



INYO COUNTY WATER DEPARTMENT
163 MAY STREET
BISHOP, CALIFORNIA 93514

Bulk Rate
U.S. Postage
PAID
Permit No. 90
Bishop, California

THE OWENS VALLEY



MONITOR

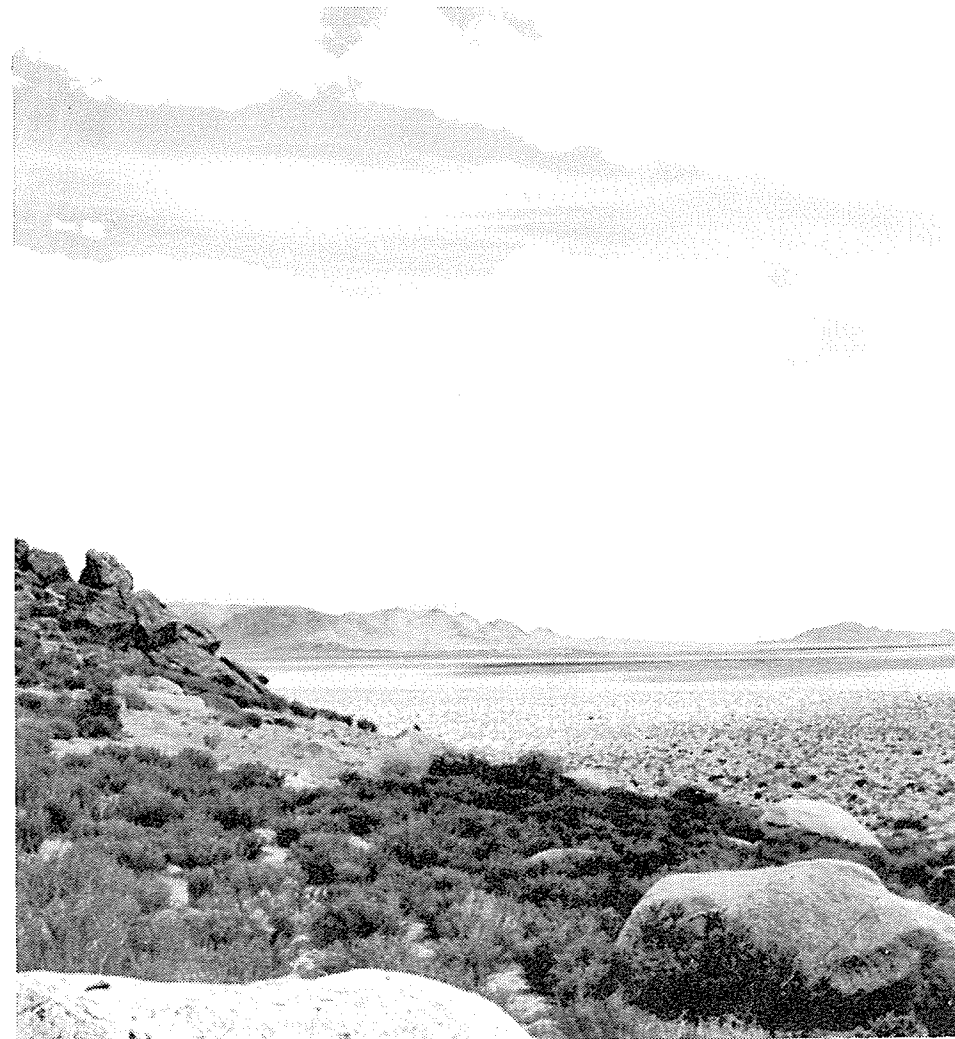
INYO COUNTY WATER DEPARTMENT'S THIRD ANNUAL REPORT ON EVENTS,
ACTIVITIES AND CONDITIONS IN THE OWENS VALLEY

1994

This is the Inyo County Water Department's third annual report, covering March 1993 through December 1994. It is a compilation of results from monitoring and other field and technical work performed by the Inyo County Water Department staff and consultants.

The Inyo County Water Department was formed in 1980 to protect the Owens Valley environment from the effects of groundwater pumping.

In accordance with a water management agreement with the Los Angeles Department of Water and Power (LADWP), the Inyo County Water Department monitors water activities in the valley and their impacts on groundwater levels and vegetation, and conducts scientific research on methods of improving water management.



The Owens Valley, near Independence

Photo by Heidi Walters

CONTENTS	PAGE
INTRODUCTION	1
PERSPECTIVE	2
ANNUAL PUMPING PROGRAM	3
CONDITIONS — RESULTS FROM MONITORING:	
HYDROLOGY	4
VEGETATION	7
SOIL WATER	10
MITIGATION	11
COOPERATIVE STUDIES	14
GIS	14
WATER DEPARTMENT	15
PUBLICATIONS	18

THE OWENS VALLEY

MONITOR

This annual report was produced by the Inyo County Water Department (ICWD) in Bishop, California. Its purpose is to explain the ICWD's yearly monitoring and management activities in the Owens Valley.

Greg James, Water Director
Heidi Walters, Editor

The ICWD also produces a newsletter called the *Owens Valley Water Reporter*. This newsletter covers the activities of the ICWD and water issues in the Owens Valley and the Eastern Sierra. If you would like to receive the newsletter and the annual report, please call 619-872-1168, or write to:

Inyo County Water Department
163 May Street
Bishop, California 93514
Attn: Heidi Walters

Front cover: Portion of the lower Owens River near Lone Pine. Photo by Greg James
Back cover: Blue heron tracks and human footprints in muddy riverbed, following flow studies in the lower Owens River. Photo by Heidi Walters

Inyo County Water Department staff produced the following documents in 1993 and 1994:

Hydrology

Inyo County Water Department:

◆ **Lower Owens River Planning Study: Discharge Data and Preliminary Estimates of Losses for the Lower Owens River Project.** (Report 93-1) By Randy Jackson. Draft being reviewed by LADWP.

◆ **Lower Owens River Planning Study: Transient Water Quality in the Lower Owens River During Planning Study Flow Releases in July and August of 1993.** (Report 93-2) By Randy Jackson. Draft reviewed by LADWP, but public release of permanent draft denied.

◆ **Shallow Groundwater Levels in the Owens Valley — 1993 Update.** (Report 93-3) By Richard Puskar and Randy Jackson. Draft being reviewed by LADWP.

◆ **Shallow Aquifer Hydraulic Conductivity As Determined by Slug Tests in Shallow Test Holes and Analytical Groundwater Model Construction and Calibration for the Five Bridges Area, Inyo County, California.** (Report 94-1) By Randy Jackson. Draft being reviewed by LADWP.

◆ **Shallow Groundwater Levels in the Owens Valley — 1994 Update.** (Report 94-2) By Randy Jackson. Draft being reviewed by LADWP.

◆ **Estimates of Change in Shallow Groundwater Storage and Area Overlying Selected Declines in Shallow Groundwater Levels in the Owens Valley, California, Based on Change in Depth To Water Maps from the Vegetation Mapping to April 1990, and the Vegetation Mapping to April 1994.** (Technical Note) By Randy Jackson. Draft being reviewed by LADWP.

Outside Publications

◆ **Preliminary Groundwater Ages from Flowing Wells in the Owens Valley, SE of Independence, California.** (OP-1) By W.B. Lyons, A.E. Carey, A.L. Herczeg, S. Huey, K.R. Font and R. Jackson.

Vegetation

◆ **Germination Tests of Owens Valley Seeds.** (December 1993) By Denise Waterbury, Irene Yamashita and Sally Manning.

◆ **Report on 1993 Rare Plant Site Visits and Proposal for Future Monitoring of Rare Plants Consistent with the Goals of the Water Agreement.** (January 1994) By Sally Manning.

◆ **Changes in Owens Valley Vegetation Due to Groundwater Pumping and Six Years of Drought.** (May 1994) By Sara J. Manning. *Crossosoma*, vol. 20, no. 1, pp 1-16.

◆ **Shrub Recruitment 1991-1993: Results from Permanent Monitoring Sites, Update on Mazourka Canyon Road *Atriplex torreyi*; Recommendations for Future Recruitment Monitoring.** (July 1994) By Sally Manning.

◆ **Effects of Four Selected Soluble Chloride Salts on the Germination of *Tamarix ramosissima*.** (December 1994) By Brian R. Stange. Humboldt State University, Department of Biology, Senior Thesis.

◆ **Results of Four Revegetation Treatments on Barren Farmland in the Owens Valley, California.** (1994) By Irene S. Yamashita and Sara J. Manning. Presented at the Wildland Shrub and Arid Land Restoration Symposium, October 19-21, 1993, Las Vegas, Nev. In press, *USDA Forest Service Gen. Tech Rep. INT-GTR-315*. Intermountain Research Station, Ogden, Utah.

Soils

◆ **Relationship of Time Domain Reflectometry Measurements to Soil Psychrometer Readings at Two Sites in Owens Valley, California.** (November 1993) By Derik Olson.

◆ **An Evolution of Soil Survey Crop Yield Interpretation for Two Central Iowa Farms.** (1994) By Aaron L. Steinwand, D.L. Karlan and T.E. Fenton. Accepted, *Journal of Soil Water Conservation*.

◆ **Landscape Evolution and Shallow Groundwater Hydrology of the Till Landscape in Central Iowa.** (1994) By Aaron L. Steinwand and T.E. Fenton. In review by the *Soil Science Society of America Journal*.

Conferences attended and other ICWD endeavors

Conferences

◆ **Society for Ecological Restoration Conference**, Irvine, Calif., July 16-20 1993 — Sally Manning and Irene Yamashita.

◆ **Wildland Shrub and Arid Land Restoration Symposium**, Las Vegas, Nev., October 19-21, 1993 — Sally Manning and Irene Yamashita. Manning presented a talk, "Effect of Simulated Rainfall on a Stand of *Atriplex torreyi* in the Owens Valley, California." Manning and Yamashita presented their poster, "The Effects of Four Revegetation Treatments on Barren Farmland in the Owens Valley." Also, Yamashita went on a field trip to the Lower Colorado River and a Mojave Desert Spring Restoration Site. Manning went to the Viceroy Gold's Castle Mountain Gold Mine to see their revegetation efforts.

◆ **The Future of California Floristics and Systematics Symposium**, sponsored by the Friends of the Jepson Herbarium, Berkeley, Calif., June 3-5, 1994 — Sally Manning.

◆ **Soil Science Society of America Annual Meeting**, Seattle, Wash., Nov. 13-18, 1994 — Aaron Steinwand

◆ **GEO FORUM '94**, sponsored by Urban and Regional Information Systems Association, Bakersfield, Calif., Dec. 8, 1994 — Chris Howard.

◆ **Fourth Annual Nevada State Geographical Information System Conference**, Sparks, Nev., Dec. 12-14 — Chris Howard.

Educational

◆ Sally Manning taught vegetation monitoring techniques to two groups of science teachers from Southern California: One group, called FRESCO (Field Research Coalition, Center for Academic Interinstitutional Programs), consists of Southern California teachers who spend their free time learning new teaching techniques from professional scientists; and the other group, called Project Issues, is a committee administered out of the University of California-Los Angeles which is charged with improving science curricula for grades K-12. Their idea is to incorporate real issues into the academic setting, and thus show students how learning science can lead to a rewarding career.

◆ Sally Manning also was a judge at the Home Street School Inventor's Fair (6th grade). And, she advised advanced biology seniors from Bishop High School on individual research projects. She also provided written advice and guidance to Lo-Inyo School students on their Science Fair projects.

◆ Aaron Steinwand gave talks on environmental monitoring in the Owens Valley to the Rotary and Lions clubs.

◆ Sally Manning was the invited speaker at the January 1994 California Native Plant Society (CNPS) Bristlecone Chapter meeting. She gave a talk titled, "Monitoring Owens Valley Vegetation Change."

◆ Irene Yamashita led a CNPS field trip in September 1993 to the Laws revegetation site.

Committees

◆ **California Native Plant Society, Plant Community Committee** (statewide) — Sally Manning — This committee has devised standardized methods for inventorying plant communities.

◆ **White Mountain Research Station Forum** — Sally Manning, Aaron Steinwand — This group meets to discuss items of mutual interest among local biologists. They have helped plan a new interagency library/resources center to be constructed at White Mountain Research Station.

◆ **Interagency Greenhouse Committee** — Irene Yamashita, Denise Waterbury, Sally Manning — This group's goal is to gather information on greenhouse design to build a native plant growth facility at the White Mountain Research Station, with a greenhouse structure, outdoor growing areas, and an interpretive garden.

◆ **Owens Valley Multi-Species Recovery Task Force** — Sally Manning — This committee advises and reviews the work of consultants who are preparing the Owens Valley Multi-Species Recovery Plan. The plan focuses on listed and candidate plant and animal species living in alkaline areas of the Owens River watershed, and it will designate critical habitat and management recommendations for recovering the species.

Defining our mission

Toward the end of 1993, the Inyo County Water Department and the Inyo County Water Commission began developing a reaffirmation of the county's commitment to protecting the environment and water resources of the Owens Valley and the rest of the county.

A resolution was developed setting forth a county water policy and definitions of the department's and commission's purposes, as well as the roles of other agencies involved in Inyo County water issues. In 1994, the resolution was approved by the Inyo County Board of Supervisors. The water policy is based on the groundwater ordinance passed by Inyo County voters in 1980. Specifically, the county's policy is "to protect the county's environment, citizens and economy from adverse effects caused by activities relating to the extraction, export or use of water resources and to seek mitigation of any existing or future adverse effects resulting from such activities."

The resolution also defines guidelines for the performance of the county's duties and responsibilities under the Inyo/Los Angeles Standing Committee's Statement of Intent (adopted in 1993) and the Inyo/Los Angeles long-term water management agreement (approved in 1991 by Inyo and Los Angeles but yet to be approved by the court).

The commission's role is to "assist in the implementation" of the water policy by remaining informed about water resources issues, conducting public meetings to share this information and to gather public opinion, submitting recommendations or advice, and reports, to the Inyo County Board of Supervisors, and designating two commissioners to serve on the Inyo/Los Angeles Standing Committee.

The water department's purpose includes:

◆ helping implement the water policy by continuing to monitor and participate in the proceedings of the Third District Court of Appeal with respect to the long-term water management agreement, and to negotiate with Los Angeles, other agencies, citizens and environmental groups regarding the agreement;

◆ monitoring the environment of the Owens Valley and helping manage the water resources according to the agreement;

◆ coordinating for Inyo County the implementation, and oversight of, the enhancement/mitigation projects and other environmental provisions in the agreement;

◆ conducting scientific and other research related to the county's water resources; and

◆ serving as staff to the water commission.

Agreement, EIR in court

Yet another year has passed and still the fate of the

Inyo/Los Angeles water management agreement, and an associated environmental impact report required to be written by Los Angeles, remains undecided, locked in the hands of the Third District Court of Appeal. All required briefs and responses to them were submitted to the court last December, and now all involved await word from the court as to the next step to be taken.

Owens Valley tour

In October, Inyo County hosted a tour of the Owens Valley, from north to south, for Los Angeles officials to view first-hand aspects of the Inyo/Los Angeles water management agreement. From Los Angeles, members of the City Council, the Department of Water and Power, the Water and Power Commission, and the Mayor's office attended, and the city's chief legislative analyst. From Inyo County, members of the Water Commission, the Board of Supervisors, and the Water Department attended, as well as the County Administrator and a legislative representative.

Inyo County and Los Angeles tour presenters described the vegetation and hydrologic monitoring programs, and gave demonstrations of monitoring techniques. The tour stopped at several enhancement/mitigation projects, irrigated pastures, groundwater pumping impacted sites such as the now dry Hines Spring area, the Owens River, and the Eastern California Museum.

Lower Owens River

Los Angeles and Inyo County offered to the California Department of Fish and Game (DFG) and State Lands Commission a memorandum of understanding (MOU) regarding the Lower Owens River Project (LORP). The MOU commits Los Angeles and Inyo County to implement the LORP, and would provide a resolution to the conflict with DFG regarding the project.

The LORP involves releasing flows to the river between the aqueduct intake and the Owens River delta, enhancing off-river lakes and ponds, and creating waterfowl and fish habitat.

Toward this goal, the lower Owens River was the subject of a two-phase study by Don Chapman Consultants, Inc. Phase I, in 1993, involved releasing varying flows, from low to high, into the dry stretch of river. Phase II, analysis of the flow data, was completed in 1994. The results of the study included a description of management options, computer modeling results of stream flows, sediment transport, water quality, fishery habitat, riparian vegetation, and wildlife habitat, and options for channel preparation. Based on their study results, the consultants recommended an ongoing flow in the river of 40 cubic feet per second (cfs), and periodic flushing flows of 200 cfs.

Inyo County and Los Angeles agreed to a groundwater pumping limit of 90,000 acre-feet for the April 1, 1994 to March 31, 1995 runoff year. The forecasted runoff for the year was 62 percent of average.

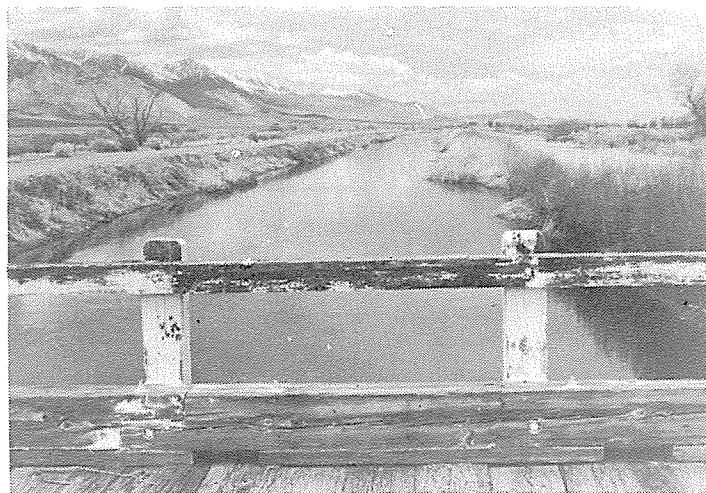
Under the April 1, 1994 to March 31, 1995 pumping program, many of Los Angeles Department of Water and Power's 96 pump-equipped wells were not operated.

Of the 90,000 acre-feet LADWP was allowed to pump, about 85,000 acre-feet was used within the Owens Valley and about 5,000 acre-feet supplied water to the Los Angeles Aqueduct for export.

The LADWP had wanted to pump 105,000 acre-feet, initially, and Inyo County had suggested a limit of 87,000 acre-feet. The compromise limit of 90,000 acre-feet finally agreed upon was determined to be the maximum amount of groundwater that could be pumped and still have water tables remain stable or continue to slightly rise.

Of the 85,000 acre-feet of groundwater to be used in the Owens Valley, about 65,000 acre-feet was intended to directly supply in-valley uses or to replace surface water applied for such uses. This supply of groundwater for in-valley uses was reduced from an original allotment because of extremely dry conditions in 1994. In-valley uses include irrigation and stockwater, recreation and wildlife projects, and town domestic water supply.

The remaining 20,000 acre-feet of groundwater to be used in the valley was allocated to enhancement/mitigation



Los Angeles Aqueduct

photo by Heidi Walters

projects. Enhancement/mitigation projects are those projects installed by LADWP under the 1984 interim water agreement between Inyo County and Los Angeles. They include Klondike Lake, Lone Pine riparian park, woodlots in Independence and Lone Pine, several pastures and alfalfa fields, and the lower Owens River rewatering project.

The Inyo/Los Angeles Technical Group develops the pumping program each year, based on several factors, including projected runoff derived from snow survey results, and monitoring results of vegetation conditions, water tables, soil water availability to the vegetation and vegetation water requirements.

The Inyo/Los Angeles Standing Committee agrees on a pumping limit before adopting the pumping program.

To develop the pumping program, the Technical Group used the long-term agreement on groundwater management, the Green Book (technical manual for carrying out the agreement), and the drought recovery policy agreed upon by Inyo County and Los Angeles.

The drought recovery policy was adopted by Inyo and Los Angeles in 1990, following more than three years of drought. Under this policy, LADWP's groundwater pumping is to be managed in an environmentally conservative manner during the drought, which began in 1986, and for a period of recovery following the drought to allow for recovery of water tables and soil water available to plants in the valley.

Since 1990, water tables generally have been rising, even during the continued drought. Water tables also were boosted in 1993-1994, an above-normal runoff year amidst the seven-year drought.

When the drought began in 1987, water tables were at or near the highest levels in about 20 years. However, from 1987 to 1989, groundwater pumping was high and water tables in the Owens Valley declined.

This prompted Inyo and Los Angeles to adopt the drought recovery policy.

Planned pumping, 4-1-1994 to 3-31-1995

Wellfield	Pumping (acre-feet)
Laws	13,500
Bishop	11,350
Big Pine	26,400
Taboose-Aberdeen	12,000
Thibaut-Sawmill	15,400
Independence-Oak	7,050
Symmes-Shepherd	2,550
Bairs-Georges	500
Lone Pine	1,250
TOTAL	90,000

Staff lends assistance in other water issues

Briggs heap leach gold mine

Inyo County Water Department staff have been lending assistance to the county planning department in reviewing an administrative draft environmental impact report on the CR Briggs Project — a proposed heap leach gold mine in Panamint Valley. CR Briggs is a subsidiary of Canyon Resources, based in Golden, Colorado.

The project would consist of a 112-acre open pit mine, waste rock dumps, heap leach facilities, a gold recovery plant, and other facilities such as shops, warehouses, offices, etc. The pit would be in the mouth of Redlands

Canyon, at the foot of the Panamint Range, and other facilities would be on the adjacent alluvial fan. The mining company, CR Briggs Corporation, says that over an eight-year period the project would disturb about 500 acres of land in order to move about 27 million tons of wasterock and process about 18 million tons of ore. Gold and silver would be recovered using cyanide heap leach methods. The company would restore about 400 acres of the disturbed area.

The company plans to pump water from the playa in Panamint Valley to provide non-potable water to the project operations.

The project is one and a half miles from Redlands Spring, which is used periodically by bighorn sheep.

The water department is reviewing and commenting on the water resources aspects of the project, and the reclamation component.

Owens Lake soda ash project

Inyo County Water Department staff also reviewed and commented on the water resources portions of the draft environmental impact report covering the Owens Lake Soda Ash Company's proposed trona mining project on Owens Lake. The draft came out in June 1994.

The water department's comments focused particularly on possible impacts from groundwater pumping on the Cottonwood Springs wetlands along the east shore of Owens Lake. Water for processing the trona ore would be pumped

from a well west of the wetlands.

OLSAC proposes to expand an existing trona mining operation and to produce soda ash (sodium carbonate). The project would entail mining the trona ore deposit from a 16,120-acre portion of lakebed leased from the State Lands

Commission. The deposit is up to nine feet deep and is expected to last 40 years. OLSAC plans to invest \$150 million in the project and expects it to create 100 to 155 jobs during its 40-year lifespan.

A plant to process the ore into soda ash would be built within 40 acres along the west shore of the lake, 15 miles south of Lone Pine. Total surface disturbance for all of the facilities on the shore would be about 200 acres.

Initially, the project would produce 500,000 tons of soda ash per year, expanding to a maximum 600,000 tons per year.

At maximum production, 964 gallons of water per minute would be pumped for plant operations. The draft EIS/EIR for the project identified potential significant adverse effects to the Cottonwood Springs wetlands as a result of project pumping.

Las Vegas water import plan

Inyo County's Board of Supervisors participated in a joint meeting in August 1994 in Tonopah with county and other officials from rural Nevada. They discussed their concerns and heard presentations on studies being conducted in connection with Las Vegas Valley Water District's proposed groundwater importation project.

Inyo officials met with representatives from Nye, White Pine and Lincoln counties, from the Duckwater Shoshone tribe and the Moapa Band of Paiutes, consultants, attorneys and Nevada residents.

Five years ago, Las Vegas filed for water rights to pump groundwater from an aquifer underlying the three counties in Nevada and import it to Las Vegas. Water from this aquifer eventually surfaces in springs in Inyo County's portion of Death Valley National Park. The water importation project could impact the sole source of water for Furnace Creek Resort and for the towns of Shoshone and Tecopa. It also could dry up seeps and springs that sustain bighorn sheep, endangered pupfish, and other wildlife.

At the Tonopah meeting, the concerned groups were able to update each other on hydrologic and other studies and on their progress in monitoring the application process.



Briggs site, Panamint Valley

Photo by Greg James

Inyo County Board
of Supervisors
Linda Arcularius, Chair
Julie Bear
Bob Michener
Robert Gracey
Paul Payne

Inyo County Administrator
C. Brent Wallace

Inyo County Water
Commission
Vince Yoder, Chair
Harry Holgate
Scott Kemp
Ray Gray
David Miller



Inyo County Water Commission: left to right, Vince Yoder, Scott Kemp, David Miller, Harry Holgate, Ray Gray
Photo by Heidi Walters

Water Department staff, consultants, etc.

1993-1994 Water Department budget

The Inyo County Water Department operates under two budgets. One, the larger budget, is for general operation such as ongoing monitoring and management in the valley and office administration. The other budget is for cooperative studies, which are studies administered by the Inyo/Los Angeles Technical Group and often involve hiring outside consultants to perform specialized work in the valley.

The general budget for 1993-1994 was \$915,626. Of this amount, \$874,264 was provided by the Los Angeles Department of Water and Power. The remainder, \$41,362, came from the county's geothermal trust fund.

The cooperative studies budget for 1993-1994 was \$82,550. This budget was supplied totally by LADWP.

THIS REPORT IS PUBLISHED
ON RECYCLED PAPER.

General

Greg James
Director
Douglas Daniels
Fiscal operations supervisor
Irene McLean
Secretary, receptionist
Leah Kirk
Environmental specialist
Heidi Walters
Editor

Consultants

Tom Griepentrog
Hydrologist
David Groeneveld
Plant ecologist
Bill Hutchison
Hydrologist
Dani Or
Soils specialist
Tony Rossmann
Legal counsel
John Wraith
Soils scientist

Vegetation

Sally Manning
Vegetation monitoring specialist
Irene Yamashita
Supervising research assistant
Brian Cashore
Supervising research assistant
Derik Olson
Research assistant
Denise Waterbury
Research assistant

Soils

Aaron Steinwand
Soils specialist

Hydrology

Randy Jackson
Hydrologist
Rick Puskar
Hydrologic technician

GIS

Chris Howard
Geographic Information Systems (GIS) specialist

Monitoring and managing the Owens Valley

Throughout the year, the Inyo County Water Department monitors the native vegetation, groundwater, surface water and soil water in the Owens Valley, as part of the long-term water management agreement between Inyo County and Los Angeles.

The purpose of this monitoring is to protect the valley's environment from groundwater pumping and other water

activities performed by the Los Angeles Department of Water and Power. Inyo County and Los Angeles use these results to make management decisions to avoid significant decreases or composition changes in vegetation and to avoid groundwater mining (the depletion of water in the aquifer that exceeds replenishment from recharge over a 20-year period).

Hydrology

Precipitation

Inyo County monitors precipitation in the Owens Valley using seven rain gages. The following table shows precipitation totals recorded at each of the rain gage sites for water years 1993 and 1994 (a water year is from October 1 through September 30):

Rain Gage	Precipitation in inches	
	1993	1994
RG-1, near Five Bridges	5.95	3.4
RG-2, near Laws	6.3	3.62
RG-3, southeast of Bishop	7.25	4.34
RG-4, south of Big Pine	8.35	4.24
RG-5, near Goose Lake	6.83	2.15
RG-6, near Blackrock	9	2.95
RG-7, near Independence	5	1.61
Average	6.95	3.19

Snowpack and runoff

Los Angeles Department of Water and Power's April 1, 1994 snow survey found water content in the Mammoth area snowpack to be 55 percent of normal. This marked a return to extremely dry conditions, following the first above-normal year, 1993, since the drought began in 1986 (the April 1, 1993 snow survey found the water content in the snowpack to be 168 percent of normal).

Runoff in 1993 was 117 percent of normal. In 1994, runoff was 62 percent of normal.

Surface water

After a watery respite in 1993 in which surface water

abounded in the Owens Valley, low flows returned to the Owens River and to the more than 20 creeks that flow into the valley from the Sierra Nevada and the White Mountains.

LADWP, which operates three power plants in the Owens River Gorge above Pleasant Valley Reservoir north of Bishop, controls the amount of water flowing through the reservoir. LADWP is required to keep a minimum of 100 cubic feet per second (cfs) flowing into the Owens River below the reservoir.

Between April 1, 1993 and March 31, 1994, flows in the Owens River from Pleasant Valley Reservoir ranged from highs above 600 cfs to lows just below 100 cfs.

Flows were continuously higher in 1993 than in 1994 — between 400 cfs and nearly 600 cfs for several months because of the higher, above-normal 1993 precipitation and runoff. Low runoff in 1994 produced markedly lower flows overall in the river, with flows rarely rising above 175 cfs, and several times dipping below 100 cfs.

Groundwater recharge

Recharge, the amount of water percolating into the aquifer, is estimated for a water year, October through September, and is based on projected runoff.

Estimated recharge into the Owens Valley for 1993 was 184,632 acre-feet. In 1994, estimated recharge into the Owens Valley was 117,552 acre-feet.

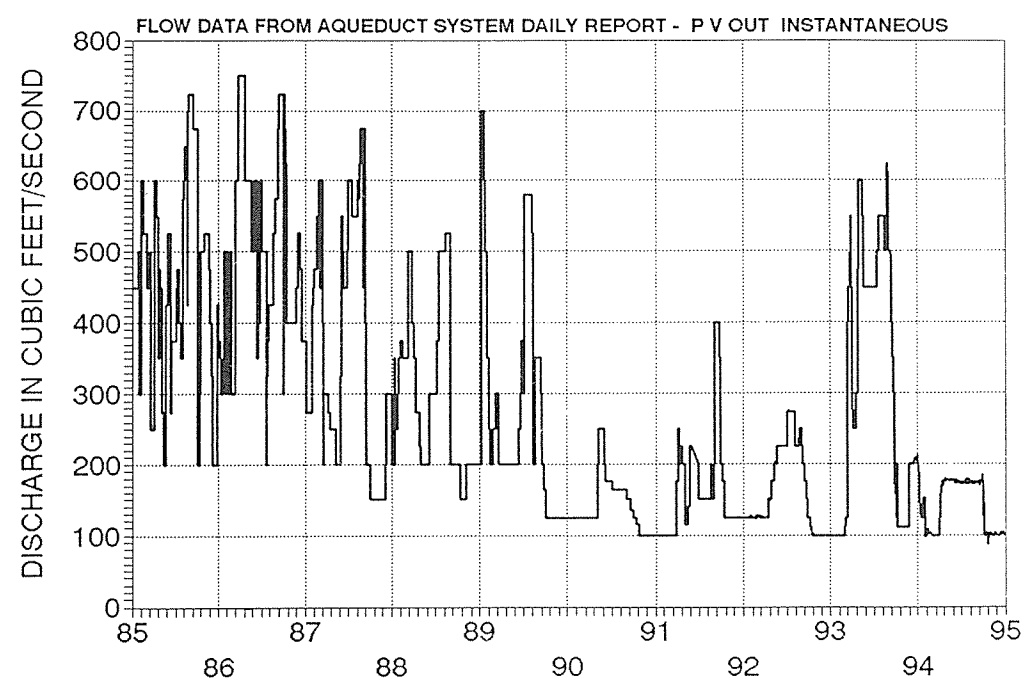
Estimated 1994 recharge by wellfield

Wellfield	Acre-feet
Laws	10,429
Bishop	33,033
Big Pine	17,634
Taboose-Thibaut	22,022
Ind-Sym-Bairs	24,331
Lone Pine	10,103

Shallow aquifer water level recovery in 18 indicator wells

Depth to groundwater (feet) for April of each year						Recovery (feet) April 1993-April 1994	Recovery needed to reach April 1987 water levels
Wellfield	Well #	1987	1992	1993	1994		
Laws	436T	-7.18	Dry at -19	-18.53	-14.71	3.84	7.51
	492T	-32.34	-51.31	-50.48	-41.92	8.59	9.55
Big Pine	425T	-14.25	-26.63	-26.24	-24.41	1.9	10.09
	426T	-11.4	Dry at -19.7	Dry at -19.7	-19.05	at least 0.68	7.62
Taboose-Aberdeen	418T	-8.3	-17.8	-16.75	-15.34	1.51	6.94
	419T	-6.49	-21.81	-18.75	-15.64	3.19	9.07
	421T	-34.25	-47.46	-45.24	-42.55	2.72	8.27
	502T	-7.64	Dry at -16	-15.71	-13.38	2.33	5.74
Thibaut-Sawmill	415T	-18.5	-33.1	-32.38	-28.38	4	9.88
Independence-Oak	407T	-7.21	-16.93	-15.38	-15.58	-0.18	8.35
	408T	-3.02	-9.34	-8.34	-7.5	0.83	4.49
	409T	-17.4	-19.4	-17.39	-12.74	4.4	-4.41
Symmes-Shepherd	401T	-17.53	-24.96	-24.37	-23.93	0.58	6.26
	403T	-6.07	-11.36	-10.45	-10.84	-0.54	4.92
	404T	-3.81	-7.44	-6.31	-7.29	-0.93	3.43
	447T	-22.97	-47.49	-46.36	-45.04	1.25	22.14
Bairs-Georges	398T	-5.64	-7.45	-5.44	-5.92	-0.47	0.27
	400T	-6.6	-6.78	-6.3	-6.63	-0.29	-0.01

Owens River at Pleasant Valley discharge, calendar years 1985-1994



Inyo County and the Los Angeles Department of Water and Power frequently conduct studies to investigate new monitoring methods. The studies completed in 1994 were funded by LADWP and conducted by Inyo County consultants Drs. Dani Or, David Groeneveld and Jon Wraith.

Soil spatial variability

Spatial variability is a measure of how homogeneous or heterogeneous soil properties are and governs how many data collection points are needed to accurately measure the amount of soil water available to the vegetation. One goal of this study was to measure the scale of spatial variability to guide the redesign of the monitoring sites. A second goal was to develop methods to improve estimates of water stored in the soil profile. The three-year project concluded in 1994.

Work in 1994 included an analysis of the spatial variability of important soil properties at two sites and an examination of the relationship of soil and vegetation patterns at several sites. A full assessment of spatial variability at all monitoring sites is probably not feasible. However, management decisions can be made without full assessment, according to county soil specialist Aaron Steinwand. The effect of spatial variability can be accounted for by statistical analyses that group variability from all sources. The study concluded that vegetation and landscape patterns can be used to target placement of monitoring instruments to account for a large source of soil spatial variability.

This study proposed several improvements to the moni-

toring program, including new instrumentation and data analyses to replace the procedures currently used. The study also developed the statistical methods to quantify the uncertainty in measurements of available soil water. Incorporating these methods into the monitoring program increases the credibility of the county's data and allows staff to identify where further improvements in the monitoring program are needed most.

Soil water prediction

Another accomplishment in 1994 was the development of a computer model that predicts the amount of water remaining in the soil after a specified time. The model also calculates an estimate of the uncertainty in the prediction. The model performed well in tests using vegetation, soil and climatic data collected during earlier studies and routine monitoring. It will be a valuable tool to predict how long the soil water will sustain the vegetation between water table drawdown and recovery.

Anomalous soil water recharge

Jon Wraith and David Groeneveld reevaluated two previously collected datasets that showed an apparent increase in soil water content that could not be attributed to precipitation or groundwater inputs. The analysis suggested the earlier observations were correct, but the actual mechanism causing the increase could not be identified because of the small dataset. This study provided insight into a potentially important factor promoting vegetation survival during periods of lowered water tables.

GEOGRAPHIC INFORMATION SYSTEMS

In fall 1994, Inyo County hired GIS Development Specialist Chris Howard to develop a Geographical Information System (GIS) program for the water department and two other departments: roads and the Yucca Mountain division of the planning department.

Howard received a Master's of Regional Planning degree in 1994 from Washington State University in Pullman, Washington. Since coming to Inyo County in September, he has divided his time among the three departments, gathering existing data from state, federal and local sources and entering it into GIS format.

GIS consists of computer software and hardware which together make up a spatially oriented database whereby one can store, manipulate and analyze geographic data.

Inyo County is using GIS software called ArcCad, made by Environmental Systems Research Institute, and a drawing program called AutoCad.

For the water department, Howard is collecting existing

data on vegetation classifications, well locations, soils information, etc., and entering it into the computer. Howard said such a system will prove more efficient than traditional methods of compilation and analysis, such as paper maps and manual drafting. With the GIS program the water department will be able to view more easily different aspects of management in relation to each other. For example, a map can be called up on the computer showing production well locations, and then monitoring sites can be viewed on top of that, and then soil types, and perhaps rare plant sites. Or, one could query the GIS database for all of the well locations within 100 meters of the Owens River. The GIS would display this information graphically.

The GIS program will be used to continue documenting existing conditions and will be updated with information from the ongoing field monitoring program, and eventually will be used to analyze this information and thus to make better water management decisions in the Owens Valley.

control) has only one shrub remaining.

The highest survival and increase in growth was found in the following three combinations:

- 1) irrigation, fertilizer, low density and weed control;
- 2) irrigation, fertilizer, low density and no weed control;
- 3) irrigation, fertilizer, high density and weed control.

The progress report notes that because there were fewer shrubs in 1994 (caused by the continued, though slowed, decrease in plants) in some treatments, there was thus less water and nutrient stress. As a result, some treatment effects are likely becoming obscured.

ICWD will continue to monitor the shrubs' growth, survival, flowering and natural recruitment at the site, al-

though no treatments will be applied in 1995.

In addition to the original revegetation project with 400 four-wing saltbush plants, new revegetation efforts at the site are being conducted. In late 1994, for example, the east side of the fenced site was planted with 30 shrubs: 15 rubber rabbitbrush, seven greasewood, four winterfat, three desert needlegrass, and one budsage.

These shrubs were germinated in the spring of 1994 from local seed and grown in newspaper/plastic wrap pots (see seed story, this page). Planting holes were hand augered about two meters apart and watered before and after planting. No treatments will be applied. The plants will be monitored for growth and survival.

Study of native plant seeds' viability sprouts results

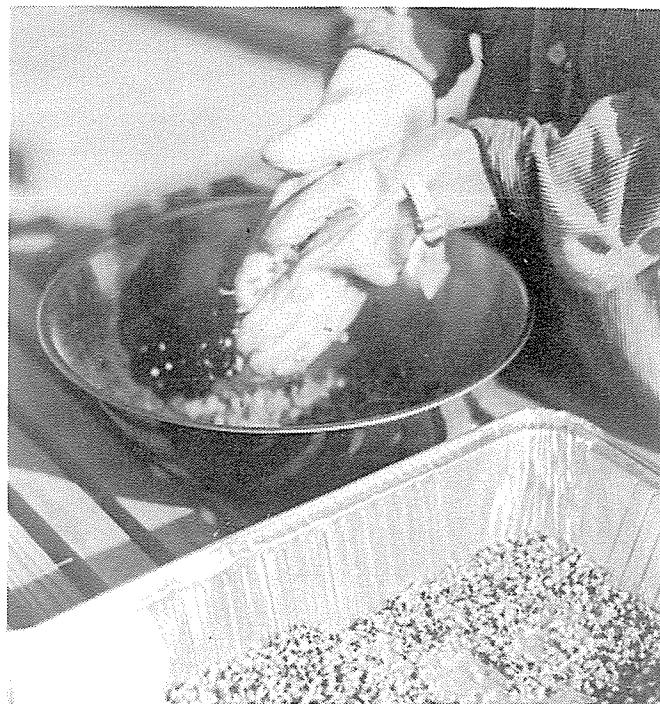
Ideally, Inyo County Water Department staff would like to use native seeds for revegetation projects in the Owens Valley. To explore this possibility, staff began collecting native plant seeds, including those of saltbush, rabbitbrush, sagebrush, winterfat, greasewood and grasses. Since 1993 the water department has been conducting germination tests on these seeds.

The tests should help staff to learn the best methods for maximizing germination of the various seeds, and to glean other information about seed biology such as seed dormancy characteristics. For example, the tests should reveal how long a seed can be stored and remain viable, and the best places to collect seeds of different species.

In the seed study, the Inyo County Water Department conducted germination trials with seeds of eight native shrub species: *Atriplex canescens*, *A. confertifolia*, *A. parryi*, *A. polycarpa*, *A. torreyi*, *Artemisia tridentata*, *Chrysothamnus nauseosus*, *C. albidus*. First, an attempt was made to germinate the seeds without pre-treatment. Then, species showing less than 20 percent germination without treatment were treated and placed in a growth chamber regulating light and temperature. Treatment included removing surrounding fruit or other appendages on the seed, and/or subjecting the seeds to scarification, leaching, and varying the periods of cold temperature.

It was found that under laboratory conditions, all of the species are viable. However, the saltbushes — *Atriplex canescens*, *A. confertifolia*, and *A. parryi* — experienced low germination.

ICWD experimenters theorized that perhaps these seeds required a period of afterripening. Or, perhaps the seeds of these species had low fruit-fill (percentage of fruits containing viable seeds), either an innate trait or perhaps resulting from drought or other stress. Timing of collection also



Preparing seeds for germination

Photo by Heidi Walters

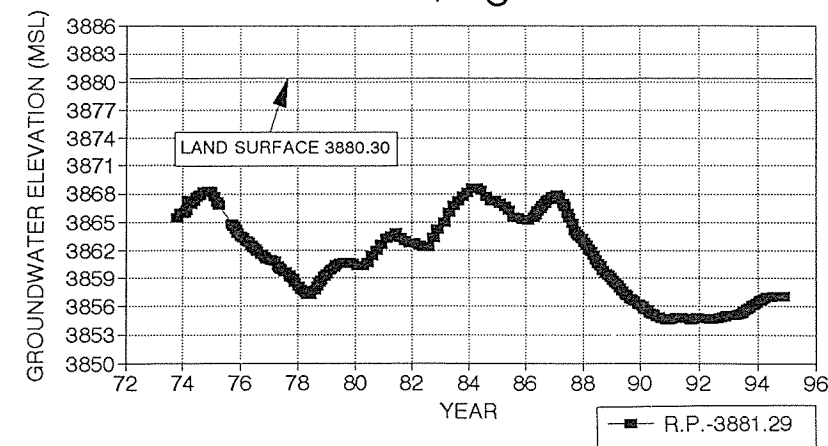
might affect seed viability.

In early 1994, ICWD conducted more germination studies to test these theories, as well as to compare the differences between seed crops (by conducting tests on a newer batch of seeds). The tests showed that germination rates will vary with different seed crops of the same species. As for afterripening, only one test resulted in a significant increase in germination — scarification of *A. canescens* seeds. How fruit-fill affects germination will continue to be studied in connection with environmental conditions.

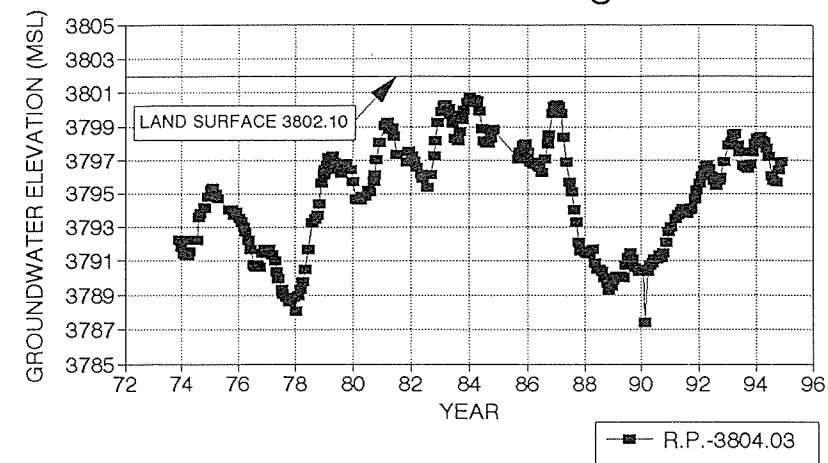
Whatever seedlings occur from these experiments are transferred to pots, as reserve for revegetation projects.

Samples of hydrographs showing groundwater elevations 1975-1994

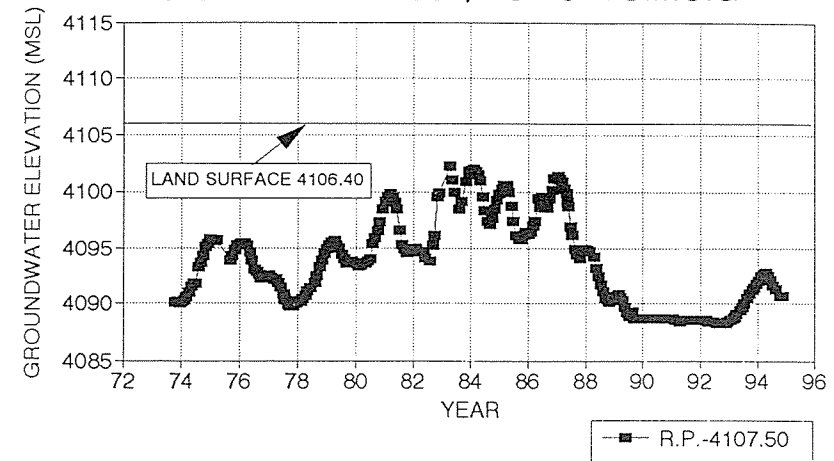
Indicator well 425T, Big Pine wellfield



Indicator well 398T, Bairs-Georges wellfield



Indicator well 436T, Laws wellfield



Vegetation

Conditions at permanent vegetation transects

For purposes of monitoring and management, Inyo County and LADWP have established 33 monitoring sites in the Owens Valley, of which 25 are within wellfields in the area of drawdown.

The eight monitoring sites not in wellfields are control sites, which are used for comparison between pumping affected areas and non-pumping affected areas.

Sixty of LADWP's 96 pump-equipped production wells are linked to the monitoring sites. If soil water at any of these sites is less than the estimated water needs of the vegetation at the site, LADWP wells linked to that site are turned off.

LADWP and Inyo County also may agree to turn off a well or reduce pumping in an area for other reasons in order to achieve the goals of the Inyo/Los Angeles long-term agreement.

Wells may be turned back on once soil water recovers sufficiently to meet the needs of the vegetation at the time the wells were turned off.

Twenty-five LADWP wells not linked to monitoring sites are exempt from the well turn-off provisions of the agreement, either because they are the sole supply for town water systems, fish hatcheries or irrigation, or because they are located away from areas of groundwater-dependent

vegetation. The remaining 11 unlinked production wells are in Bishop.

In addition to the agreement's provisions for managing groundwater pumping, there is the Drought Recovery Policy adopted in 1990 by Inyo County and Los Angeles. (See pumping program for description of the policy, page 3.)

Plant cover —

1993: Owens Valley precipitation and snowpack in the Sierra exceeded normal prior to the 1993 growing season.

Although runoff generally was not sufficient to significantly elevate the water table under sites where it had been drawn down by heavy groundwater pumping in 1987 and 1988, relative to 1992, plant cover in the Owens Valley generally showed an increase at most wellfield and some control sites, according to Inyo County Water Department's plant specialist Sally Manning.

1994: Precipitation and snowfall during the period prior to the 1994 growing season were below normal, and water tables did not rise significantly at most of the sites.

As a result, plant cover declined at most of the sites. At some sites, plant cover fell to the level it had been in 1990, one of the driest years of the drought. See graphs, page 8.

Recruitment —

New plant "recruitment" has been monitored at the permanent monitoring sites since 1991.

The heavy rains in March 1991 induced a profusion of seed germination in the, dominant perennial shrubs.

But subsequent years saw a decline in seed germination, until finally no seeds germinated in 1994.

Although there was high mortality of the 1991 seedlings, relative to the quantities that germinated, a fair number remain alive and have grown measurably since then. Thus, the biggest contribution to new plant establishment occurred in 1991, following the March rains that year.

Most of the new seedlings are Nevada saltbush, but a few rabbitbrush and other saltbush species have established. Some of the sites with the highest recruit survival appear to be changing from grass-dominated sites to shrub-dominated ones.



Monitoring site transect near Big Pine

Photo by Brian Cashore

Year three: Laws revegetation study

Inyo County Water Department (ICWD) staff continues to monitor an experimental revegetation study in Laws, north of Bishop.

ICWD initiated the study to increase understanding of effective techniques for rehabilitating barren abandoned farmland in the Owens Valley.

The study site is among 1,000 acres of barren land in the Owens Valley that have been identified in an environmental impact report as candidates for revegetation. The EIR, covering Los Angeles' groundwater pumping in the Owens Valley, requires that areas impacted since 1970 by pumping and/or surface water practices be mitigated.

Irene Yamashita, ICWD research assistant, is primarily responsible for developing Inyo County's revegetation program and leads the pilot project at Laws.

The study, begun in 1991, is being conducted on part of a 139-acre piece of land that had been mostly barren since it was abandoned as farmland in the 1920s. Before the revegetation study began at the Laws site, the only vegetation growing there were weedy species. Native perennials had failed to re-establish from surrounding seed sources.

In November 1991, the Los Angeles Department of Water and Power fenced a 172- by 173-foot portion of the site,



The revegetation site in 1994

Photo by Heidi Walters

and in December 1991, ICWD staff planted 400 four-wing saltbush shrubs inside the fence.

The plants were subjected to four treatments, applied in different combinations: irrigation, fertilizer, density (how far apart the plants are spaced), and weed control. (An uncontrollable factor is precipitation.)

Since the study began, the shrubs' growth and survival have been monitored annually to examine the effects of the treatments. Results, as documented in the 1994 progress report on the study written by ICWD's Yamashita and Sally Manning, were as follows:

The first year of the study took place in what was the sixth year of continuous drought, and precipitation was 76 percent of normal. In 1993, precipitation was 128 percent of normal. In 1994, precipitation was 67 percent of normal — back to drought conditions. However, both 1993 and 1994 received higher than normal spring precipitation.

In the 1994 growing season, 25 shrubs died, resulting in an overall survival rate of 60 percent after three years. The annual loss of shrubs has been decreasing each year with a loss of 97 shrubs the first year and 36 shrubs in the second.

Overall, Yamashita and Manning report, 1994 results were similar to previous years. Treatments that reduce plant stress (planting at low density, irrigating and weed-ing) increased survival.

The treatment combination that included all the stress factors (high density, no fertilizer, unirrigated and no weed



The first year of the study

Photo by Heidi Walters

Pilot project to control saltcedar begins

In the summer of 1994, Inyo County's Brian Cashore and Brian Stange began a pilot project to control the spread of saltcedar in the Owens Valley.

Saltcedar (*Tamarix* sp.) is a non-native invasive plant that uses large quantities of surface water and groundwater and tends to outcompete native plants. It has been spreading throughout the Owens Valley, moving from the south toward the north.

Hoping to stop the invasion of this weedy tree in the valley, Inyo County and Los Angeles included provisions for a saltcedar control program in the long-term Owens Valley water management agreement. That agreement and an accompanying environmental impact report have yet to be approved by the Third District Court of Appeal.

The purpose of the pilot saltcedar control project is to evaluate saltcedar removal techniques and to determine potential costs of a control program. The results are to be used to develop a saltcedar control program for the entire Owens Valley.

In this initial project, the county and others involved concentrated on stopping the spread



CDF crew member cuts saltcedar Photo by Heidi Walters



Bill Neill's license plate

of saltcedar in the north end of the Owens Valley.

The project initially removed individual trees, and tested different eradication techniques including cutting the plants and applying herbicide. Later the project involved tackling larger stands of saltcedar. (The techniques tested were known to be environmentally sound.)

Saltcedar expert Bill Neill, volunteers, and crews from the California Department of Forestry assisted with the project.

In the fall, a volunteer group led by Neill cut and treated large stands of saltcedar at the Owens River near Big Pine and at Klondike Lake.

Also in the fall, California Department of Forestry inmate crews, under Cashore's and Neill's supervision, cut

large saltcedar stands in Bishop near Dixon Lane and at McNally Ponds. County staff and Neill then applied herbicide to the cut stumps.

The 1994 work will be monitored, and the pilot project will continue with more cuttings and applications of herbicide.

Salinity's effects on saltcedar subject of thesis study

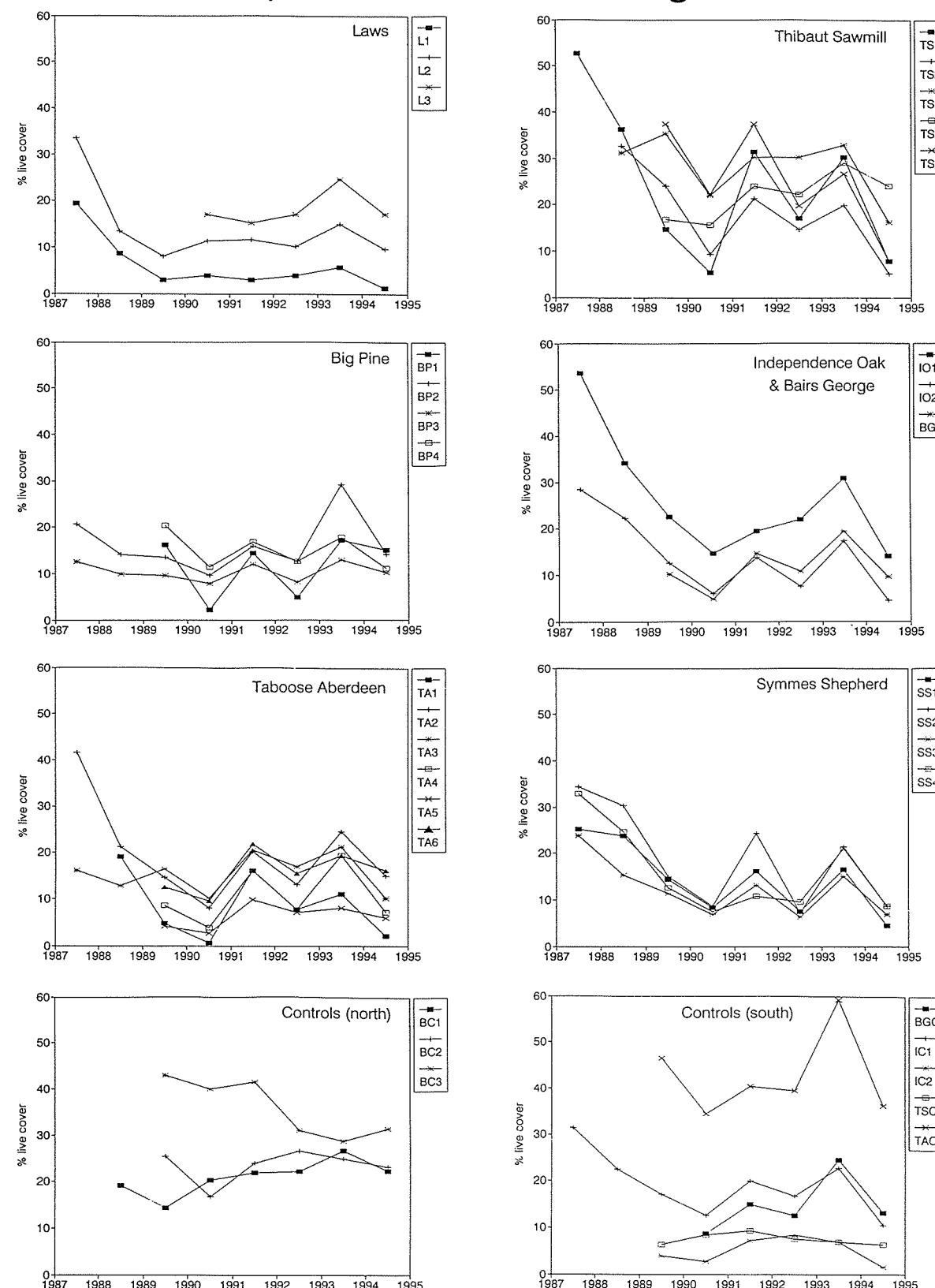
Brian Stange, who has worked for the water department for the past three summers as a field technician, wrote his senior thesis at Humboldt State University on a subject of interest to the water department's saltcedar work.

In his thesis, titled "Effect of Four Selected Soluble Chloride Salts on the Germination of *Tamarix ramosissima*," Stange examined the germination rates of saltcedar seeds when they were placed in salt solutions at different concentrations. He wanted to see if salinity could limit the germination and hence the spread of saltcedar in certain areas.

He tested chloride salts of calcium, sodium, magnesium and potassium.

He found that in tap water, saltcedar seed germination averaged about 90 percent. At low salt concentrations, saltcedar seeds still germinated readily. At higher concentrations, germination was depressed for most types of salt. Stange's conclusion relative to management is that saltcedar "is well adapted for rapid colonization of saline habitats based on its ability to germinate and grow under high saline conditions without any substantial decrease in substrate salinity."

Plant cover at permanent monitoring sites, 1987-1994



Valley-wide monitoring of vegetation change

The goal of the Inyo County/Los Angeles water agreement is to manage Los Angeles' water gathering activities in the Owens Valley to avoid adverse changes in vegetation. This is achieved by ongoing monitoring of vegetation conditions. For comparison, baseline conditions throughout the valley were inventoried and mapped by LADWP between 1984 and 1987.

In 1993 and 1994, the Inyo County Water Department's plant monitoring specialist Sally Manning, with staff, re-inventoried vegetation cover and composition in 60 vegetation parcels inside and outside wellfields. Results consistently show that control parcel perennial plant cover remains constant in wet years and dry, but wellfield parcels have experienced a decline in perennial plant cover since they first were inventoried between 1984 and 1987. While wellfield plant cover improved somewhat in 1993, relative to 1992 cover, it declined again in 1994.

These results are shown in the table on this page. The first column shows the year of the re-inventory. The re-inventory compares vegetation in that year (say, 1991) to the vegetation conditions during the years from 1984 to 1987.

Because each vegetation parcel started with its own value for live cover (typically ranging from 10-60 percent), Manning used the *percent change* in live cover for compar-

ison. For example, Parcel A may have changed from 15 percent live cover in 1985 to eight percent in 1991, while Parcel B may have changed from 55 percent to 26 percent. Thus, both parcels have exhibited a 47 percent decline in vegetation cover relative to when they first were inventoried.

The second column shows the average relative change in cover of perennial plants in wellfields, where the water table was lowered by pumping. Bold type indicates that the change was statistically significant, with the probability (p) of this result occurring due to chance less than five percent.

The third column shows the number of parcels in this category (wellfield) that were re-inventoried.

The fourth column shows the relative change in perennial cover for control parcels — those not influenced by pumps. Note that none of the values in this column are statistically significant. That is, as a group, there was no measurable change in cover in the control parcels in any of the four years (they have more or less held steady whether it has been a wet or a dry year).

The last two columns show the change in the proportion of annual (mostly weedy) plants in the parcels. In 1993, the wet year, there was a significant increase in weeds in both wellfield

and control parcels. One question being asked is whether the space opened by die-back of perennial plants will make room for the weeds, which may take over even more space, once enough water becomes available.



Derik Olson, line-point transect monitoring
Photo by Denise Waterbury

Summary of line-point transect results to measure vegetation change, 1991-1994

to year	wellfield perennials	# parcels	control perennials	# parcels	wellfield annuals	control annuals
1991	-40.8%	21	-8.4%	9	+13.5%	+1.6%
1992	-41.8%	49	+0.9%	50	+10.3%	+5.3%
1993	-14.8%	36	+23.8%	24	+14.2%	+3.2%
1994	-36.9%	36	+7.5%	24	-2.2%	-0.7%

Rare plant monitoring, 1993-1994

The Inyo County Water Department monitors two rare plant species in the Owens Valley: *Sidalcea covillei* ("Coville mallow" or "Owens Valley checkerbloom"), a state-listed rare plant, and *Calochortus excavatus* ("Inyo County star tulip" or "alkali mariposa lily"), a candidate for the federal list of endangered species.

Both plants are perennial herbs adapted to the wet, alkaline soils that occur in Owens Valley native alkali meadows. Thus, both occur in areas managed and monitored by the provisions of the Inyo/Los Angeles water agreement

Since 1982, many populations of both of these species have been found and reported to the California Natural Diversity Database by Los Angeles Department of Water and Power range and wildlife staff. The populations were checked periodically over the years and their status noted.

Inyo County Water Department's Sally Manning has developed a systematic monitoring program that involves counting rare plants in selected populations.

About 30 populations, located both in areas potentially affected by pumping



Calochortus excavatus

and in control areas, are checked each year.

During 1994, Manning and staff visited 38 rare plant sites. They found that:

- ♦ by using standardized counting techniques, they arrived at estimates of total numbers of plants in populations that in some instances vary greatly from previous estimates (in fact, they tended to count many more plants than were previously estimated);

- ♦ despite 1994 being a dry year and 1993 being a wet year, there were few differences in total number of *Sidalcea* plants at most rare plant sites from 1993 to 1994;

- ♦ *Calochortus* numbers appear to fluctuate from year to year in a way that cannot be explained by annual precipitation patterns;

- ♦ livestock grazing during the time rare plants are flowering can result in shorter plants and fewer plants with flowers, but does not appear to influence the total number of plants counted in a population;

- ♦ *Sidalcea* plants near the Five Bridges area, which was impacted by pumping, remained viable but small and non-reproductive.

Soil water

Soil water conditions

According to Inyo County Water Department's soil specialist, Aaron Steinwand, soil water conditions remained little changed during 1994.

Below normal winter precipitation and nearly no rain during summer precluded opportunities for soil water recharge.

The water table at all sites remained relatively stable or dropped slightly. One site went into surplus in January 1994 because of a rising water table which gradually declined thereafter. No additional sites changed status. As of Oct. 1, 1994, 14 of the 22 wellfield monitoring sites were in soil water deficit.

Soil water monitoring activities

Much of 1994 was occupied with the task of revising the soil water monitoring program. This included field and laboratory work to collect soil data needed to analyze previously collected data for each monitoring site.

Steinwand also worked closely with consultants to develop the methods required to improve the soil water monitoring program.

Other activities included a re-examination of the previously collected psychrometer data and incorporation of quality control into data handling procedures. Also, the water department purchased laboratory equipment and set up a soils laboratory capable of routine soil characterization.