STATE OF NEVADA
NUCLEAR WASTE PROJECT OFFICE

PRESENTATION TO THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUBJECT: REGIONAL WATER CONCERNS RELATED TO THE PROPOSED HIGH LEVEL NUCLEAR WASTE REPOSITORY, YUCCA MOUNTAIN, NEVADA

DATE: JUNE 26, 1989

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CONCERNS

- THE RELATIONSHIP OF YUCCA MOUNTAIN TO THE REGIONAL FLOW SYSTEM
- POSSIBLE CONTAMINATION OF THE DOWN-GRADIENT FLOW SYSTEM
- IMPACTS ON FUTURE WATER SUPPLY DEVELOPMENT

REQUIRED ANALYSIS

- **DETERMINE THE PROBABLE FLUID FLOW PATHS TO THE ASSESSIBLE ENVIRONMENT**

  THIS REQUIRES A THOROUGH UNDERSTANDING OF THE SATURATED ZONE FLOW SYSTEM AT REGIONAL, SUB-REGIONAL AND SITE SCALES

- **EVALUATE CONSEQUENCES OF PRE AND POST CLOSURE SYSTEM DYNAMICS**

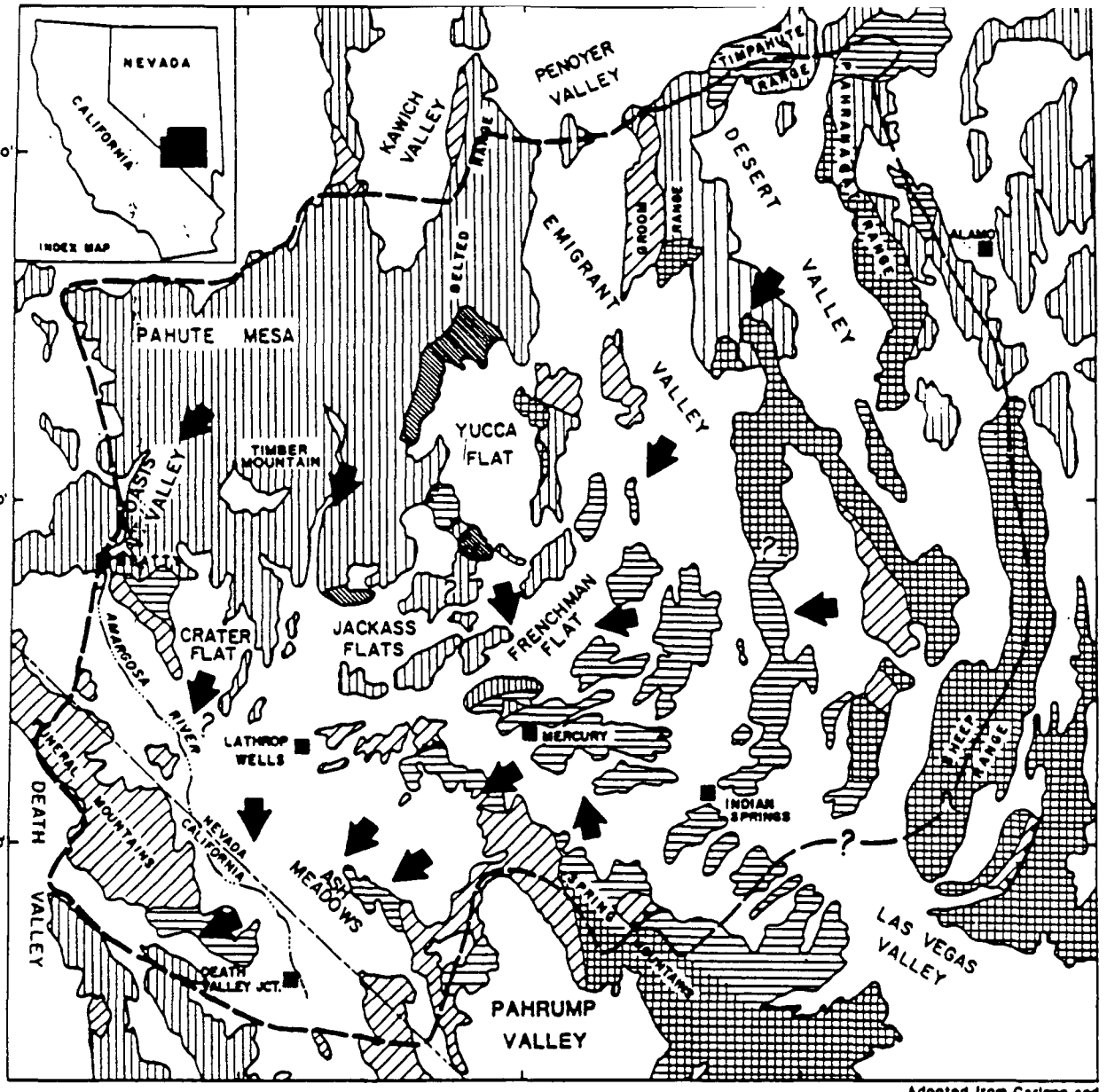
  INCREASED REGIONAL WATER USE – IRRIGATION
  MINERAL
  URBAN

  CLIMATIC CHANGE EFFECTS – WATER LEVELS
  DISCHARGE LOCATIONS

  STRUCTURAL CHANGES – FAULTING

REGIONAL FLOW SYSTEM

- CURRENT UNDERSTANDING ORIGINALLY BASED ON WORK BY WINOGRAD AND THORDARSON (1975)
- UPDATED, REVISED, AND MODELED BY WADDELL (1982)
- FURTHER REFINED BY CZARNECKI AND WADDELL (1984) (SUB–REGIONAL)
- ADDITIONAL WORK BY DRI AND USGS RELATED TO THE REGIONAL CARBONATE AQUIFER



Adopted from Carlson and Winden, 1968; Denny and Drewes, 1965; Winograd, Thordarson, and Young, 1971; and Stewart and Carlson, 1978.

EXPLANATION

QUATERNARY

Alluvium, lake beds, and minor volcanic rocks

TERTIARY

Tuff, rhyolite, and associated volcanic rocks

MESOZOIC (Minor -- not shown)

PALEOZOIC

Undifferentiated upper clastic aquitard, and lower and upper carbonate aquifers

Upper clastic aquitard

Lower carbonate aquifer

PALEOZOIC (CAMBRIAN)-PRECAMBRIAN

Lower clastic aquitard

SYMBOLS

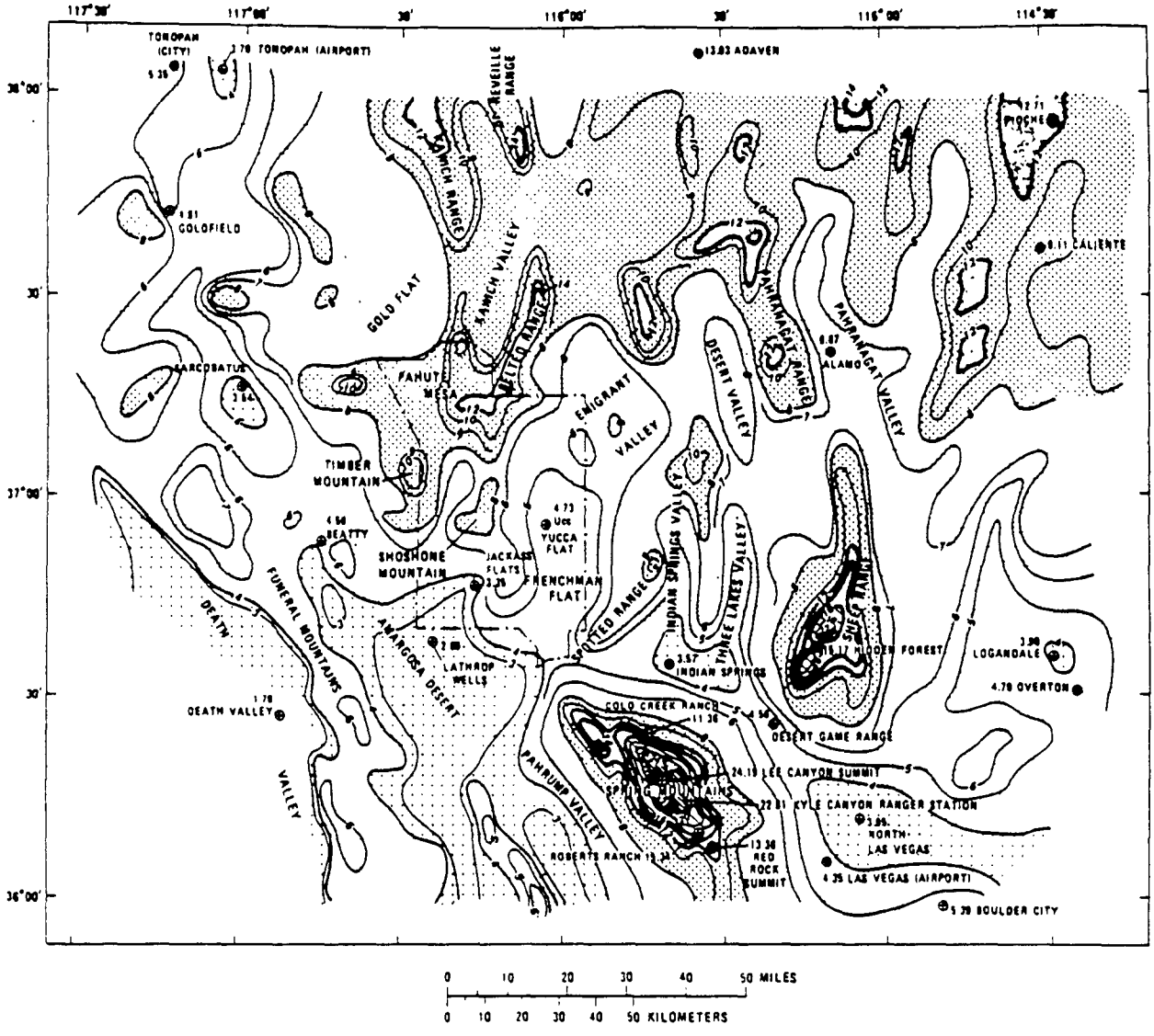
Contact

Thrust fault

Approximate boundary of ground-water system

Approximate direction of ground-water flow

Generalized geology.



Mean annual precipitation

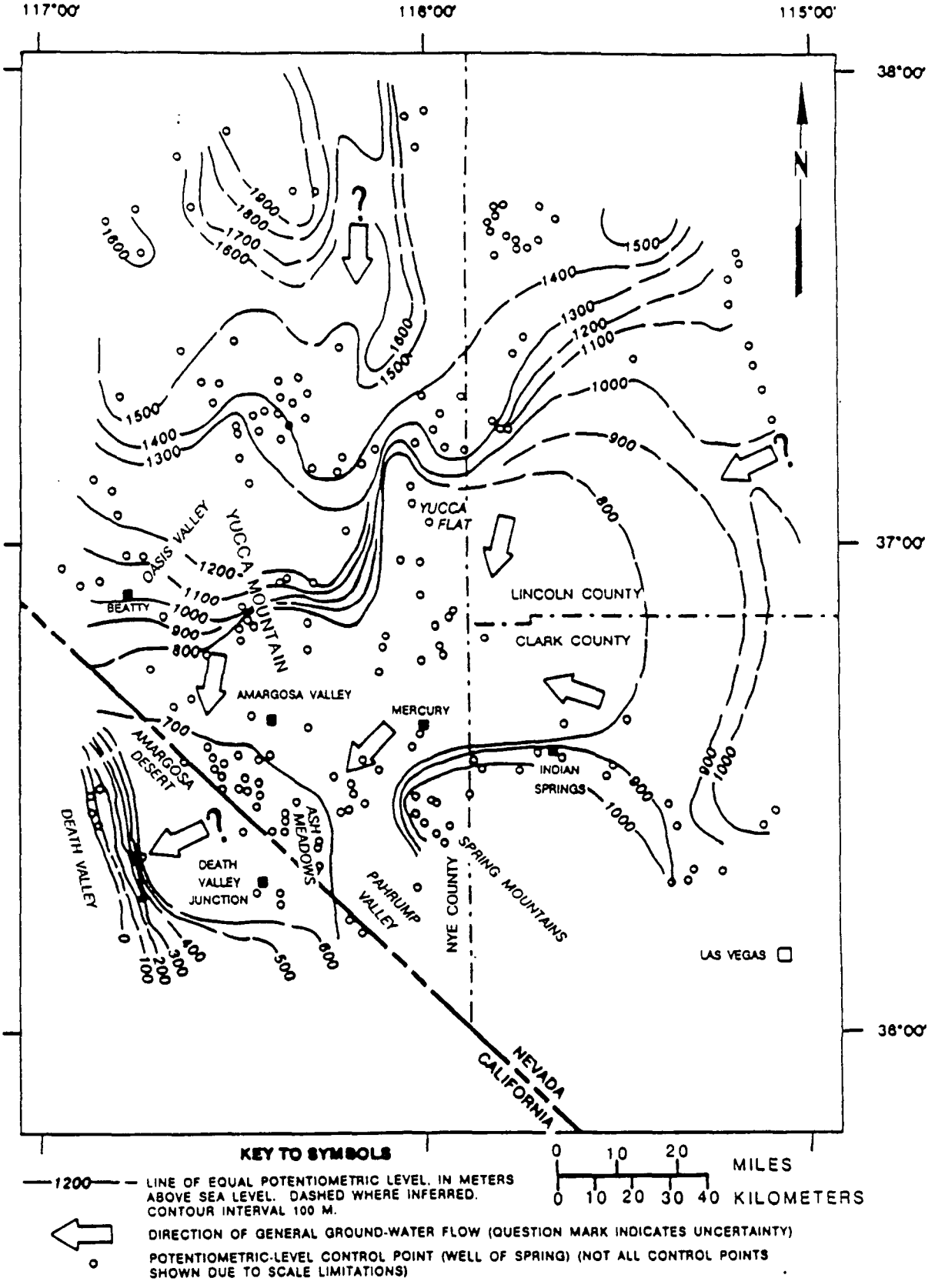


Figure 3-10. Regional ground-water flow paths. Modified from Waddell et al. (1984).

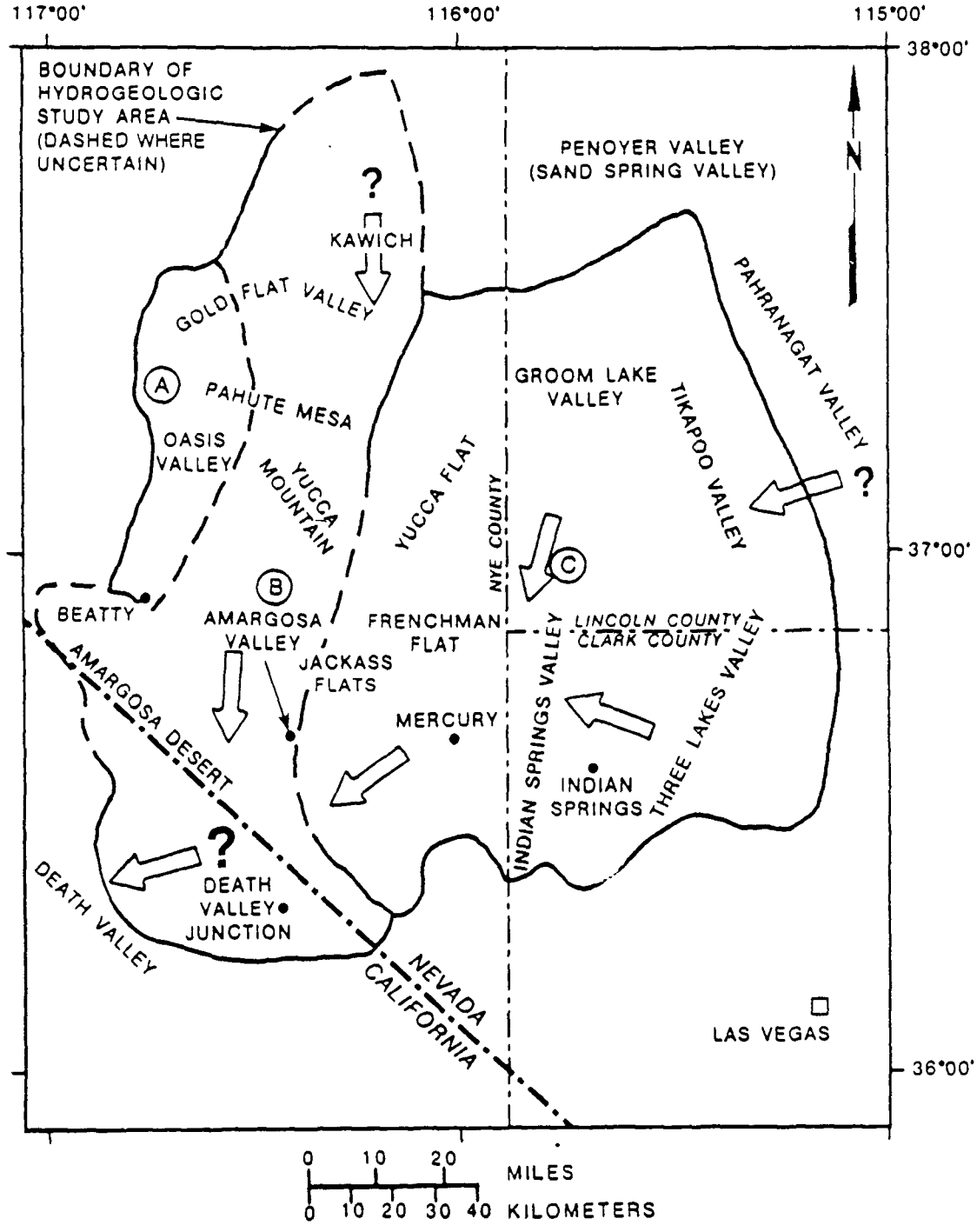


Figure 3-2. Hydrogeologic study area, showing three ground-water subbasins. Modified from Rush (1970), Blankennagel and Weir (1973), Winograd and Thordarson (1975), Dudley and Larsen (1976), Waddell (1982), and Waddell et al. (1984).

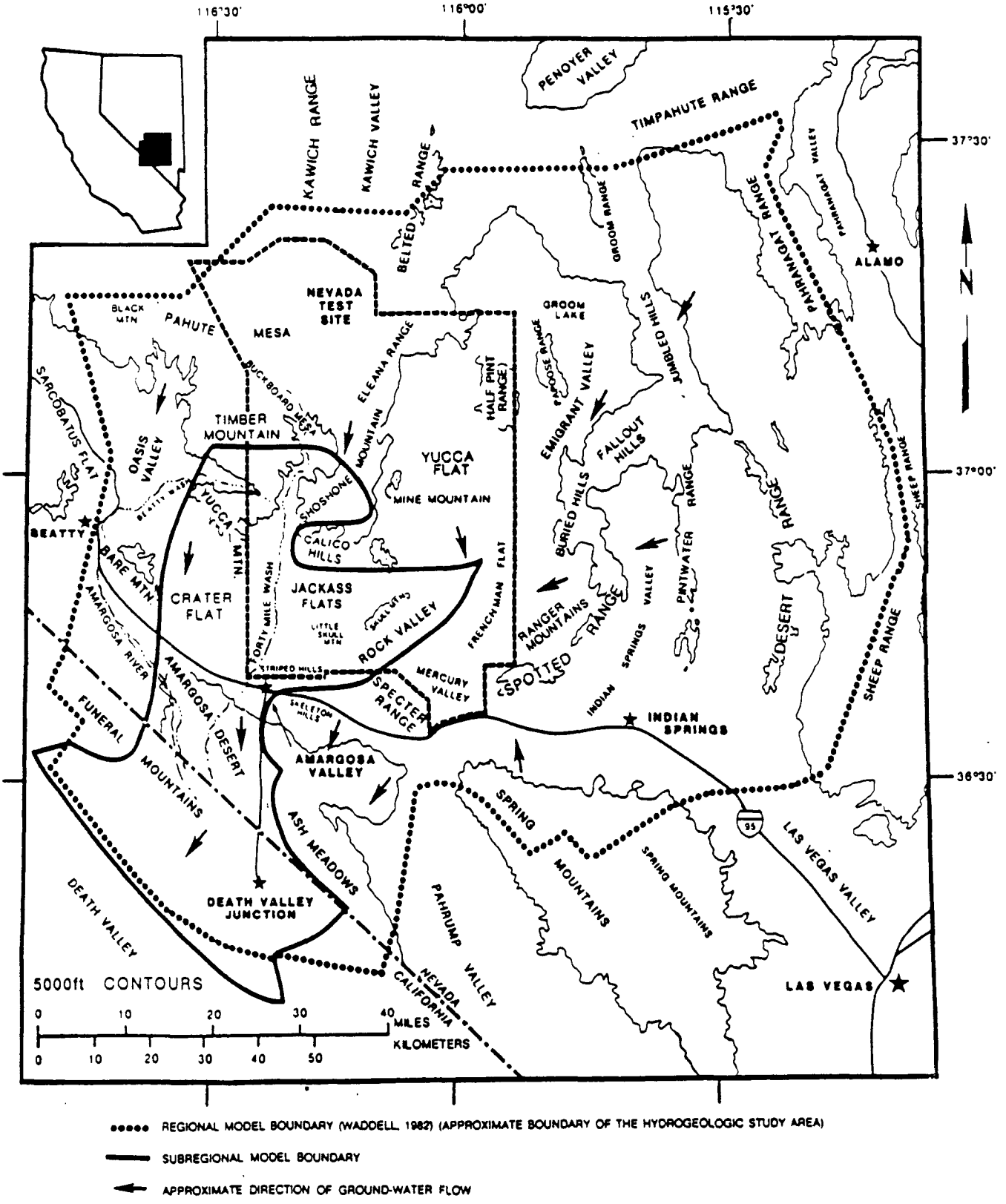
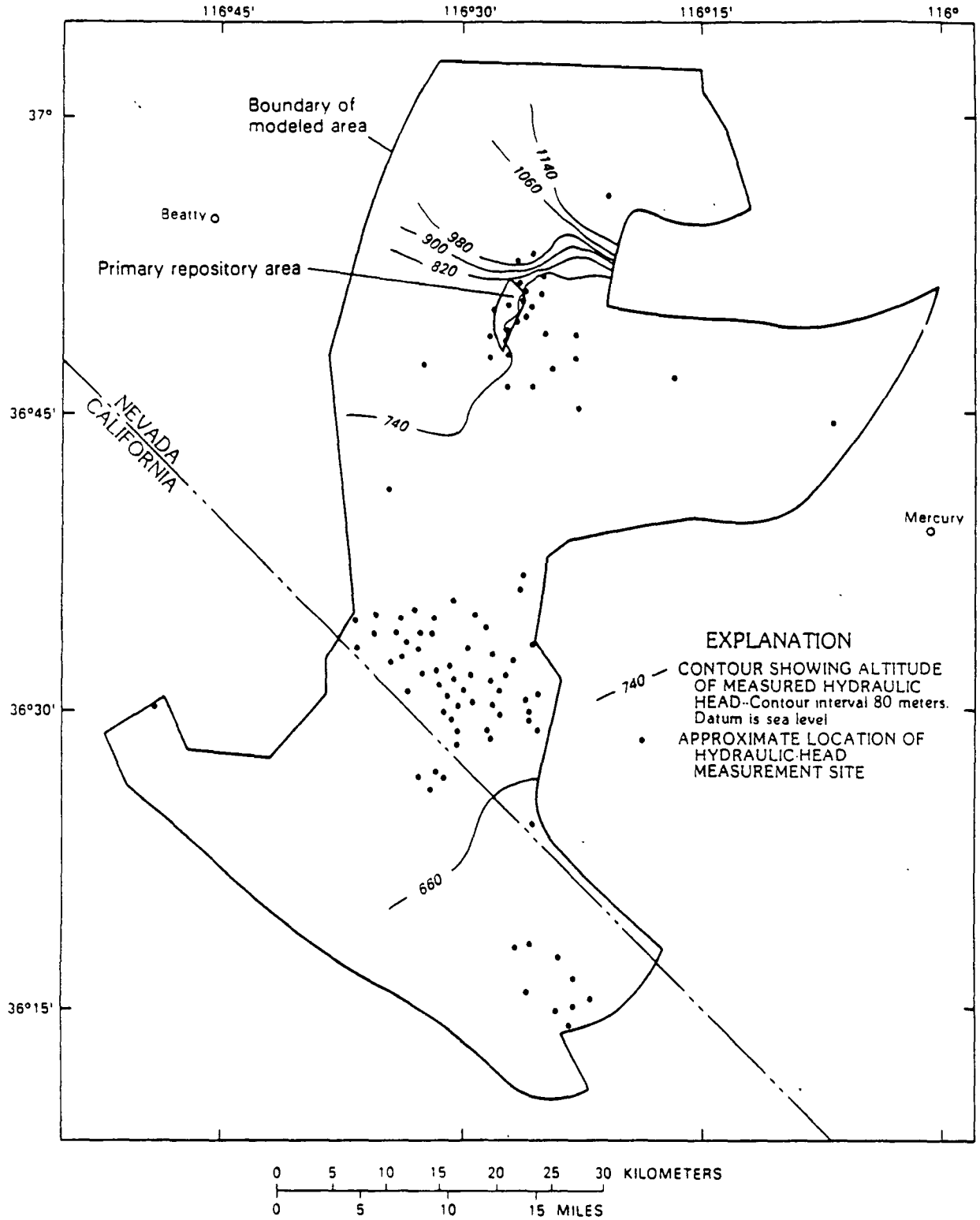
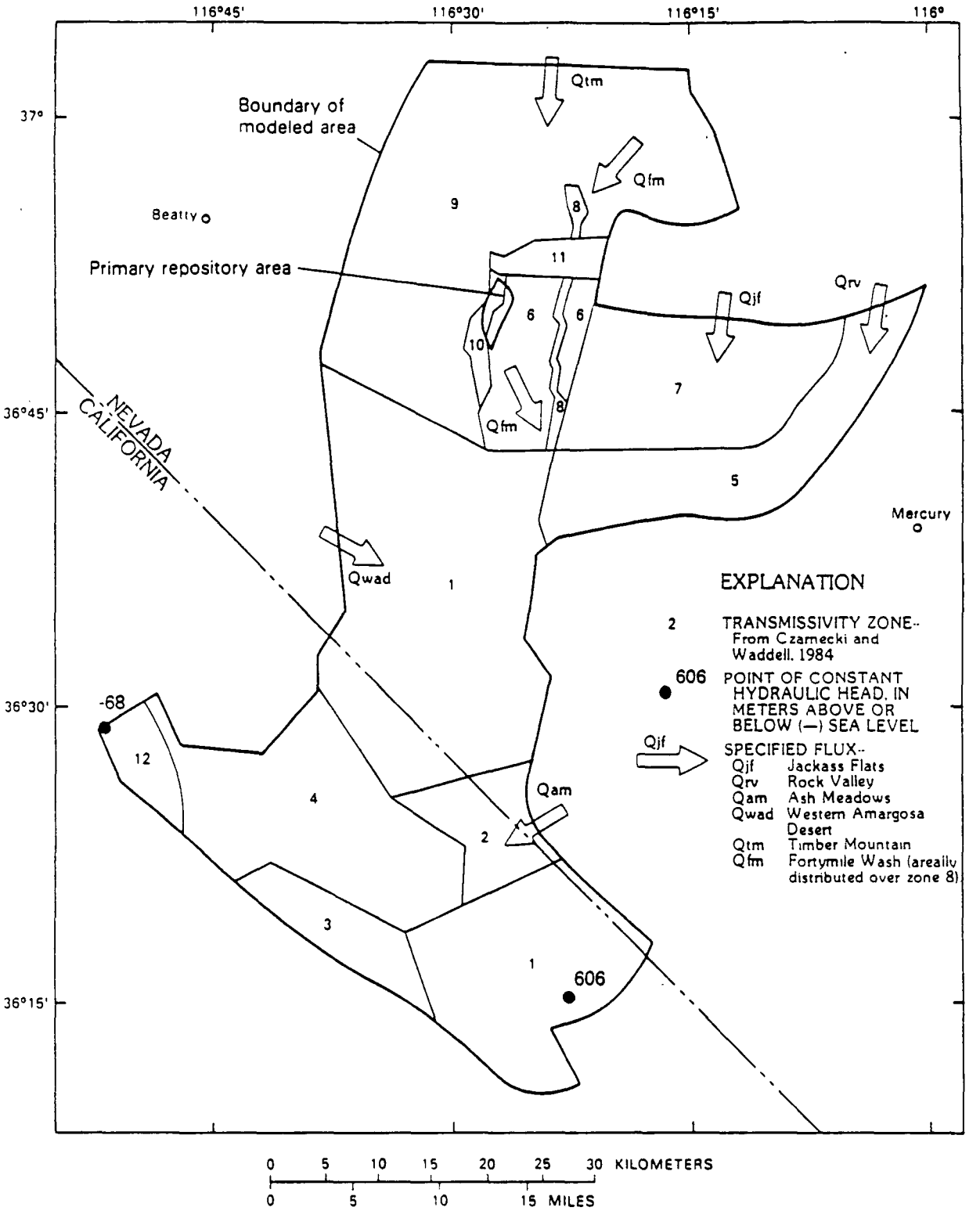


Figure 3-43. Location of regional and subregional modeled areas, with generalized ground-water flow directions. Modified from Czarnecki and Waddell (1984)



Measured hydraulic head and location of measurement sites.



Model boundary fluxes, constant-head nodes, and transmissivity zones.

A REFINED ACCURATE REGIONAL/SUB-REGIONAL MODEL WHICH WILL DEFINE THE PRESENT SYSTEM AND WHICH CAN BE USED TO EVALUATE POSSIBLE FUTURES IS REQUIRED

- A MORE EXTENSIVE DATA BASE IS NEEDED TO DEFINE THE SATURATED ZONE FLOW REGIME
  - FRACTURE FLOW IMPORTANCE
  - BARRIERS/CONDUITS
  - INTERACTION WITH REGIONAL CARBONATE SYSTEM (i.e., VERTICAL FLOW COMPONENTS)
- EVALUATE THE IMPACT OF PERTABATIONS TO THE EXISTING FLOW SYSTEM
  - CLIMATE
  - INCREASED USE
  - STRUCTURAL CHANGES

CLIMATE CHANGE

(INCREASED RECHARGE)

RISE IN WATER TABLE

SHORTENED FLOW PATHS

[IF ONE LOOKS AT GWTT UNDER THIS OR SIMILAR CONDITIONS TOGETHER WITH INCREASED SITE FLUX – GWTT COULD BE VERY SHORT.]

INCREASED REGIONAL WATER USE

- EFFECTS OF INCREASED IRRIGATION (AMARGOSA DESERT)
- EFFECTS OF INCREASED MINING OPERATIONS SUCH AS SAGA MINERALS; BOND GOLD
- EFFECTS OF INCREASED URBAN WATER USE – i.e., DEVELOPMENT OF THE REGIONAL CARBONATE AQUIFER FOR THE LAS VEGAS AREA

STRUCTURAL CHANGES

- REGIONAL CHANGES IN POTENTIAL AND DISCHARGE LOCATIONS
- SITE CHANGES IN POTENTIAL
- NEW BARRIERS OR CONDUITS

RECOMMENDATIONS

CONCENTRATED EFFORT TO REFINE REGIONAL/SUB–REGIONAL AND SITE FLOW MODELS

- REGIONAL SYSTEM BOUNDARIES NEED BETTER DEFINITION – LITTLE REFINEMENT HAS BEEN MADE SINCE ORIGINAL WORK IN THE EARLY 70'S
- DEFINITION OF RECHARGE AREAS QUESTIONS WILL REMAIN RELATED TO UNDERFLOW FROM THE NORTH AND THE IMPORTANCE OF WASH SYSTEM RECHARGE TO THE REGIONAL AND SUB–REGIONAL SYSTEMS (e.g., AMARGOSA RIVER)
- STUDIES TO DEFINE THE MECHANISMS FOR AND IMPORTANCE OF AREAS WITH STEEP GRADIENTS – NEAR DEATH VALLEY, EAST OF MERCURY, NORTH OF YUCCA FLAT
- NEED TO BETTER UNDERSTAND THE SOURCE AND CONTROLS ON DISCHARGE FOR THE SPRINGS NEAR FURNACE CREEK RANCH

- NEED TO DEFINE THE INFLUENCE OF ANISOTROPY ON LOCAL FLOW PATHS
- TESTING SHOULD BE EXPANDED BEYOND THE SITE TO THE SUBREGIONAL SYSTEM
- IMPORTANCE OF VERTICAL GRADIENTS NEEDS ADDITIONAL STUDY – SHOULD DEVELOP ADEQUATE DATA FOR A 3–D MODEL TO ANSWER QUESTIONS CONCERNING THE CARBONATE AQUIFER AND DISCHARGE TO DEATH VALLEY
- THOROUGH EVALUATION OF POSSIBLE FUTURE CONDITIONS NEEDS TO BE UNDERTAKEN ONCE ADEQUATE REVISED MODELS ARE AVAILABLE

EXAMPLE OF FUTURE CONDITIONS

CZARNECKI (1985)

CHANGE:
- Δ PRECIP = 100%
- Δ RECHARGE = 15 TIMES

RESULTS:
- ΔWT = 130 M RISE
- FLOW PATH SHORTENED BY 2/3

IF A SCENARIO SUCH AS THIS WERE TO OCCUR: 1) THE UNSATURATED ZONE WOULD BE REDUCED TO 20 M IN THE TOPOPAH SPRING UNIT (DISTURBED ZONE TO WATER TABLE); AND 2) SATURATED ZONE FLOW PATH WOULD BE $\approx$ 14 KM TO NEW DISCHARGE POINTS

TRAVEL TIME COULD BE <1,000 YEARS

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EDUCATION

B.S.C.E. (1965) University of Nevada, Reno
M.S.C.E. (1968) University of Nevada, Reno
Additional graduate work in hydrology (1968-1972)

EXPERIENCE

1976 - Present Senior Research Engineer, Water Resources Center, Desert Research Institute, University of Nevada System, Reno. Research in water resources evaluation, hydrologic modeling, and environmental assessment.

Project Manager, Yucca Mountain Project 1986-1989 funded through Nuclear Waste Project Office, State of Nevada.

Principal Investigator, "Environmental Assessment - Runway Extension Indian Springs AFAF," U.S. Air Force, 1986.

Principal Investigator, "Conjunctive Water Supply Management," U.S. Geological Survey and Sierra Pacific Power Co., 1985-86.

Assistant Project Manager, "Environmental Impact Analysis - Groom Mountain Withdrawal," U.S. Air Force, 1985-86.

Principal Investigator, "Environmental Assessment Nellis AFB Eastside Development," U.S. Air Force, 1985.

Co-Investigator, "Environmental Assessment Hi-Shear Technology Corp. - Moapa Indian Reservation," Hi-Shear Technology Corp., 1985.

Principal Investigator, "Analysis of Digital Spectral Satellite Data for Hydrologic Mapping," U.S. Department of Energy, 1984-85.

Investigator, Yucca Mountain High Level Nuclear Waste Repository - Technical Review State of Nevada, 1984.

Investigator, Tatum Dome Field Program - 1984, U.S. DOE, 1984.

Principal Investigator, "Evaluation of TIMET Waste Disposal and Pond Area for RCRA" - TIMET, Inc., Henderson, Nevada, 1984.

Principal Investigator, Colorado River Return Flow Versus Effluent Reuse; Project Review for Colorado River Commission of Nevada, 1983.

Department of Civil Engineering, University of Nevada, Reno. Engineering Hydrology - CE 364-564; Advanced Hydrology 1-CE 718.

Co-Principal Investigator, Soil Gas Vapor Analysis Technique Evaluation, US EPA, 1983.

Principal Investigator, "Truckee River Studies," 1977-1983.

Principal Investigator, "City of Sparks Water Quality Monitoring," 1981-1983.

Principal Investigator, "Hydrologic Studies for Long Valley Dam Safety Analysis," 1982.

Investigator, Evaluation of Water Reuse Potential at Jean Prison, Nevada Public Works Board, 1982.

Co-principal Investigator, "Small Scale Hydroelectric Potential Reconnaissance for Nevada," 1981.

Principal Investigator, "Evaluation of Future Water Use in The Truckee Meadows," 1981.

Principal Investigator, "Truckee River Flow Modelling," 1979-1980.

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Principal Investigator, "Review and Evaluation of Water Supply and Wastewater Facilities for Selected Rural Nevada Communities," 1980.

Co-principal Investigator, "Banking Colorado River Allotment Water in Las Vegas Valley, Nevada," 1978-1979.

Co-principal Investigator, "Water and Related Resource Problems and Research Needs in the Arid Southwest," 1978.

Co-investigator, "Institutional Constraint Evaluation of Land Application Sites and Water Right Availability for Reno-Sparks," 1978.

Co-principal Investigator, "Application of Numerical Simulation Techniques to Flood Plain Management," 1977-1978.

Co-principal Investigator, "Hydrologic Evaluation of Surface Water Supply Shortages in an Arid Region," 1977.

1974-1976 Acting Deputy Director, Water Resources Center. Responsible for information dissemination program and Center day to day operations. Procurement of grant and contract funds through various agencies, including state, local and Federal governments. Center operating authority during frequent absence of Director. Research on water resources systems engineering and hydrological modeling.

Lecturer, Department of Civil Engineering, University of Nevada, Reno.

Co-principal Investigator, "Arid Basin Management with Concurrent Quality and Flow Constraints, Phase III," 1974-1976.

Co-principal Investigator, "Wind Hydro," 1975-1977.

Teaching Engineering Hydrology CE 364-664, Fall 1975, and Advanced Hydrology I CE 918, Spring 1976.

Co-investigator, "Island Park Dam Rehabilitation Environmental Assessment," USBR, 1976.

Principal Investigator, "Flood Studies, Muddy River near Overton, Nevada," Nev. Dept. of Wildlife, 1976.

Co-investigator, "Water Quality and Its Effect on Suburban Development," 1975.

1973–1974	Planning Engineer, Hydrologist, Rio Parana Study Group, IECO–ELC, Rio de Janeiro, Brazil.
1973	Planning Engineer, Hydrologist, International Engineering Company, San Francisco, California.
1972–1967	Research Associate, Water Resources Center, Desert Research Institute.

Co-principal Investigator, "Arid Basin Management with Concurrent Quality and Flow Constraints," 1972–1973.

Co-principal Investigator, "Time Variant Characteristics of Water Quality Control Plants in Nevada," 1972–1973.

Co-principal Investigator, "Application of Statistical Method of Groundwater Flow System Analysis," 1971–1972.

Principal Investigator, "Evaluation of Streamflow Forecasts for Reservoir Operation," 1970–1971.

Co-principal Investigator, "Application of Simulation Theory to Water Resources Planning and Management, Phase III," 1970–1971.

Principal Investigator, "Bitterroot Valley Simulation Model" for Montanta Water Resources Board, 1970–1971.

Co-investigator, "Hydrology of Truckee Meadows," 1970–1971.

Co-principal Investigator, "Optimal Basin Development and Water Allocation with Consideration of Restricted Water Supply Condition," 1969–1971.

Co-investigator, "Application of Simulation Theory to Water Resources Planning and Management, Phase I and Phase II," 1968–1970.

Co-investigator, "The Optimum Release Policy for a Multipurpose Reservoir Using Stochastic Hydrology," 1968–1970.

Principal Investigator, "Application of Watershed Simulation Model to Truckee River Basin," 1969.

Principal Investigator, "Application of Watershed Simulation Model to Walker River Basin," 1967–1968.

Co-investigator, "Development of Watershed Simulation Model," 1967.

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1965–1967	Graduate Research Assistant, Water Resources Center, Desert Research Institute.
1964–1956	Engineering Aid, Eagle-Picher Company, Clark Station, Nevada.

MEMBERSHIPS

Registered Professional Engineer, Nevada
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Sigma Tau

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CONSULTING ACTIVITIES

Pacific Gas and Electric Company, San Francisco, California, Wateshed Modeling. 1967.

Millard-Spink Associates, Reno, Nevada, PMF and Spillway Adequacy-Kitteridge Creek Dam. 1969.

Clyde-Criddle-Woodward, Inc., Salt Lake City, Utah, Reservoir Operation Model. 1971.

World Health Organization, Wastewater Reuse Symposium Organization and Presentations, Manama Bahrain. September - October 1984.

While employed by IECO 1973-74

a. Eyser Engineering, Madrid, Spain, Rio Rubi Flood Studies (Design Flood).

b. Seattle City Light, Seattle, Washington, PMF for Boundry Dam (Safety of Dams).

c. Electrobras, Rio de Janeiro, Brazil, Basic hydrologic and reservoir operation studies - Itaipu Dam.

Clyde-Criddle-Woodward, Inc., Salt Lake City, Utah, River Basin Simulation Model. 1975-76.

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