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MEMORANDUM

September 30, 1997

TO: Indian Wells Valley Producers

FROM: Bill B. Dendy

SUBJECT: Final Report: Findings and Recommendations of the Technical Working Group

INTRODUCTION

The Indian Wells Valley lies east of the southern Sierra Nevada in California at the junction of the Inyo, Kern and San Bernardino County Lines. The average elevation of the Valley is about 2300 feet above sea level. Except for a few very minor sources, all water supply in the Valley is produced from wells. There are about 850 wells in all, including 34 wells owned by the five major producers and about 670 individual domestic wells, 120 residential cooperative wells and 32 small agricultural wells. The total estimated annual water production in the Valley currently is about 25,000 acre feet. Plate 1 shows the general distribution of wells in the Valley.

Past studies have reached a range of conclusions as to the sources and amounts of inflow of groundwater into the Valley, the amounts of groundwater outflow from the Valley, the long term average annual yield of the groundwater for production that can be sustained without incurring undue changes in storage or water quality degradation, and the existence of discrete subbasins or subareas within the Valley.

In May 1997 a group of governmental and water supply interests in the Valley, termed collectively the Indian Wells Valley Producers ("Producers"), agreed to pool their resources to retain Bill Dendy & Associates to form a Technical Working Group ("TWG") consisting of representatives of each Producer and to facilitate discussion and technical analysis by the TWG of several factual issues involving groundwater and the groundwater basin underlying the Valley.

Following is a listing of the Producers and their representatives on the TWG.

Brown Road Farming: Tom Stetson

China Lake Naval Air Weapons Station: Mike Stoner and Jim McDonald

Indian Wells Valley Water District: Arden Wallum and Charles Krieger

InyoKern Community Services District: Janet Stuebner and LeRoy Marquardt

North American Chemical Company: Gail Moulton and Mike Lovejoy

City of Ridgecrest: Gina-Marie Robinson

The charge to the facilitator and the TWG was: *"to gather data and generate a report to the Producers on the following factual issues related to the Indian Wells Valley groundwater basin or basins:*

1. *The boundaries of the basin or basins if there are more than one and whether and how groundwater production in one basin affects groundwater production in another basin if there are more than one;*
2. *The existence or nonexistence of subbasins within a basin or basins and whether and how groundwater production in such subbasin affects groundwater production in any other subbasin or subbasins;*
3. *The source and amount of water supply to each identified basin and subbasin;*
4. *The existence or nonexistence of overdraft in any identified basin or subbasin;*
5. *The existence or nonexistence of outflow from the Indian Wells Valley basin or basins to adjoining basins and whether and how groundwater production in the Indian Wells Valley affects such flow."*

In addition, the facilitator and the TWG were instructed as follows: *"if the report contains a consensus on the existence of sufficient data to identify and suggest an institutional solution to a groundwater production problem or problems, it shall do so."*

The TWG met regularly during June, July, August and September 1997 and members of the TWG worked between meetings to prepare maps and cross-sections, to compile and analyze data on water production, quality and levels, and to prepare informal reports for presentation and discussion at the regular meetings. The TWG relied heavily on the members' knowledge of past studies of the Valley as well as their individual expertise and knowledge of the Valley.

FINDINGS

The TWG did not set out to conduct and publish an exhaustive technical review and comparison of past studies of the geology and hydrology of the Valley. Past studies have sometimes disagreed over assumptions or interpretations of data. Instead, this report is a distillation of the TWG's conclusions on factual issues, set forth in the charge to the TWG, which will be relevant to further discussions focusing on assuring an adequate water supply for the Valley over the long term. The members of the TWG could not determine a quantitative answer to every technical question posed by the Producers. However, there are consensus responses to all questions and the members of the TWG are in agreement that this report fairly sets forth those responses. The TWG's findings can be summarized as follows:

a) the natural water supply for the Indian Wells Valley may not be adequate to sustain current and future levels of use over the long term; and

b) it will take several years of additional monitoring and analysis to determine the exact level of use that can be sustained by the natural supply without undue reduction of storage or water quality degradation, neither of which appears imminent; but

c) there is sufficient information available to support a conclusion that it would be in the public interest to reach an early consensus in the Valley on what is the best way to implement the data collection and analysis programs needed to characterize the water supply situation and any water quality changes that may occur over time, to develop and implement long term plans to define and address future needs and to institutionalize the protection of the water supply interests of all current water users in the Valley; and

(d) with a proper management plan and governance structure there is every reason to believe that the Valley has or will have the water resources necessary to sustain its economy for many years to come.

Following are the specific findings of the TWG on the factual issues set forth in the charge to the facilitator and the TWG:

Factual Issue No. 1: The boundaries of the basin or basins if there are more than one and whether and how groundwater production in one basin affects groundwater production in another basin if there are more than one.

The Indian Wells Valley groundwater basin is a single basin. The approximate boundaries of the water bearing portion of the basin are shown on Plate 1 and described generally in Exhibit 1. The regional groundwater gradient is generally toward the China Lake playa.

Factual Issue No. 2: The existence or nonexistence of subbasins within a basin or basins and whether and how groundwater production in such subbasin affects groundwater production in any other subbasins.

The basin can be considered to consist of four subareas, as opposed to subbasins. The approximate boundaries of the subareas are shown on Plate 1. There appears to be at least some degree of hydraulic continuity throughout the basin which means water can flow between subareas, although the flow cannot be measured at this time. At current water levels and production rates the available data support a conclusion that a combination of faulting, clay masses and the west-to-east regional groundwater gradient prevents any significant flow of water between Subareas I and IV or from Subarea III to Subarea IV. There is insufficient data to support such a conclusion relative to flow between Subareas I and II, between Subareas I and III or between Subareas II and III. The potential for inter-Subarea flows to occur and to affect the interests of the producers is a water management factor to be taken into consideration and appropriate monitoring programs should be implemented.

Factual Issues Nos. 3 & 4: The source and amount of water supply to each identified basin and subbasin; the existence or nonexistence of overdraft in any identified basin or subbasin.

Virtually all useable natural inflow of water to the basin is subsurface. Water flows naturally from the basin through evaporation from the China Lake playa and through subsurface

outflow. It is not possible to measure inflow and outflow for the basin or any subarea at this time. The only two variables that can be measured with any degree of reliability are water production and groundwater levels. Exhibit 2 summarizes the reported or estimated production by major producers over the twenty year period 1977-1996. Exhibit 3 presents estimates of current annual production by small producers. Exhibit 4 presents a discussion of methodologies for estimating the apparent net annual water supply to subareas in the Valley using production and water level data.

During the time frame for its deliberations the TWG was unable to reach a definitive estimate of the apparent net natural water supply or changes in storage for any subarea, primarily due to problems of data reliability or comparability. The findings for each Subarea are as follows:

(a) For **Subarea I** a comparison was made of water level histories during the early 1980's, when production averaged about 13,000 to 14,000 acre feet per year, with the water level histories in the late 1980's, when production averaged about 7,000 acre feet per year. The data for several wells indicated falling water levels at the higher production rates followed by more stable water levels at the lower rates. Since 1990 production has averaged about 7,700 acre feet per year and during that time period some water levels have declined slightly, some have risen slightly and others have stayed about the same.

(b) For **Subarea II** the TWG concluded that, due to a paucity of wells, there are not sufficient data available to characterize the water quality, production capabilities, water levels, water supply or overdraft, if any. Any proposed water supply development in Subarea II should be preceded by a thorough study of potential impacts on adjacent subareas.

(c) For **Subarea III** there is almost no production and the groundwater is quite saline, particularly in the shallow zone. The TWG concluded that there are not sufficient data available to estimate the water supply or overdraft, if any, but that future water development in Subarea III seems unlikely to occur.

(d) For **Subarea IV** the TWG was not able to arrive at definitive estimates of water supply or changes in storage because data sets for water levels in different years are not comparable. Historical data do indicate that water levels have declined in some parts of

the Subarea and not in others. In addition, since the Indian Wells Valley Water District shifted about 25% of its production from the "Ridgecrest Area" (east of Jacks Ranch Road) to the "Intermediate Area" (west of Jacks Ranch Road) in 1993, water levels in the Ridgecrest Area, which had been declining, appear to have stabilized. Taken together, the figures in Exhibits 2 and 3 indicate that the average annual production in Subarea IV over the past five years was about 17,000 acre feet per year, which is about the same as the average annual production in the Subarea over the past twenty years. In September 1995 the major producers in Subarea IV, along with other interested agencies, entered into a non-binding agreement entitled Cooperative Groundwater Management Plan for the Indian Wells Valley. The Plan includes criteria for well locations, well spacing, production rate limitations and an improved water level monitoring program, and is a good first step toward production management in the Subarea. Continued acquisition of data on year-to-year changes in water levels, using uniform monitoring protocols, will enable better estimates of changes in storage and water supply in the future.

Water quality changes can also be used as an indicator of potential overdraft in circumstances where water of undesirable quality may be induced to flow toward production wells that cause changes in groundwater gradients. Water in some parts of the Indian Wells Valley basin exhibits high salinity, including water in Subarea III, the southern and eastern portions of Subareas I and the extreme eastern portion of Subarea IV. The regional groundwater gradient generally maintains flow from the areas with low salinity toward the areas of higher salinity. There have been some increases in dissolved mineral content in water produced in Subarea I and in Subarea IV east of China Lake Boulevard. The potential for inducing either horizontal or vertical intrusion of poor quality water, particularly locally near the high salinity/low salinity interfaces, is a water management factor to be taken into consideration. Monitoring near the interfaces on a regular basis is essential to enable an early warning of any developing water quality problems.

Creating and maintaining a data base of the characteristics (depth, perforations, annual usage, logs) of all existing and future wells in the Valley, regardless of size, production capacity or ownership, is a necessary step toward attaining a full understanding of any present or future

production-related impacts on the Valley groundwater system generally. Improved coordination and communication between Valley water producers and the agencies who are charged with enforcement of well ordinances would facilitate this data base effort.

Regular, comprehensive accounting for production and changes in storage is an essential element of water management in the Valley.

Factual Issue No. 5: The existence or nonexistence of outflow from the Indian Wells Valley basin or basins to adjoining basins and whether and how groundwater production in the Indian Wells Valley affects such flow.

Studies by some TWG members, and others in the past, have indicated the existence of subsurface outflow toward Searles Lake. There is no consensus on the rate of outflow. There is no evidence to indicate that historical production in Indian Wells Valley has reduced such outflow. This relationship should be monitored in the future.

RECOMMENDATION FOR FURTHER ACTION

It is apparent to the TWG that, in order to maintain hydrologic balance in the basin and in each subarea, some form of Valley-wide water management governance structure, built on the efforts of the past, needs to be established to address and resolve in a fair and equitable way all of the water management issues that are important to the Valley, including:

a) Continuing to improve the monitoring of water production and use, changes in storage and changes in water quality.

b) The potential for wastewater reuse

c) The potential for water demand reduction through conservation measures

d) The potential for treatment and use of brackish water

e) The potential benefits to be gained from control of the patterns and rates of production

f) The potential efficiencies that might be gained through an orderly program of voluntary water transfers while assuring protections for the producers in each subarea.

g) The potential need for a backup source of imported water

To that end, the TWG recommends that the major producers and representatives of the smaller producers organize an Institutional Working Group with the objective of reaching a consensus on a water management governance structure that is tailored to fit the needs of Indian Wells Valley.

LIST OF EXHIBITS

1. General Boundary Descriptions for the Groundwater Basin and Subareas
2. Groundwater Production History, 1977-1996, Reported by or Estimated for Major Producers
3. Estimated Groundwater Production By Small Producers, 1996
4. Estimating Apparent Net Annual Water Supply

LIST OF PLATES

1. Map Showing Approximate Basin and Subarea Boundaries and the General Distribution of Wells

EXHIBIT 1

INDIAN WELLS VALLEY

General Boundary Descriptions

for the

Groundwater Basin and Subareas

For purposes of this report the Technical Working Group established the Indian Wells Valley groundwater basin boundary as being generally defined by the interface of alluvial deposits and bedrock along the various mountain ranges surrounding the Valley: the Sierra Nevada on the west, the Coso Range on the north, the Argus Range on the east and the El Paso Mountains/Rademacher Hills on the south. In places where there is no alluvium/bedrock interface the boundary was defined by surface water drainage divides. Total surface area of the basin is about 540 square miles.

The TWG also divided the basin into four subareas based on fault zones and stratigraphy. The subareas are not completely separate hydrologic units but each subarea has characteristics, such as water chemistry or aquifer characteristics, that sets it apart from the others. The TWG agreed that it is appropriate to use the term "subarea" rather than "subbasin". The approximate basin and subarea boundaries are shown on Plate 1

Subarea I, which is the northwest portion of the Valley, is bounded on the west by the Sierra Nevada bedrock/alluvium interface, on the north and east by the Little Lake Fault Zone, and on the south by an apparent unnamed fault, described in prior reports, which runs from northwest to southeast in the general vicinity of Leliter Road. The surface area is about 84 square miles.

Subarea II, which is the northern portion of the Valley and includes Airport Lake and the Coso Basin, is bounded on the west by the Little Lake Fault Zone, on the north and east by the Coso Range and Argus Range bedrock/alluvium interfaces, and on the south by the edge of a

confining clay layer together with the Wilson Canyon Fault. The surface area is about 71 square miles.

Subarea III, which is the east-central portion of the Valley and includes China Lake, is bounded on the north by the edge of a confining clay layer, on the east by the Argus Range bedrock/alluvium interface, and on the south and west by the Little Lake Fault Zone. The surface area is about 113 square miles.

Subarea IV, which is the south-central and southwest portion of the Valley and includes Ridgecrest and InyoKern, is bounded on the north by an unnamed fault (see Subarea I) together with the Little Lake Fault Zone, on the east by a surface water drainage divide that extends south from Lone Butte to the El Paso Mountains/Rademacher Hills, on the south by the El Paso Mountains/Rademacher Hills bedrock/alluvium interface, on the southwest by a surface water drainage divide that extends northwest from the El Paso Mountains to the Sierra Nevada, and on the west by the Sierra Nevada bedrock/alluvium interface. The surface area is about 273 square miles.

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EXHIBIT 2

INDIAN WELLS VALLEY

Groundwater Production History, 1977-1996

Reported by or Estimated for Major Producers

Acre Feet per Year

Year	Subarea I				Subarea IV							Total
	Brown Road Farming	Neal Ranch	Spike Leroy (estimated)	Subtotal	North American Chemical Company	Indian Wells Valley Water District	China Lake Acres (estimated)	Ridgecrest Heights (estimated)	China Lake Naval Air Weapons Station	InyoKern CSD (1977-87 estimated)	Subtotal	
1977	2,702	2,000	1,600	6,302	3,315	3,063	400	1,000	5,000	300	13,078	19,380
1978	3,216	2,000	1,600	6,816	3,081	3,357	400	1,000	5,000	300	13,138	19,954
1979	3,257	2,000	1,600	6,857	3,081	3,402	400	1,000	5,154	300	13,337	20,194
1980	7,515	2,041	1,600	11,156	2,887	3,319	400	1,000	4,995	300	12,901	24,057
1981	10,036	2,002	1,600	13,638	3,065	4,223	400	1,000	4,804	300	13,792	27,430
1982	10,324	1,478	1,600	13,402	2,887	3,963	400	1,000	4,450	300	13,000	26,402
1983	10,087	1,752	1,600	13,439	2,476	4,316	400	1,000	4,402	300	12,894	26,333
1984	10,312	1,568	1,600	13,480	2,307	4,940	400	1,000	4,694	300	13,641	27,121
1985	10,100	2,450	1,600	14,150	2,397	4,981	400	1,000	4,002	300	13,080	27,230
1986	5,839	2,353	1,600	9,792	2,557	5,901	400	1,000	4,430	300	14,588	24,380
1987	4,141	1,447	Ranch	5,588	2,560	7,426	Purchased by IWVWD		4,422	300	14,708	20,296
1988	5,255	1,195	Closed	6,450	2,560	7,889			3,980	173	14,602	21,052
1989	7,064	Ranch		7,064	2,320	8,725			4,205	175	15,425	22,489
1990	6,187	Closed		6,187	2,505	8,600			3,667	170	14,942	21,129
1991	6,737			6,737	2,406	7,700			3,364	150	13,620	20,357
1992	7,104			7,104	2,528	7,650			3,351	141	13,670	20,774
1993	7,701			7,701	2,607	7,800			3,411	150	13,968	21,669
1994	7,504			7,504	2,607	8,300			3,684	146	14,737	22,241
1995	7,427			7,427	2,710	8,100			3,848	125	14,783	22,210
1996	7,807			7,807	2,620	8,504			3,367	134	14,625	22,432

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EXHIBIT 3

INDIAN WELLS VALLEY

Estimated Groundwater Production By Small Producers, 1996

Acre Feet Per Year

Township/ Range	Residential					Agricultural			Total Production	
	Cooperatives Number Of Wells	Residences Served	Single Residence Wells	Total Residences Served	Total Residential Production (AFY)	Number Of Wells	Production Low Estimate (AFY)	High Estimate (AFY)	Low Estimate (AFY)	High Estimate (AFY)
Subarea I										
T25S/R38E	13	76	93	169	203	8	14	23	217	226
T25S/R39E	1	12	3	15	18	0	0	0	18	18
Subtotal	14	88	96	184	221	8	14	23	235	244
Subarea IV										
T26S/R38E	16	52	79	131	157	1	77	129	234	286
T26S/R39E	73	549	246	795	954	18	672	1062	1626	2016
T26S/R40E	19	68	147	215	258	1	0	0	258	258
T27S/R38E	0	0	1	1	1	1	39	64	40	65
T27S/R39E	0	0	8	8	10	3	145	242	155	252
T27S/R40E	1	16	89	105	126	0	0	0	126	126
T28S/R37E	0	0	1	1	1	0	0	0	1	1
Subtotal	109	685	571	1256	1507	24	933	1497	2440	3004
Total	123	773	667	1440	1728	32	947	1520	2675	3248

Estimating Methodology: Aerial photographs, field observations and other sources (state and county records) were used to obtain a count of wells and residences. Based on a sampling of water usage in the Valley, a water duty of 1.2 acre feet per year per residence was used to estimate residential water usage. Aerial photographs and field observations were used to locate irrigated agricultural plots. Agricultural water usage estimates were derived from estimated acreages, crops and generally accepted ranges for water duties in the area.