LOS ANGELES COUNTY WATERWORKS DISTRICTS

REPORT ON EXISTING AND PROJECTED

WATER DEMANDS AND SOURCE OF SUPPLY

FOR THE ANTELOPE VALLEY

As a result of the current drought and the rapid growth in the Antelope Valley over the past decade, various individuals, organizations, associations and public agencies have questioned the availability of water to meet existing and future needs.

The following is Los Angeles County Waterworks' assessment of the available water supplies to meet the present demands and future growth in the Antelope Valley. This report addresses such specific issues as:

1. Projected growth rate for the Antelope Valley.
2. The quantity of water currently being extracted from the groundwater basin.
3. The amount of water currently in storage in the groundwater basin.
4. The amount of water that can be extracted from the groundwater basin without depleting this local supply (referred to as the safe yield).
5. Number of people (population) that can be served from the current source of supply.

EXISTING ESTIMATED POPULATION

The Los Angeles County Department of Regional Planning estimates that the present population of the Antelope Valley within Los Angeles County is approximately 187,000 of which approximately 179,000 or 94% of this population reside in the Palmdale, Lancaster and Quartz Hill areas. The remaining 8,000 or 6% of the total reside in the various rural communities scattered throughout the Valley. Table No. 1 indicates the estimated population of the thirteen largest water purveyors within the Los Angeles County area. The data for this table was obtained from the Los Angeles County Department of Regional Planning and the various water purveyors in the Antelope Valley.

Table No. 1

Estimate of Present Population within the Service Areas of the Various Water Purveyors within the Los Angeles Area of the Antelope Valley

Water Purveyor	Estimated Population @2.9 Persons/Du 1989
1. Los Angeles County Waterworks Districts Nos. 4, 34, 24, 27, 33, 35, 38 and 39	102,843
2. Palmdale Water District	49,581
3. Quartz Hill Water District	10,995
4. Palm Ranch Water District	4,512
5. Littlerock Creek Irrigation District	2,697
6. Land Project Mutual Water Company (MWC)	1,683
7. Shadow Acres MWC	225
8. White Fence Farms MWC	2,271
9. White Fence Farms No. 3 MWC	1,320
10. Averydale MWC	885
11. Westside Park MWC	603
12. Aqua-J MWC	192
13. Reesedale MWC	72
14. Other 15 MWCs	1,332
TOTAL:	179,211

FUTURE POPULATION

According to the Los Angeles County Regional Planning Department, the Year 2010 projected population for the Los Angeles County area is 305,000. While the Southern California Association of Government (SCAG) estimates the Year 2010 population for this area at 421,000.

Using the SCAG population projection of 421,000, the average yearly population growth is estimated at 12,000. The estimated Year 2010 growth of the various public water districts and mutual and investor owned water companies in Los Angeles County are shown on Table No. 2 below. These projected growth figures are based on a ratio of each purveyor's present population to the total present population times the total projected population.

Table No. 2

Projected Year 2010 Population of
the Water Purveyors in the Antelope Valley

Water Purveyor	Year 2010 Estimated Population*	Year 2010 No. of Equivalent Services**
1. Los Angeles County Waterworks Districts	237,000	82,000
2. Palmdale Water Distric	124,000	43,000
3. Quartz Hill Water District	27,000	9,500
4. Palm Ranch Water District	11,000	3,900
5. Littlerock Creek Irrigation District	6,800	2,300
6. Various Mutual & Investor Owned Water Companies	15,000	5,300
TOTAL:	421,000	146,000

* Based on SCAG population projected for the Year 2010 of 421,000.

** Based on 2.9 persons/service

It should be noted that the distribution of the estimated population into specific areas is difficult and may be impossible to accurately predict and is beyond the scope of this study. For this purpose, it was assumed that the estimated growth would totally be absorbed in Los Angeles County. However, a portion of this expected growth will extend into the Rosamond/Willow Springs area in Kern County. Information obtained from Kern County and the Rosamond Community Service District indicates that this area contains 2% and has the potential to increase to 14% of the total population in the Antelope Valley. Edwards Flight Test Center also within Kern County contains approximately 3% of the total population. Altogether these two areas currently contain 5% of the total population of the Antelope Valley.

WATER DEMANDS

The major water demands come from agriculture and water purveyors providing water for municipal and industrial (M & I) purposes. Historically, the water for M & I use was very small with the water purveyors serving the domestic needs of the local farmers and other residents residing in the Lancaster, Palmdale, Quartz Hill, Littlerock and other rural communities. Since World War II, with the expansion of military and aerospace and substantial growth in Southern California, the Antelope Valley is no longer dependent on agriculture and thus has become primarily an urban area.

The largest growth and accompanying water demands are expected to be concentrated within the Los Angeles County area of the Antelope Valley and a negligible amount in the Rosamond and Edwards Flight Center in Kern County. The present water demands of this area represent at this time a negligible impact on the water resources and therefore were not considered in the following analysis.

1. Municipal and Industrial Water Demands

The 1989 water demands for M & I purposes of the various water purveyors are shown in Table No. 3. This data was obtained from the Department of Regional Planning, Waterworks records and telephone inquiries to the various purveyors. Waterworks consumption data indicates that the yearly demand of water for M & I varies from 0.59 acre-feet per dwelling unit per year (ac-ft/du/yr) in the rural communities to 0.90 ac-ft/du/yr in the urban areas.

Table No. 3

Existing 1989 Water Demands of the Purveyors

Water Purveyor	Existing Water Demands Ac-Ft/Year	Groundwater		SWP	
		Demand Ac-Ft/Yr	% of Total Demand	Demand Ac-Ft/Yr	% of Total Demand
1. Los Angeles County Waterworks Districts	35,517	16,467	46	19,050	54
2. Palmdale Water District	16,709	8,650	52	8,059	48
3. Quartz Hill Water District	3,665	2,296	63	1,369	37
4. Littlerock Creek Irrigation District	2,471	1,500	61	971	39
5. Palm Ranch Water District	1,556	562	36	994	64
6. Various Mutual and Investor Owned Water Companies	3,757	1,145	31	2,612	69
Total	63,675	30,620	48	33,055	52

2. Agricultural Water Demands

Based on data from the 1989 Los Angeles County Agricultural Commission Report, the following is a breakdown of the current agricultural production in the Antelope Valley and estimated water demands.

Table No. 4

Antelope Valley Agricultural Land and Applied Water Demands

Crop	Area (Acres)	Duty* (Ac-Ft/Ac/Yr)	Applied Water Ac-Ft/Yr
Alfalfa	6,300	5	31,500
Dry Onions	1,675	3.7	6,200
Peaches	800	2.8	2,240
Total	8,775		39,940

* Water required to irrigate one acre of land per year.

The total water applied to these crops is estimated at 39,940 acre-feet per year. The 1969 Soil Conservation District Report indicates that approximately 30% of irrigation water percolates into the basin and reduces the net water for irrigation to 28,000 acre-feet. This water comes from the following sources.

Table No. 5

Agricultural Water Use
in Acre-Feet

Source	Amount (Ac-Ft)	% of Total
Groundwater	10,800	38
Imported (SWP)	16,000	57
Reclaimed Water	1,200	5
Total	28,000	100

3. Total Water Demands

The water demands of the Antelope Valley are met by extracting groundwater from the Antelope Valley Groundwater Basin and by importing SWP water. Table No. 6 below delineates the water usage from these sources for both agricultural and M & I needs. Agricultural use according to the State of California Department of Water Resources (DWR) Report has been substantially diminished from 86% in 1975 to the present 31%. However, due to the encroachment of urban growth on to agricultural land, the M & I demand for water has increased from 14% to 69% of the total. The utilization of SWP water has diminished the use of groundwater and now provides 54% of total demands.

Table No. 6

1989 Antelope Valley Total Water Usage
(Acre-Feet)

Use	Groundwater	Imported Water	Reclaimed Water	Total
Agricultural	10,800	16,000	1,200	28,000
Municipal & Industrial	30,620	33,055	-	63,675
Total	41,420	49,055	1,200	91,675
	45%	54%	1%	

Present consumptive water use per dwelling varies from 0.59 to 0.90 ac-ft/yr. The projected population growth and water demands expected for Year 2010 are based on 2.9 persons per dwelling unit and an annual water use per dwelling unit of 0.8 acre-feet. It is also assumed that water for irrigation will remain the same.

Table No. 7

Total Water Demand for M & I and Agriculture in Ac-Ft/Yr

	1990	2010
Agricultural	28,000	28,000
Municipal & Industrial	63,675	116,000
Total	91,675	144,000

WATER RESOURCES

The Antelope Valley has two sources of available water. The primary and most reliable is from the Antelope Valley Groundwater Basin. The second water source is from the State Water Project through the Antelope Valley-East Kern Water Agency (AVEK), Palmdale Water District (PWD) and Littlerock Creek Irrigation District (LCID) and is considered a supplemental supply. This supplemental water supply is susceptible to delivery reductions during drought years and is not a guaranteed supply.

1. Antelope Valley Groundwater Basin

Based on the various studies conducted by the U.S. Geological Survey and the State of California Department of Water Resources, the Antelope Valley Groundwater Basin consists of the principal or upper aquifer from which most of the water is currently being extracted and the deep aquifer.

The groundwater basin has a storage capacity of approximately 68,000,000 acre-feet (1) (2) of which approximately 13,000,000 acre-feet has been extracted leaving approximately 55,000,000 acre-feet in storage. The groundwater basin has an annual natural recharge from the watershed area varying from a minimum of 40,700 acre-feet to a maximum of 76,000 acre-feet for an average of 58,000 acre-feet per year (1) (2) (3) (4).

Due to past water extractions primarily for agricultural purposes, pumping has exceeded the natural recharge. The groundwater extraction between 1926 and 1972 resulted in the overdrafting of the aquifer, and caused the groundwater levels to drop 200 to 300 feet or an average rate of decline of 4 to 6 feet per year. This overdrafting has produced groundwater pumping depressions in the aquifer underlying several areas of the Antelope Valley. It has also resulted in loss of water production in certain wells located around the periphery of the groundwater basin.

Agricultural lands during the past several years have been taken out of production and replaced by urban development. Consequently, groundwater extractions have been reduced due to the lesser amounts required for agricultural purposes and also due to the use of imported water from the State Water Project. According to the Department of Water Resources report dated October 1980, approximately 50,000 acres were under irrigation in 1959. This acreage has been steadily declining to approximately 8,775 acres presently. The conversion from agricultural to M & I and the use of SWP water by the groundwater extractors has resulted in relieving the overdraft of the basin. This has stabilized the groundwater levels and a rise has been recorded in Waterworks wells indicating the banking of some of the natural recharge.

Water quality of groundwater is generally good, except in certain areas, where total dissolved solids (TDS) are high or where some water wells contain high levels of nitrate. The best quality water is found in the western and southern parts of the Valley where the natural recharge is the greatest.

The Antelope Valley Groundwater Basin is not adjudicated and the existing pumpers and overlying landowners have correlative water rights in the basin and may pump without limit. To safeguard the basin from intrusion of undesirable quality water and provide a reliable water supply for the present and future inhabitants of the area, the supplemental water supply must be utilized to its greatest extent possible and extractions controlled.

2. Imported Water Supply

The State Water Project provides an important supplemental water supply to the Antelope Valley. Its availability is dependent on hydrologic conditions in Northern California. Since 1987, we have been experiencing a drought cycle which has now extended into 1991. This cycle was somewhat alleviated, according to DWR Bulletin No. 132-89 in 1989, when above average precipitation and heavy run-off occurred in the Feather River Basin during March 1989. This condition improved SWP water availability and full entitlement delivery requests for 1989 were met. With the drought continuing through 1990, SWP deliveries for M & I water were met; however, agricultural water requests were reduced by 50 percent. At this point in time due to the continuing drought, 1991 SWP deliveries of agricultural water have been eliminated and M & I water has been cut 90%. However due to the recent rainfall and snow pack accumulation in Northern California, we anticipate additional deliveries to be made this year.

Table No. 8 based on data from DWR Bulletin No. 132-89 shows the various SWP water contractors, their maximum entitlements, their requested amounts and their received amounts.

Table No. 8

State Water Project
Entitlements and 1989 Water Requests
in Acre-Feet/Year

	Contract Amount	Amount Requested	Amount Received
Antelope Valley-East Kern Water Agency	138,400	55,000	45,646
Palmdale Water District	17,300	9,000	8,059
Littlerock Irrigation District	2,300	2,071	971
Total	158,000	66,071	54,676

The contract amount is the maximum entitlement of each contractor and is based on each contractor's projected long-term need. Table No. 8 indicates that there is potentially more water available than can be utilized. This excess SWP water can be used in lieu of groundwater pumping, thereby, banking the natural recharge in the basin during wet weather cycles. The conjunctive use of these two sources of water will balance the groundwater basin storage and maximize the SWP yield of 158,000 acre-feet.

The procedure to allocate deliveries during drought conditions is described in the State Contract. The State Department of Water Resources currently uses a risk analysis curve for delivery of SWP water which was developed in 1989. This analysis provides the mechanism for the Department of Water Resources to forecast water supply availability based on the latest hydrological conditions. This analysis generates a delivery forecast with a probability of exceedance of approximately 90 percent. It should also be noted that agricultural deliveries are reduced first. After initial agricultural reductions have occurred, if further reductions are necessary, reductions can be allocated to both agricultural and M & I contractors. A copy of the section on SWP Water Delivery Capability described in Bulletin 132-89, September 1989, "Management of California State Water Project" Appendix "A" is attached.

In October 1988, Glen M. Reiter & Associates, prepared a water supply analysis projecting SWP deliveries from 1995 to 2010. This water delivery analysis utilizes 56 years of hydrological records of the Sacramento River Index (SRI). This index is the sum total of the principal Sacramento River Basins (Sacramento, Feather, Yuba and American). This type of analysis indicates that during the period from 1995 to 2010, delivery of the full entitlement may occur only 6 of 16 years. The probability of occurrence is 38 percent. However, at least 90% of the entitlements may be available 11 of 16 years and 80% of entitlements may be available 15 of the 16 years. The delivery reductions of SWP water to the Antelope Valley SWP contractors based on said analysis are shown in Table No. 9 below.

Table No. 9

Estimate of Available Deliveries
to Antelope Valley SWP Contractors

Year	M & I Delivery Reductions %	Estimated Deliveries (Acre-Feet)			
		AVEK (138,400 Ac-Ft)**	Palmdale Water District (17,300 Ac-Ft)**	Littlerock Creek Irrigation Dist. (2,300 Ac-Ft)**	Total Available (Ac-Ft)
1995	0.00	138,400	17,300	2,300	158,000
1996	3.00	133,030	16,629	2,211	151,870
1997	6.81	128,974	16,122	2,143	147,239
1998	4.16	132,643	16,580	2,204	151,427
1999	28.94	98,347	12,293	1,634	112,274
2000	0.00	138,400	17,300	2,300	158,000
2001	0.00	138,400	17,300	2,300	158,000
2002	0.00	138,400	17,300	2,300	158,000
2003	9.60	125,114	15,639	2,079	142,832
2004	0.00	138,400	17,300	2,300	158,000
2005	0.00	138,400	17,300	2,300	158,000
2006	17.08	114,761	14,345	1,907	131,013
2007	13.72	119,411	14,926	1,984	136,321
2008	19.31	111,675	13,959	1,856	127,490
2009	6.63	129,224	16,153	2,148	147,525
2010	15.63	116,768	14,596	1,941	133,305

** Contracted entitlement.

To firm the SWP water supply, it is necessary to store water during wet cycles or when excess SWP water is available. The accumulated water in storage would then be available during dry cycles or periods of cutback without adversly effecting the groundwater basin. As was mentioned before, there is approximately 13 million acre-feet of storage capacity in the Antelope Valley Groundwater Basin for this purpose. The storage of water in this basin can be accomplished by direct or indirect recharge.

The direct recharge is by spreading SWP water in selected areas which are suitable for this purpose or by injection through water wells. Waterworks is currently evaluating data and conducting studies to determine the feasibility of implementing such a program.

The indirect method involves maximizing the use of SWP water to meet water demands. This is commonly referred to as in lieu pumping, thereby, banking part of the natural basin recharge and withdrawing this banked water during cutbacks in the SWP water supply or during emergencies when such a supply is not available. This method appears to be the most economical as the storage capacity is available and most purveyors have the capacity to pump, when necessary, the stored water to meet demands.

The groundwater basin is not adjudicated, therefore, such a limitation on the groundwater extractions cannot be enforced and may be only voluntary. Currently, the public water districts are conjunctively using the available water resources as shown on Table No. 10.

Table No. 10

Conjunctive 1989 Water Usage

Water Purveyor	Groundwater Extractions % of Total	SWP Water % of Total
Los Angeles County Waterworks Districts Nos. 4, 24, 27, 33, 34, 35, 38 and 39	46	54
Palmdale Water District	52	48
Quartz Hill Water District	63	37
Palm Ranch Water District	36	64
Littlerock Creek Water District	61	39
Various Mutual and Investor Owned Water Companies	31	69

CONCLUSIONS

Table No. 11 indicates that the existing water resources of the Antelope Valley can accommodate more than the SCAG 2010 population projection of 421,000 by utilizing 70% of SWP water and 30% groundwater. For Year 2010, the projected demands for both agriculture and M & I water is 144,000 acre-feet compared to a projected available supply of 191,305 acre-feet. This 191,305 acre-feet figure consists of 133,305 acre-feet of SWP water and 58,000 acre-feet of groundwater.

Current groundwater extractions are less than natural recharge and overdrafting of the basin has stopped. Groundwater levels have stabilized in the central part of the basin with water level increases from 10 to 60 feet in the east and west portions of the basin. Waterworks well records in the Lancaster area indicate that during the last five years, due to the in lieu pumping program, the aquifer in this area has recovered a minimum of 1.4 to 4.4 ft/yr for an average of 2.5 ft/yr. It is estimated that 110,000 ac-ft of water has been added to storage in this general area over the past five years. Also as shown on Table No. 6, agricultural interests are attempting to reduce groundwater extractions by using reclaimed water and untreated SWP water.

Last year, the Waterworks Districts utilized approximately 54% of SWP water to meet their demands. These Districts currently have the capability to use up to 75% SWP water. Upon completion of certain major transmission mains and storage reservoir projects within the next two to five years, the Districts will have the ability to utilize 90% SWP water. This will result in an increase of groundwater banking potential to approximately 28,000 ac-ft/yr. This water could then be extracted during cutbacks of SWP water without overdrafting the groundwater basin. However, this data is based on a limited number of wells and over a relatively short time period. To ascertain these results, it will be necessary to monitor more wells over a longer period of time.

At this point in time, hydrological conditions indicate that the drought conditions will continue through 1991 and DWR will be curtailing the availability of SWP water. To meet the Waterworks Districts' water demands, it appears that it will be necessary to make a greater use of groundwater. From the above data, it appears that groundwater extractions to meet the Waterworks Districts' demands should not have an adverse effect on groundwater levels. It would be prudent until our data is ascertain, to initially impose, on the Districts' customers a reduction of their water use. The Waterworks Districts will, during the year, closely monitor well production and groundwater levels and ascertain the effects on the groundwater table and adjust the imposed reductions, if necessary.

This assessment of the water situation in the Antelope Valley is limited in its scope and complexity and we strongly believe that a comprehensive Antelope Valley Water Management Plan needs to be developed and adopted by all the Cities and purveyors to insure a long term reliable source of water to the entire Antelope Valley. Towards this end, Waterworks staff is currently drafting a request for proposal (RFP) for the preparation of an Antelope Valley Water Management Plan. This draft RFP will be provided to all Cities in the Valley, purveyors and other interested parties for review and comments. Once all comments and suggestions are evaluated, the final RFP will be finalized and submitted to consultants for detailed proposals.

Table No. 11

Year	Estimated Population	Equivalent Dwelling Units 2.9 Person/Du	Estimated M & I Water Demands 0.8 Ac-Ft/Du (Ac-Ft)	Estimated Agriculture Water Demand (Ac-Ft)	Total Estimated Water Demands (Ac-Ft)	Estimated SWP Water Deliveries (Ac-Ft)	Total Estimated M & I Groundwater Extractions* (Ac-Ft)	Accumulated Net Natural Recharge Banked Into Groundwater Basin**
1995	254,000	88,000	70,400	28,000	98,400	158,000	31,920	26,080
1996	265,000	91,000	72,800	28,000	100,800	151,870	32,640	51,440
1997	276,000	95,000	76,000	28,000	104,000	147,239	33,600	75,840
1998	287,000	99,000	79,200	28,000	107,200	151,427	34,560	99,280
1999	298,000	103,000	82,400	28,000	110,400	112,274	35,520	121,760
2000	310,000	107,000	85,600	28,000	113,600	158,000	36,480	143,280
2001	321,000	111,000	88,800	28,000	116,800	158,000	37,440	163,840
2002	332,000	115,000	92,000	28,000	120,000	158,000	38,400	183,440
2003	343,000	118,000	94,400	28,000	122,400	142,832	39,120	202,320
2004	354,000	122,000	97,600	28,000	125,600	158,000	40,080	220,240
2005	365,000	126,000	100,800	28,000	128,800	158,000	41,040	237,200
2006	376,000	130,000	104,000	28,000	132,000	131,013	42,000	253,200
2007	388,000	134,000	107,200	28,000	135,200	136,321	42,960	268,240
2008	399,000	138,000	110,400	28,000	138,400	127,490	43,920	282,320
2009	410,000	141,000	112,800	28,000	140,800	147,525	44,640	295,680
2010	421,000	145,000	116,000	28,000	144,000	133,305	45,600	308,080

* Water extractions for M & I purposes limited to 30% of total M & I water demands.
** Accumulated differences between estimated annual basin recharge of 58,000 acre-feet and estimated ground water extractions.

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2. Department of Water Resources, "Planned Utilization of Water Resources in the Antelope Valley", dated October 1980.

3. U.S. Department of the Interior, Geological Survey, "Water Resource Division, Water Resources of the Antelope Valley", dated 1967.

4. U.S. Department of Interior, Geological Survey, Water Resource Division, "Calibration of a Mathematical Model of the Antelope Valley Groundwater Basin, California", dated 1976.

5. U.S. Department of Interior, Geological Survey, Geohydrology of the Antelope Valley Area, California and Design for a Groundwater Quality Monitoring Network" Report 84-4081, dated 1987.

6. Littlerock Creek Irrigation District Feasibility Report, prepared by Henry E. Suzuki, dated 1985.

SWP Water Delivery Capability

The measure of the SWP's delivery capability is founded on the concept of "firm yield" operation. Defined in the water supply contracts as "minimum project yield," firm yield is the dependable annual water supply that can be made available without exceeding specified allowable reductions in agricultural deliveries during extended dry periods.

The firm yield of existing SWP facilities is approximately 2.4 million acre-feet per year. Since 1987, contractor requests for entitlement water have exceeded that amount (see Table 14). In addition to continued planning of structural features to improve firm yield, DWR and the SWP contractors have been examining alternative operational strategies to improve the existing facilities' average annual delivery capabilities. Particular attention has been focused on methods outside the conventional firm yield procedures, involving a calculated risk of reduced deliveries in some years.

Since 1978, operational decisions for the SWP have been based on an annual analysis of the risk of delivering water instead of storing it against future needs. Such a risk analysis provides a rational means of deciding how much water to deliver in a given year and how much to leave in storage to provide for subsequent dry periods.

The risk analysis procedure, developed in 1978, was originally designed to assure a high probability of meeting delivery schedules for the current and following year, assuming a water supply equivalent to that of the two driest years on record. The procedure, termed the "Rule Curve" beginning in 1979, has three parts. The first part uses known beginning storage (carryover from the previous year), defined target storage (end-of-year storage in SWP conservation facilities), and historical hydrology to chart annual SWP water delivery capability against an index, formerly called the "Four Basin Index," which represents unimpaired runoff of streams entering the Sacramento Valley. The second part uses the chart and periodic forecasts of the index to determine capability of the SWP to deliver water. The forecast ordinarily used is that which would probably be exceeded 99 percent of the time. The third part of the procedure is allocation of the calculated water delivery capability to contractors and confirmation of the result using a complex operations study. If the operations study shows that the delivery schedule cannot be met, the schedule is reduced to the amount which can be delivered; otherwise, the total and the allocation are confirmed.

Implementation of this 1978 procedure required a high target storage and often delayed the approval of water delivery requests until late in the water-producing season. Furthermore, because of the two-year analysis period, the procedure failed to address how storage should be managed over an extended dry period.

In 1985, DWR reviewed the roles that target storage and dry period duration played in the risk analysis procedure. With water contractor approval, the 1986 "Rule Curve" incorporated a schedule of target storage which decreased each year by equal amounts, reaching a minimum after seven years. The target selected each year depended on the carryover storage and the previous year's target storage. Further study and information provided by the contractors led in 1987 to a lower schedule of target storage and in 1988 to a calculation by formula based only on the carryover storage.

In 1989, the "Rule Curve" became the Water Delivery Risk Analysis (WDRA), the "Four Basin Index" became the Sacramento River Index (SRI), and "conservation storage" was interpreted to include Lake Oroville, the State share of San Luis Reservoir, and the balance owed to DWR by the Bureau of Reclamation under the Coordinated Operations Agreement. The 1989 WDRA used the same criteria as in 1988 for development of the Risk Analysis Curve, but the procedure for determining delivery approvals was changed. Departing from the 99 percent used previously, the initial delivery approval was increased by basing it on a forecast of the SRI with a probability of exceedence of approximately 90 percent.

As in previous years, DWR reviewed the water supply forecast and the Risk Analysis monthly to determine if, because of changing water supply conditions, approved deliveries could be increased. The SWP contractors understood that the results of the final Risk Analysis study would be more conservative than the interim monthly reviews and that approved 1989 delivery amounts could potentially be lowered if dry water conditions continued. As in all previous years, monthly updates were based on 99 percent probability of exceedence. To smooth the transition from the 90 percent to the 99 percent forecast, the monthly updates for February and March were allowed only to increase approved deliveries. The same rule was applied to the May and June updates, unless conservation storage would thereby become less than the minimum 1.0 million acre-feet.

The 1989 Risk Analysis procedure is again being implemented on a one-year trial basis, as it has been since 1986.