Subject: Climate Change Concerns of the Proposed Nuclear Waste Repository, Yucca Mountain, Nevada

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Climate Change

GENERAL CONCERNS

• A vadose-zone repository at Yucca Mountain will experience major hydrologic impacts from a climate change similar to the last pluvial climate which occurred about 16,000 to 10,000 years before the present.

• Anticipated hydrologic changes from a pluvial climate acting on Yucca Mountain is about 10 x more effective moisture--more recharge, more fracture flow, more perched water, and a rise in the water table to a level below the repository horizon.
REGIONAL EVIDENCE

- Former extent of pluvial lakes in the Great Basin.

- Change in effective moisture (runoff and recharge) was about a one order of magnitude increase (10x modern).

- Extensive areas of ground-water discharge deposits in the Yucca Mountain region indicate greater discharge flux and rise in water tables up to several hundred feet.
Figure 3. Plenipluvial Pleistocene lakes in the Great Basin (after Morrison, 1965; modifications from Mifflin and Wheat, 1979).
Plate 2.
LATE QUATERNARY PLUVIAL LAKES IN NEVADA
(MODIFIED FROM MIFFLIN AND WHEAT, 1979)

Nevada Bureau of Mines and Geology
Quarterly 95-03, page 83
• Glass alteration occurs well above the present water table. Some appears to be related to a paleowater table and some, well above the zone of complete alteration, to perched water.

• Fractures have secondary mineral coatings and fillings precipitated from aqueous solutions.

• The macro-fossil evidence (packrat middens) reflects the timing of vegetation community changes, the approximate climate related, and, locally, phreatophytic plant fossils which require perennial saturation at root level.
Major Clinoptilolite / Mordenite Intervals

Modified from Bish & Vaniman (1985) LA-10543-MS
Amargosa Desert Packrat Middens:
Averaged relative abundance of environmentally sensitive plant taxa
(Spaulding and Graumlich, 1986)
SUMMARY

- It is important to confidently predict future climate changes when characterizing a repository in fractured rock within the vadose zone because of hydrologic sensitivity to increases in effective moisture.

- A change to the full pluvial climate would markedly increase fracture flow and perched-water conditions.
REFERENCES


QUADE, J., 1986, Late Quaternary environmental changes in the Upper Las Vegas Valley, Nevada; Quaternary Research, 26, p. 340-357.


VITAE

MARTIN D. MIFFLIN

EDUCATION:
Ph.D., 1968, University of Nevada, in Hydrogeology.
B.S., 1960, University of Washington, in Geology.
Washington State University, Eastern Washington.

PROFESSIONAL EXPERIENCE:
President and Senior Hydrogeologist of Mifflin & Associates, Inc., a consulting firm which conducts hydrogeologic and geologic investigations, July, 1986 to Present.
Research Professor, Water Resources Center, Desert Research Institute, University of Nevada System. Research in ground-water problems in arid-zone hydrology. Specific areas of activity: carbonate-rock hydrology, ground-water exploration and development, exploratory-drilling techniques, vadose-zone moisture conditions, and recharge in arid terrane. During this period of time, major ground-water exploration and development programs were established for the State of Nevada (Jean Prison water supply, Valley of Fire State Park), the U.S. Air Force (Tonopah Test Range, Tolicha Peak), and Nevada Power Company (Meadow Valley Well Field development, monitoring, and modeling; carbonate-rock ground-water exploration program near Moapa). Program Director of the Yucca Mountain Candidate High-Level Nuclear Waste Repository technical support program for the State of Nevada (1983-1986), Sept., 1977 to July, 1986.
Senior Hydrogeologist, UNDP, Chile. Leave of absence from the Desert Research Institute for service in Region 4, Chile United Nations Development Program (UNDP) project. Water-resource assessment project in semi-arid region of Chile, chief resident administrative responsibility for the UNDP of the project, March, 1978 to March, 1979.
Water Resources Center Associate Director and Research Professor, Desert Research Institute, Las Vegas, Nevada. Head administrator for the Water Resources Center of the Desert Research Institute in the Las Vegas branch office. General responsibilities included research funding, direction, and execution of program of the Water Resource Center in Southern Nevada. Areas of research interest during this period included land subsidence caused by fluid withdrawals and associated earth fissures and faults in Las Vegas Valley and Mexico, deep carbonate-rock aquifers in Nevada as a potential water-supply alternative for Eastern and Southern Nevada, and waste-water treatment by natural marsh systems in Las Vegas Valley. Expert testimony on the Cross Florida Barge Canal ground-water hydrology was given to the State of Florida Bureau of Planning and Florida Cabinet in July, 1976; as well as serving on the board of review for the Water Element of the State Plan of Florida from 1976 to 1977. Periodic consulting 1975, 1976, 1977 for the Comision del Plan Nacional Hidraulico, in the area of ground-water policy and executed programs of resource evaluation and advanced training of personnel, July, 1975 to Sept., 1977.
Resident Consultant, International Bank for Reconstruction and Development (World Bank). Leave of Absence from the University of Florida in order to accept an 18-month position as World Bank Resident Consultant in ground water to the Plan Nacional Hidraulico (PNH), a newly-created planning organization within the Mexican government. Held additional position of Jefe de Aguas Subterraneas (chief in charge of ground-water planning and associated investigations within PNH). Responsibilities involved training and development of professional staff, development of procedures and policy, and direction of ground-water studies designed for both short and long-term planning of ground-water exploitation and management. PNH was a joint effort by the United Nations Development Programs (UNDP) and the Mexican Government. The effort of the UNDP was executed by the World Bank (International Bank for Reconstruction and Development), July, 1975 to Sept., 1977.
Development) and the procedure was to supply five resident consultors who were expert in various disciplines in water-resource planning and development. I was also appointed to a Mexican government management role, and maintained the Bank title. Subsequently, the experimental program was judged successful by the UNDP, World Bank, and the Mexican Government formalized the organization into the continuing national planning agency for water-resource development in Mexico (Comision del Plan Nacional Hidraulico, ASRH), Sept., 1973 to July, 1975.

Associate Professor Geology, University of Florida. Teaching responsibilities in the following courses: Physical Geology, Introductory Geosciences, Geomorphology, Structural Geology, Ground-Water Geology and Hydrogeology. Research was more or less limited to local problems of ground-water pollution and continued work (summers of 1970, 1972) on isostatic rebound in the Lahontan Basin of the Great Basin. Member of the University of Florida Graduate Faculty, served on graduate committees (M.S. and Ph.D.) for Geology, Environmental Engineering, Coastal Engineering, and Civil Engineering graduate students. Considerable involvement in ground-water pollution aspects of the Cross Florida Barge Canal controversy, with testimony given to Florida Legislative committees, the State of Florida Cabinet, and the U.S. Presidential Council on Environmental Quality. Principal expert witness in ground water for EDF and the Department of Interior in court proceedings (U.S. Government vs. Florida Canal Authority) in August, 1973, Sept., 1969 to July, 1975.

Research Associate, Desert Research Institute and Nevada Center for Water Resources Research. Activities primarily research in ground water and hydrogeology. Principal Investigator or co-investigator in research dealing with the following: hydrologic safety, AEC underground nuclear detonation; investigation of land subsidence in Las Vegas Valley and the development of the theory of mechanics; investigation of the hydrogeology of Las Vegas Valley for feasibility of artificial recharge; delineation of ground-water flow systems using studies of fluid potential, water chemistry, isotopes, and other methods; paleohydrologic investigations in Nevada (surface and ground water); stratigraphic studies of alluvial basins; documentation of mudlump formation and hydrologic relationships causing formation, and developing a theory for mechanics of formation; investigations of carbonate-terrain hydrology in Nevada using tritium and hydrogeochemical techniques; exploration and development of ground water in a number of arid areas for federal, state, and private agencies; investigation of techniques for delineation of ground-water flow systems. Other activities included guest and substitute lecturing in ground water, hydrogeology, and physical geology, and direction of graduate student research in the Great Basin on hydrologic problems, July, 1963 to Sept., 1969.

Graduate Research Assistant, Montana State University (the Montana State University experience consisted of 1/2-time teaching of geology laboratories and two winters of snow avalanche research), Sept., 1962 to June, 1963.


Graduate Teaching Assistant, Montana State University, Sept., 1960 to June, 1962.

Apprentice Geologist, Pan Petroleum Corp., Field-reconnaissance mapping in Western Alaska, April, 1959 to Aug., 1959.

PROFESSIONAL AFFILIATIONS
Geological Society of America
National Water Well Association
Sigma XI

PROFESSIONAL HONORS AND OTHER PROFESSIONAL ACTIVITIES:
DRASTIC Advisory Board Member, National Water Well Assoc., 1986-1987
Invited Speaker, International Workshop on Regional Aquifers, Sponsored by the Institute of
Consulting Experience:
Consultant to USAID, University of Wisconsin, and OTDC, Government of Tunisia, on design and feasibility of potable water development for dispersed populations in Central Tunisia, Feb.-Mar., 1980.
hydrogeological studies for land developers as senior hydrologic consultant for the firms. 
Eco Impact, Inc. and Environmental Science Engineering, Inc. (1972-73). Solid-waste 
disposal and site suitability for Alachua County (1972). Three landfill sites located, 
evaluated, and subsequently adopted by the County. Landfill monitoring, Alachua 
County (1972-73). OffShore Nuclear Power Plant site evaluation - aspects of tectonic 
in arid terrain for U.S. Fish and Wildlife Service, Nevada State Parks, and several 
development and mining firms; ground-water supply and contamination studies, U.S. 
Gypsum.

PUBLICATIONS AND REPORTS:
Mifflin, M. D., Johnson, C. L., and Johnson, R. J., 1989, Hydrogeologic assessment, Upper 
Mifflin, M. D. and J. Quade, 1988, Hydrogeology and paleohydrology of the Carbonate Rock 
Centennial, Annual Meeting.
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Mifflin, M. D., Ed., 1988, Review of consultation draft of the site characterization plan, Yucca 
Mountain Site, Nevada research and development area, Nevada (DOE/RW-0160), 
Mifflin, M. D. and J. Quade, 1987, Estimating climate change from hydrologic response: 
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Yucca Mountain site, Nevada Research and Development Area, Nevada (May 1986, 
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environmental assessment: Yucca Mountain Site, Nevada Research and Development 
Mifflin, M. D. and D. E. Zimmerman, 1984, Ground-water availability in the lower Meadow 
Valley Wash near Glendale, Nevada: WRC-DRI, 52 p.
Truckee River Basins, Nevada: in Western Geological Excursions, 1984 Annual Meeting, 
Wash exploration program, October and November: WRC-DRI, 47 p.
rapid infiltration basin siting and monitoring study: WRC-DRI Project Report, 100 p.
Mifflin, M. D., 1982, Preliminary report on the Jean Correctional Facility test/production well: 
Elzeftawy, A. and M. D. Mifflin, 1982, Soil sample analyses from borings of the RIB site 
Mifflin, M. D., 1982, Exploration and development of a ground-water supply for the southern 
Nevada Correctional Center, Jean, Nevada: WRC-DRI, 43 p. and Appendices.
NPC-2, NPC-11, NPC-25, and NPC-34, Meadow Valley Wash Field: WRC-DRI, 203 p.
Mifflin, M. D. and A. Elzeftawy, 1982, Lateral hydraulic conductivity of the alluvial sediments 
near the RIB site: WRC-DRI Letter Report to City of Henderson, 6 p.
Mifflin, M. D., 1982, Preliminary results of additional test holes for the determination of the 
useful life of the test/production well, Jean Correctional Facility: WRC-DRI Memo. Rept. 
to Nevada Legislature Intrum Finance Committee, 4 p.
a soil stabilizer: WRC-DRI Project Report, 64 p.
Woessner, W. W., M. D. Mifflin, R. H. French, A. Elzeftawy, and A. Zimmerman, 1981,


Mifflin, M. D., 1979, Ground water of the Rio Elqui Valley, Region IV, Chile: UNDP, Project Chi/69/535.


STUDIES DIRECTED AND/OR COAUTHORED IN MEXICO (In Spanish by Plan Nacional Hidralico, Secretary of Water Resources, Mexico):


Ground-Water Reconnaissance and Availability, Region NW Pacific coast, NW Mexico, 1975.


Ground-Water Reconnaissance and Availability, Region Papaloapan, SE Mexico, 1974.