they feel that it will be approximately two weeks before their final report is available to us. I think we should wait for that final report from NRC before we make a final determination on the revocation or renegotiation of the license.

Bruce Arkell, Elmo DeRicco, as well as staff members from the Department of Conservation and Natural Resources, Bill Horton and I met this morning. We feel that as soon as we receive this report from NRC, we will be able to make a determination whether the license should be renegotiated with the same company or revoked and put out to bid for a new contractor.

In addition, some time the latter part of this week, NRC feels they are going to have to turn over some of the information which they have attained to the F.B.I.

They have also found out some additional information about the current operation. One of the most disturbing factors we have found from some of these investigations with former employees, is that liquid waste was being poured directly into the ground at the bottom of the trenches. These employees stated that this occurred from 1967 through 1975. This is in complete violation of the license and does not speak very well for Mr. Neel's operation as well as the former president. While the water table is some 300 feet below the surface in the Beatty area, we still don't know how fast this liquid waste may have penatrated to that water table. We are going to find out additional information about this matter.

This certainly does not add much creditability to the current operation which we thought was much improved over the former management. There are still some concerns about Jim Neel and his management of the NECO operation.

Attached, for your information, is a letter which Bob Engelken has sent to some 1,500 residences in the communities of Beatty, Goldfield, Pahrump and Lathrop Wells. They are still trying to get additional information from residents in that community, and this is another reason why I feel that we should not make any move on that license until we have a complete report from all of the agencies, and I'm sure the last report will come from NRC since they are doing more extensive research. We have found that most of the producers of radioactive waste will have anywhere from 30 to 60 days capacity for storage before a real problem is felt by any of their operations. Therefore, I feel that we do have some time before it gets to be a problem.

ROGER S. TROUNDAY

RST/ls

Attachment

OFFICE OF INSPECTION AND ENFORCEMENT

REGION V

IE Inspection Report No. 76-02

Licensee: Nuclear Engineering Company, Inc. Docket No. 27-10

9200 Shelbyville Road License No. 4-3766-1

Louisville, Kentucky Priority 2

Facility: Land Burial Site Category D

Location: Beatty, Nevada

Type of Facility: Land Burial of Radioactive Material

Type of Inspection: Special

Dates of Inspection: March 9 to April 15, 1976

Dates of Previous Inspection: February 3, 1976

Principal Inspector: F. A. Wenslawski 5/10/76
F. A. Wenslawski Date

Accompanying Inspectors: H. E. Book, for 5/11/76
G. A. Phillip Date

H. S. North Date

Other Individuals Involved: W. C. Horton, State of Nevada
R. S. Trounday, State of Nevada
J. J. Ward, NRC
P. R. Zurakowski, NRC
R. F. Fish, NRC
J. R. Curtis, NRC
R. H. Smith, NRC

Reviewed by: H. E. Book 5/11/76
H. E. Book, Chief, Fuel Facility and Materials Safety Branch Date

065

Enforcement Action

This report describes information gathered during a joint special inspection conducted by the State of Nevada and the U. S. Nuclear Regulatory Commission. In some cases, a particular act or a certain practice by the licensee may result in noncompliance with similar requirements of both the State and the NRC. Listed below are only those matters which appear to be in noncompliance with or deviation from NRC requirements.

A. Matters Involving Only Special Nuclear Material

1. Objects designated for burial as radioactive waste were given or otherwise transferred to unauthorized individuals contrary to 10 CFR 70.42.

2. Contrary to 10 CFR 70.51(b), records were not maintained of the special nuclear material transfers described in Item 1 above.

3. Condition 10 of the license prescribes that the licensee shall not remove solid radioactive wastes from shipping containers except for removal of certain inner containers and sealed sources from shipping casks. Contrary to this requirement, radioactive waste containers scheduled for burial were opened and the contents removed. The items identified in Item 1 above were among those that had been retrieved for salvage purposes as a result of opening the containers.

4. Condition 17.A of the license requires that all waste byproduct, source and special nuclear material shall be disposed of by burial in the soil within six months from the date of receipt by Nuclear Engineering, Company, Inc. Contrary to this requirement, the materials identified in Item 1 above were not buried within six months of the date of receipt by the licensee.

5. Condition 17.E of the license prescribes that the licensee shall not dispose of any uncontained waste byproduct, source and special nuclear material. Contrary to this requirement, waste containers were opened and the uncontained radioactive waste, which included special nuclear material, was dumped directly into the burial trenches in order to salvage the containers (Bennett Buckets and Plywood).

6. Contrary to 10 CFR 20.201(b), radioactive waste materials identified in Item 1 above were released beyond the control of the licensee without performing surveys for alpha radioactivity as necessary to assure compliance with 10 CFR 20.103 and 104, although surveys for beta-gamma radioactivity were reportedly made.

7. Contrary to 10 CFR 20.401(b), records were not maintained of the beta-gamma radiation surveys reportedly made of waste material released beyond the control of the licensee of those materials identified in Item 1 above.

8. Condition 12.A of the license permits burial of packages containing only solid radioactive materials. Contrary to this requirement, packages containing solutions of special nuclear material in double wall containers surrounded by absorbent material were buried.

B. Matters Involving Byproduct Material Occurring Prior to July 1, 1972 When Nevada Became an Agreement State

1. Noncompliance with AEC requirements identical or similar to Items A.1 through A.8 above, except that noncompliance was with Part 30 instead of Part 70 for A.1 and A.2.

2. License Number 4-3766-1 requires that radioactive liquid wastes be solidified using Portland Cement and other materials prior to burial.

   Contrary to this requirement, during the period 1966 to about mid-1972 large quantities of radioactive liquid waste were received by tanker truck at the Beatty site, and were released directly into the burial trench without solidification.

C. Other Enforcement Considerations

All of the items of noncompliance listed above reveal a widespread lack of control by company management over the actions of employees and over the control of radioactive material at the site. There are also indications that company management was aware of improper activities and in some cases was directly involved.

These findings are not final and represent only the results of the Federal investigation to date - June 11, 1976.

On another occasion, Individual P had made a deal at Mare Island wherein the Navy disposed of 5,000 pair of new coveralls in their original boxes and in separate sizes and in two colors, magenta and yellow. He stated that for the most part they were unused and they were not at all contaminated, but they had been sent to the Beatty site by the Navy in a truck on which a radioactive placard had been hung in order to dispose of them. When these were received at the site, Individual I stated that he stored them in a shed which was full of them - there were approximately 150 to 200 pairs in a box. He had subsequently sent some of these coveralls around to all the different sites for use as Nuclear Engineering coveralls.

In regard to plywood, Individual I stated that often the boxes arriving at the site would be coming apart on their own. When placed on the edge of the trench they would fall apart. He stated that for example when San Jose was being torn down, they knew that there was only a low uranium contamination involved and the boxes from that shipment were saved and the wood was used for various projects. Individual I stated that where this material could be of some use to his employees on a special project they were allowed to use it. He stated that Individual P told him when he first arrived at Beatty that he needn't worry about his constructing a stable for his horses since he was free to use the lumber and plywood that was stored at the Beatty site which had been taken from the various boxes that had come in for disposal.

A signed statement was obtained from Individual I, a typed transcript of which is attached to this report as Exhibit #9.

23. Second Interview With Individual B on March 25, 1976

On March 25, 1976 NRC representatives interviewed Individual B. During this interview, Individual B corroborated the information provided by Individual G concerning the dumping of liquid radioactive waste into the burial trench at the Beatty facility. He stated that from the beginning of his employment in June 1966 until the Spring of 1975, the Beatty facility had no means of solidifying liquid radioactive waste received at the facility. He said there had been a cement mixer on the site which was apparently intended to be used for

this purpose and some piping had been rigged up to make it appear that a solidification system was operational. The mixer, however, was never in operating condition to his knowledge.

Individual B stated that a 2600 gallon tank was used by NECO to pick up liquid radioactive waste from various customers. When the loaded tank arrived onsite it was taken to the trench and the liquid was drained from it.

Individual B stated that in his opinion corporate management, specifically Individual P, had to be aware that liquid radioactive waste was being disposed of in this manner.

A statement in this regard was obtained from Individual B, a typed transcript of which is attached to this report as Exhibit #10.

At the conclusion of this interview, Individual B also advised that during a visit to the NECO Richland, Washington facility about five years ago, he participated in the dumping of unsolifified liquid radioactive waste received from Jersey Nuclear into a burial trench at that facility. (NOTE: Follow-up of this allegation at the Richland facility disclosed that the disposal occurred under the jurisdiction of the State of Washington license and with the prior knowledge and approval of the State.)

24. Third Interview With Individual A on March 25, 1976

On March 25, 1976, Individual A was interviewed by an NRC representative. During this interview, Individual A corroborated the information provided by Individuals B and G concerning the handling of radioactive waste at the Beatty facility prior to the installation of an operating liquid radioactive waste solidification system in the Spring of 1975. A signed statement in this regard was obtained from Individual A, a typed transcript of which is attached to this report as Exhibit #11. (NOTE: On April 12, 1976 a letter was received from Individual A amending his March 25 signed statement. A typed transcript of this letter is attached to this report as Exhibit #12.)

V. E. Liquid Waste Handling Practices at Beatty Facility

1. Condition 17 of License No. 04-3766-01 incorporates the licensee's procedures and specifies conditions for processing and disposal of radioactive waste received in liquid form. Large quantities of low level liquid wastes have been transported to the Beatty site in a NECO tanker truck authorized by a Special Department of Transportation permit. The license requires that these liquids be solidified using Portland Cement and other materials prior to burial.

2. During the course of the overall investigative effort, Individual G disclosed that in the past, liquid wastes received at the Beatty facility were disposed of directly into the burial trench without solidification. During followup investigation of this particular matter, employees A and B and former employees G and I made signed statements to the effect that during the period 1966 to 1975 the solidification system was not operable, and liquid waste from the tanker was released directly to the burial trench without solidification as required by the license. Copies of those statements are included as Exhibits 11, 10, 9 and 7, respectively, to this report. Exhibit 12 is a letter received from Individual A amending his statement in Exhibit 11.

3. Examination of records of liquid waste received by NECO at Beatty revealed the following:

Calendar Year	Gallons Received	Total Activity mCi	Principal Isotopes
1966	27,700	1178	Mixed Fission Products (MFP)
1967	11,800	175	MFP
1968	20,900	84	MFP
1969	13,100	734	Sr-90, Co-60, C-14, H-3, Cs-137, P-32, MFP
1970	5,200	94	MFP
1971	2,400	600	Co-60, Cs-137, Mn-54
1972	3,300	694	H-3
1973	No Record of Receipts for 1973 were reviewed. However, NECO management stated that a few thousand gallons were received.		
1974	13,565	233	H-3, Co-58, Co-60, Mn-54
1975	100,296	17625	H-3, Co-58, Co-60, Mn-54, Cs-137, Cr-51

4. License No. 04-3766-01 also authorizes transportation and solidification of liquid waste received in DOT approved double wall containers surrounded by absorbent material. However, Condition 12 limits burial of packages to those containing only solid materials and limits opening and solidification of liquids received in packages to those which do not exceed a radioactive concentration of 10^{-1} microcuries per milliliter. Individual I stated that in some cases packages of liquid waste received in double wall containers surrounded by absorbent were opened and liquid was dumped directly into the trench, and in some cases the liquid was solidified. In addition, Individuals A and C stated to the inspectors that normally these double wall packages containing liquid were placed in the trench as received, without solidification or other processing.

5. Examination of records of liquid waste received by NECO at Beatty revealed that numerous shipments of this type were received each year. Examples of typical shipments of this type are as follows:

Date Received	Gallons Received	Total Activity mCi	Principal Isotopes
7-22-66	19	4.83 grams	U-235
2-23-66	10	8	C-14
3-29-67	4	11	P-32, H-3, C-14
12-11-67	1	15	H-3
6-19-68	9	82.6	P-32, H-3, C-14
8-8-68	57	"Negligible"	U-235
3-17-69	60	1306	C-14, I-131, P-32, I-125, Cr-51, Fe-59
10-29-70	10	8	C-14, H-3
12-29-70	5	.011	U-235
7-28-71	5	4.68 curies	H-3
7-22-72	330	3.5 curies	H-3
5-9-73	30	1212	H-3, C-14
5-29-75	36	161.5	H-3, C-14, I-125, P-32, Na-22, Cd-36, Ca-45
7-8-75	72	56.8	H-3, C-14, I-125, Na-22, P-32, Cr-51

STATEMENT OF INDIVIDUAL B

I, Individual B, make the following statement freely and voluntarily to G. A. Phillip who has identified himself to me as an Investigator, Office of Inspection and Enforcement, U. S. Nuclear Regulatory Commission. I have been advised by Mr. Phillip that I do not have to make a statement and that any statement I do make may later be used in a court of law.

From at least the beginning of my employment at the NECO Beatty facility in June 1966 until the installation of a solidification facility in about March or April 1975, all liquid radioactive waste received at the Beatty facility was dumped into the trench as liquid. Although there was a mixer on the site, it was inoperable and therefore there was no means of solidifying the liquid wastes for burial.

All of the individuals who served as site managers at the Beatty facility were aware of this situation, and it is my opinion that NECO corporate management had to be aware that radioactive liquid wastes were being received and that there was no means of solidifying it before it was buried.

I have read the above statement and it is ture and correct to the best of my knowledge and belief.

Individual B
Signed March 25, 1976

Exhibit #10

LETTER SENT BY INDIVIDUAL A

Dear Mr. Phillip:

On March 25th 1976 I was requested by you and Mr. H. Book of NRC Region #V to sign a statement concerning the disposition of Rad. Waste Liquid received at our site.

Since then I keep thinking I've given you some misleading information.

As stated it is true that there were no liquids solidified from the time I hired in June 2, 1969 until the present Solidification system was put into operation.

I don't think at that time I informed you that we had stored in the neighborhood of 38,000 gal. of Rad. Liquid in storage tank. This liquid was solidified when the system went into operation. This storage was started in mid 1973.

I think that you and my company should know this.

Please accept this letter as being written on my own free will and as my suggestion.

If you have any questions concerning this, please feel free to call me, or call on me.

Sincerely,

Signed Individual A

cc: File
Site Mgr.
Individual D
H. Book, NRC Region V
Individual O

Exhibit #12

Liquid Waste Received at the Beatty, Nevada, Radioactive Waste Facility*

Year	Amount (gallons)	
1966	27,700	
1967	11,800	
1968	20,900	
1969	13,100	
1970	5,200	
1971	2,400	
1972	3,300	
1973	5,000	- approximation
1974	13,565	
1975	100,296	
	203,261	subtotal
	38,000	in storage tank
	165,261	total

* Source: United States Nuclear Regulatory Commission Inspection Report, dated May 1976.

US Ecology May Have Illegally Disposed of 700,000 Gallons of Liquid Waste at Its Beatty, Nevada, Radioactive Waste Disposal Facility

According to a 1973 letter from an official with the State of Nevada, the investigation report estimate of about 165,000 gallons of liquid waste illegally disposed of at Beatty appears to have been an underestimate. Information in the letter, when combined with data disclosed in the 1976 inspection report, suggests that US Ecology may have illegally disposed of approximately 600,000 gallons of liquid waste at Beatty over a 14-year period, or roughly 43,000 gallons per year. It is conceivable that there could have been an additional 100,000 gallons of liquid waste disposed of by US Ecology, for a maximum of 700,000 gallons, or about 50,000 gallons per year.

This assumes that US Ecology began its illegal liquid waste disposal as soon as it opened the Beatty facility in 1962. During their 1976 inspection, a former US Ecology employee told regulators that liquid waste dumping had occurred at least since he had started working there in 1966. The exact commencement date of the illegal dumping practices does not appear to have been firmly established. If liquid wastes were first dumped in 1966 instead of 1962, the records indicate that approximately 270,000 gallons of liquid waste were illegally disposed of during a 10-year period, or about 27,000 gallons per year.

Thus, it appears that US Ecology illegally disposed of between 270,000 and 600,000 gallons of liquid waste at its Beatty disposal site.

Liquid Waste Disposal at Beatty, Nevada, Radioactive Waste Facility, 1962-1975 (in Gallons)*

Year	Unclassified	Federal & Military	Hospitals & Medical	States & Universities	Industrial & Research	Total
1962	2,800	5,500	128	535	119,700	128,662
1963	3,600	18,066	138	440	111,709	133,953
1964		1,121			35,846	36,967
1965		11,248			15,926	27,174
1966		25,018		421	26,590	52,030
1967		9,392		231	2,806	12,429
1968		1,018	863	4,971	25,473	32,325
1969		967	698	14,568	6,920	23,152
1970			710	2,024	5,056	7,791
1971		130	612	3,662	15,022	19,426
1972						3,300
1973						5,000
1974						13,565
1975						100,296
Total	6,400	72,460	3,148	26,852	365,049	596,070

* Source (1962-1971): Letter from Wendell D. McCurry, Nevada Bureau of Environmental Health, to Lon Meyers, U.S. Environmental Protection Agency, dated April 23, 1973. Figures rounded to the nearest gallon. Source (1972-1975): U.S. Nuclear Regulatory Commission Inspection Report, dated May 1976. Reported figure for 1973 is an approximation. Site managers reported that they had received "a few thousand gallons" in 1973. An unidentified additional amount of liquid wastes appears to be excluded from these totals. The authors of the NRC report indicate that "numerous shipments" of this waste was shipped to Beatty each year. Examples cited in the report suggest the average shipment was about 50 gallons.

April 23, 1973

Lon Meyers
Office Radiation Programs
Environmental Protection Agency
Parklawn Building, Room 1875
5600 Fishers Lane
Rockville, Maryland 20852

Dear Mr. Meyers:

Please find enclosed a tabulation of material buried at Beatty Burial Site. This supercedes the partial listing submitted in January. The specific breakdown is as far as one can go without the aid of computer.

The tabulation is divided into five categories by type of customer, i.e., Federal and Military, Hospitals and Medical, States and Universities Industrial and Research, and Unclassified-Neco. The last category may involve some duplication, since this involved material which was stockpiled in California in the earlier days of operation and in some instances may have been listed twice.

Two types of tables are included. One shows quantities buried by six month and year intervals and the other shows quantities buried by 12 month intervals and total for each category.

If a tabulation is desired for dates after 1971, we could provide one with minimum of additional manhours.

Sincerely,

Wendell D. McCurry, Assistant Chief
Bureau of Environmental Health

WDMc/pr

Enclosures

cc: Mike O'Connell
Bob Hensyel

STOMER -- UNCLASSIFIED - NECO - (Possibly some duplication)

Date Rec'd.	Curie Solid	Curie Liquid	Curie Gas	SNM Grams	SNM Lbs.	Volume Cu. Ft.	Gallons
1962	290.120320			3.56	14.29	23511.05	
1962		.045500	40.000000				2800.00
1963	15.730670			1687.78	399.30	49186.34	
1964	1.851680				8.00	15396.40	
1964		.190000					3600.00
1965	1.087380					16219.50	
TOTAL	308.790050	.235500	40.000000	1691.34	421.59	1,04313.29	6400.00
CUSTOMER -- FEDERAL AND MILITARY							
1962	.317820					755.00	
1962		.007710					5500.00
1963	19.188403					6875.11	
1963		.218429					18066.00
1964	5.178199			3.00	369.60	1457.17	
1964		.073141					1121.00
1965	40.819312			.19	423.11	11083.62	
1965		3.050506					11248.00
1966	501.277393			78.00		17087.80	
1966		1.074159					25018.00
1967	156.371992				20.00	17183.30	
1967		.198181					9392.00
1968	30.577247				3.10	9994.95	
1968		.016032					1018.00
1969	1168.654461					17083.60	
1969		.002485					966.75
1970	578.859397			8.31	8.00	17230.80	
1971	137.288456			1.00		24916.03	
1971		.040150					130.50
TOTAL	2639.032680	4.680793		90.50	457.90	123667.38	72460.25

CUSTOMER -- FEDERAL AND MILITARY

Date Rec'd.	Solid	Liquid	Gas	SNM Grams	Lbs.	Volume cu. ft.	Gallons
CUSTOMER - HOSPITALS AND MEDICAL							
1963	8.005394						
1963		27.527500			.84	1399.20	
1964	.684371						127.50
1964		3.489278				501.30	
1965	.086670						138.00
1966	.017880					82.90	
1967	.003482					126.90	
1968	66.442416					31.50	
1968		.225027		.02	.07	1576.85	
1969	11.543636						863.00
1969		1.642633				2507.70	
1970	12.844891						697.50
1970		.364458				2302.10	
1971	8.348682						710.00
1971		.495358				1976.52	
							612.00
TOTAL	107.977422	33.744254		.02	.91	10507.97	3148.00
CUSTOMER - STATES AND UNIVERSITIES							
1963	1.124829						
1963		1.044422				1100.58	
1964	2.055870						535.00
1964		.402487		.05	17.90	1820.40	
1965	6.233221						440.00
1966	1.834217				97.00	777.45	
1966		.046649				522.00	
1967	18.685580						421.00
1967		.992479				1867.40	
1968	7.952561						231.00
1968		2.651821				5452.56	
1969	77.751452						4971.00
1969		2.178509				5963.95	
1970	54.612811						14568.00
1970		2.036933				6166.52	
1971	29.442080				.02		2024.38
1971		8.641166				9663.39	
							3662.00
TOTAL	199.692621	17.994466		.05	114.92	33334.25	26852.38

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CUSTOMER -- INDUSTRIAL -- RESEARCH

Date Rec'd.	Solid	Liquid	Gas	SNM Grams	Lbs.	Volume Cu. Ft.	Gallons
1960	.027570			10.10		2319.44	
1961	.030330			183.87		3726.10	
1962	12.466226			121.07	639.65	35393.78	
1962		5.158477		.16			119700.00
1963	5583.076561			39616.40	642.12	65457.01	
1963		34.569613			.02		111709.00
1964	6458.008452			171883.50	335.26	80976.41	
1964		5.143984		143.61			35846.00
1964			.020000				
1965	6233.543149					42034.46	
1965		1.612688		229.94			15926.00
1965			91.300000		-	2.50	
1966	10817.111286			5789.32	292.89	107044.62	
1966		2.643471		4.83			26590.50
1966			651.000000				
1967	9950.462945			22643.68	543.23	94147.74	
1967		.555198			200.00		2806.00
1967			766.000000				
1968	6492.019369			8601.76	2296.10	109244.93	
1968		8.495851			.01		25473.00
1968			200.000000			6.00	5.10
1969	8501.478477			5004.76	639.57	125649.09	
1969		2.004743					6920.00
1970	11729.824534			7699.98	703.01	121133.65	
1970		3.068523					5056.50
1971	4124.121781			755.65	.66	158785.96	
1971		7.536826					15021.75
TOTAL	69902.170680	70.789174	1708.320000	262688.63	6292.52	945921.69	365048.75

US Ecology Liquid Waste Dumping at Beatty Put Into Perspective

Based on available records, the annual volume of liquid waste dumped by US Ecology at Beatty can be estimated to range from an average of 27,000 gallons per year for 10 years to an average of 50,000 gallons per year for 14 years.

The significance of this amount of liquid waste can be put into perspective by comparing the averages and totals with the amount of water falling on the Beatty trenches from rainfall. Doing this, we find that the amount of liquid waste dumped at Beatty is insignificant when compared to the amount of water falling on the trenches from rainfall alone.

As shown in the following table, nearly 2 million gallons of water from rainfall falls on the Beatty trenches during a typical year. This amount of rain dwarfs the 27,000 to 50,000 gallon per year estimate of liquid waste dumping based on official records.

The conclusion is clear: *Liquid waste dumping could have had only an insignificant impact on the migration of radioactive wastes at Beatty.*

Annual Precipitation at Beatty, Nevada, Radioactive Waste Disposal Facility*

Trench No.	Width (feet)	Length (feet)	Area (Sq. Ft.)	Annual Volume of Precipitation (gallons)
1	31	350	10,850	30,369
2	40	350	14,000	39,185
3	40	350	14,000	39,185
4	40	350	14,000	39,185
5	40	350	14,000	39,185
6	4	350	1,400	3,919
7	40	650	26,000	72,773
8	4	350	1,400	3,919
9	4	350	1,400	3,919
10	35	650	22,750	63,676
11	4	350	1,400	3,919
12	4	350	1,400	3,919
13	4	350	1,400	3,919
14	75	650	48,750	136,449
15	10	350	3,500	9,796
16	75	650	48,750	136,449
17	10	650	6,500	18,193
18	10	650	6,500	18,193
19	91	670	60,970	170,653
20	112	790	88,480	247,652
21	102	770	78,540	219,830
22	298	810	241,380	675,613
		Total:	707,370	1,979,901

* These calculations are based on an annual precipitation rate of 4.49 inches per year as measured in Beatty, Nevada, and reported in USGS Water-Supply Paper 2312. The trench dimensions are based on information supplied by David Prudic of USGS.

Nearly 37 Million Gallons of Rain Has Fallen In or On Beatty Trenches

Supporters of the proposed Ward Valley radioactive waste disposal facility claim that the Beatty facility leaked because US Ecology dumped liquid wastes at the site. This, they say, distinguishes Beatty from Ward Valley because liquid waste disposal will not be allowed at Ward Valley. (They do not, however, mention that liquid waste disposal was also banned at Beatty.) If we assume that US Ecology will not dispose of liquid wastes at Ward Valley, then it is necessary to assess whether liquid waste disposal at Beatty was indeed responsible for radioactive contaminants moving offsite at the facility.

One way to undertake this assessment is to calculate the amount of rainwater that fell into and onto the trenches at Beatty prior to the discovery of radioactive contaminants outside the facility. This calculation can be made using data about the area of each trench, the date each trench was opened, and the average annual precipitation rate at Beatty. As shown on the following page, nearly 37 million gallons of water has fallen into or onto the trenches at Beatty between the time each trench opened and the first measurements for contaminants in the soil outside the facility in April 1994. The table on the following page also shows that nearly 11 million gallons of rain fell into the trenches while they were open.

At maximum, US Ecology dumped about 700,000 gallons of liquid waste at Beatty. This pales in comparison to the nearly 37 million gallons of rain that fell into or onto the trenches prior to the discovery of radioactive contaminants outside the facility. It also pales in comparison to the nearly 11 million gallons of rain that fell into the trenches while they were open. Liquid waste dumping, therefore, could have, at most, played an insignificant role in the rapid migration of radioactive contaminants at Beatty. When compared to rainfall, there just wasn't enough liquid waste dumped at Beatty to make any real difference in the migration of waste at the site.

Precipitation In and On Waste Disposal Trenches at Beatty, Nevada, Radioactive Waste Disposal Facility, Sept. 1962 - April 1994*

Trench No.	Width (feet)	Length (feet)	Area (Sq. Ft.)	Date Opened	Date Closed	Time Opened (Months)	Vol. of Precip While Opened (inches)	Vol. of Precip While Opened (gallons)	Time Between Trench Closure and Prudic Measurements (Years)	Vol. of Precip After Trench Closure (gallons)	Total Vol. of Precip In and On Trenches (gallons)
1	31	350	10,850	Sept. 1962	Jan. 1963	4	1.50	10,123	31.2	949,023	959,146
2	40	350	14,000	Jan. 1963	Sept. 1963	8	2.99	26,124	30.6	1,198,422	1,224,545
3	40	350	14,000	Oct. 1963	Aug. 1964	10	3.74	32,655	29.7	1,162,502	1,195,156
4	40	350	14,000	Sept. 1964	June 1965	9	3.37	29,389	28.8	1,129,847	1,159,236
5	40	350	14,000	June 1965	Feb. 1966	8	2.99	26,124	28.2	1,103,724	1,129,847
6	4	350	1,400	July 1965	July 1966	11	4.12	3,592	27.8	108,740	112,332
7	40	650	26,000	Jan. 1966	Sept. 1967	20	7.48	121,288	26.6	1,934,549	2,055,837
8	4	350	1,400	July 1966	Oct. 1966	3	1.12	980	27.5	107,760	108,740
9	4	350	1,400	Mar. 1967	May 1968	14	5.24	4,572	25.9	101,556	106,127
10	35	650	22,750	Aug. 1967	Jan. 1970	29	10.85	153,885	24.2	1,544,152	1,698,036
11	4	350	1,400	May 1968	Dec. 1968	7	2.62	2,286	25.3	99,270	101,556
12	4	350	1,400	Dec. 1968	June 1969	6	2.24	1,959	24.8	97,311	99,270
13	4	350	1,400	June 1969	Nov. 1969	5	1.87	1,633	24.4	95,678	97,311
14	75	650	48,750	Dec. 1969	May 1973	41	15.34	466,202	20.9	2,854,066	3,320,268
15	10	350	3,500	Dec. 1969	Jan. 1971	13	4.86	10,613	23.2	227,765	238,378
16	75	650	48,750	Jan. 1972	Sept. 1974	31	11.60	352,494	19.6	2,672,133	3,024,627
17	10	650	6,500	June 1972	Jan. 1973	7	2.62	10,613	21.2	386,606	397,219
18	10	650	6,500	Jan. 1973	Dec. 1973	11	4.12	16,677	20.3	369,929	386,606
19	91	670	60,970	Apr. 1974	Jan. 1979	57	21.33	810,600	15.2	2,602,453	3,413,053
20	112	790	88,480	Feb. 1977	Sept. 1979	31	11.60	639,768	14.6	3,611,593	4,251,361
21	102	770	78,540	Sept. 1979	Apr. 1982	30	11.22	549,576	12.0	2,637,965	3,187,541
22	298	810	241,380	July 1981	Dec. 1992	137	51.26	7,713,251	1.3	900,818	8,614,069
		Total:	707,370			492	184	10,984,401	504	25,895,859	36,880,261

* These calculations are based on annual precipitation rate of 4.49 inches per year as measured in Beatty, Nevada, and reported in USGS Water-Supply Paper 2312. The trench dimensions are based on information supplied by David Prudic of USGS.

US Ecology Contractor Agrees That Rainfall Is More Likely Than Liquid Wastes to Account for Radionuclide Transport at Beatty

US Ecology has hired contractors to assist in its efforts to gain approval for the proposed Ward Valley radioactive waste facility. Grant Environmental has been one of US Ecology's key contractors pushing for approval of the Ward Valley project. James L. Grant, who heads Grant Environmental, was among those at the NAS panel meeting at which David Prudic disclosed that high levels of tritium had been found in groundwater at the site between 1982 and 1984. In response to this disclosure, US Ecology asked Grant Environmental to evaluate and explain the discovery of tritium in groundwater at Beatty.

Working under the same assumptions used to claim that the Ward Valley facility would not leak, Grant concluded that "tens of thousands of years would be required for liquid or dissolved waste constituents to move from the trench through the unsaturated zone to the ground water [at Beatty]." He added:

> The amount of water that would be required to move radionuclides from the trenches to the ground water far exceeds the amount that can be derived even from abnormally large rainfalls in the area. Likewise, the dry soils would quickly soak up any liquids that might leak from the waste. *Given the properties of the waste that has been disposed at the Beatty facility, migration of the small amounts of liquid that might be in the waste is even more improbable than transport by infiltrating rainwater.*
>
> (emphasis added)

Grant refused to accept that radionuclides could migrate at Beatty. He wrote that tritium in groundwater at the site likely had been "introduced into the well directly" (*i.e.*, by sabotage). He ended his letter with a conclusion that would soon be directly contradicted by the findings at Beatty. Grant wrote, "In summary, all of the information that has been gathered at the site indicates that waste migration through the unsaturated zone beneath the Beatty facility has not occurred."

GRANT
ENVIRONMENTAL

December 14, 1994

Mr. James A. Shaffner
US Ecology, Inc.
3855 Atherton Road, Suite 5
Rocklin, California 95765

Re: Evaluation of Tritium in Beatty, Nevada Monitoring Well, 1982 - 1983
JLGA Project No 883763

Dear Mr. Shaffner:

At your request, I have reviewed the information describing the detection of tritium in site monitoring well 302 in 1982. As a part of the review, I identified various mechanisms that might have allowed the tritium to reach the well, and evaluated the likelihood of these mechanisms in light of the current knowledge of the geology and hydrology of the site.

Since it was established as a low-level radioactive waste disposal site in 1962, the site has been the subject of numerous studies. Of particular note are the studies by the USGS that began in 1976, and studies by US Ecology that began shortly thereafter. The purpose of these studies is to characterize various aspects of the site and the surrounding environment. The ability of the site to sequester the radioactive waste materials is the focus of these studies.

In 1988, James L. Grant & Associates, Inc. completed an analysis of the potential movement of radionuclides through the unsaturated zone into the ground water. That analysis was based upon the site information that was available then, including geologic and hydrologic information collected for US Ecology by the Mark Group. We revised the analysis in 1993. At that time, we updated the geologic and hydrologic characterizations to incorporate data collected by US Ecology and the USGS since 1988, and revised the waste inventory to conform to the inventory when the site was closed in December, 1992.

Our analyses considered all possible ways that waste constituents might move from the trench into the environment. We concluded that movement from the trenches is unlikely so long as the area climate remains as it is now. Our analyses suggested that there is little water available in the subsurface that might dissolve and transport the waste constituents. Conservative assumptions indicated that, if such movement does occur, it is extremely slow and tens of thousands of years would be required for liquid or dissolved waste constituents to move from the trench through the unsaturated zone to the ground water.

In addition to characterizing the liquid pathway at the site, we considered the possibility of diffusive movement of gaseous radionuclides such as tritium through the unsaturated zone. We found such movement is credible, but the slow rate of diffusion and the limited amount of radionuclides that might diffuse from the trench prevent diffusion from being an important mode of waste constituent movement at the Beatty site.

The arid climate and the resulting unsaturated zone separating the waste and the ground water are the features that make the site so effective in isolating the buried waste. Because of the arid climate, the 300 feet or so of soil above the water table at the site is extremely dry. A very large amount of water would have to be added to the site soils before the soils would allow significant water flow. The amount of water that would be required to move radionuclides from the trenches to the ground water far exceeds the amount that can be derived even from abnormally large rainfalls in the area. Likewise, the dry soils

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would quickly soak up any liquids that might leak from the waste. Given the properties of the waste that has been disposed at the Beatty facility, migration of the small amounts of liquid that might be in the waste is even more improbable than transport by infiltrating rainwater.

Since the tritium was discovered in the well, several hypotheses have been advanced to explain the finding. In my opinion, the most credible explanation is that the tritium was introduced into the well directly. The observations of the occurrence and subsequent behavior of the tritium are consistent with this hypothesis. Another possible explanation of the finding is that tritiated rainwater somehow ponded around the well casing during a large rain, and moved into the well along the discontinuity between the well casing and the soil. This explanation is credible provided that such ponding around the well does occur, and provided that water that ponds around the well is tritiated. To my knowledge, neither precedent has been observed, and so this explanation must be considered unlikely.

In summary, all of the information that has been gathered at the site indicates that waste migration through the unsaturated zone beneath the Beatty facility has not occurred. The multiple lines of evidence that support this conclusion simply are too strong to admit an hypothesis that such migration might occur in amounts sufficient to be detectable in the ground water. Consequently, the presence of the tritium in the well must result from some phenomenon other than transport by percolation through the unsaturated zone.

I appreciate the opportunity to submit my evaluation of this occurrence. If you have any questions about this letter, or if I can provide any additional information regarding the tritium, please contact me.

Very truly yours,
Grant Environmental

James L. Grant
President

JLG:hs

cc: Art Palmer, CRC & SO, US Ecology

Theory, Data, and an Explanation of the Findings at Beatty

Good science demands that, given theories contradicted by data, one must amend or jettison those theories. In science, data win over theory every time. At Beatty, supporters of the Ward Valley radioactive waste facility are faced with an extraordinary wealth of data contradicting their theory that radioactive waste moves slowly, if at all, in arid environments.

What's wrong with their theory? They assume that waste migration only occurs in what is referred to as a "piston-flow" scenario (*i.e.*, that there are no preferential pathways, or "fast paths" for migration). In their theory, sediments at an arid disposal site must be either saturated (*i.e.*, all the air space filled with water) or nearly saturated before contaminants can migrate. In addition, they believe that contaminants do not migrate laterally along subsurface layers of sediments with low-permeability. The data from studies at Beatty have invalidated all of these theories. The sediments have not been saturated and radioactive contaminants have migrated laterally at least 500 feet outside the southwest corner of the facility and 357 feet vertically down to just above the groundwater table, in periods of time far faster than their models had claimed possible.

How did this happen? Dr. Howard Wilshire, the former USGS scientist who was fired after he criticized the proposed Ward Valley facility, predicted that radioactive contaminants could migrate at Ward Valley just as they did at Beatty. Wilshire and his colleagues explained that preferential pathways must be considered in such an analysis. They also predicted that contaminants could migrate laterally along subsurface layers of low-permeable sediments.

If Wilshire's concerns about the proposed Ward Valley radioactive waste facility were correct, and the data at Beatty suggest that they were, then his warnings about the potential contamination of the Colorado River must be heeded. To do otherwise would be dangerous and naive.

DESCRIPTION OF EARTH-SCIENCE CONCERNS REGARDING THE WARD VALLEY LOW-LEVEL RADIOACTIVE WASTE SITE PLAN AND EVALUATION

by

Howard G. Wilshire, Keith A. Howard, and David M. Miller

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[1]This report does not represent the policies or positions of any government agency. It does represent the professional judgements of its authors who are employed by the U.S. Geological Survey as research geologists. The report has been reviewed by professional scientists in geology, hydrology, isotope geochemistry, and soil physics, and has been modified by consultation with many experts in these fields within and outside of the USGS.

EXECUTIVE SUMMARY

This report documents and assesses seven concerns that we expressed in a memorandum, dated June 2, 1993, addressed to the Secretary of the Interior, but does not represent the policies or positions of any government agency. The report has been thoroughly reviewed by experts in many earth-science specialties. There is a broad consensus that the significant concerns we expressed in our June 2 memorandum are valid, and that the Ward Valley site has not been demonstrated to be safe for the proposed use. Because of the very long period of continued hazard, it is our view that the very best science available should be brought to bear to resolve the scientific problems or to seek other solutions for waste disposal.

Although critics charge that the issues we raised are not new and that they were addressed by the various evaluation documents (License Application, EIR/S, and SEIS), we conclude from examination of all of these documents that the three major issues were either not addressed, or are unsupported or inadequately supported by data, and that the data collected were not analyzed conservatively. Two of our four secondary concerns merit further study.

We confirm our initial concerns and identify additional issues related to them:

1. The potential for shallow lateral flow of water downslope into the waste trenches and from the trenches was not addressed in any of the site evaluation documents.

    - Available data show that shallow low-permeability layers in the alluvial fan slope beneath the site and toward the main valley drainage (Homer Wash). These could promote lateral flow, leading to excess water leaking into the trenches and migration of contaminants from the trenches to Homer Wash. Once in Homer Wash, these contaminants could be redistributed into the general environment by wind and water erosion much faster than by percolation to the water table.

2. Evaluation of possible transfer of contaminants to ground water was inadequate.

    - Data presented in the site evaluation documents show that sediments at the site are highly complex and have widely variable properties. It is our opinion that the properties measured and used in modeling water migration in the zone above the water table do not adequately represent the variability and complexity of the materials present.
    - No consideration was given to rapid migration of water along preferred pathways, a subject widely dealt with in current scientific literature.
    - The finding of measurable tritium in deep soils on the site indicates vertical transport at rates much faster than presumed in the evaluation documents, and, by conservative estimate, could have reached a level close to the water table in 60 years.
    - Electrical sounding data indicate higher moisture contents below nearby Homer Wash and the possibility for recharge of ground water from that location. The implications of these data were not pursued in the siting documents.
    - When plotted correctly, reported deuterium values show evidence that the ground water is young. The interpretation of carbon-14 "ages" to indicate that the ground water is ~15,000 years old is based on uncorrected data and is virtually meaningless. The aquifer below the proposed site may well have experienced modern recharge, which is contrary to site evaluation documents that indicate no recharge of the aquifer for thousands of years.

3. The conclusion that no route exists for contamination of the Colorado River or any other surface water source was based on inadequate assessment of the regional geology; scientific literature reaches opposite conclusions.

- We establish that at least five hydrologic connections may exist between the proposed site and the Colorado River ground water reservoir. Those routes are as short as 23 miles.
- These possible connections engage aquifers presently in use even closer to the site than the Colorado River.

4. The proposed monitoring array does not appear to us to be an adequate safeguard. Evidence of viable north- and east-directed routes, both shallow and deep, were not considered for the monitoring plan.

5. Site evaluation documents incorrectly claimed that the upslope diversion berms are a sufficient protection against erosion of the primary flood-control berm, and underestimated the effect of accelerated erosion resulting from channelization at the ends of diversion berms. Present conditions are sufficient to threaten the integrity of the above-ground trench cover over the long term, especially after regular maintenance ceases.

In our review of the site evaluation documents, we identified four additional areas of concern that merit further research, but time did not permit thorough analysis.