INYO COUNTY WATER DEPARTMENT

2017-2018 ANNUAL REPORT

Table of Contents

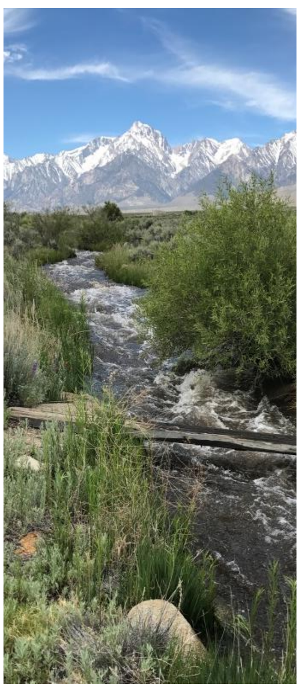
List of Figures

List of Tables

PHOTO CREDIT: Cover photo by Keith Rainville

SECTION 1: EXECUTIVE SUMMARY

To protect the County's environment, citizens, and economy from adverse effects caused by activities relating to the extraction and use of water resources and to seek mitigation of any existing or future adverse effects resulting from such activities.



The Water Department's efforts during 2017-2018 were directed toward our core mission of assisting in the implementation of the County's water resources policies through the Inyo/Los Angeles Long-Term Water Agreement. Our work on the Water Agreement consists of four main activities: joint management with LADWP of LADWP water-related activities through the Inyo/Los Angeles Technical Group and Standing Committee; environmental monitoring to assess impacts of LADWP activities and compliance with Water Agreement goals; planning, monitoring, implementation, and enhancement of mitigation measures associated with the Water Agreement; and disseminating information and fostering public knowledge and involvement in County water policy. In addition to the core mission of implementing the Water Agreement provisions, the Water Department has been instrumental in the County's efforts to comply with the State Groundwater Management Act (SGMA).

The 1997 MOU between LADWP, Inyo County, California Department of Wildlife, California State Lands Commission, the Sierra Club, and the Owens Valley Committee requires that "*DWP and the County will prepare an annual report describing environmental conditions in the Owens Valley and studies, projects, and activities conducted under the Los Angeles Agreement and this MOU.*" This requirement has customarily been fulfilled by two reports, one issued by LADWP and one issued by the Water Department. In addition to fulfilling this MOU requirement, the Water Department's Annual Report is a vehicle for disseminating information to the public about conditions and activities related to the Inyo/Los Angeles Long-Term Water Agreement. The Water Agreement contains a number of provisions for collecting and sharing data, analyzing data, managing groundwater pumping, and mitigating negative effects of LADWP water management. We strive to make this report informative broadly for those wishing an overview of conditions and trends, and also to provide detailed data and analysis for those desiring to look more closely at conditions in Owens Valley. In general, this report covers the 2017-18 runoff year (April 1, 2017 through March 31, 2018), and contains material pertaining to LADWP's planned pumping for the 2018-19 runoff year.

Central to the Water Department efforts each year is analysis of LADWP's pumping plan prepared each April. Runoff conditions following the extremely wet winter of 2017-18 was substantially greater than during the previous drought years. Actual Owens Valley runoff was of 826,439 ac-ft. (203% of normal) which was very near the forecasted value of 801,900 ac-ft further bolstering the confidence in LADWP runoff forecast models even in extreme years. Total pumping within the Owens Valley for 2017-18 was 47,609 ac-ft which was less than the planned pumping 56,936 ac-ft. The Water Agreement and Green Book include procedures to calculate a pumping limit to prevent groundwater mining to ensure no long-term decline in aquifer storage. The mining calculation is a comparison of pumping and recharge for each wellfield on a water year basis (October 1st through September 31st) for a 20 water year period. No wellfield was in violation of the groundwater mining provision. The Big Pine wellfield was the only wellfield close to its mining limit and the County requested that pumping in this wellfield be curtailed.

Water levels in most wellfields in the valley stayed approximately the same or rose significantly in 2017-18. Average water table rise was 3.5 ft. Average increases greater than 3 ft. occurred in Laws, Big Pine, Taboose-Aberdeen, Independence-Oak and Bairs-Georges. Water levels also increased substantially in the Thibaut Sawmill area near the Blackrock Waterfowl project. The record winter of 2017 assisted in allowing water levels to recover from the 2012-2016 drought. As of April 2018, DTWs in most wellfields were at or above baseline levels. However, portions of three wellfields remained below baseline, including southern Big Pine, Independence - Oak, and Symmes-Shepherd. Water levels in west Bishop declined and returned towards historic norms. During 2015-2017, west Bishop experience extremely shallow or perched groundwater likely due to increased seepage from area ditches and ponds. This situation appears to have resolved.

The Water Agreement's ON/OFF method of managing LADWP pumping wells is based on monitoring sites where vegetation cover, soil water, and depth to the water table are measured, and the vegetation's water needs are compared to the available soil water. Pumping wells are linked to a monitoring site, and if sufficient soil water is present for vegetation at a site, then wells linked to that site may be pumped. As part of the monitoring effort, each month the Water Department measures depth to groundwater and soil water at 25 monitoring sites in wellfields and 8 sites in control areas (areas unaffected by pumping). Large winter storms in 2016-17 brought ample rain and snow to the valley floor and prompted Los Angeles to begin water spreading in February and March 2017. Twelve sites went into On-status during the winter due to infiltration of rain and snow and/or water table recovery, and by April 2017, sixteen sites of 25 were in On-status. Three sites went into Off-status in July and another in October. No sites went into on status during the winter of 2017-2018. At the beginning of the 2018 growing season, the water table was shallow enough to supply water to the root zone at 21 of the 25 wellfield monitoring sites.

Each year the Water Department monitors selected vegetation parcels within the valley to ensure that the Water Agreement's vegetation goals are met. The primary goal of this monitoring, according to the Green Book are to detect any *"significant decreases and changes in Owens Valley vegetation from conditions documented in 1984 to 1987"*. Vegetation live cover and species composition documented during the 1984-87 mapping effort were adopted as the baseline for comparison with each annual re-inventory according to the Water Agreement. From September 1984 to November 1987, LADWP inventoried and mapped vegetation on 223,168 acres of the Owens Valley floor. In the summer of 2017, the Water Department and LADWP sampled 140 parcels using the line-point procedures described in the Green Book. For each parcel, staff evaluated the change in perennial vegetation cover since baseline and assessed whether the relative proportion of shrubs, grass, and herbaceous vegetation was different from baseline or has changed over. The effects of pumping are examined by comparing cover and composition of groups of parcels classified as either control or wellfield based on criteria derived from groundwater drawdown during the period of maximum pumping rate that occurred between 1987 and 1993.

Average vegetation cover in 2017 increased substantially from 2016 (a dry year). The control parcel group reached baseline cover, and the wellfield parcel group recovered above baseline for the first time since 2008. Perennial cover in the wellfield group has an increasing but not significant trend, while the control group has a decreasing but not significant trend over the last 27 years. In general, wellfield parcels are getting shrubbier with slight decreases in grass cover over the period. Control parcels have lost grass cover since the late 1990s, but 2017 levels were still slightly above baseline.

For individual parcels, 19 of the 91 wellfield parcels were below baseline perennial cover while 28 were below baseline grass cover. In control parcels, 11 were below baseline perennial cover.

The primary type of vegetation change in both pumped and unpumped areas in 2016, was a decline in grass cover. In 2017, grass recovered in many parcels in response to higher precipitation and water table recovery. The increase in shrub cover in control parcels likely has several drivers including climate change, grazing, drought, lack of flooding and other disturbances that preclude shrub encroachment. The reversibility of woody dominance could be facilitated if the water table were at levels incompatible with shrubs or by increased disturbance such as flooding and fire. Under present conditions and restrictions, the frequency and extent of recent burns is likely inadequate to reverse such woody dominance over large areas. Flooding in 2017 caused widespread shrub mortality but the extent of this is largely unquantified. Grazing management, water table recovery and a long wet period offering natural cycles of flooding and wildfire could plausibly provide conditions compatible with regaining herbaceous dominance in shrub encroached meadows.

In 2017, ICWD monitored six *Sidalcea covillei* sites and 28 *Calochortus excavatus* sites. Site abundance estimates are based on counts where attainable or estimates based on random sampling depending on the extent and size of populations.

Due to the abundant winter precipitation, many annuals grew in 2017. The Water Department staff took the opportunity to locate eleven rare species that are only found in the wetter years.

The Water Department in 2017-18 made substantial progress in the acquisition and utilization of remote sensing data for a variety of monitoring purposes. Examples described in this report include the use of Landsat data to estimate vegetation cover, LIDAR data to map mature trees in the Lower Owens River Project, low altitude drone imagery to map the aftermath of the Pleasant Valley fire. A larger effort this year applied air photo interpretation and Landsat data to assess conditions of irrigated pastures in the Owens Valley (Type E vegetation). Several irrigated parcels were identified where irrigation may have been deficient using remote sensing and suggestions for future monitoring were developed.

One of the roles of the Water Department is to monitor and report on the status of environmental mitigation projects in the Owens Valley. In May 2016, the Inyo/Los Angeles Standing Committee directed staff to identify and evaluate all mitigation commitments arising from the Water Agreement. LADWP and ICWD also were directed to report where the agencies differed in their assessments on the status of these projects. That effort was completed in February 2017.

Sixty-four projects, spread throughout the valley, mitigate for a range of environmental impacts due to abandonment of irrigated agriculture and groundwater pumping in the Owens Valley. These improvements range in size from single-acre spring restoration projects to the 78,000-acre Lower Owens River Project (LORP). The majority of these projects are described in the Water Agreement and associated 1991 Environmental Impact Report and in the 1997 MOU which resolved conflicts and concern over the 1991 EIR. Inyo and LADWP staff assessed each and placed them into one of five categories: Complete, Ongoing as necessary, Implemented and ongoing , Implemented but not meeting goals, or Not fully implemented. In nearly all cases, Inyo and Los Angeles agreed on the project status. Inyo concluded that 15 projects were not meeting their goals or not fully implemented. This will aid future efforts by focusing on projects where Inyo and Los Angeles agree that improvement is needed.

Implementing and monitoring the numerous provisions of the Water Agreement occupies most of the Water Department efforts. In addition, the Water Department undertakes a number of activities unrelated or indirectly related to the Water Agreement, including participation in the Inyo-Mono Integrated Regional Water Management Group, assistance to other County departments needing hydrologic analysis on projects they are working on (e.g., environmental analysis for permitting of solar, industrial, or residential developments), or of projects permitted under Inyo County's groundwater ordinance. In 2014 California enacted the Sustainable Groundwater Management Act. The Owens Valley was a deemed a medium priority basin requiring selection of a responsible local agency to develop a plan to manage groundwater in the Valley. The Water Department has been involved in efforts to form a Groundwater Sustainability Agency (GSA) comprised of several local agencies with groundwater or land management responsibilities. These activities are also covered in this Annual Report, but information on their status may be found on our web site http://www.inyowater.org.

SECTION 2: THE CALIFORNIA SUSTAINABLE GROUNDWATER MANAGEMENT ACT IN THE OWENS VALLEY

INYO COUNTY
WATER DEPARTMENT

Inyo County Water Department

135 South Jackson St.
PO Box 337
Independence,
California 93526
Tel 760-878-0001
Fax 760-878-2552

In September 2014, Governor Brown signed into law what is probably the most significant water-related legislation in the past fifty years - the Sustainable Groundwater Management Act of 2014 (SGMA). SGMA provides a statewide framework for sustainable groundwater management where local agencies manage groundwater within their local jurisdictions by forming groundwater sustainability agencies (GSAs) which will then develop and implement groundwater sustainability plans (GSPs). Because SGMA puts the responsibility for implementation on local agencies such as counties, the Water Department has been involved in efforts to form a GSA in the Owens Valley Groundwater Basin.

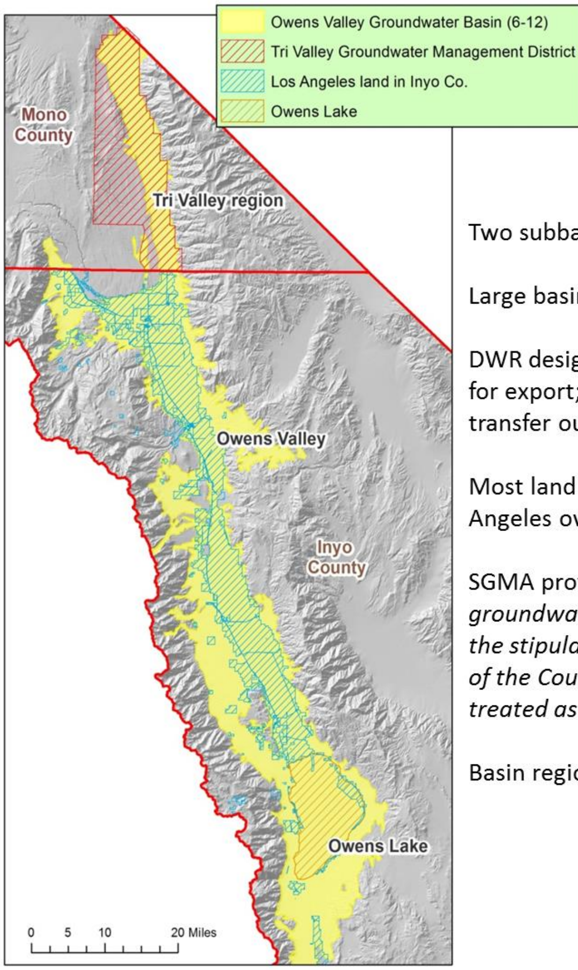
ICWD's 2016-17 Annual Report (available online at inyowater.org) gave a comprehensive summary of SGMA's goals, requirements, participants, and deadlines. The most relevant SGMA activities that have occurred in the past year are highlighted below.

- As of June 2018, the Owens Valley Groundwater Basin (OVGB) is currently a medium priority basin which requires GSA formation by June 2017, GSP preparation by January 2022, and groundwater sustainability by 2042.
- DWR added the Fish Slough subbasin to the OVGB and prioritized it as low priority.
- Sustainability is defined by SGMA as avoiding "undesirable results" including lowered groundwater levels and storage, saltwater intrusion and degraded water quality, subsidence, interconnected surface water depletions, and impacts to groundwater-dependent ecosystems.
- A Joint Powers Authority, "The Owens Valley Groundwater Authority" (OVGA), was formed and became the sole GSA for the OVGB.
- The current 11 OVGA members are Inyo and Mono counties, City of Bishop, Tri Valley Groundwater Management District, and seven Community Service Districts (Wheeler Crest, Starlight, Eastern Sierra, Indian Creek-Westridge, Sierra Highlands, Big Pine, Keeler)
- Staff from Inyo County, City of Bishop, and Mono County are serving as staff for the OVGA
- The OVGA is in the process of accepting a $713,000 grant from the

- Department of Water Resources (DWR) f or the creation of a GSP for the OVGB.
- The OVGA is in the process of hiring a consultanting team for the purpose of developing the GSP and submitting it to DWR by January 2022.
- DWR has released numerous Best Management Practices (BMPs) which provide guidance on the necessary components of a GSP.
- Agendas, meeting minutes, and other SGMA items can be found on inyowater.org/sgma/
- Future OVGA activities are likely to include developing by-laws, consideration of SGMA participation for additional entities, and work developing sustainability criteria for the OVGB.

Guiding the Eastern Sierra through initial SGMA implementation has been a significant task for the Water Department the past several years and has assisted in the region in meeting the state-imposed strictures and deadlines. The OVGA is currently on track to meet the next critical SGMA milestone of completing and submitting a GSP to DWR by January 2022. For additional information on SGMA visit: https://water.ca.gov/Programs/Groundwater-Management/SGMA-Groundwater-Management

In relationship to the Long Term Water Agreement, SGMA exempts adjudicated areas from the requirement to form GSAs and develop GSPs, and provides that any groundwater basin or portion of a groundwater basin managed under the Inyo/Los Angeles Long Term Water Agreement (LTWA) is considered adjudicated (CWC §10720.8(c)). As long as Los Angeles's groundwater pumping is conducted pursuant to the LTWA, it is exempt from SGMA's requirement for a GSA and GSP, but must meet certain annual reporting requirements that SGMA imposes on adjudicated areas. SGMA does not have clear requirements or guidance for how GSAs for non-adjudicated areas interact with adjudicated areas in basins that are partially adjudicated. This relationship will be considered in the upcoming years as the GSP is developed.



Owens Valley Groundwater Basin

Two subbasins: Owens Valley (6-12.01) and Fish Slough (6-12.02).

Large basin: 1,037 square miles; 125 miles north to south.

DWR designated basin as Medium priority based on LADWP pumping for export; DWR proposes to rank High based presence of water transfer out of basin.

Most land is state (Owens Lake), federal (BLM, USFS, NPS), or Los Angeles owned.

SGMA provides that *"Any groundwater basin or portion of a groundwater basin in Inyo County managed pursuant to the terms of the stipulated judgment in City of Los Angeles v. Board of Supervisors of the County of Inyo, et al. (Inyo County Case No. 12908) shall be treated as an adjudicated area pursuant to* [SGMA]."

Basin regions:

- Tri Valley – Northern extent of basin
- Fish Slough – Small northcentral portion
- Round Valley/Swall – Northwestern portion
- Owens Valley – Central portion
- Owens Lake/Olancha – Southern extent of basin

LADWP prepares an operations plan each April in accordance with the Water Agreement. The plan describes runoff conditions, wellfield pumping, water uses in the Valley, and export to Los Angeles.

ICWD and LADWP each monitor groundwater levels throughout the Valley.

SECTION 3: PUMPING MANAGEMENT AND GROUNDWATER CONDITIONS

2018-19 Pumping Plan and Groundwater Conditions

In accordance with the Water Agreement, Los Angeles Department of Water and Power prepares an Operations Plan each April for the ensuing 12-month runoff year spanning April 1 to March 31. The 2018-2019 plan included projected amounts for runoff, pumping, water used in the Owens Valley, water exported to Los Angeles, and an update of the groundwater mining calculations. Also, the plan must comply with the pumping well On/Off provisions of the Agreement based on soil water and vegetation measurements. The Inyo County Water Department (ICWD) reviews LADWP's proposed operations plan, performing an analysis of the effects of LADWP operations on groundwater levels in the Owens Valley. Following a Technical Group meeting to resolve concerns raised by the County, LADWP finalizes the plan.

Predicted runoff from the Owens River watershed during the 2018-19 runoff-year is forecast to be 317,500 acre-feet (ac-ft) or 78% of the 50-year (1966-2015) average. The actual runoff value will be available in 2019 when the all the surface water measurements that constitute the sum have been verified and tabulated. Figure 3.1 compares LADWP's forecasted runoff with the ensuing, actual runoff for each year. Planned pumping for 2018-19 is in a range of 77,990-96,230 ac-ft. LADWP is predicting 98,100 ac-ft of water will be used in the Owens Valley, 49,000 of which is planned for irrigation. The 2018-19 water exports from the Eastern Sierra (Inyo and Mono Counties) is planned to be 248,800 ac-ft. A more detailed discussion of the 2018-19 Operations Plan is presented in the "2018-19 Pumping" subsection that follows.

Looking at actual totals from 2017-18, runoff was 826,439 ac-ft, approximately 203% of the 1966-2015 long-term average. Total pumping within the Owens Valley from Laws to Lone Pine for 2017-18 was 47,609 ac-ft, which was significantly less (84%) than LADWP's planned pumping amount of 56,936 ac-ft. Owens Valley water uses for 2017-18 were 110,000 ac-ft, and Eastern Sierra water exports were 365,000 ac-ft.

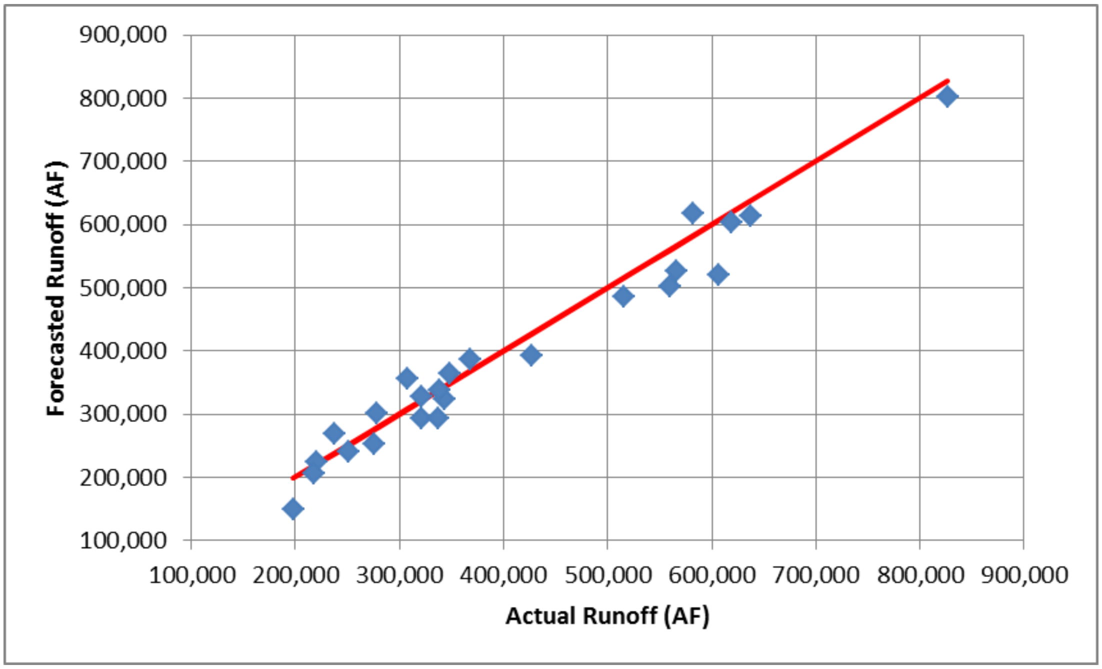


Figure 3.1. Comparison of actual and forecasted runoff 1994-2017 runoff years with the one-to-one correspondence (100% accuracy between forecast and actual runoff) in red. The 2017 actual runoff was 826,439 ac-ft; forecasted runoff was 801,900 ac-ft.

Table 3.1. Planned and LADWP actual pumping by wellfield for the 2017-18 runoff-year. Estimated minimum pumping prepared by Inyo County for sole source uses is included for reference although in an extremely dry year minimum pumping would be insufficient to supply all uses.

Wellfield	Estimated Minimum Pumping (ac-ft)	Planned Pumping (ac-ft)	Actual Pumping (ac-ft)	Percent Actual vs. Planned
Laws	6,300	5,520	2,284	41%
Bishop	10,400	6,120	4,061	66%
Big Pine	20,550	21,160	21,705	103%
Taboose-Aberdeen	300	3,270	3,190	98%
Thibaut-Sawmill	8,160	8,466	7,986	94%
Ind.-Oak	5,990	8,800	5,939	67%
Symmes-Shepherd	1,200	2,400	1,059	44%
Bairs-Georges	500	250	404	161%
Lone Pine	1,035	870	981	113%
Total	**54,435**	**56,936**	**47,609**	**84%**

Table 3.2. Depth to Water (DTW) at Indicator wells, April 2018. All data are in feet. Negative values denote a decline in water level. Depths are from reference point on the test well. Baseline elevation at monitoring sites is the April average of water levels from years 1985-87. Baseline was predicted from monitoring site/indicator wells regression models if the test well was not present from 1985-87.

Station ID, Monitoring site	DTW April 2018	Change from April 2017	Deviation from Baseline in 2018
Laws			
107T	23.45	NA	0.82
434T	6.13	2.19	1.47
436T	6.22	5.76	1.88
438T	8	4.9	1.60
490T	10.16	7.43	2.91
492T	23.65	11.64	9.15
795T, LW1	8.17	6.34	5.12
V001G, LW2	14.10	NA	5.52
574T, LW3†	10.15	5.76	2.93
Big Pine			
425T	17.15	4.57	-2.25
426T	13.78	3.1	-2.21
469T	21.75	4.16	-0.08
572T	8.59	1.99	3.31
798T, BP1	11.90	2.82	4.15
799T, BP2	19.31	1.64	-0.80
567T, BP3	15.02	4.28	-1.06
800T, BP4	16.01	3.66	-2.42
Taboose Aberdeen			
417T	23.22	4.75	3.75
418T	8.15	1.19	0.08
419T, TA1	4.67	4.69	1.96
421T	33.27	6.78	1.08
502T	9.11	3.36	-1.62
504T	8.36	4.82	2.41
505T	15.03	4.89	3.57
586T, TA4	7.11	2.91	1.21
801T, TA5	14.81	-0.11	-1.29
803T, TA6	4.86	4.69	3.84
Thibaut Sawmill			
415T	9.47	2.84	9.03
507T	4.67	-1.25	0.00
806T, TS2	9.60	1.81	3.58
Independence Oak			
406T	5.44	0.23	-3.87
407T	13.11	-0.84	-5.81
408T	5.10	0.77	-1.97
409T	7.70	9.17	-6.10

Station ID, Monitoring site	DTW April 2018	Change from April 2017	Deviation from Baseline in 2018
546T	4.51	7.16	-1.08
809T, IO1	10.57	6.09	-4.00
Symmes Shepherd			
402T	10.36	0.11	-2.33
403T	8.19	1.4	-2.86
404T	6.51	-0.66	-2.94
447T	40.14	9.35	-18.27
510T	7.20	-0.9	-2.20
511T	8.03	-0.93	-3.40
V009G, SS1	22.36	7.48	-15.53
646T, SS2	Dry	NA	NA
Bairs George			
398T	3.57	2.3	2.78
400T	5.40	0.29	0.90
812T, BG2	10.17	8.70	3.29

ICWD uses groundwater levels from a suite of key test wells (Indicator Wells) located throughout the Owens Valley near LADWP wellfields to both track and predict (using regression models) the effects of groundwater pumping on water tables. The effect of pumping and runoff in 2017-18 on water levels in the Indicator Wells is shown in Table 3.2. Water levels in a larger set of monitoring wells are discussed below.

Groundwater levels rose in 38 of the 44 non-dry test wells (Figure 3.2); the average change in DTW in the 44 wells was a rise of 3.6 feet, with a median rise of 3.5 feet. However, groundwater levels remain below levels of the mid-1980's vegetation baseline period in about a quarter of the indicator wells. A more detailed discussion of groundwater levels in Indicator wells and other monitoring wells at well-field locations across the Owens Valley in presented in the "Summary of Hydrologic Conditions" subsection that follows.

The Water Agreement and Green Book include procedures to calculate a pumping limit to prevent groundwater mining to ensure that there is no long-term decline in aquifer storage; these calculations are summarized in the 2018-19 Operations Plan and used to predict the pumping limit through September of 2018. Unlike the annual reporting periods which are based on runoff year (April to March), the annual period for the groundwater mining calculation is based on the water-year (October 1 through September 30). The mining calculation is a comparison of LADWP pumping and recharge for each wellfield on a water-year basis for the most recent 20-year period. The 2016-17 water-year groundwater recharge in the Owens Valley from the mining calculations was approximately 265,717 ac-ft compared to 51,617 ac-ft of pumping, and no wellfield was in violation of the groundwater mining provision in 2016-17.

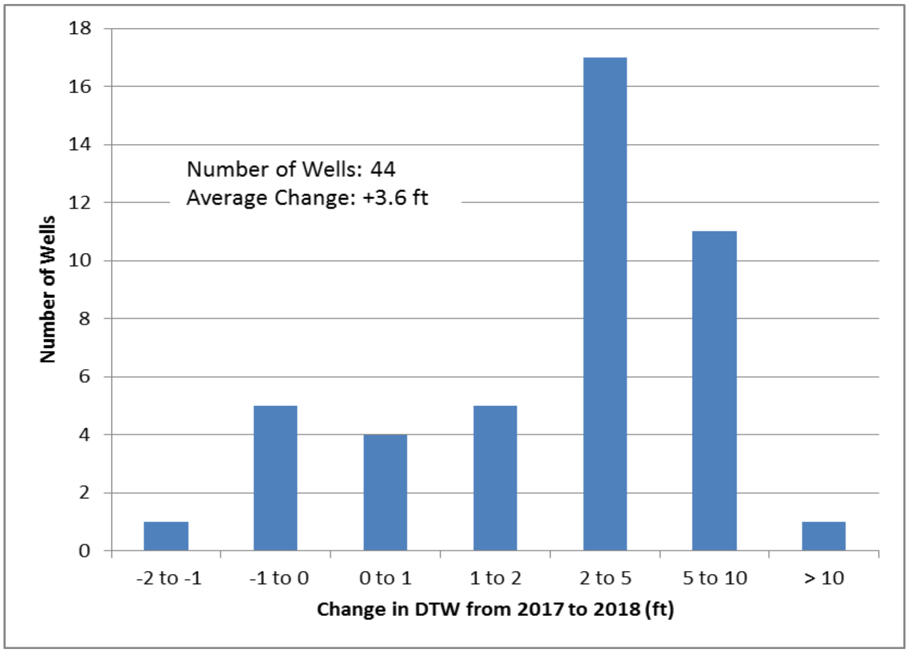


Figure 3.2. Histogram of change in DTW between April 2017 and April 2018 for 44 Indicator test wells. Positive changes indicates rising (shallowing) water tables.

The 19.5-year total of pumping (pumping through April 2018) is subtracted from 20 years of recharge (recharge through September 2018) to arrive at an April to September 2018 pumping limit for each wellfield and the Owens Valley as a whole. The 2017-18 water-year estimate of groundwater recharge in the Owens Valley from the mining calculations was approximately 145,827 ac-ft compared to 16,409 ac-ft of estimated pumping, and no wellfield is projected to be in violation of the groundwater mining provision in 2018.

The Big Pine wellfield is the only wellfield close to its mining provision limit with pumping at 92% of the total recharge thru water-year 2016-17. Pumping exceeded recharge during the five-year period of the recent drought (2012-2016). This does not constitute a violation of the groundwater mining provision, but ICWD has suggested that pumping in this wellfield be curtailed to include only sole source in-valley uses. Despite the significant amount of water spread into the Big Pine Wellfield in 2017, the narrow difference between recharge and pumping in the Big Pine wellfield (less than 39,000 ac-ft) is concerning and will continue to be monitored carefully.

For the Owens Valley, the percentage of pumping to recharge through water-year 2017-18 is projected to be 11%. Runoff (as an inflow) and pumping (as an outflow) are two of the components of the Owens Valley groundwater budget. It is important to note that evapotranspiration (evaporation and plant transpiration of groundwater primarily by native vegetation along the valley floor) is another primary component (as an outflow) of the groundwater budget; one that is implicitly protected by the Water Agreement. Therefore, looking at groundwater levels which track change in storage of the Owens Valley groundwater system and availability of groundwater to phreatophytic plants is of primary importance.

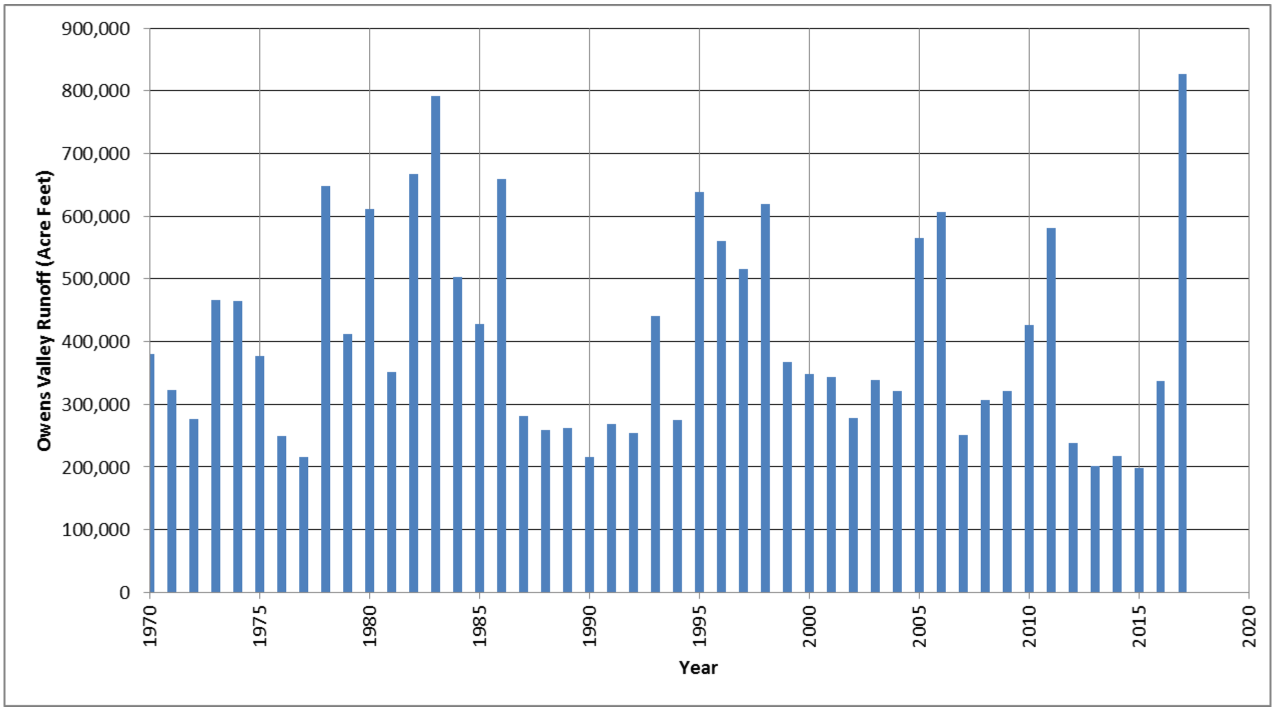


Figure 3.3. Measured Owens Valley runoff since 1970. Values are for the runoff year (e.g. runoff year 2017 includes April 1, 2017 through March 31, 2018).

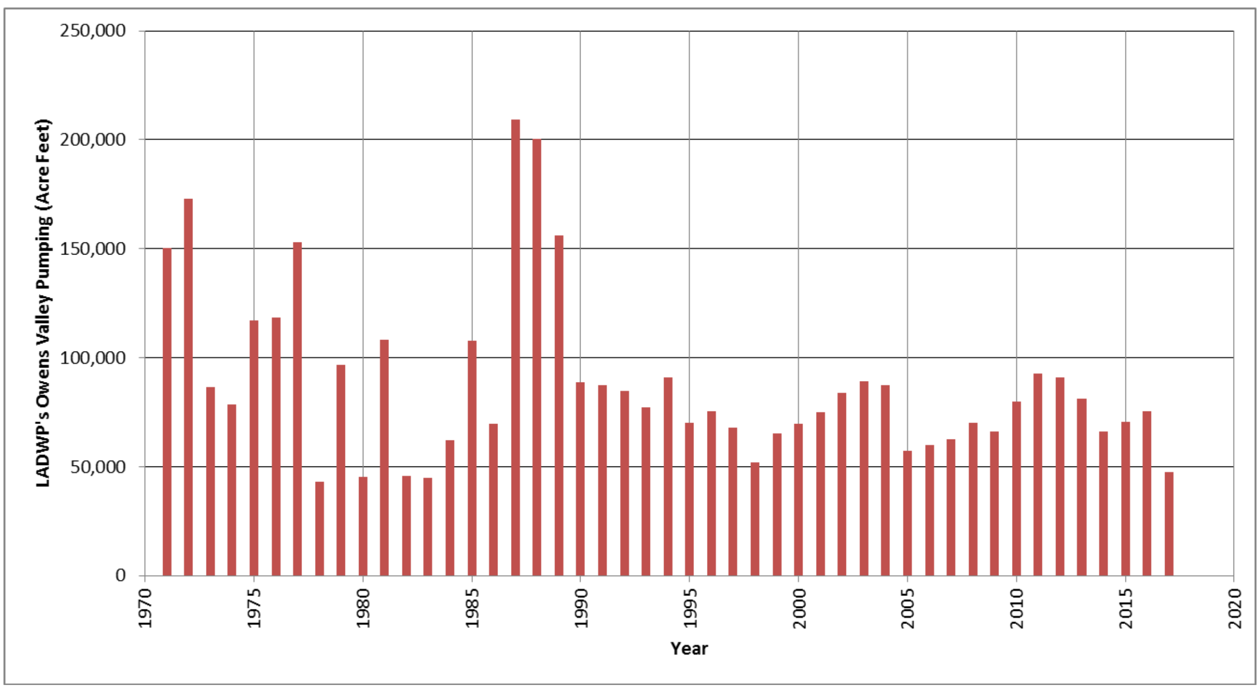


Figure 3.4. Total LADWP pumping in the Owens Valley since 1970 by runoff *year.*

Summary of Hydrologic Conditions

The history of Owens Valley pumping and runoff since 1970 are presented in Figures 3.3 and 3.4. Since the Water Agreement was adopted in late 1991, annual pumping has averaged 72,835 ac-ft and runoff 394,448 ac-ft.

Groundwater data is collected from several hundred monitoring wells located throughout the Owens Valley each spring and fall. Most wells are also visited on more frequent (weekly-monthly schedules). Data presented in this section are depth to water (DTW) below ground surface (bgs) measured in feet.

Water levels in most wellfields in the valley stayed approximately the same or rose significantly in 2017-18 (Figure 3.5). Average increases greater than 3-ft. occurred in Laws, Big Pine, Taboose-Aberdeen, Independence-Oak and Bairs-Georges. Water levels also increased substantially in the Thibaut Sawmill area near the Blackrock Waterfowl project. Water levels in west Bishop declined in the recent runoff year with a return towards historic norms. During the span of 2015-2017 west Bishop experience extremely shallow or perched groundwater likely due to increased seepage from area ditches and ponds. This situation appears to have resolved.

One method of analyzing hydrologic conditions in the Owens Valley is to compare recent groundwater levels with historic conditions. The LTWA uses the vegetation conditions documented from surveys conducted from 1984 to 1987 as its baseline for comparison of ecologic change (See Section V for details). Therefore, ICWD uses the average groundwater levels documents in April from 1985 to 1987 as a hydrologic baseline. While this hydrologic baseline is not specifically proscribed in the LTWA, it is a summary of the hydrology and the ecology of the baseline period. Also, the April time-frame roughly coincides when DTW is typically shallowest each year. The hydrologic baseline DTW usually is an adequate indicator of better soil water and vegetation conditions, but should be considered a guide rather than a specific threshold that determines whether vegetation conditions are above or below baseline in the immediate vicinity of a monitoring well. Unlike the vegetation baseline, maintaining baseline DTW is not a requirement of the Water Agreement.

The record winter of 2017 assisted in allowing water levels to recover from the recent 5-year drought. As of April 2018, DTWs in many wellfields were at or above baseline levels. However, certain wellfields were below baseline (Figure 3.6), including southern Big Pine, Independence -Oak, and Symmes-Shepherd. Hydrographs plotting DTW for selected wells are provided in the following discussions of conditions for each wellfield. The hydrographs presented below were selected to provide insight on water level changes over time.

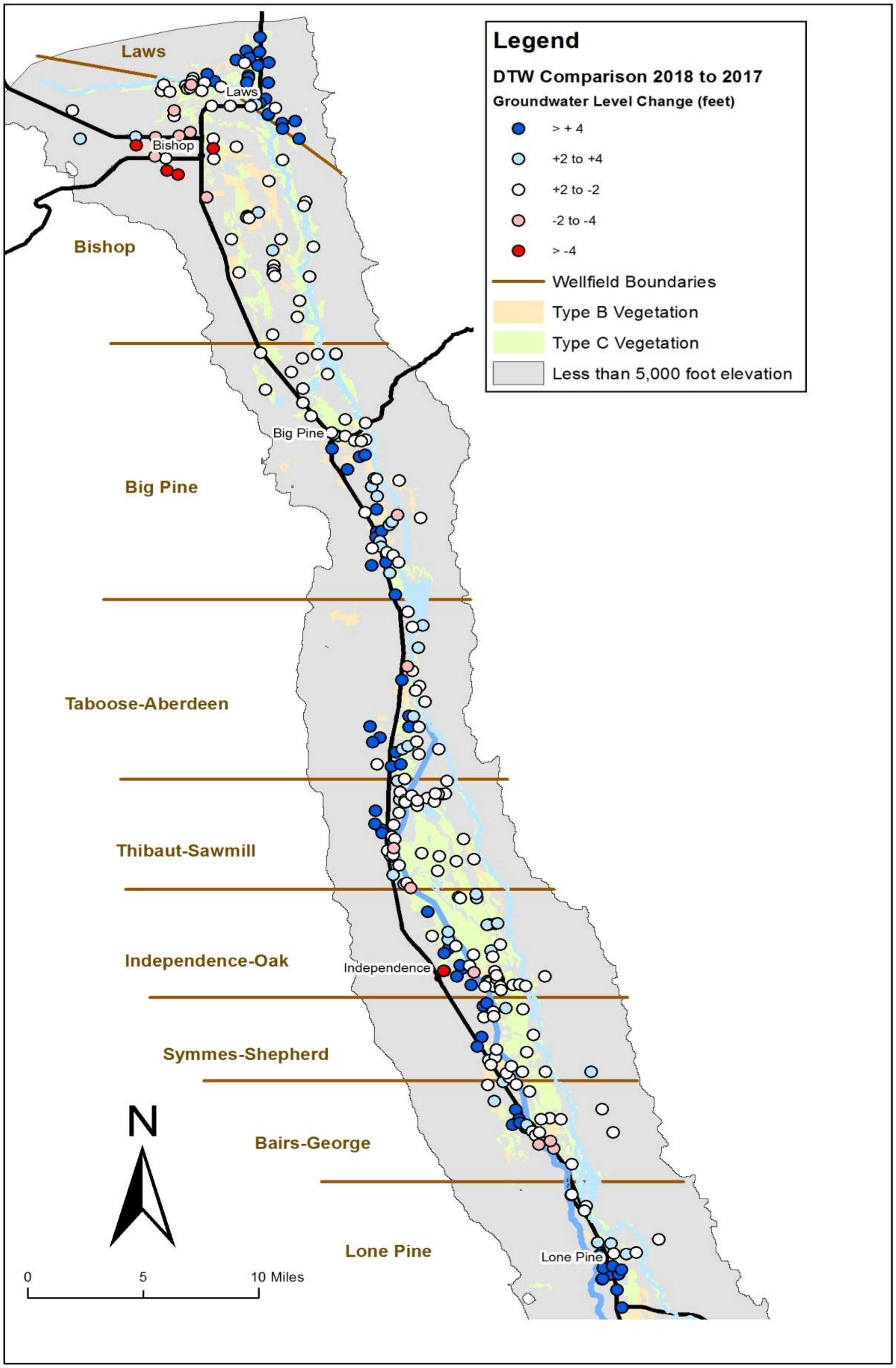


Figure 3.5. Change in water levels in Owens Valley monitoring wells in 2017-18.

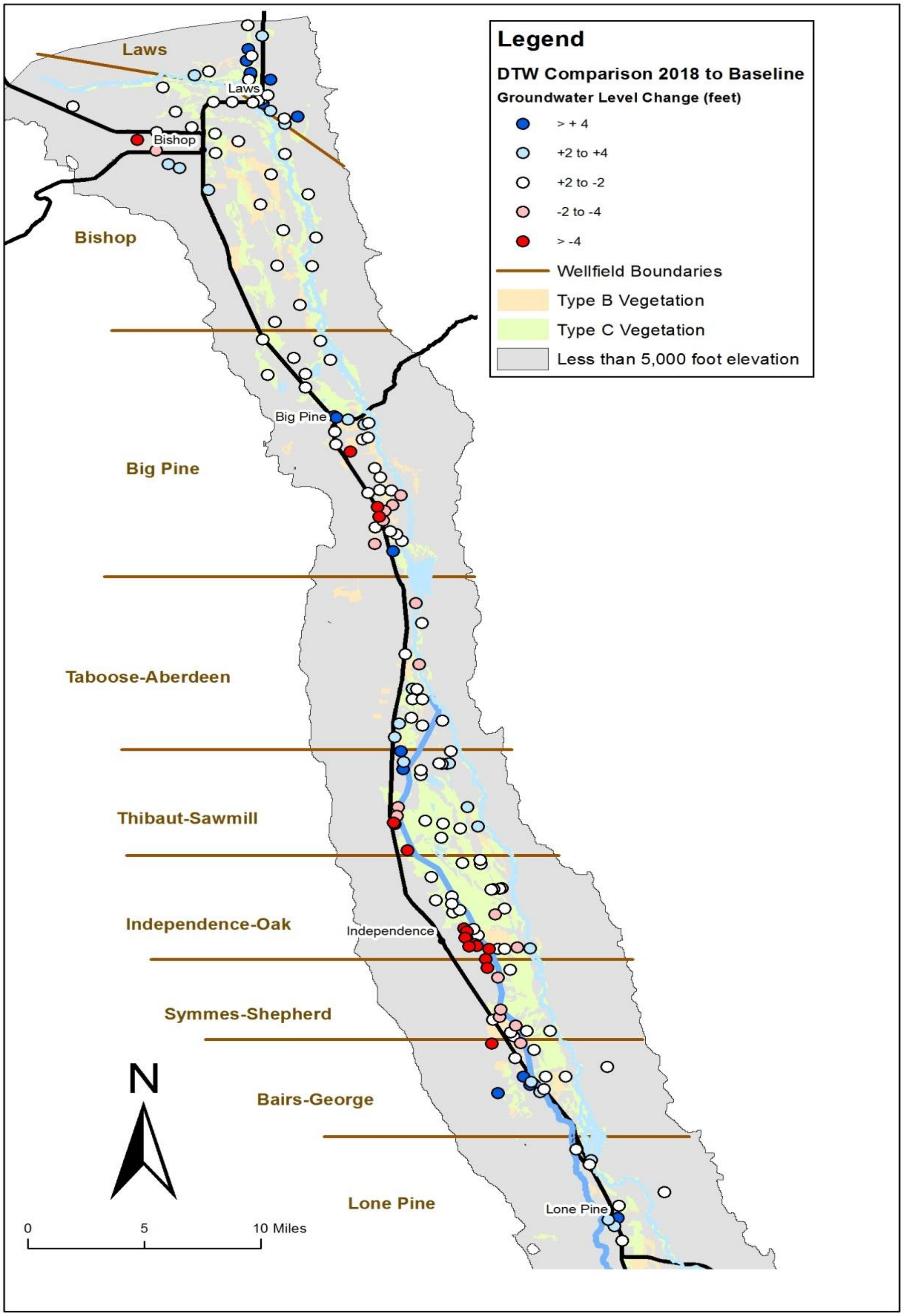


Figure 3.6. April 2018 water levels wells compared with April average water level in 1985-87.

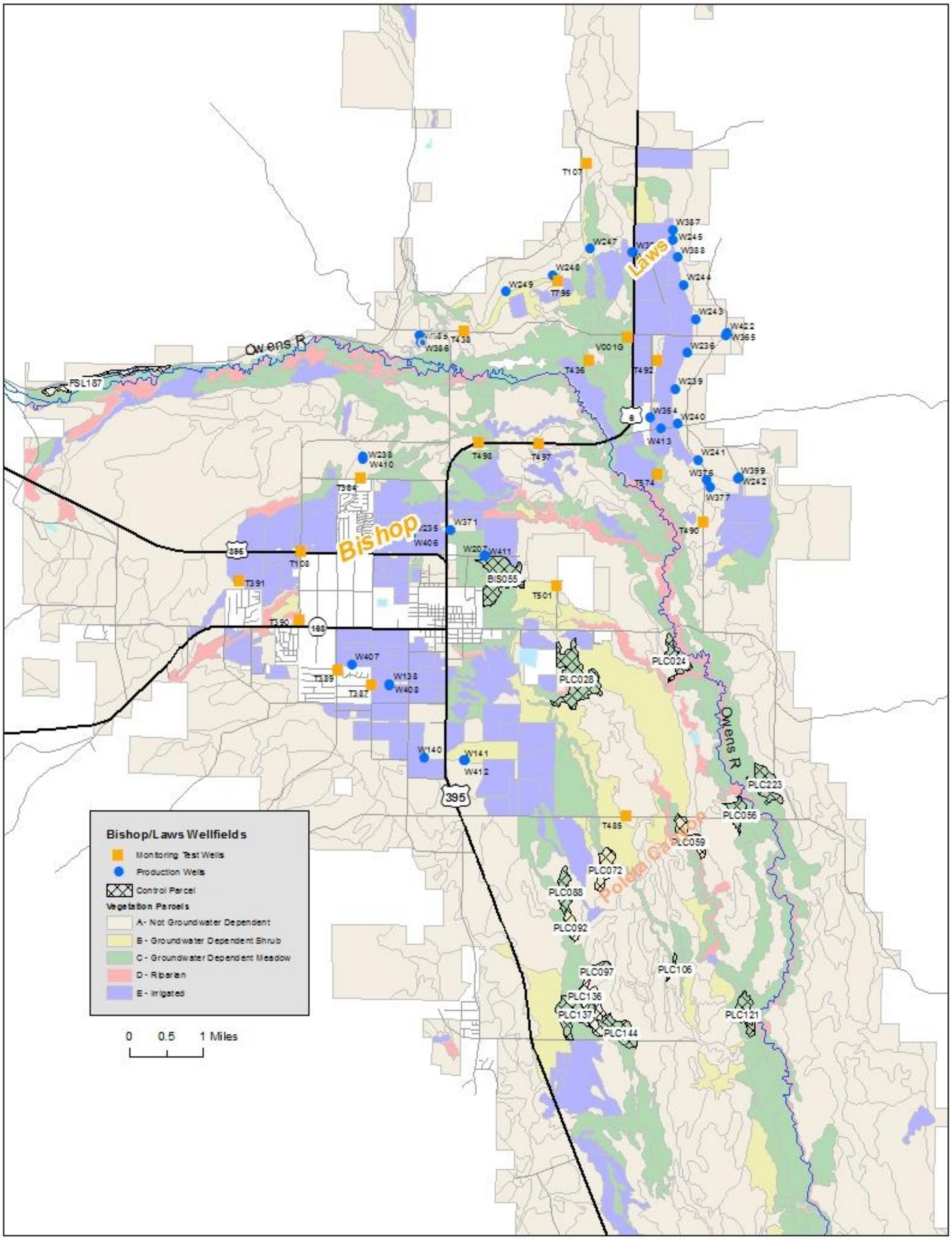


Figure 3.7. Map of monitoring wells and LADWP production wells in Laws and Bishop wellfields.

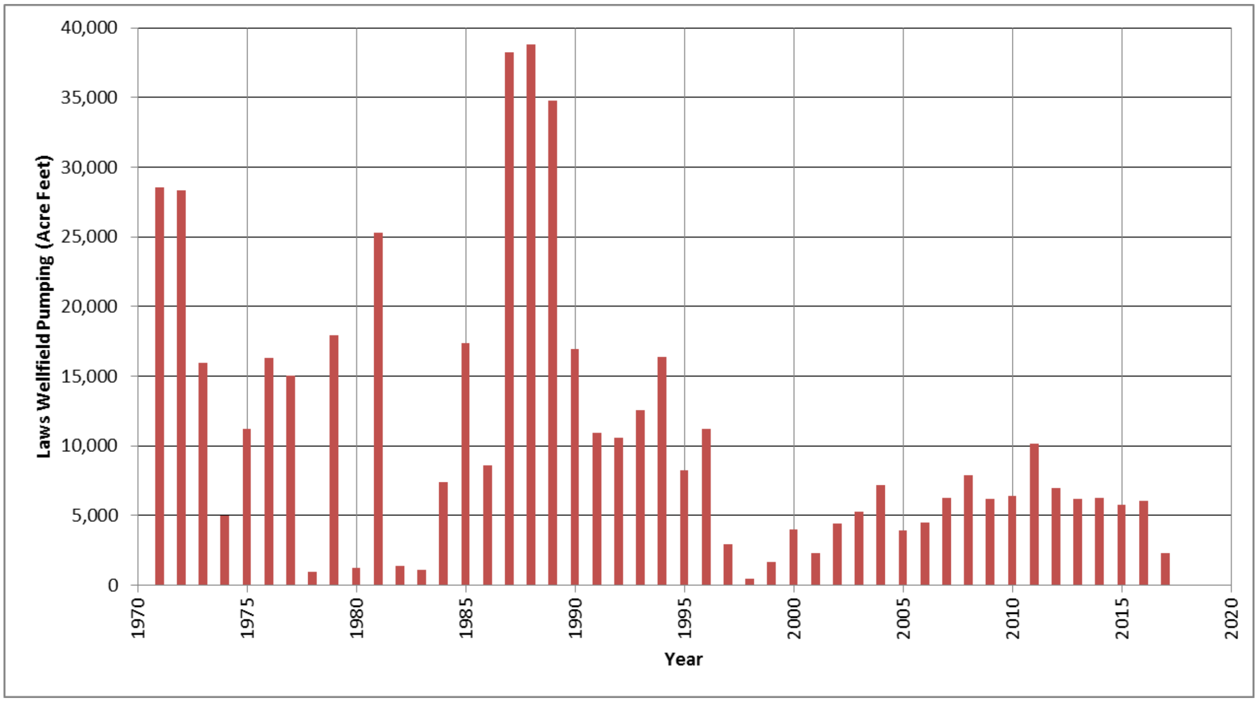


Figure 3.8. Pumping totals for the Laws wellfield.

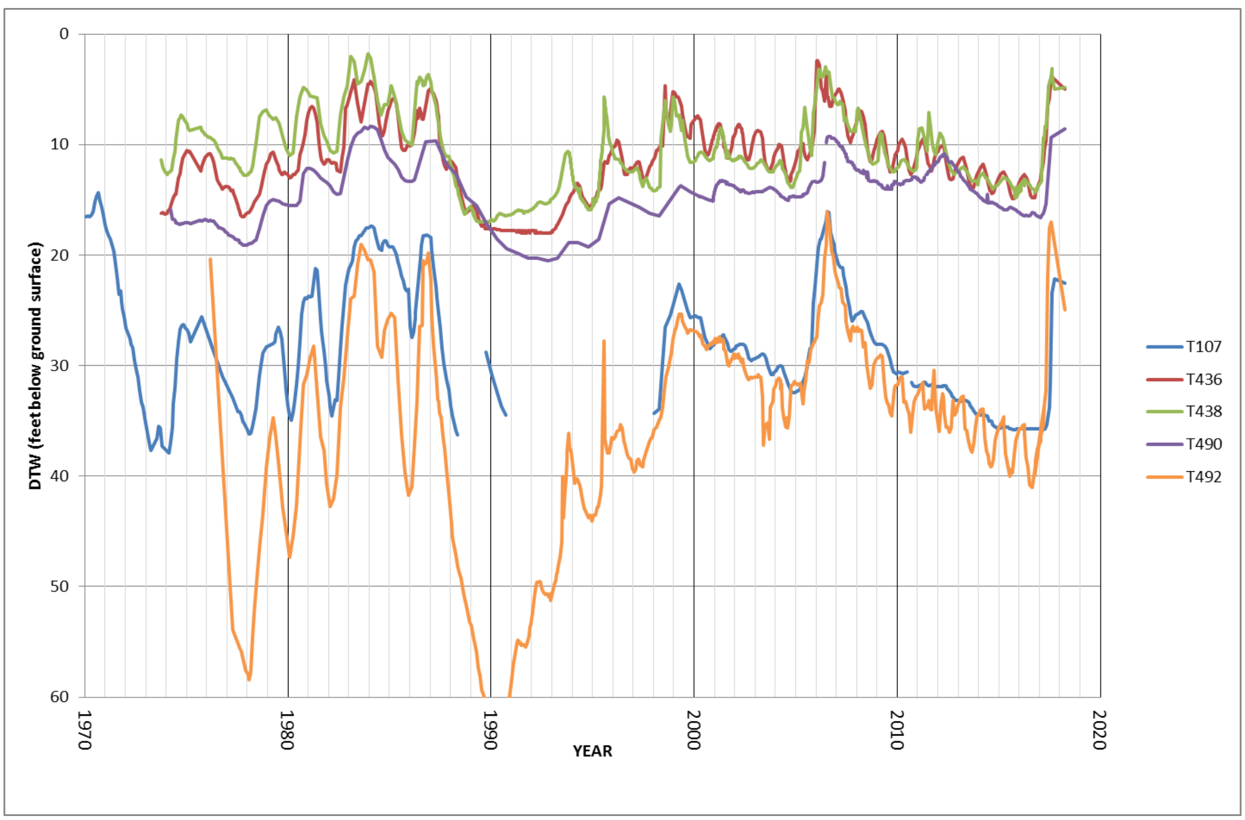


Figure 3.9. Hydrographs of indicator wells in the Laws wellfield. Well T492 is dry if DTW is below 60 ft, and well T107 is dry if DTW is below 37 feet.

Laws Wellfield

In the 1970's and 80's, pumping and irrigation and spreading from the Owens River via the McNally canals in Laws varied greatly year to year causing large fluctuations in the water table (Figures 3.7, 3.8, and 3.9). This was especially true for T107 and T492 because of their proximity to the McNally canals and LADWP pumping wells. Heavy pumping and low recharge in the late 1980's caused severe declines in the water table in Laws. Under the Water Agreement pumping has remained considerably below the maximum wellfield capacity. As a result, water levels rose, and beginning in 2000, water table fluctuations have been largely driven by pumping for local uses in the surrounding area and by water spreading following heavy snow winters (2005, 2006, 2011, 2017). In 2017-18, DTW rose in all indicator test holes, and all test holes were above baseline water levels in April 2018 (Table 3.2). It is predicted that the increased amount of pumping in 2018 (much for export) will contribute to lowering groundwater levels in Laws in 2018-19.

Bishop Wellfield

Groundwater pumping in the Bishop Wellfield is managed differently than other wellfields due to additional legal requirements governing LADWP operations. The environmental protections and goals of the Water Agreement still apply, however. The Water Agreement requires Inyo and Los Angeles to prepare an annual audit of pumping and uses on the Bishop Cone to demonstrate compliance with the Hillside Decree (the Decree itself does not contain audit procedures). The Hillside Decree is a 1940 Inyo County Superior Court stipulation and order under which LADWP groundwater extractions from pumped and uncapped flowing wells cannot exceed the annual amount of water used on LADWP owned land on the Bishop Cone.

It is important to understand that the Bishop Cone Audit is not an accounting of the water balance for the groundwater aquifer. Rather, it is an accounting based on the surface water applications (for irrigation and stockwater) to the Bishop Cone compared to the groundwater pumping and flowing wells. Water supplied for irrigation in west Bishop upstream of LADWP pumping wells consists of surface water diverted primarily out of Bishop Creek and the Owens River. Pumped water from the center of the cone is also conveyed for irrigation using the same ditches and canals as the surface water, and most lands are supplied with combined pumped and surface water. Because it is impossible to separate surface and groundwater once they are combined in a canal or ditch, the most reliable method to assess compliance with the Hillside Decree is to compare the sum of pumping and flowing water against the sum of water uses applied on the cone.

Uses in the Bishop Cone Audit are calculated as the amount of water applied to a parcel minus the amount of water flowing off the parcel back into the canal or ditch system. In some cases several parcels are grouped into a single account and several monitoring stations are used to measure the water delivered to and exiting from the account. The accounts as well as the individual deliveries/uses are only included in the Bishop Cone Audit following a field inspection and Technical Group approval to ensure that appropriate monitoring is in place. Not all lands supplied with water or all water uses are included in the Audit.

The most recent Bishop Cone Audit examined conditions for the 2016-17 runoff year. Total groundwater extraction (pumping and flowing wells) on the Bishop Cone was

14,674 ac-ft compared with 33,423 ac-ft of recorded uses. Therefore, uses on the Bishop Cone exceeded extractions by approximately 18,749 ac-ft. If extractions had exceeded the amount of recorded uses, all groundwater could not have been used on the Bishop Cone and LADWP would be out of compliance with the Hillside Decree. That situation has not occurred since the audit procedures were implemented as part of the Water Agreement.

Pumping in the Bishop Wellfield has been relatively constant for the past 25 years except in above-normal runoff years when pumping decreased, for example 1998, 2006 and 2017 (Figure 3.10). Because of the Hillside Decree and relatively constant pumping, ICWD does not routinely use indicator wells to analyze the annual operations plan for this wellfield. Water levels in west Bishop typically peak after the summer irrigation season. Groundwater levels from 1980 to 2017 at several test wells located west, north, and east of the city of Bishop are presented in Figures 3.11.a -c. Constant pumping and consistent recharge from irrigation has historically resulted in relatively stable water levels in the Bishop Cone Wellfield. However, the effects of the 2012 to 2016drought can be seen in the recent water levels from Bishop Cone wells, especially wells in the western and northern portions of the wellfield.

It is likely that a combination of diminished surface water flows caused by the 2012-2016 drought and the change in timing of Bishop Creek surface flows negatively affected shallow groundwater levels in west Bishop from the fall of 2013 through the winter of 2014. Groundwater levels in this area dropped precipitously, in some cases to their lowest recorded levels. Several domestic wells went dry. Hydrographs of these groundwater levels declines can be seen in Figure 3.12. The declining groundwater levels prompted both

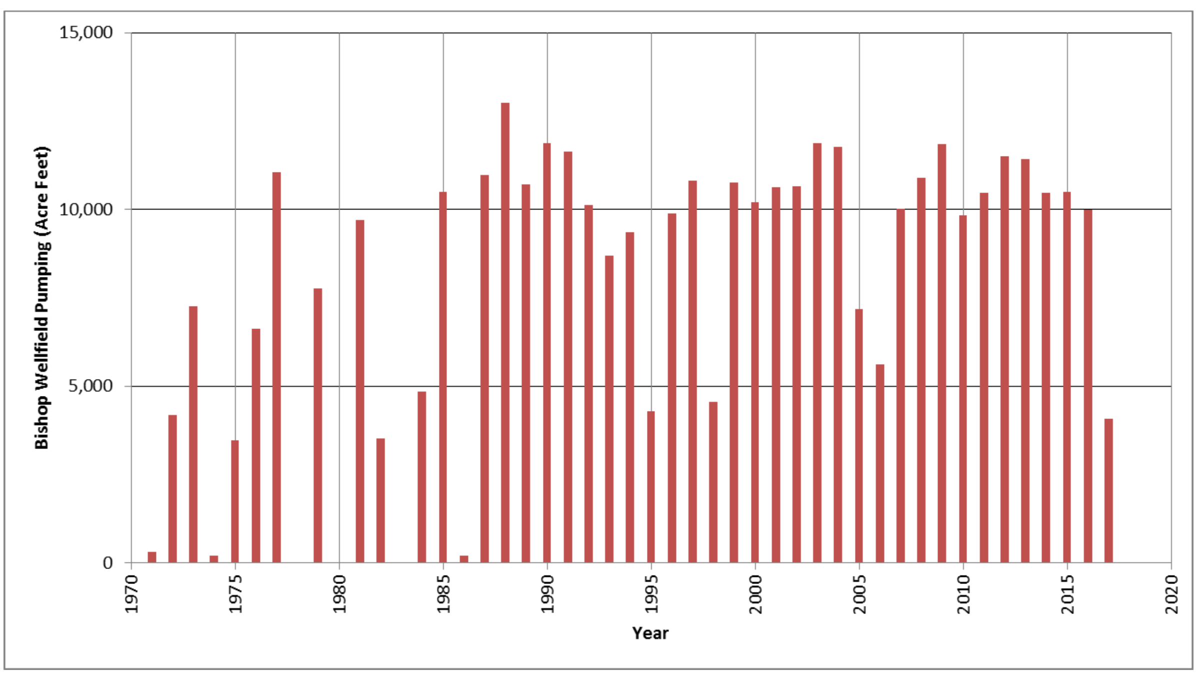


Figure 3.10. Pumping totals for the Bishop wellfield.

ICWD and LADWP to increase the frequency of their monitoring on the western half of the Bishop Cone in order to more fully understand the changes in groundwater levels during the prolonged drought.

From the water table lows in fall and winter of 2013-14, groundwater levels recovered. During this recovery, several west Bishop residents noticed extremely shallow or perched water at their properties. It is theorized that once creek and ditch flows returned to the area in 2014, increased seepage of surface water led to the oversaturation of the near surface sediments. Additional investigations were conducted in 2016, including a report issued by the Department of Water Resources (see inyowater.org, DWR Report on Shallow Groundwater Conditions in West Bishop 12/2016 and inyowater.org and February 1, 2017 Inyo County Water Commission Minutes).

In summer/fall of 2017, fewer problems with shallow groundwater were noted and it is hoped that the natural sealing caused by decaying biomass in ditches and ponds has decreased seepage amounts to their pre 2013 rates, and that the west Bishop hydrologic system is moving back towards it historic equilibrium.

For 2018-19, the forecasted flows in Bishop Creek are expected to meet or exceed the Chandler Decree minimums through September 2018 with enough water retained in storage to keep 2018-19 fall and winter flows at near historic norms.

Important takeaways from recently observed Bishop Cone conditions:

- Surface water flows play an integral role in recharging shallow groundwater levels in west Bishop; and the interaction between surface water and groundwater recharge is very sensitive to changes in equilibrium conditions

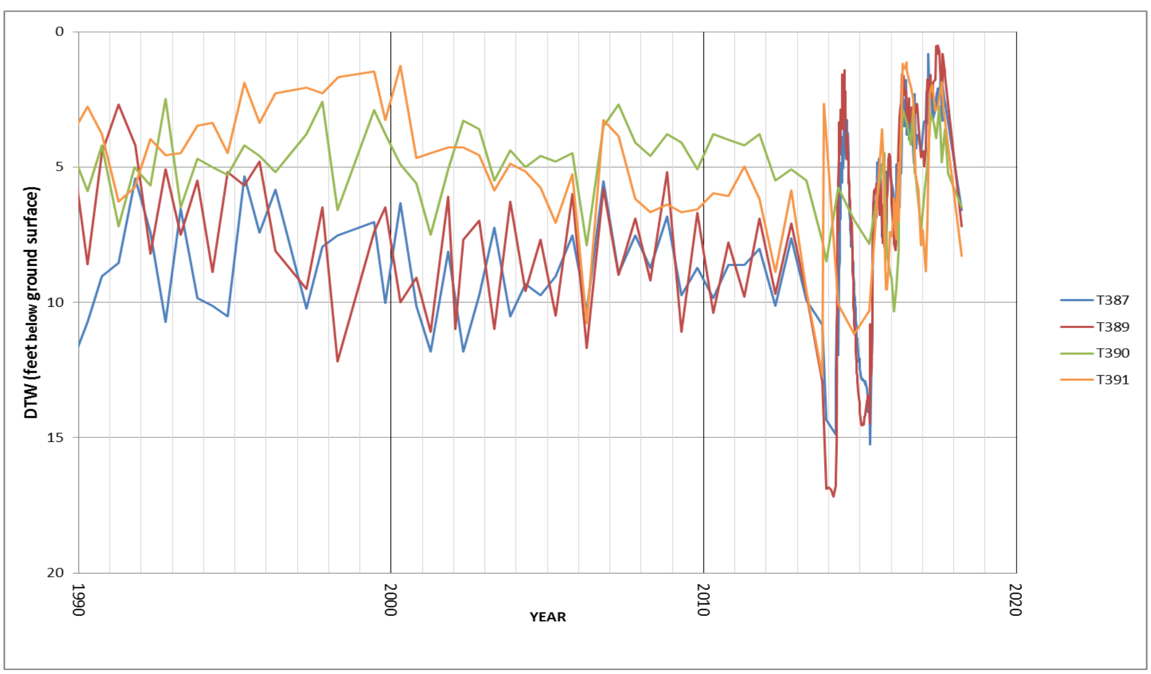


Figure 3.11.a. Hydrographs of selected monitoring wells in the western Bishop wellfield. Locations of the wells are shown in Figure 3.7

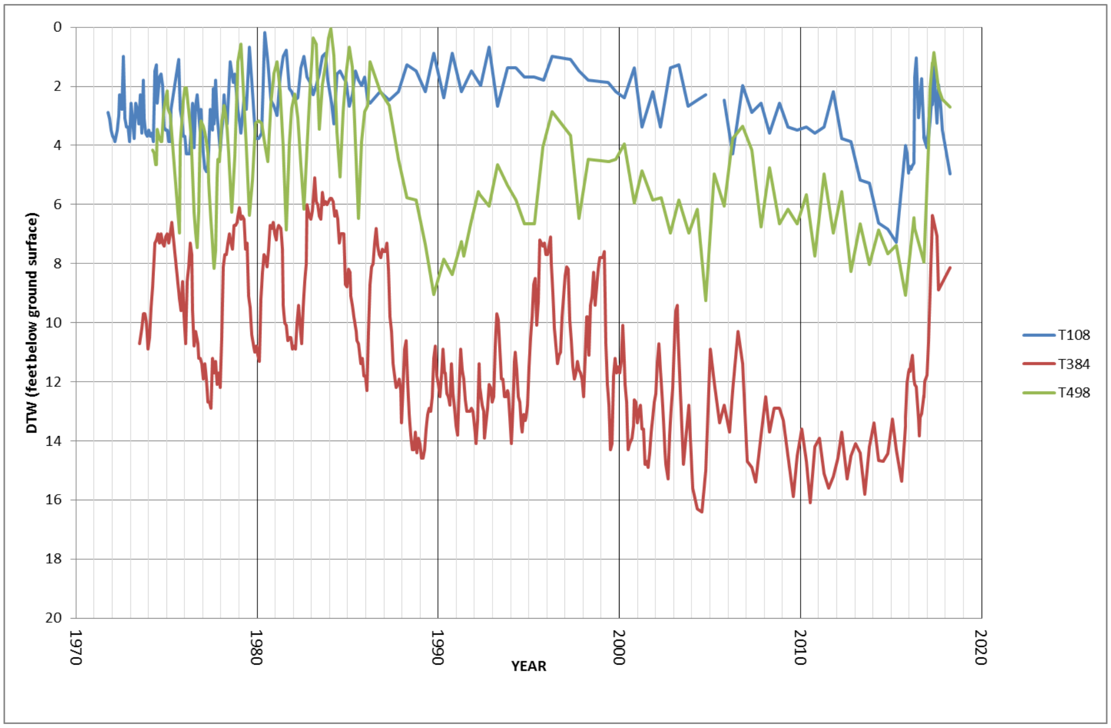


Figure 3.11.b. Hydrographs of selected monitoring wells in the northern Bishop wellfield. Locations of the wells are shown in Figure 3.7

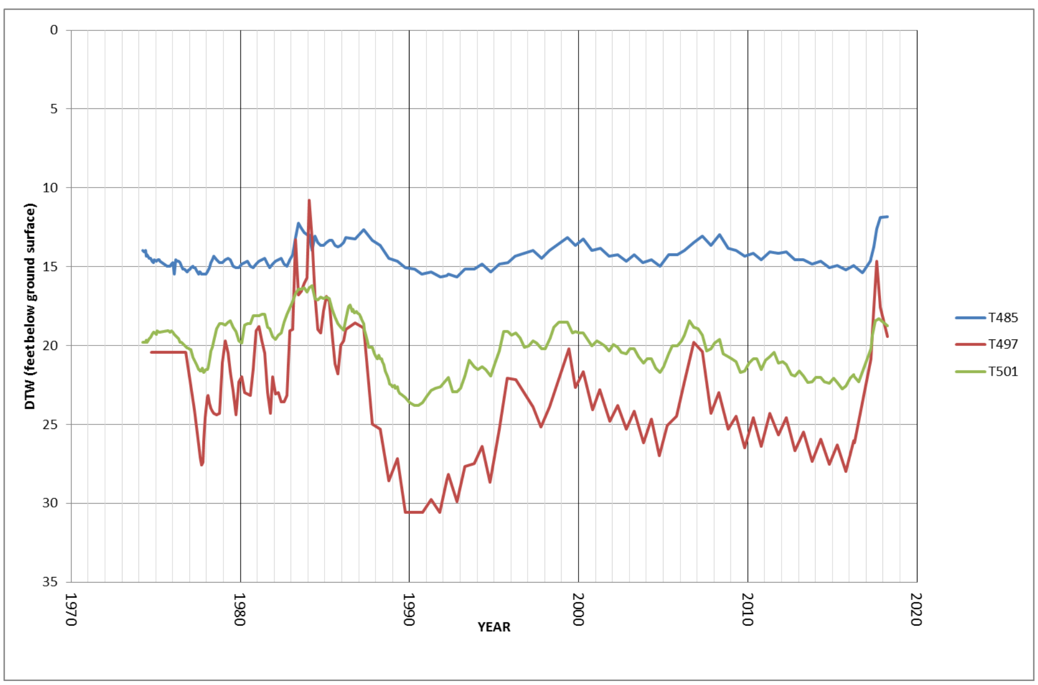


Figure 3.11.c. Hydrographs of selected monitoring wells in the eastern Bishop wellfield. Locations of the wells are shown in Figure 3.7

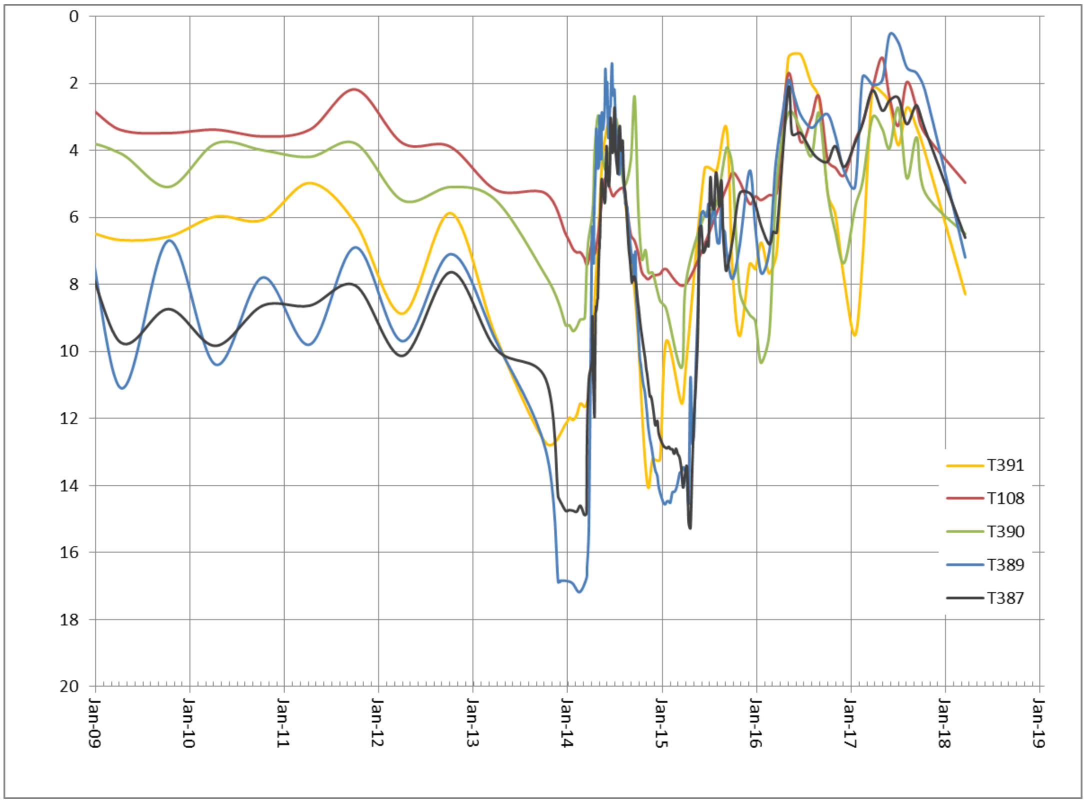


Figure 3.12. Recent hydrographs of selected monitoring wells in western Bishop wellfield. Locations of the wells are shown in Figure 3.7

- Semiannual monitoring in spring and fall does not capture the full range of groundwater fluctuations in the Bishop area
- Thoughtful water management of Bishop Creek flows and the associated diversion and ditch flows should be used during drought and/or low runoff years to maintain some flow in area ditches
- In west Bishop there is a delicate balance between enough surface water seepage to recharge area groundwater and too much seepage to overwhelm infiltration rates, leading to undesirable, extremely shallow or perched water levels
- Many of the private wells in west Bishop are shallow and, therefore, more vulnerable to impacts associated with deepening groundwater levels
- Conservative pumping practices should be used on LADWP wells W407 and W408 during drought and/or low runoff years
- Information gathered in west Bishop during the past several years should be taken into consideration in regards to LADWP's potential new wells B2 and B5

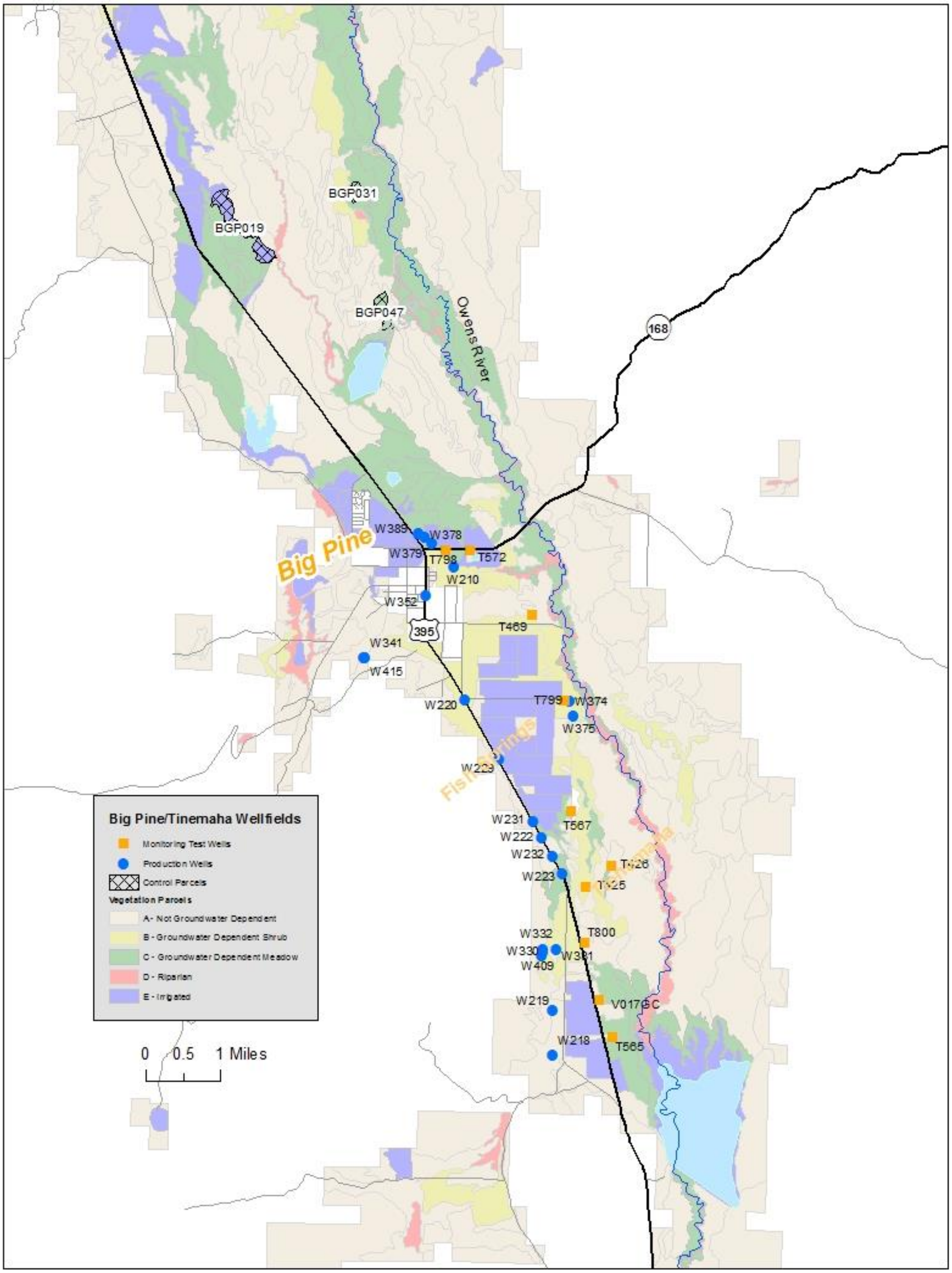


Figure 3.13. Map of monitoring wells and LADWP production wells in Big Pine wellfield.

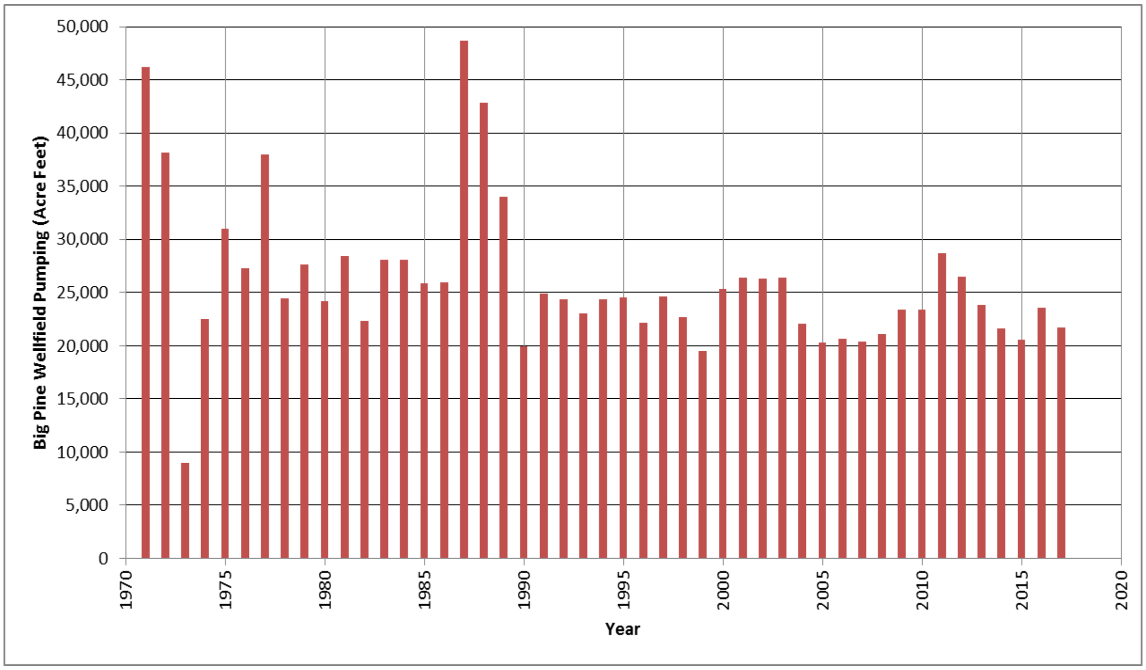


Figure 3.14. Pumping totals for the Big Pine wellfield

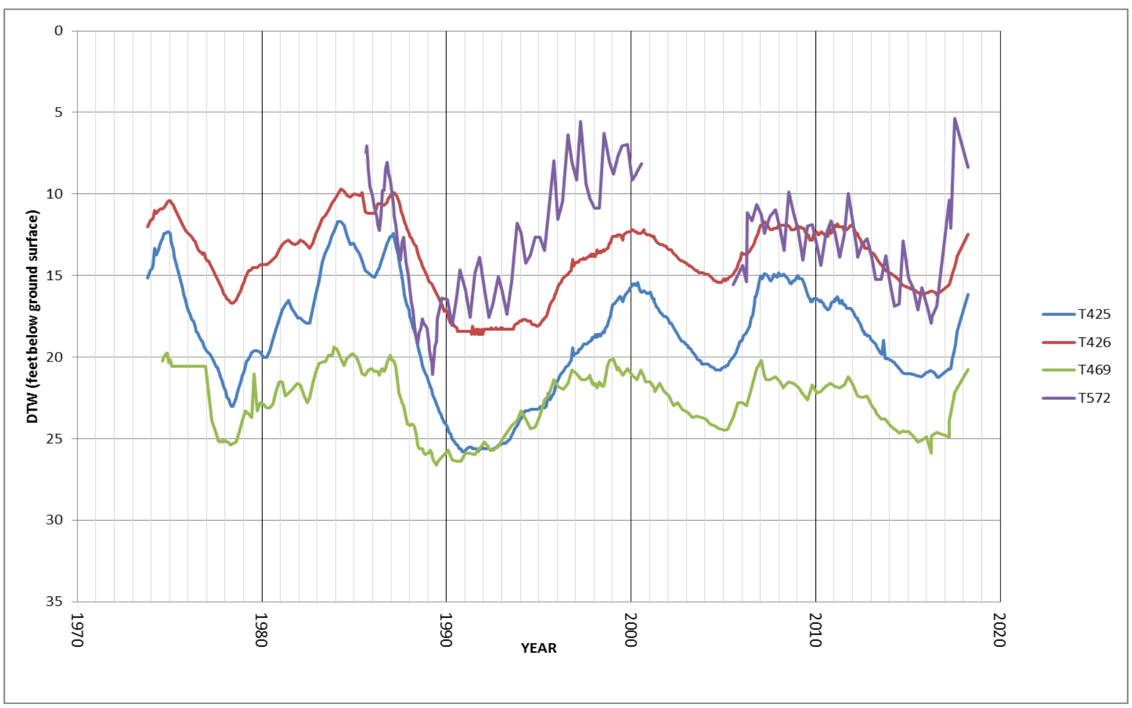


Figure 3.15. Hydrographs of indicator wells in the Big Pine wellfield. Periods of missing data for T572 occurred when the well was plugged and in need of repair.

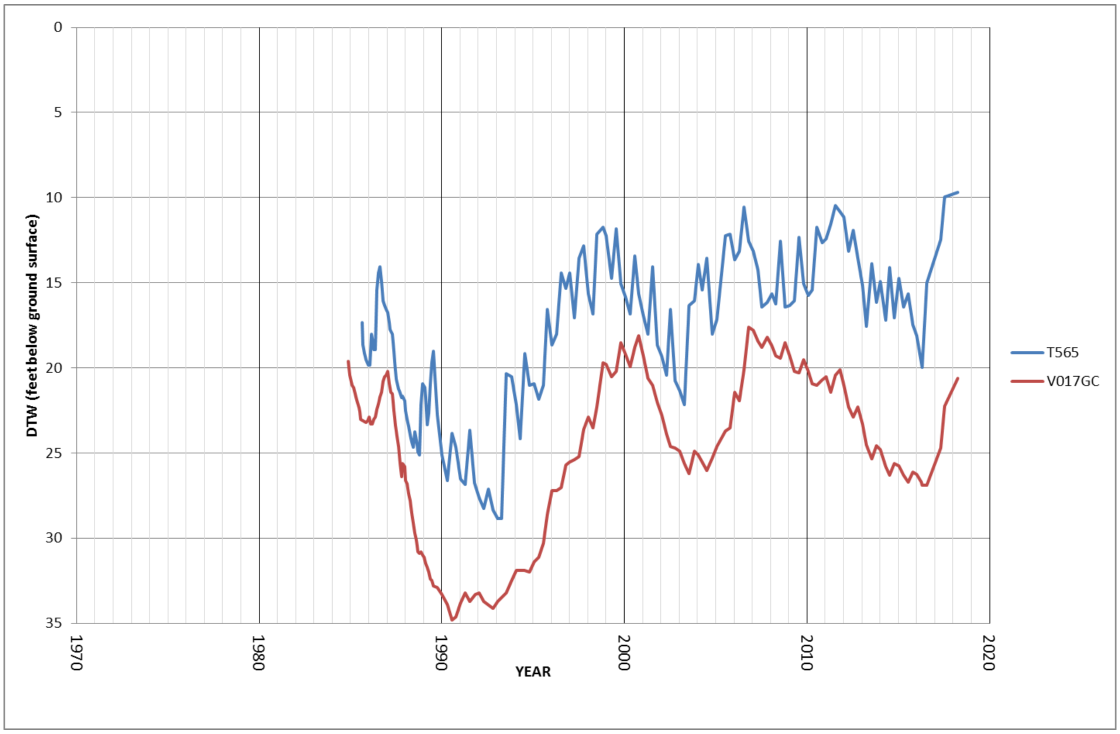


Figure 3.16. Hydrographs of monitoring wells in the southern Big Pine wellfield near pumping wells W218 and W219.

Big Pine Wellfield

Pumping in the Big Pine wellfield (Figure 3.14) since 1974 has been consistently higher than other wellfields (Figure 3.13). Minimum pumping to supply uses in this wellfield include the Fish Springs Hatchery (approximately 19,500 ac-ft per year) and Big Pine town supply (500 ac-ft per year). Pumping under the Water Agreement has largely been to supply these uses. It should be noted that most of the hatchery pumped water also reaches the aqueduct.

DTW in indicator and monitoring site wells rose in all eight wells in 2018 (Figure 3.15, Table 3.2). However, six of the eight indicator wells remain three feet or less below baseline. The two indicator wells above baseline (T572 and T798) are in the northern part of the wellfield in close proximity to and strongly influenced by the Big Pine Canal which has received above average flows in 2017 due to the historic winter. ICWD also examined two test wells located just east of U.S. 395 near W218 and W219 to assess possible impacts from the additional export pumping of recent years (Figure 3.16). Both V017GC and T565 are located in or adjacent to groundwater dependent vegetation. Water levels declined in response to drought and pumping from 2012 to 2016. In 2017, LADWP actively spread water into the Big Pine wellfield, notably south of town along the Red Mountain cinder cone. Both V017GC and T565 have recovered significantly since 2017 and are above baseline as of 2018.

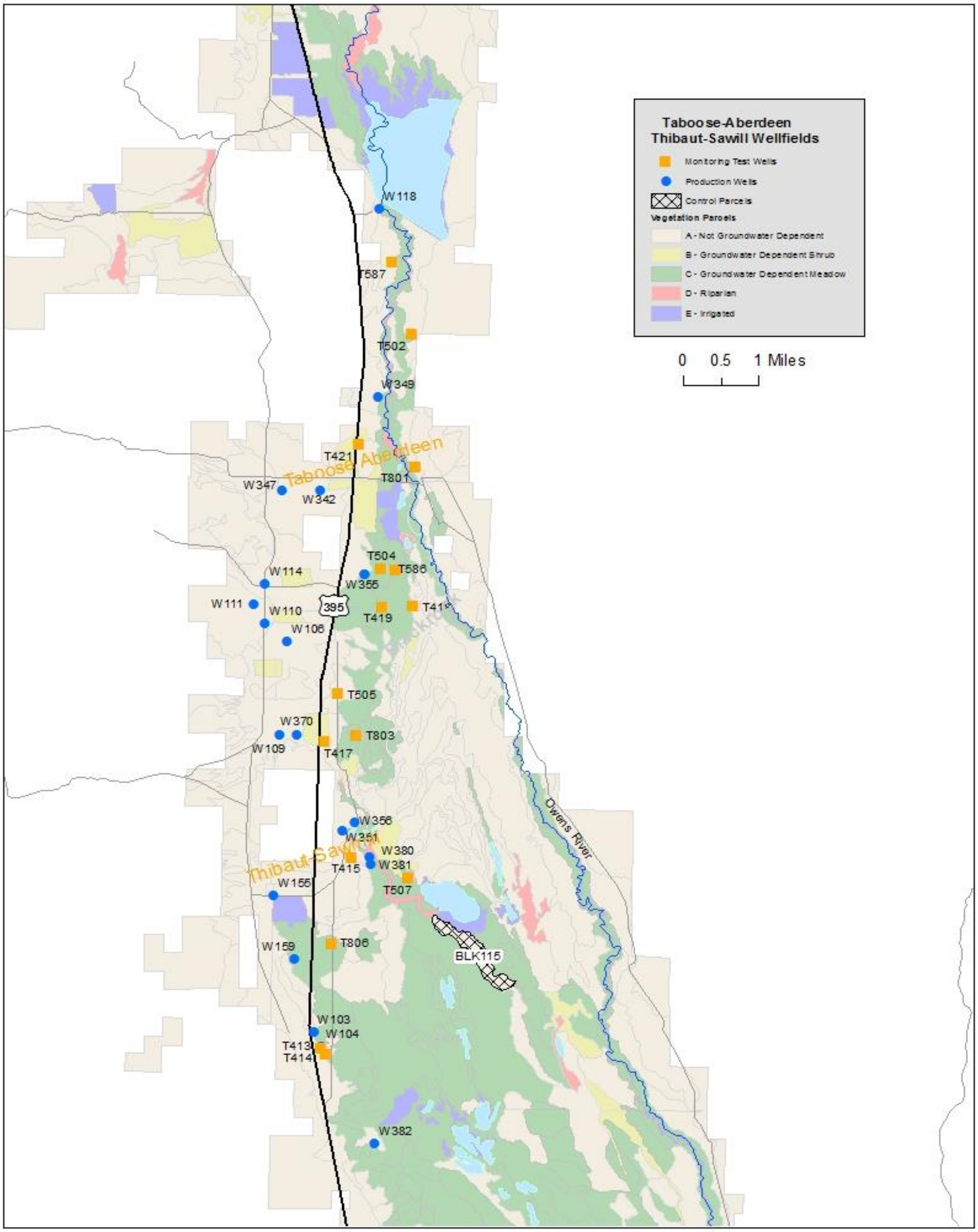


Figure 3.17. Map of monitoring and LADWP production wells in the Taboose-Aberdeen and Thibaut-Sawmill wellfields.

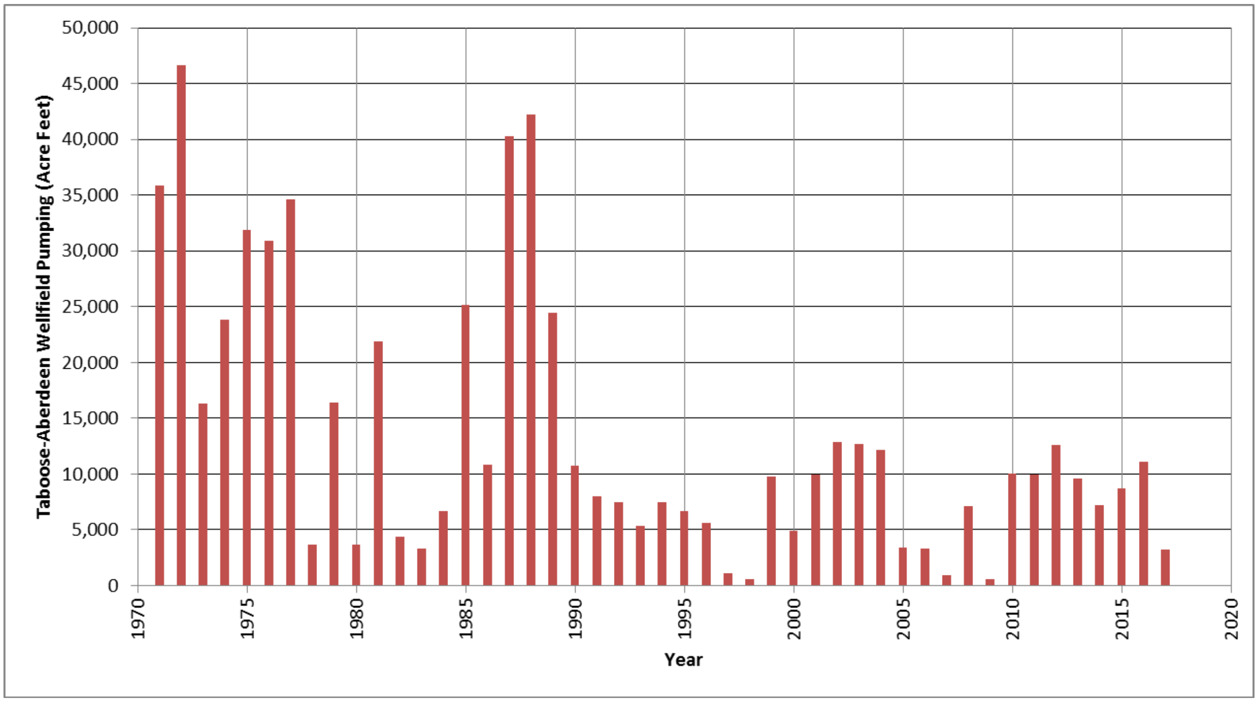


Figure 3.18 Pumping totals for the Taboose-Aberdeen wellfield.

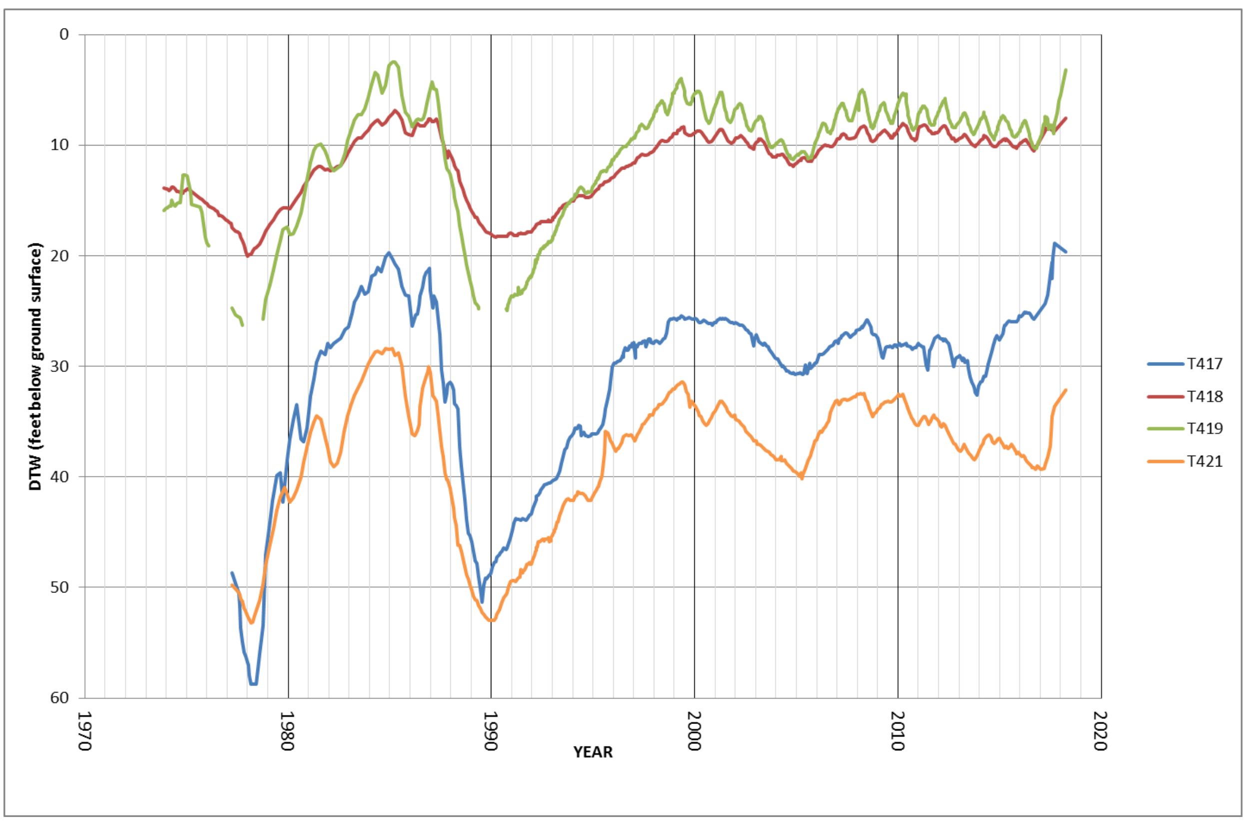


Figure 3.19. Hydrographs of indicator wells in the Taboose-Aberdeen wellfield. Periods of missing data denote when the test well was dry.

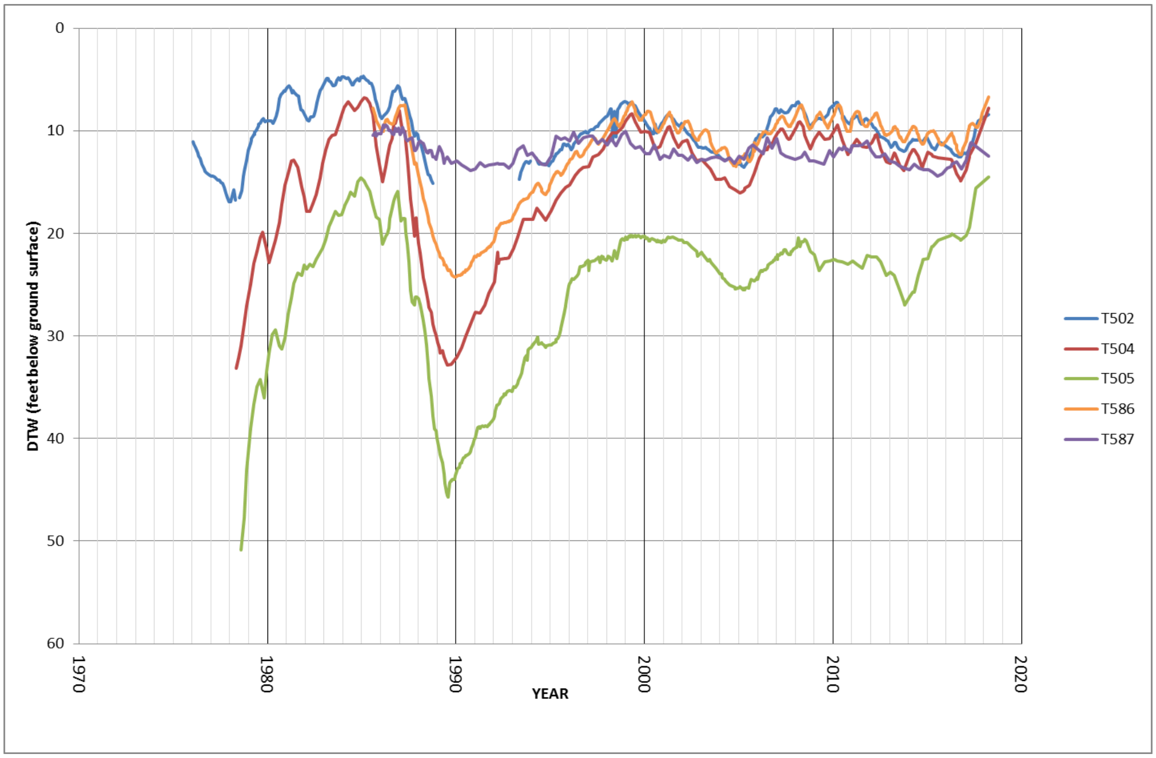


Figure 3.20. Hydrographs of indicator wells in the Taboose-Aberdeen wellfield. Periods of missing data denote when the test well was dry.

Taboose-Aberdeen Wellfield

Pumping in the Taboose-Aberdeen Wellfield (Figure 3.17) since 1990 under the Water Agreement has remained much below the wellfield capacity (Figure 3.18). Minimum pumping for this wellfield is approximately 300 ac-ft to supply one mitigation project at Big Seeley Spring, and nearly all of the pumping since 2010 has been for aqueduct supply.

Groundwater levels in 2017-2018 rose between 1 to 7 feet in nine out of ten indicator or monitoring site wells (Table 3.2). The only test well with groundwater decline (801T) is located in the northern part of the wellfield on the eastern side of the Owens River between W349 and W118. Water levels in the southern portion of the wellfield have continued to increase due to a reduction in pumping to supply the Blackrock fish hatchery in 2014. Depth to water in all wells varied from less than 2 feet below to more than 3 feet above baseline in April 2018 (Table 3.2).

Hydrographs for the indicator wells exhibit similar response to fluctuations in pumping and runoff (Figures 3.19 and 3.20). Most of the recent pumping has been from well W349 and W118 located in the northern portion of the wellfield. Well 118 has been operated consistently from 2011 to 2016, but was off for the majority of the 2017-18 runoff year. Data from well T587 (a non-indicator well) is included because it is located adjacent to groundwater dependent vegetation near W118 and is used to assess the impacts of recent pumping.

Thibaut-Sawmill Wellfield

Historically, most pumping in the Thibaut-Sawmill Wellfield has been to supply approximately 12,200 ac-ft annually to the Blackrock Fish Hatchery (Figure 3.21). In 2011-12, approximately 1,800 ac-ft was pumped from this wellfield for aqueduct supply; since then, pumping has been for hatchery or local irrigation uses. In 2014, Inyo and Los Angeles agreed to reduce hatchery pumping to approximately 8,300 ac-ft.

Hydrographs of four test wells used to track water levels in Thibaut-Sawmill have exhibited different responses due to local water management within the wellfield (Figure 3.22). Well T415, responding to reduced hatchery pumping, has exhibited a continuing rising trend since 2014. Wells T413, T414 and T507 located in the southern portion of the wellfield have recovered several feet during the past two years.

The reduction in the hatchery pumping is not as evident in these wells. Following nearly ten years of stable water levels, T507 began to respond in 2009 to the establishment of wetlands in the Blackrock Waterfowl Management Area (BWMA). The rotational flooding of BWMA affects groundwater levels in this well. Groundwater levels in all four wells rose or were stable in 2018 compared to 2017. And all three indicator wells for T

hibaut-Sawmill are at or above baseline levels.

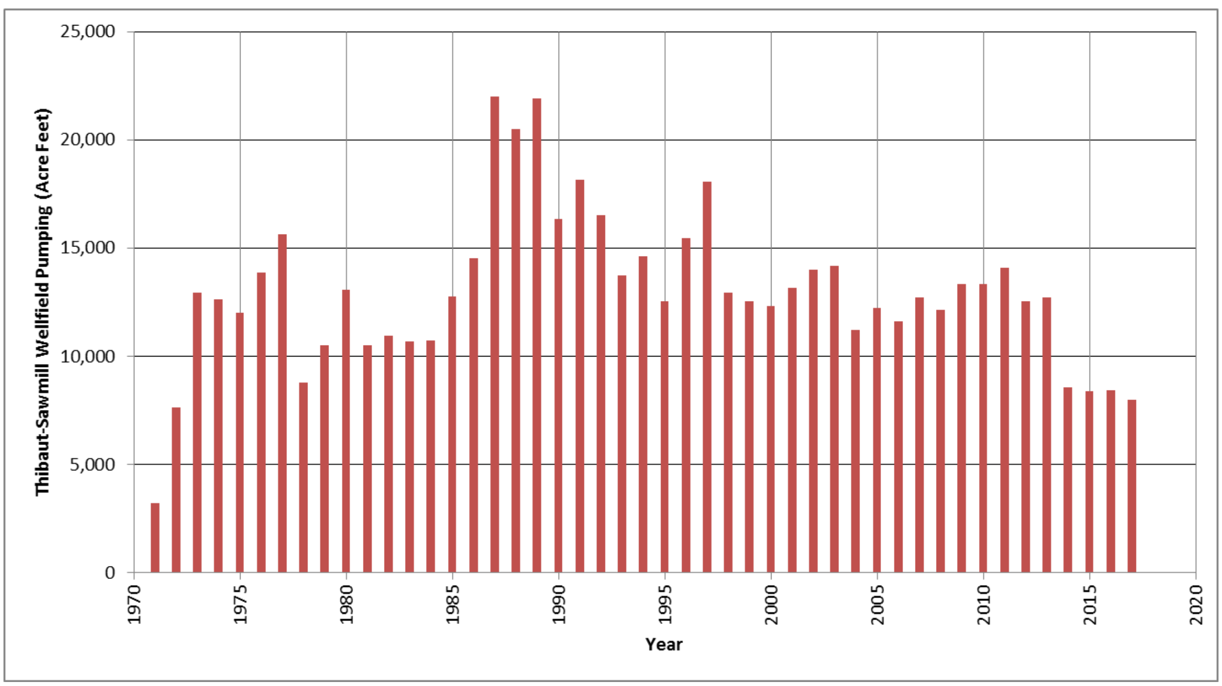


Figure 3.21. Pumping totals for the Thibaut-Sawmill wellfield.

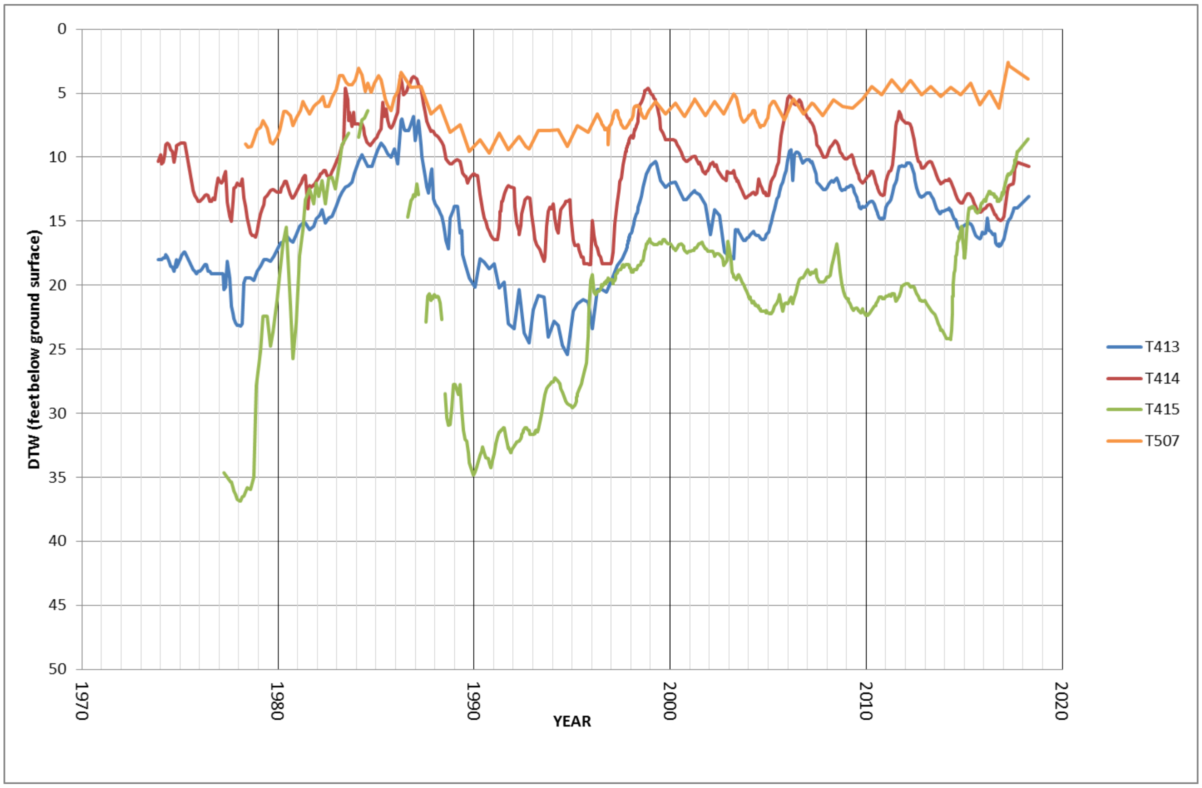


Figure 3.22. Hydrographs of selected test wells in the Thibaut-Sawmill wellfield.

Independence-Oak Wellfield

Pumping in this wellfield (Figure 3.23) is required to supply approximately 6,700 ac-ft annually for irrigation projects surrounding Independence and for town supply (Figure 3.24). LADWP pumped between 8, 600-9,600 from 2011 through 2016; however, with heavy 2017 runoff, this wellfield was only pumped for irrigation (approximately 6,000 ac-ft).

Water levels had been stable through the first decade of 2000 in wells located in the center of the wellfield (T406, T407, T408, T409), but declined in response to the increased pumping during the recent drought. This past year, the combination of reduced pumping for export and increased recharge from heavy runoff have allowed water levels to rebound somewhat. Water levels in these wells ranged from less than one foot of decline to more than 9 feet of recovery (Table 3.2 and Figure 3.25) in April 2018. The other indicator wells located east and north of Independence (T546 and T809) exhibited strong recoveries (six to seven feet) this past year (Table 3.2 and Figure 3.26).

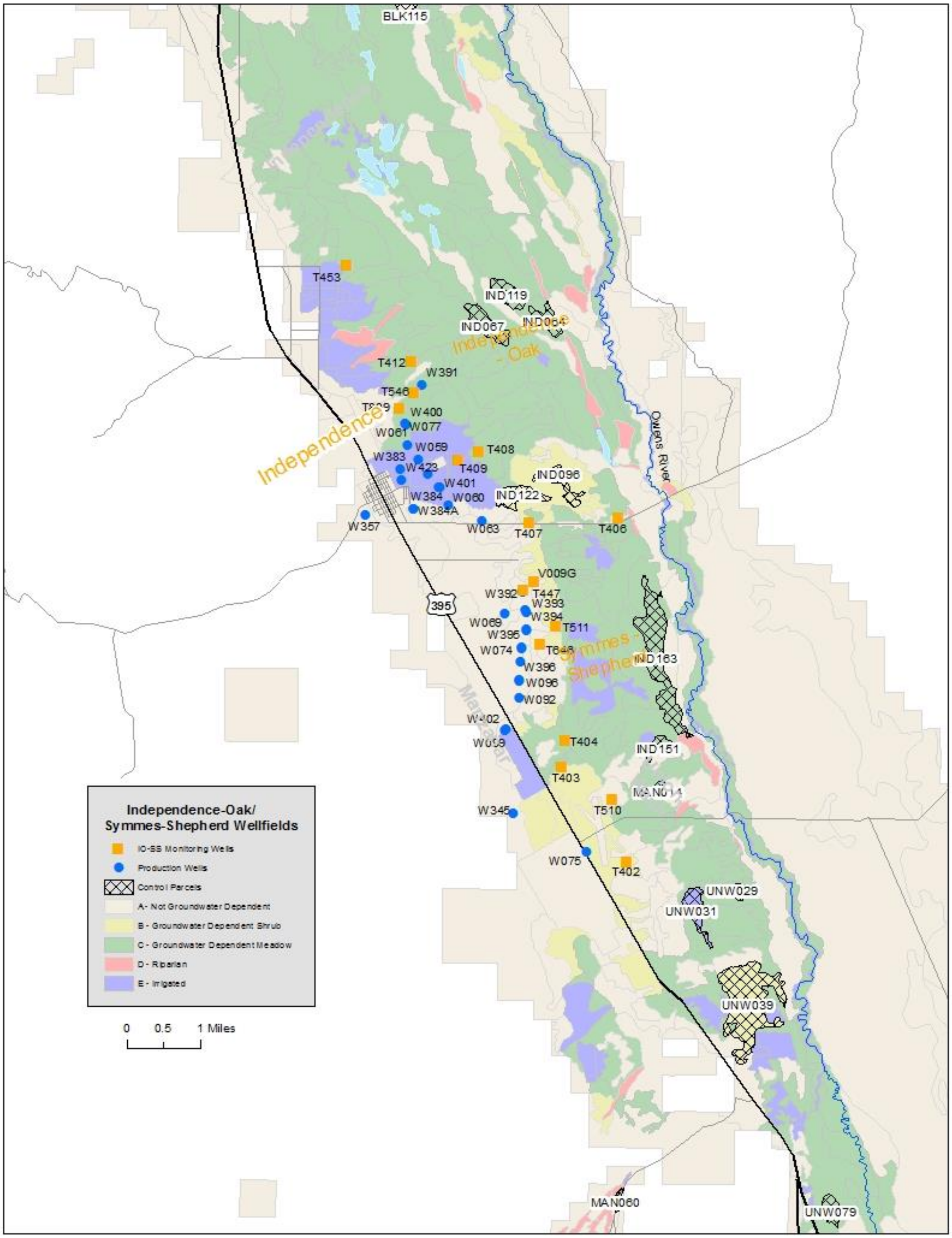


Figure 3.23. Map of monitoring and LADWP production wells in the Independence-Oak and Symmes-Shepherd wellfields.

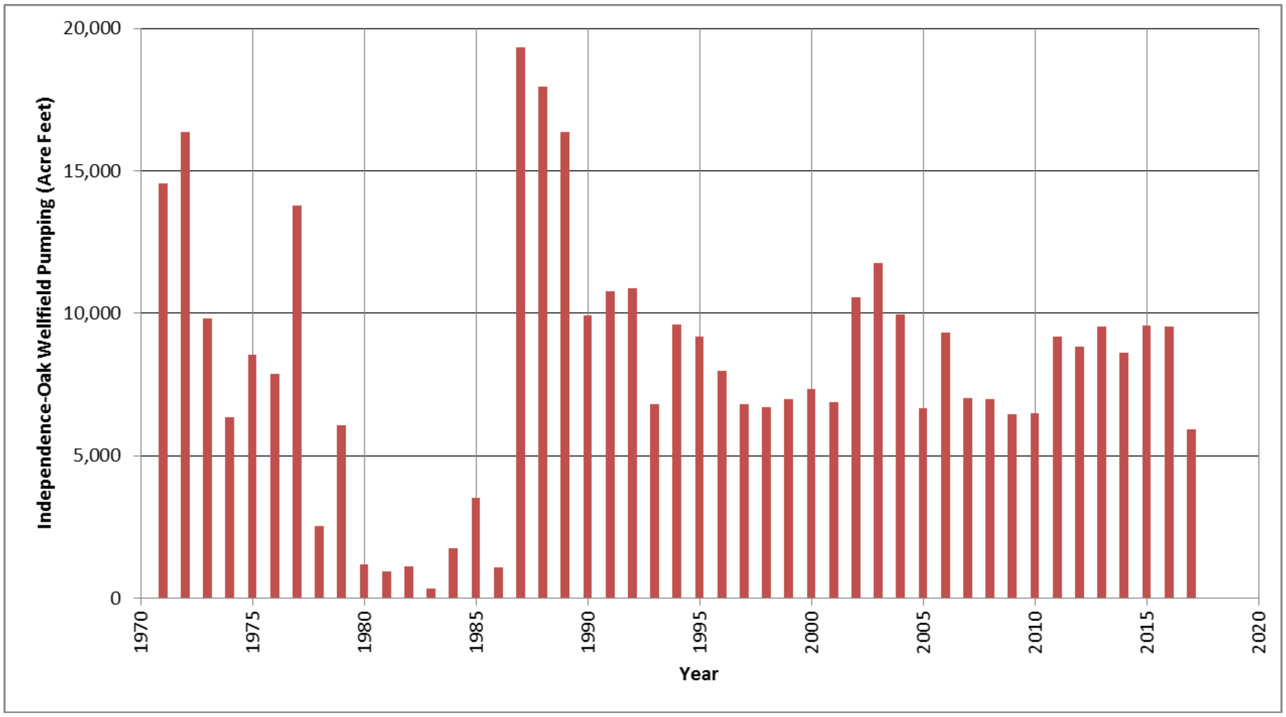


Figure 3.24. Pumping totals for the Independence-Oak wellfield.

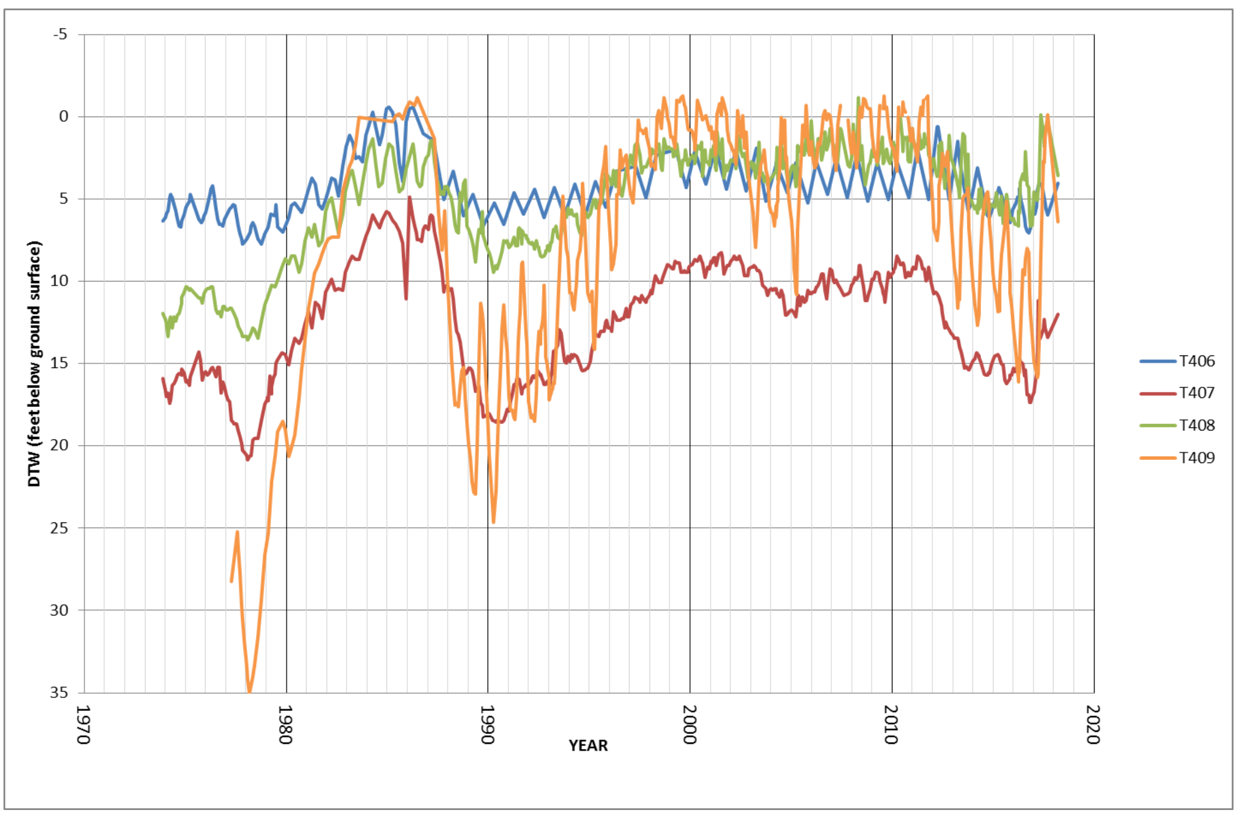


Figure 3.25. Hydrographs of selected test wells in the Independence-Oak wellfield

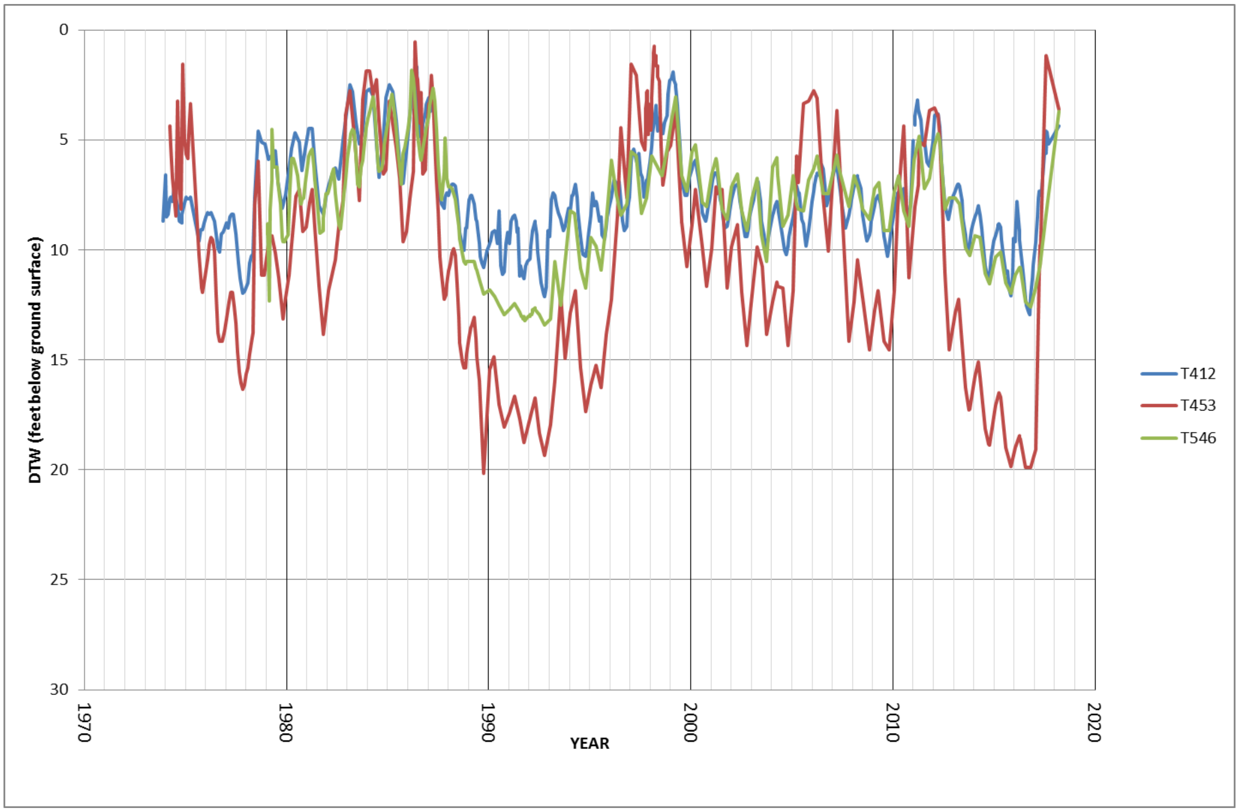


Figure 3.26. Hydrographs of selected test wells in the Independence-Oak wellfield

All of the indicator wells in the Independence-Oak Wellfield were below the baseline in April 2018 by 1 to 6 feet (Table 3.2). Due to the declines in groundwater levels as compared to the baseline period in these wells ICWD staff has recommended to LADWP that pumping for export be minimized in this wellfield.

Symmes-Shepherd Wellfield

In the 1970's and 80's, pumping in the Symmes-Shepherd Wellfield varied considerably (Figure 3.27). Under the Water Agreement, pumping was reduced. Approximately 1,200 ac-ft of pumping is required to supply one mitigation project; however, pumping for aqueduct supply has increased since 2010, primarily in the northern part of the wellfield.

In three of the seven indicator wells, groundwater levels in 2017-2018 declined. In the remaining four wells groundwater levels increased from 0.1 to 9 feet (Table 3.2). Some test wells are buffered to a degree by their proximity to the Los Angeles Aqueduct (T402-404 and T510-511), and groundwater levels are relatively stable (Figures 3.28 and 3.29). Test wells T447 and V009G are located near pumping wells in the northwestern portion of the wellfield and responded by rising dramatically (seven to nine feet) due to the reduction in pumping in 2017-18. Water levels in all monitoring wells were below baseline (Table 3.2).

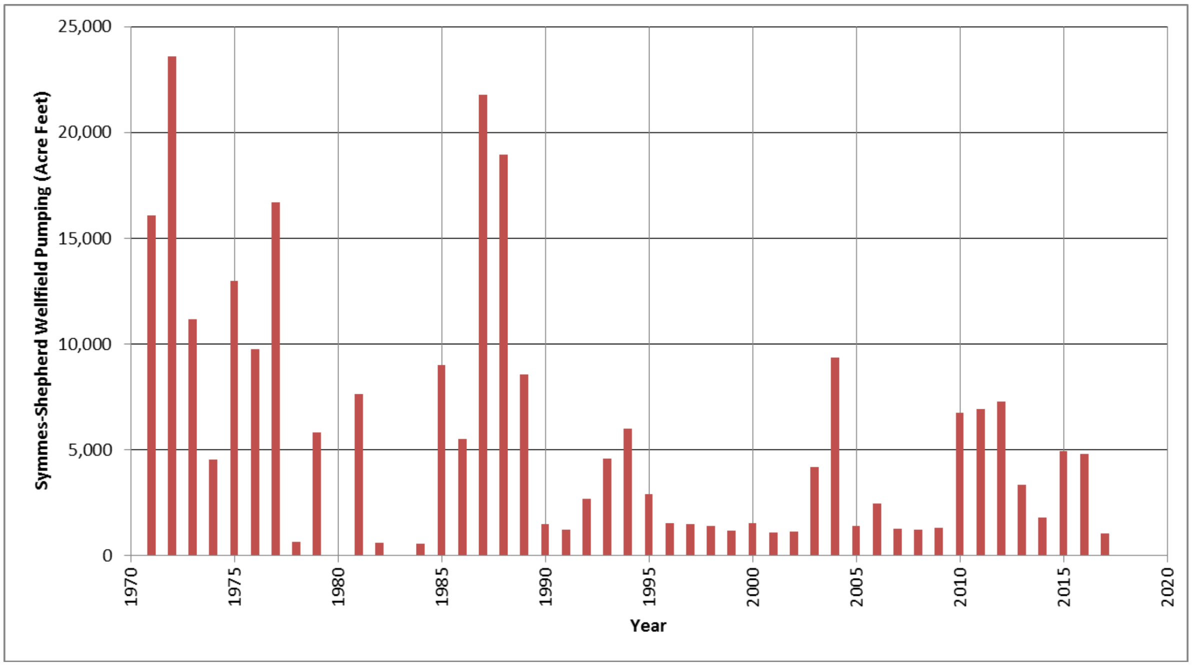


Figure 3.27. Pumping totals for the Symmes-Shepherd wellfield.

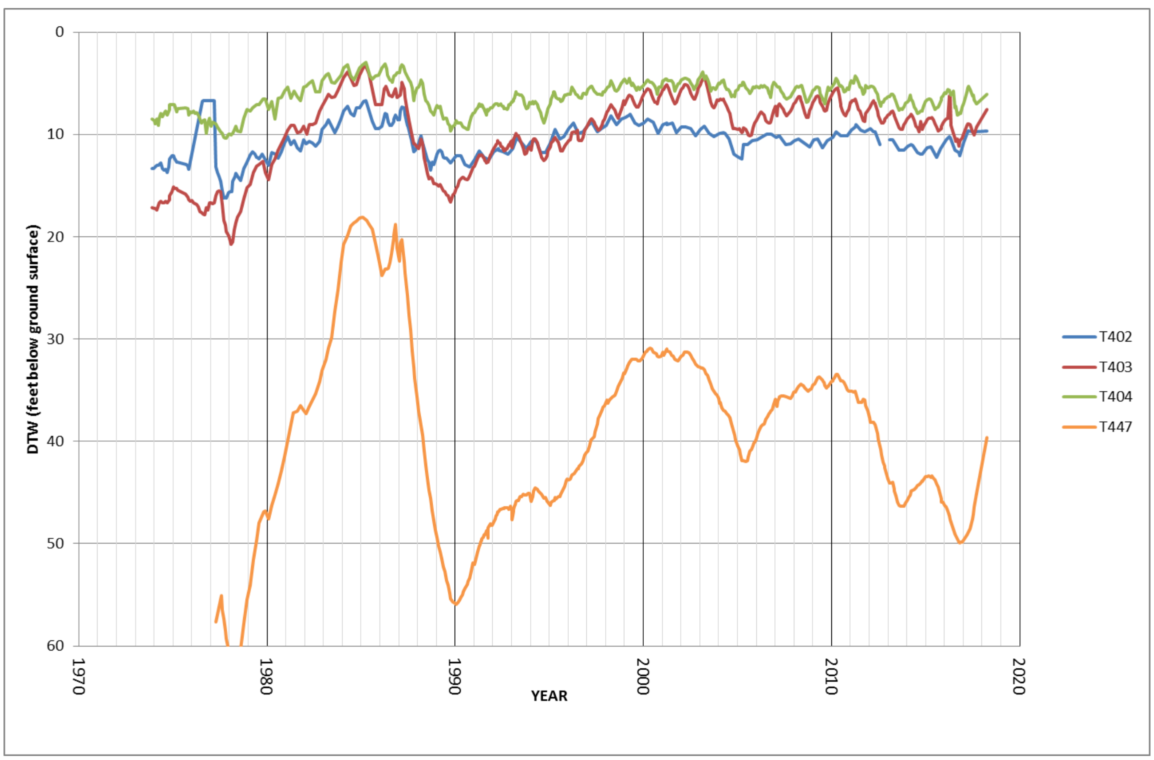


Figure 3.28 Hydrographs of indicator wells in the Symmes-Shepherd wellfield.

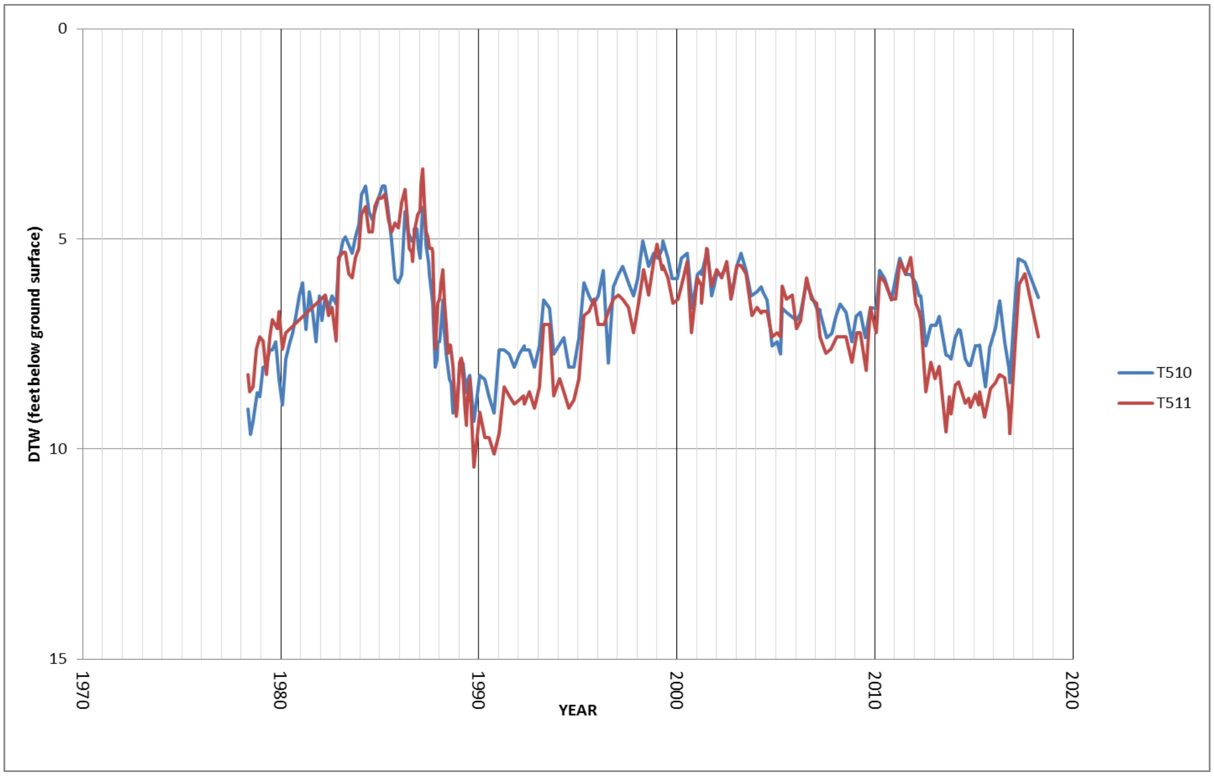


Figure 3.29 Hydrographs of indicator wells in the Symmes-Shepherd wellfield.

Due to the declines in groundwater level caused by pumping in this wellfield combined with the recent drought, Inyo County monitoring wells at the Independence landfill were dry or within a few feet of becoming dry in spring 2017. Cessation of pumping in 2017 combined with recharge has allowed water levels to recover more than 15 feet in these wells; however, ICWD continues to be concerned with water levels in Symmes-Shepherd that are well below baseline levels.

The Bairs-Georges Wellfield

In the 1970's and 80's, pumping and water levels in the Bairs-George wellfield (Figure 3.31) varied considerably, but under the Water Agreement, pumping has been reduced substantially. In dry years when surface flows decline, one well is exempt (W343) and can be operated to supply irrigated pastures. As in other wellfields, pumping for aqueduct supply increased in 2010-2016 compared with the small amounts during the five preceding years. Since the mid 1990's groundwater levels in the three indicator wells have been relatively stable. Water levels in 2017-2018 rose, and all three wells were above baseline (Table 3.2).

The pumping wells are located west of the Los Angeles Aqueduct. Monitoring wells T597 and T398 (Figure 3.32) are in the immediate vicinity of the aqueduct and well T400 is east of the aqueduct. Water table fluctuations in these wells are buffered by the infiltration from the aqueduct, though the effect of the increase in pumping since 2010 coupled with the 2012-2016 drought is plainly evident in T398 and T597. Pumping effects are less evident in T400. Wells T598 and T596 are located west of the aqueduct, and they exhibit larger fluctuations due to pumping (Figure 3.33).

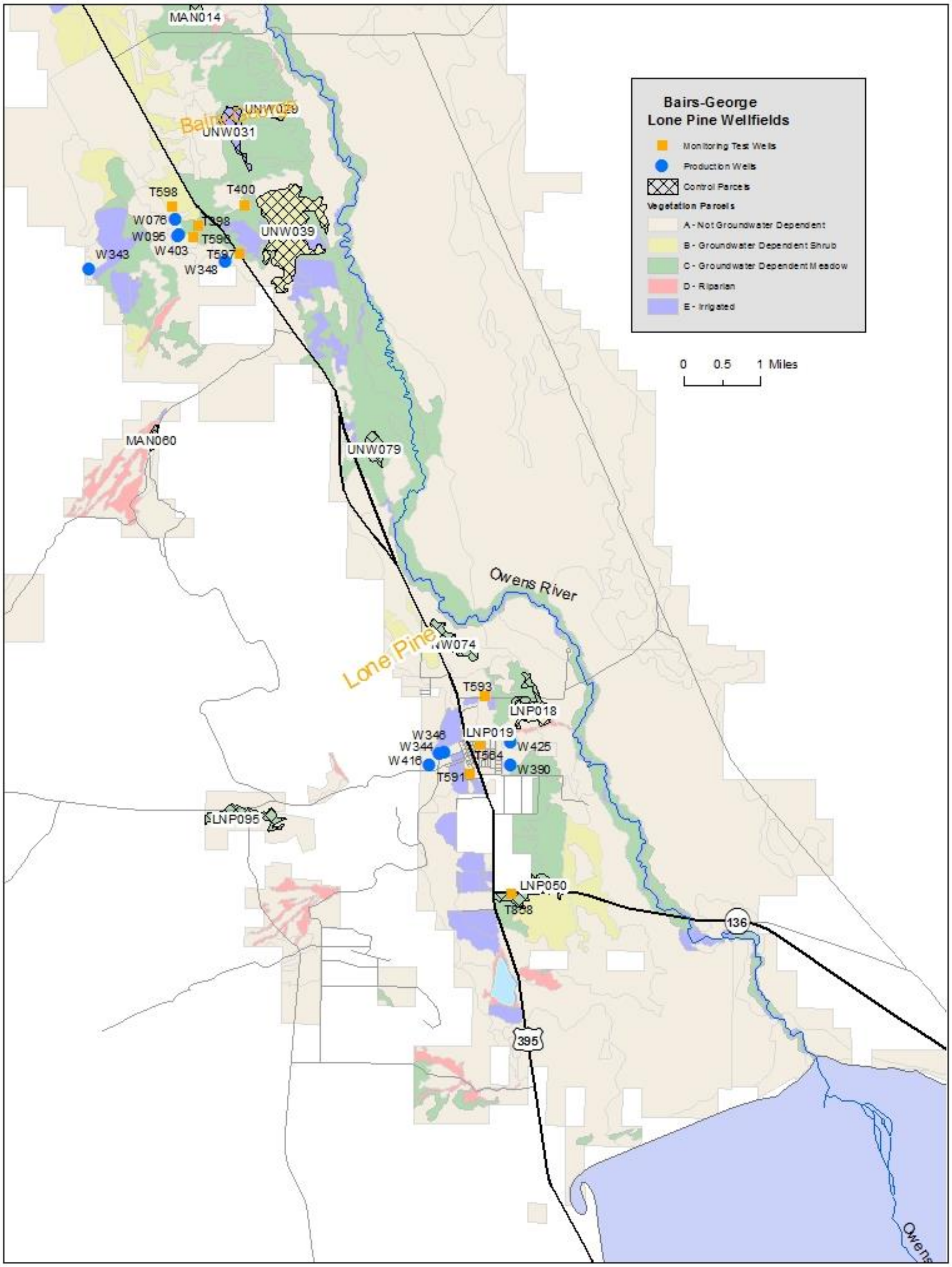


Figure 3.30. Map of monitoring and LADWP production wells in the Bairs-George and Lone Pine wellfields.

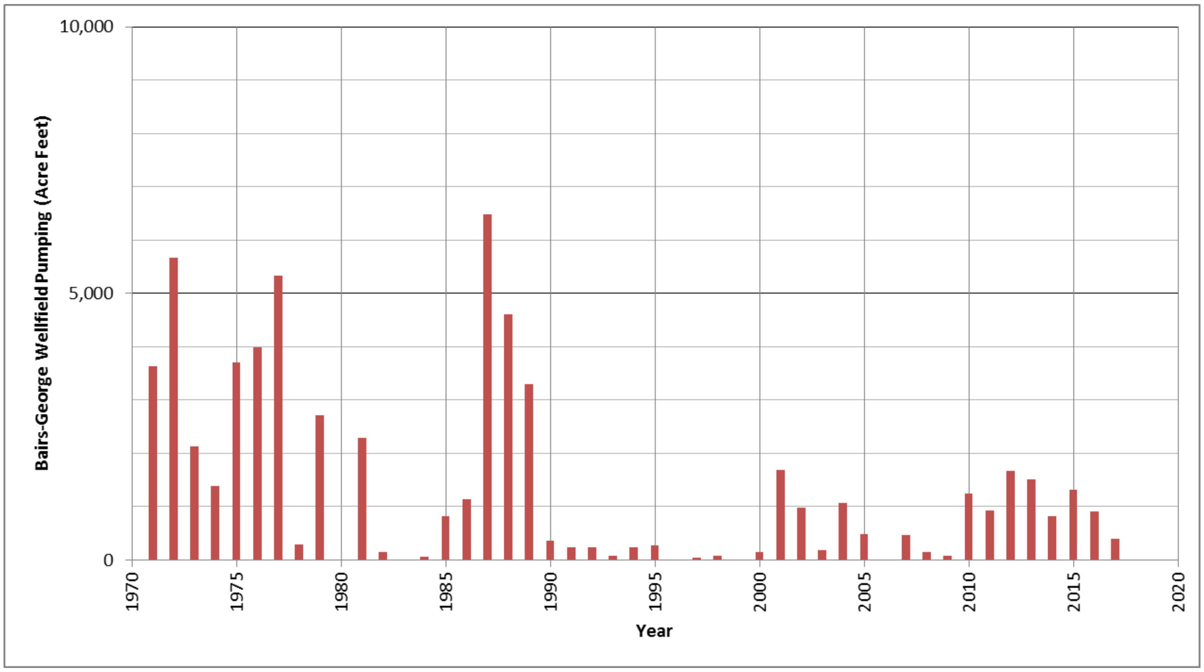


Figure 3.31. Pumping totals for the Bairs-Georges wellfield.

The Lone Pine Wellfield

Most pumping in the Lone Pine Wellfield (Figure 3.30) has been to supply the town of Lone Pine and one mitigation project (approximately 1,300 ac-ft annually). Pumping increased occasionally (e.g. in 2000) to offset aqueduct water previously supplied to Diaz Lake (Figure 3.34). In 2015, pumping also increased largely due to the operation of a new well to supply the E/M project Van Norman field. The previous well (W390) degraded and production declined noticeably in 2008. The new well (W425) has capacity to fully supply the project. Because of the relatively constant pumping for sole source uses, we do not routinely use indicator wells to analyze the annual operations plan for this wellfield.

Hydrographs for test wells T564 and T591 are presented in Figure 3.35 to represent water levels near the town of Lone Pine where the LADWP pumping wells are located. Monitoring wells T593 and T858 are located in groundwater dependent vegetation north and south of Lone Pine, respectively. All wells exhibit seasonal fluctuations as well as water table response to decreased recharge due to drought. Pumping effects are not as evident. Water levels rose in 2017 due to heavy runoff.

In early 2010, LADWP tested a new production well, W416, installed to increase aqueduct supply. This new production well has been modified and initial tests to determine well capacity and performance have been completed. However, details of the operational monitoring have yet to be agreed upon by the Technical Group.

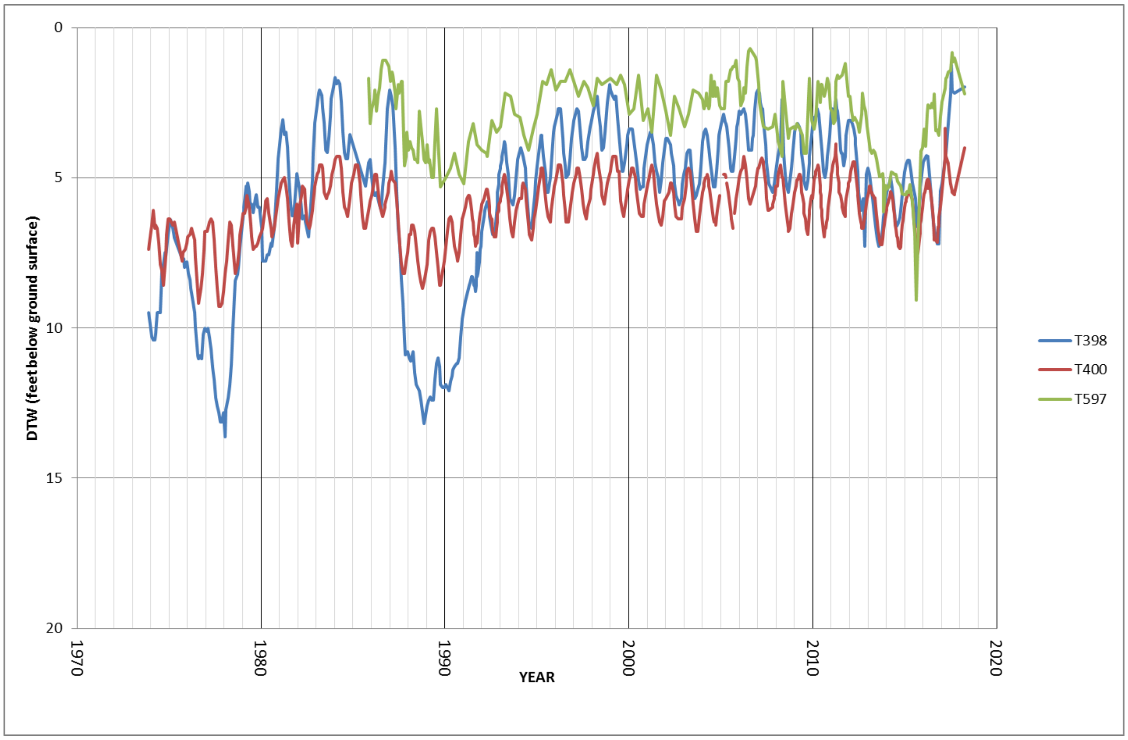


Figure 3.32. Hydrographs of indicator wells and 597T in the Bairs-Georges wellfield.

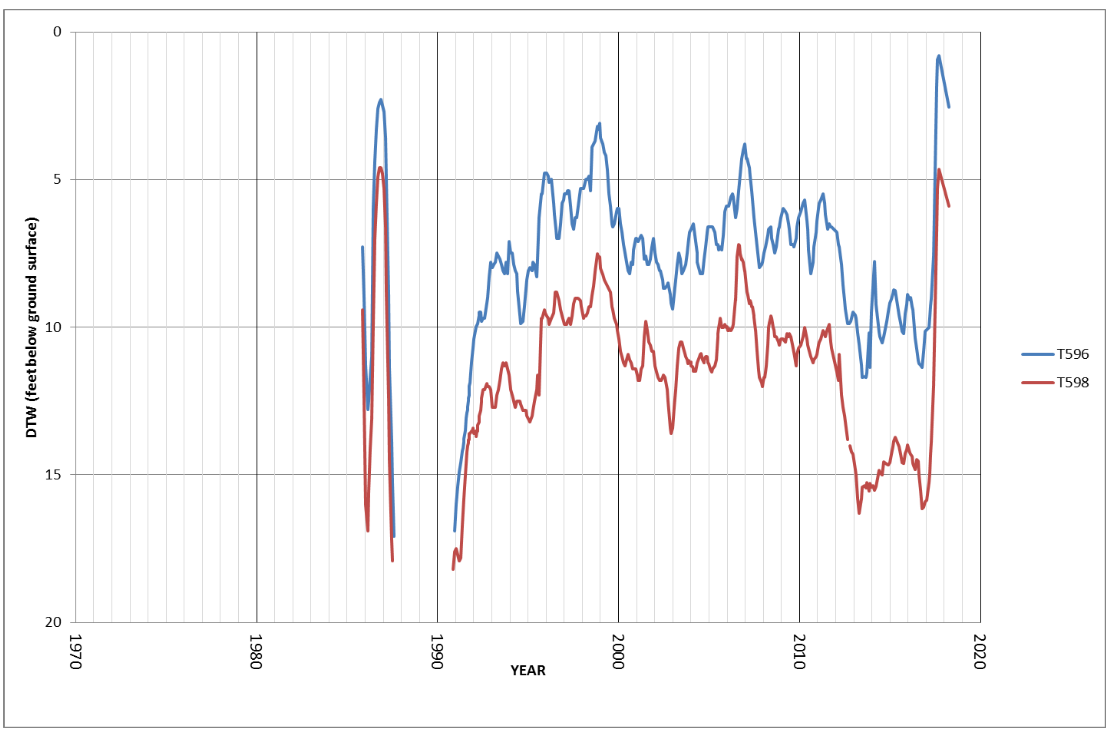


Figure 3.33. Hydrographs of selected wells in the Bairs-Georges wellfield.

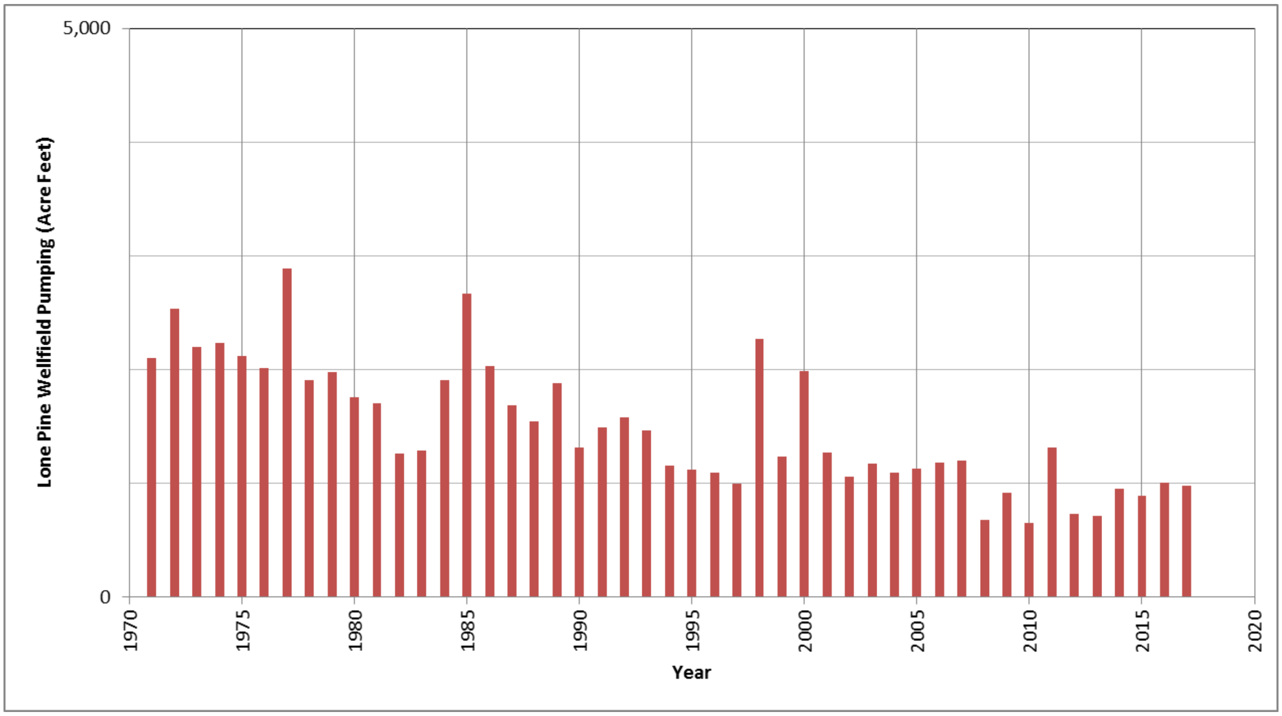


Figure 3.34. Pumping totals for the Lone Pine wellfield.

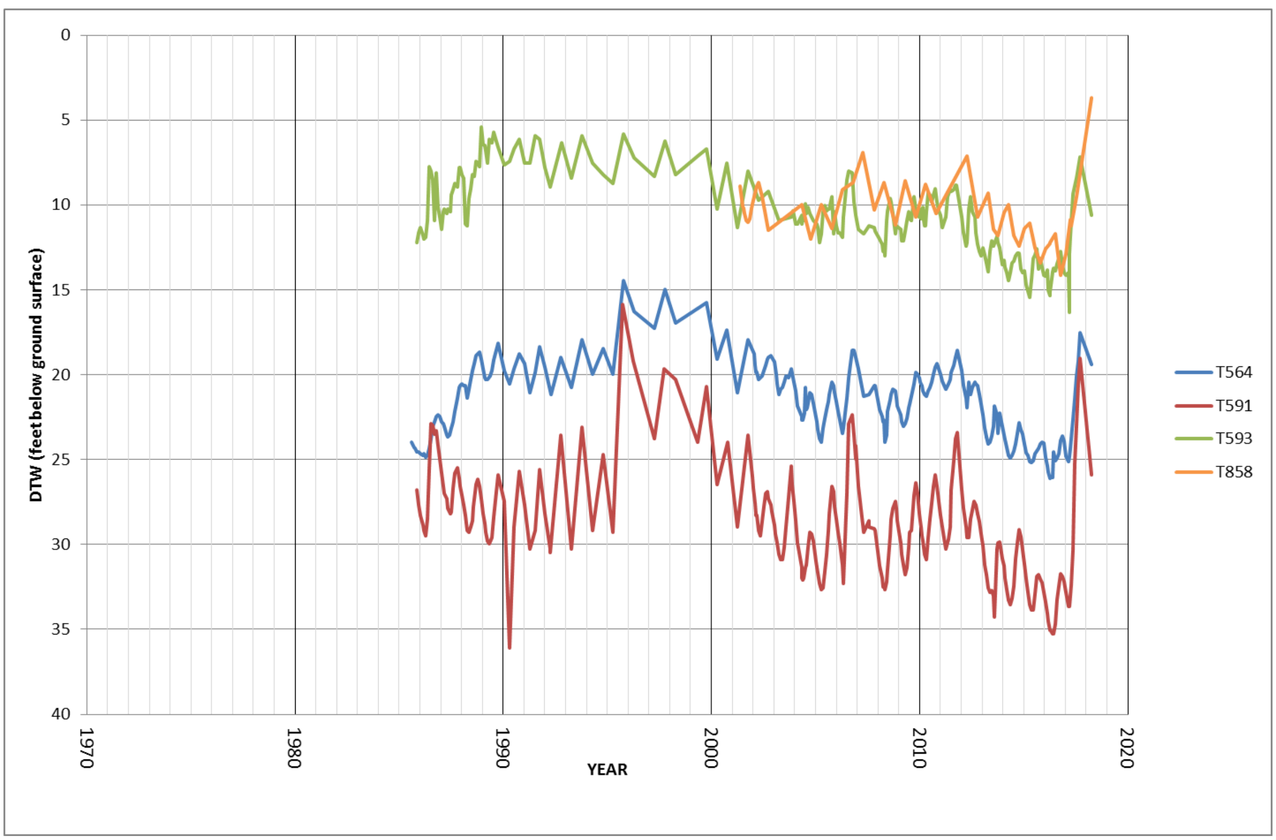


Figure 3.35. Hydrographs of selected test wells in the Lone Pine wellfield.

Table 3.3. Planned LADWP pumping by wellfield for 2018-19 and ICWD proposed pumping.

Wellfield	Minimum Pumping	LADWP proposed	Inyo Proposed
		Af/year	Af/year
Laws	6,300	13,900	6,300
Bishop	10,400	11,280	11,280
Big Pine	20,550	26,010	20,550
Taboose-Aberdeen	300	18,080	18,080
Thibaut-Sawmill	8,160	9,000	9000
Independence-Oak	5,990	13,230	5990
Symmes-Shepherd	960	960	960
Bairs-George	500	2,880	1400
Lone Pine	1,035	890	890
Sum	54,195	96,230	74,450

2018-19 Pumping Plan

LADWP issued its annual operations plan for the 2018-19 runoff year on April 20, 2018. The forecasted runoff for the Owens River watershed runoff is 317,500 ac-ft (78% of normal. LADWP provided a large range of planned pumping for the year between 77,990 and 96,230 ac-ft (Table 3.3). Much of this pumping is for sole-source (in valley) uses; however, under LADWP's high pumping scenario a significant amount of pumping for export in planned (appx. 40,000 ac-ft).

The Water Department analyzed the effect of the operations plan on groundwater levels in the Owens Valley using regression models for several monitoring wells (Table 3.4). Most models rely on measured depth to water in April 2018, planned wellfield pumping for the entire runoff year and Owens Valley runoff, to predict water levels next April. For several wells, Owens Valley runoff was not a statistically significant variable in the regression model. Water levels in those wells are correlated with pumping, and the models are still useful for evaluating the pumping plan. Models in Laws use the amount of water diverted from the Owens River into the McNally canals as the variable associated with recharge. No water spreading is planned for Laws in 2018-19 (Table 2.5 of the Draft Plan), so no operation of the McNally Canals was assumed in the Laws regression models.

The models used by the Water Department to analyze the annual operations plan predict water levels one year in the future (e.g. April 2018 to 2019) based on annual pumping for each wellfield. Since LADWP began presenting a range of pumping amounts, the final annual pumping total has most often been just below the proposed upper limit. Therefore, it was deemed unnecessary to evaluate the low range of proposed pumping.

Table 3.4. Predicted water level changes at indicator wells and monitoring sites for LADWP's proposed annual operations plan, for minimum pumping, and for pumping proposed by Inyo County. Negative DTW values denote a decline.

Station ID, Monitoring site	Change from 2018 to 2019 LADWP pumping 96,230 af	Deviation from baseline in 2019 LADWP pumping 96,230 af	Change from 2018 to 2019 Minimum pumping 54,195 af	Change from 2018 to 2019 Inyo pumping 74,450 af
	(ft)	(ft)	(ft)	(ft)
Laws				
107T	-7.05	-6.22	-4.52	-4.52
434T	-2.12	-0.65	-1.04	-1.04
436T	-3.83	-1.95	-2.74	-2.74
438T	-4.60	-3.00	-3.68	-3.68
490T	-2.55	0.36	-2.07	-2.07
492T	-9.88	-0.73	-5.81	-5.81
795T	-13.99	-8.87	-10.38	-10.38
V001g	-8.03	-2.51	-5.94	-5.94
574T	-5.14	-2.20	-4.00	-4.00
Big Pine				
425T	-1.31	-3.56	-0.38	-0.38
426T	-0.78	-2.99	-0.25	-0.25
469T	-1.08	-1.16	-0.57	-0.57
572T	-3.35	-0.04	-2.34	-2.34
798T, BP1	-4.19	-0.04	-3.29	-3.29
799T, BP2	-0.31	-1.11	0.17	0.17
567T, BP3	-1.71	-2.76	-0.88	-0.88
800T, BP4	-1.14	-3.56	-0.01	-0.01
Taboose-Aber.				
417T	-4.69	-0.95	-0.04	-4.69
418T	-1.40	-1.31	0.62	-1.40
419T, TA1	-4.02	-2.06	0.77	-4.02
421T	-4.45	-3.37	0.41	-4.45
502T	-2.02	-3.64	0.20	-2.02
504T	-5.10	-2.69	0.85	-5.10
505T	-4.62	-1.05	0.13	-4.62
586T, TA4	-3.00	-1.79	0.96	-3.00
801T, TA5	-0.51	-1.79	0.59	-0.51
803T, TA6	-4.74	-0.90	-0.33	-4.74
Thibaut-Sawmill				
415T	-0.48	8.55	0.17	-0.48
507T	0.40	0.39	0.53	0.40
806T, TS2	0.04	3.62	0.20	0.04
Ind.-Oak				
406T	-0.35	-4.22	0.16	0.16
407T	-1.76	-7.57	0.70	0.70
408T	-1.30	-3.27	0.34	0.34

Station ID, Monitoring site	Change from 2018 to 2019 LADWP pumping 96,230 af	Deviation from baseline in 2019 LADWP pumping 96,230 af	Change from 2018 to 2019 Minimum pumping 54,195 af	Change from 2018 to 2019 Inyo pumping 74,450 af
409T	-4.82	-10.92	0.21	0.21
546T	-2.70	-3.78	-1.63	-1.63
809T, IO1	-2.78	-6.78	-0.27	-0.27
Symmes-Shep.				
402T	0.15	-2.19	0.15	0.15
403T	0.84	-2.02	0.84	0.84
404T	0.59	-2.36	0.59	0.59
510T	1.66	-16.62	1.66	1.66
511T	0.46	-1.74	0.46	0.46
447T	0.50	-2.90	0.50	0.50
V009G, SS1	1.36	-14.17	1.36	1.36
Bairs-Georges				
398T	-4.00	-1.22	-0.76	-1.99
400T	-0.97	-0.07	-0.37	-0.60
812T	-5.54	-2.25	-2.73	-3.79

†: Values in this table are only significant to 0.1 ft. Extra digits are presented for transparency before rounding.

Three pumping scenarios are presented in Table 3.4: minimum pumping, the upper limit of pumping proposed in the Draft Plan, and ICWD's recommended pumping (Tables 2 and 3). The analysis of water level changes if minimum pumping were conducted for specific uses in the Owens Valley is included as a basis for comparison with the higher levels of pumping in LADWP's proposed and Inyo County's recommended pumping amounts. Minimum pumping is not a constant and varies depending on runoff availability to supply irrigation or mitigation projects instead of groundwater where possible. The estimated minimum pumping of 54,195 af represents expected pumping needs for uses in the Owens Valley in normal or slightly below normal runoff years (Table 2). The upper limit of the pumping proposed in the Draft Plan is used to evaluate LADWP's proposed pumping because (1) it represents the maximum impact on the water table that the Draft Plan could have, and (2) except in high runoff conditions, LADWP has generally pumped near the upper end of the proposed range.

Water levels are expected to fall in all wellfields except Tibaut-Sawmill and Symmes-Shepherd under LADWP's proposed 2018-19 operations plan (Table 3.4). The average water level decline in indicator wells is predicted to be 2.7 ft. By April 2019, average predicted water levels will be at or above baseline in Thibaut-Sawmill and within 3 feet of baseline in Laws, Big Pine, Taboose-Aberdeen, and Bairs-Georges. Average water levels are predicted to be more than 3 feet below baseline in Independence-Oak and Symmes Shepherd.

Concerns and recommendations to LADWP's proposed 2018-19 pumping plan were made by Inyo County in the Water Department's April 30, 2018 letter to LADWP. A summary of these comments are presented as follows. The extraordinarily high amount of the 2017-2018 runoff-year promoted substantial rise in the water table in most areas of the Owens Valley; however, some areas remain below the water levels that prevailed during the mid-1980s when the baseline vegetation mapping was done. ICWD's analysis and recommendations are based on water table conditions in each well field relative to baseline water levels, groundwater uses within each wellfield, and groundwater dependent vegetation conditions.

Although 2017 was an exceptional year for runoff, water availability, and groundwater recharge in Owens Valley, it comes on the heels of an exceptional drought with runoff values below 60% for four consecutive years. The negative effects of this drought on vegetation are evident in 2016 perennial cover values. Increased cover was noted in most parcels in 2017; however, perennial cover and grass cover remain below baseline in many vegetation parcels across the valley, notably in Laws. Maintaining a shallow water table in areas of groundwater-dependent vegetation in 2018 is necessary to encourage further recovery to baseline values, especially given the feast-or-famine pattern of precipitation observed during the past 30 years. Shallow groundwater levels are particularly important to maintain perennial grasses which have seen more substantial declines than overall cover.

The upper range of pumping in the Draft Plan (Table 3.3) would be the most pumping since the environmentally damaging amounts of the late 1980s and would significantly lower water levels in areas like Laws, where perennial cover continues to be below baseline, and Big Pine and Independence where water tables are depressed. ICWD's recommend pumping amount is a more prudent recommendation which allows the multiple goals of the Water Agreement to be met with a more responsible and sustainable approach: a significant amount of groundwater would be pumped for use in Owens Valley and export to Los Angeles, while maintaining hydrologic conditions conducive to vegetation recovery.

ICWD has expressed concerns to LADWP about pumping and water level declines in three wellfields during the recent drought: Big Pine, Independence-Oak, and Symmes-Shepherd. Pumping for aqueduct supply has been concentrated from exempt and On-status wells located in these wellfields. Groundwater levels in several wells in Independence-Oak and Symmes-Shepherd wellfields are predicted to remain several feet below baseline. In addition, the groundwater mining limit calculation for the Big Pine wellfield shows a relatively small amount of recharge in excess of pumping over the past 20 year period. ICWD recommended that pumping in these wellfields and Laws be limited to sole source uses to allow for maximum water level recovery in this exceptional runoff year.

The Water Department's comment letter can be found on the inyowater.org website.

Evaluation of 2017 DTW predictions

As noted in the previous sub-section, ICWD routinely uses linear regression models to predict the effects of pumping on DTW as part of its analysis of LADWP's annual operations plans. Periodically, we examine the accuracy of these models by comparing the predictions with DTW measurements collected the following year on April 1. The regression models were constructed from historical data for wellfield pumping, Owens Valley runoff, and current water levels. The models in Laws rely on an estimate of the diversions into the McNally canals instead of Owens Valley runoff as the variable related to groundwater recharge. For six of the permanent monitoring sites, a second model was used that relies on predicted DTW in a nearby indicator well that responds similarly to pumping and runoff. The models were originally developed by Harrington (1998) and Steinwand and Harrington (2003). These reports are available on the Water Department website.

This analysis of the predictions includes uncertainty in the input variables (runoff forecast and planned pumping) as well as uncertainty in the models. Model uncertainty includes all management actions and environmental conditions not captured in the regression model e.g. atypical recharge or pumping operations near one of the test wells. Predictions for 43 indicator wells made in April 2017 were examined for this report.

The predicted DTW values were based on the high pumping amount planned by LADWP in the 2017-18 pumping plan. Actual pumping was 84% of the planned high amount (Table 3.1). Wellfield pumping totals for the year differed by as much as 3,200 acre feet of the planned amounts in wellfields with indicator wells. The discrepancies in planned and actual pumping decrease the accuracy of predictions. The model predictions also rely on forecasted Owens Valley runoff and unavoidably include the uncertainty in that prediction. The LADWP runoff forecast has tracked actual runoff with accuracy since 1994, and therefore that contribution to model uncertainty is small.

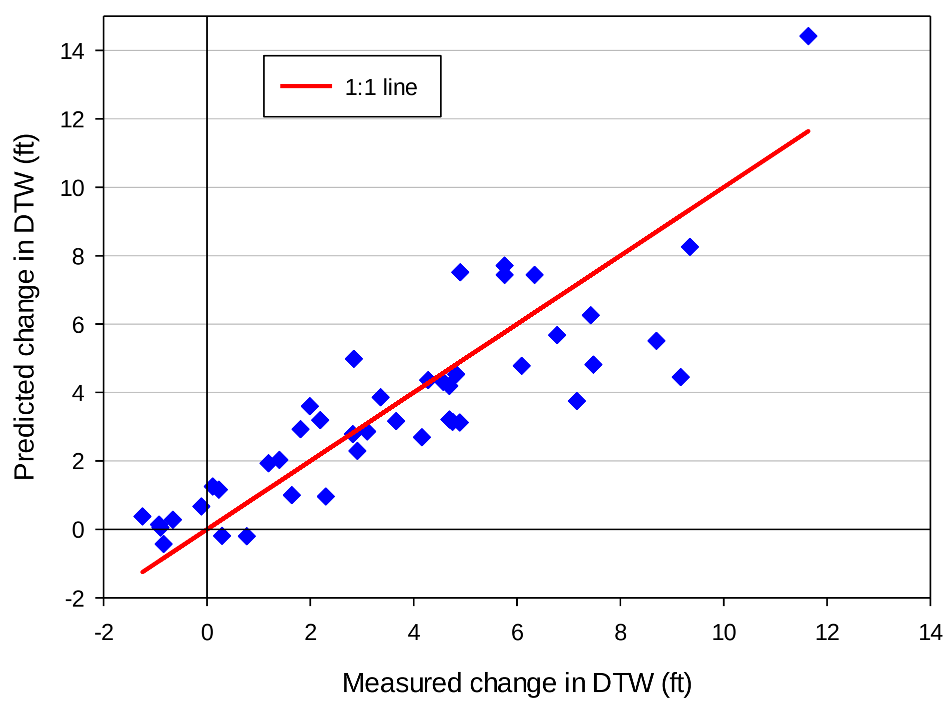


Figure 3.36. Measured and predicted change in DTW from April 2016 to April 2017 for 39 indicator and monitoring site wells. The sold line is the 1:1 line Negative values denote decline in water level.

Exceptionally high runoff and low pumping conditions in 2017 both were at the extreme range of the historic data used to prepare the models. In most other years where model performance was examined, the range of predicted pumping was small. That was not the situation in 2017 when predicted water level changes ranged from near zero to more than 14 ft. This situation should present a challenge to how well the models predicted 2018 water levels.

Model performance in 2017-18 was satisfactory and comparable to previous years. Measured and predicted change in DTW are plotted in Figure 3.36. If the models were perfect predictors, the points would fall on the 1:1 line between the lower left and upper right quadrants. Most points were in the correct quadrant and of the 43 wells, actual and predicted DTW in 20 wells differed by less than 1 ft, and 31 differed by less than 1.5 ft. The average of the actual deviation for all monitoring wells was 1.29 ft. Two wells in Independence-Oak and one in Bairs-George were outliers. In all three cases, the water level rose >3 ft more than was predicted.

As mentioned previously, at six wells, two regression models were used sequentially to predict DTW could introduce an additional source of uncertainty in predictions for those wells. The average absolute deviation for the predictions based on one model and two models were 1.3 ft and 1.1 ft, respectively. Given the similar accuracy of the two sets of wells, relying on the paired regressions was not a source of additional uncertainty. The models prepared in 2017 for wells with a shorter period of record (800 series, V009G, 574T, 434T) however did not perform as well as the larger set (mean deviation, 1.64 ft). Most of the predictions for these wells was within a foot of the predicted values; 812T and V009g under predicted recovery by 2-3ft, probably due to spreading activities near these sites.

References

Harrington, R. F., Multiple regression modeling of water table response to groundwater pumping and runoff, Inyo County Water Department report, 1998.

Steinwand, A.L, and R.F. Harrington. 2003. Simulation of water table fluctuations at permanent monitoring sites to evaluate groundwater pumping. Report to the Inyo/Los Angeles Technical Group, February 25, 2003.

SECTION 4: SOIL WATER CONDITIONS

The purpose for monitoring soil water and the On/Off procedures is to manage pumping to protect plant communities that require periodic access to the water table for long-term survival.

Introduction

The Water Agreement established procedures to determine which LADWP pumping wells can and cannot be operated based on soil water and vegetation measurements (On/Off status). As part of the monitoring effort for the Agreement, the ICWD regularly measures depth to groundwater (DTW) and soil water content at 25 sites in wellfields and eight sites in control areas. Three of the wellfield sites are not used to determine the operational status of nearby pumping wells but are monitored to continue the data record. Each site is equipped with 1 to 6 soil water monitoring locations. Soil water measurements are collected using a neutron gauge calibrated for each site (Dickey, 1990; Steinwand, 1996).

The purpose for the On/Off procedures is to manage pumping to protect plant communities that require periodic access to the water table for long-term survival. Generally, the sites with On-status have wet soil and shallow water tables, and sites in Off-status have dry soil and deep water tables.

To assist the evaluation of LADWP pumping proposals, the Water Department examined the DTW and soil water data to determine whether groundwater is accessible to plants at the permanent monitoring sites at the beginning of the 2017 growing season.

How well plants can access groundwater depends on the vegetation type as well as water table depth. In similar soils, a shallower water table is necessary to supply groundwater to grasses than shrubs because of the shallower roots of the grasses. For management purposes in the Water Agreement, shrub-dominated sites are assigned a root zone of 4 m (13.1 ft.); grass-dominated or mixed grass and shrub assemblages are assigned a root zone of 2 m (6.6 ft.). These approximate values are not the actual rooting depth at a particular monitoring site, but they are useful to compare with the soil depth that received recharge from groundwater.

Soil water in the root zone can be supplied by infiltration from the surface (rain or irrigation) or from contact with the water table. It is usually possible to discriminate deeper soil affected by groundwater from soil near the surface affected by infiltration based on the depth and timing of the measured changes in soil water content. Plant roots can utilize groundwater directly, and if the water table is within the root zone it is reasonable to conclude that groundwater is available. A rising water table can progressively wet the root zone from below and provide water to plants. Plant roots can also tap groundwater that is drawn into the soil above the water table by capillarity where it is held in soil pores or adsorbed to soil particles. Plant uptake during the summer depletes soil water, and when transpiration ceases in the fall,

Table 4.1 June 2017 monitoring site status and July 1, 2017 soil/vegetation water balance calculations according to Green Book, Section III.

Site	June, 2017 Status	July, 2017 Veg. Water Req./ Soil AWC for turn-on	July 2017 soil AWC	July 2017 Status	Soil AWC required. for well turn-on
		(cm)	(cm)		(cm)
L1	ON	4.2/NA	109.7	ON	NA
L2	ON	4.1/NA	9.0	ON	NA
L3	ON	8.3/NA	45.6	ON	NA
BP1	ON	7.8/NA	39.0	ON	NA
BP2	OFF	12.1/28.4	7.3	OFF	28.4, OFF 7-98
BP3	ON	9.6/NA	13.7	ON	NA
BP4	ON	8.0/NA	46.9	ON	NA
TA3	ON	15.2/NA	16.1	ON	NA
TA4	ON	7.2/NA	14.9	ON	NA
TA5	ON	4.4/NA	26.9	ON	NA
TA6	ON	12.0/NA	23.6	ON	NA
TS1	ON	15.5/NA	11.8	OFF	28.9, OFF 7-17
TS2	ON	12.7/NA	12.3	OFF	23.4, OFF 7-17
TS3	ON	11.1/NA	18.0	ON	NA
TS4	ON	29.5/NA	46.4	ON	NA
IO1	OFF	31.2/42.2	17.5	OFF	42.2, OFF 10-98
IO2	ON	4.6/NA	9.5	ON	NA
SS1	ON	18.5/NA	9.4	OFF	34.0, OFF 7-17
SS2	OFF	2.4/25.6	6.2	OFF	25.6, OFF 7-11
SS3	OFF	34.4/33.8	16.3	OFF	33.8, OFF 10-11
SS4	OFF	12.9/15.9	4.0	OFF	15.9, OFF 7-05
BG2	ON	16.9/NA	23.1	ON	NA

†: These values of soil water required for well turn-on were derived using calculations based on % cover that were routinely performed in the past. The values have not been updated to conform to the Green Book equations in section III.D.2, p. 57-59.

Table 4.2. Monitoring site status and soil/vegetation water balance calculations for Oct. 1, 2017 according to Green Book, Section III.

Site	July 1, 2017 Status	October, 2017 Veg. Water Req./Soil AWC for turn-on	October 2017 soil AWC	+50% annual ppt.	October 1 2017 Status	Soil AWC req. for well turn-on
		(cm)	(cm)	(cm)		(cm)
L1	ON	7.4/NA	126.3	126.3 + 7.9 = 134.2	ON	NA
L2	ON	7.3/NA	20.7	20.7 + 7.9 = 28.6	ON	NA
L3	ON	15.2/NA	45.8	45.8 + 7.9 = 53.7	ON	NA
BP1	ON	14.1/NA	47.9	47.9 + 7.9 = 55.8	ON	NA
BP2	OFF	22.4/28.4	1.5	NA	OFF	28.4, OFF 7-98
BP3	ON	17.0/NA	18.8	18.8 + 7.6 = 26.4	ON	NA
BP4	ON	14.3/NA	39.1	39.1 + 8.2 = 47.3	ON	NA
TA3	ON	28.4/NA	9.3	9.3 + 7.3 = 16.6	OFF	28.4, OFF 10-17
TA4	ON	13.4/NA	13.5	13.5 + 7.3 = 20.8	ON	NA
TA5	ON	7.9/NA	21.1	21.1 + 8.2 = 29.3	ON	NA
TA6	ON	22.2/NA	19.4	19.4 + 7.3 = 26.7	ON	NA
TS1	OFF	28.9/28.9	3.7	NA	OFF	28.9, OFF 7-17
TS2	OFF	23.4/23.4	8.3	NA	OFF	23.4, OFF 7-17
TS3	ON	20.5/NA	14.5	14.5 + 7.3 = 21.8	ON	NA
TS4	ON	53.5/NA	37.4	37.4 + 7.3 = 44.7	OFF	53.5, OFF 10-17
IO1	OFF	58.0/42.2	12.2	NA	OFF	42.2, OFF 10-98
IO2	ON	8.5/NA	5.4	5.4 + 6.5 = 11.9	ON	NA
SS1	OFF	34.0/34.0	7.2	NA	OFF	34.0, OFF 7-17
SS2	OFF	4.5/25.6	4.0	NA	OFF	25.6, OFF 7-11
SS3	OFF	64.1/33.8	11.3	NA	OFF	33.8, OFF 10-11
SS4	OFF	24.1/15.9	1.5	NA	OFF	15.9, OFF 7-05
BG2	ON	31.3/NA	35.7	35.7 + 6.6 = 42.3	ON	NA

†: These values of soil water required for well turn-on were derived using calculations based on percent cover that were routinely performed in the past. The values have not been updated to conform with the Green book equations in section III.D.2, p. 57-59.

Table 4.3. Monitoring site status on April 1, 2018 according to Green Book, Section III.

Site	Oct 2017 soil AWC	50% Annual Precip.	Proj. soil AWC	October 2017 Veg Water Req./ Water Req. for well turn-on	Oct 2017 Status	April 2018 soil AWC	April 2018 Status	Soil AWC req. for well turn-on
	(cm)	(cm)	(cm)	(cm)		(cm)		(cm)
L1	126.3	7.9	134.2	7.4/NA	ON	111.8	ON	NA
L2	20.7	7.9	28.6	7.3/NA	ON	46.1	ON	NA
L3	45.8	7.9	53.7	15.2/NA	ON	45.7	ON	NA
BP1	47.9	7.9	55.8	14.1/NA	ON	27.1	ON	NA
BP2	1.5	NA	1.5	22.4/28.4	OFF	2.9	OFF	28.4, OFF 7-98
BP3	18.8	7.6	26.4	17.0/NA	ON	25.3	ON	NA
BP4	39.1	8.2	47.3	14.3/NA	ON	49.9	ON	NA
TA3	9.3	7.3	16.6	28.4/NA	OFF	12.5	OFF	28.4, OFF 10-17
TA4	13.5	7.3	20.8	13.4/NA	ON	22.4	ON	NA
TA5	21.1	8.2	29.3	7.9/NA	ON	22.7	ON	NA
TA6	19.4	7.3	26.7	22.2/NA	ON	42.9	ON	NA
TS1	3.7	NA	3.7	28.9/28.9	OFF	6.4	OFF	28.9, OFF 7-17
TS2	8.3	NA	8.3	23.4/23.4	OFF	14.1	OFF	23.4, OFF 7-17
TS3	14.5	7.3	21.8	20.5/NA	ON	21.7	ON	NA
TS4	37.4	7.3	44.4	53.5/NA	OFF	52.2	OFF	53.5, OFF 10-17
IO1	12.2	NA	12.2	58.0/42.2	OFF	23.0	OFF	42.2, OFF 10-98
IO2	5.4	6.5	11.9	8.5/NA	ON	4.0	ON	NA
SS1	7.2	NA	7.2	34.0/34.0	OFF	5.7	OFF	34.0, OFF 7-17
SS2	4.0	NA	4.0	4.5/25.6	OFF	4.1	OFF	25.6, OFF 7-11
SS3	11.3	NA	11.3	64.1/33.8	OFF	18.3	OFF	33.8, OFF 10-11
SS4	1.5	NA	1.5	24.1/15.9	OFF	2.8	OFF	15.9, OFF 7-05
BG2	35.7	6.6	42.3	31.3/NA	ON	47.8	ON	NA

Table 4.4. Comparison of DTW preceding the growing seasons in 2017 and 2018. Data compare measurements taken near April 1 of each year except for and BP3 where the minimum DTW is in the fall. Depths are below ground surface.

Wellfield Site	2017 DTW (m)	2018 DTW (m)	DTW Change 2017-18†
Laws			
L1	4.39	2.29	2.09 (6.87)
L2	Dry at 7.53	3.64	>3.89 (12.77)
L3	5.18	3.15	2.03 (6.67)
Bishop Control			
BC1	3.03	2.29	0.74 (2.42)
BC2	4.28	4.03	0.26 (0.84)
BC3	1.09	1.13	-0.03 (-0.11)
Big Pine			
BP1	4.33	3.45	0.84 (2.75)
BP2	6.20	5.67	0.52 (1.72)
BP3	5.63	3.19	2.45 (8.02)
BP4	5.81	4.72	1.09 (3.57)
Taboose Aberdeen			
TA1 & 2	2.49	0.95	1.54 (5.04)
TA3	4.95	3.50	1.45 (4.75)
TA4	2.99	2.09	0.90 (2.95)
TA5	4.42	4.42	0.00 (0.00)
TA6	2.71	1.36	1.34 (4.41)
TAC	1.36	0.85	0.51 (1.68)
Thibaut Sawmill			
TS1	5.40	3.77	1.65 (5.41)
TS2	3.33	2.82	0.51 (1.67)
TS3	2.32	2.53	-0.21 (-0.69)
TS4	1.41	1.86	-0.46 (-1.50)
TS6	6.62	3.34	3.29 (10.78)
TSC	0.78	1.19	-0.42 (-1.36)
Independence Oak			
IO1	4.94	3.08	1.87 (6.12)
IO2	11.82	8.26	3.56 (11.68)
IC1	1.22	1.19	0.03 (0.09)
IC2	2.41	2.20	0.21 (0.68)
Symmes Shepherd			
SS1	8.21	5.95	2.26 (7.42)
SS2	Dry at 8.41	Dry at 8.41	NA
SS3	5.06	4.03	1.03 (3.39)
SS4	6.76	6.18	0.58 (1.91)
Bairs George			
BG2	5.40	2.77	2.63 (8.64)
BGC	2.60	2.15	0.45 (1.47)

†: positive values denote a rise in the water table.

water from the moist soil above the water table will replenish the drier soil in the root zone via capillarity or through inactive plant roots even if the water table is stable or declining. This is a slow process and usually provides much less soil water recharge than a rising water table.

Results

Monitoring results for available soil water, vegetation water requirement, water table depth, and the On/Off status for all sites are presented in the figures that are periodically updated and available at Technical Group meetings and on the ICWD website. At the beginning of the 2017-18 runoff year, sixteen sites were in On-status:L1, L2, BP1, BP3,BP4, TA3, TA4, TA5, TA6, TS1, TS2, TS3, TS4, IO2, SS1, and BG2 (Table 4.1). Sites TS1, TS2, and SS1 went into Off-status in July (Table 4.2), and TS4 went into Off-status in October, 2017. No sites entered On-status before April 2018 (Table 4.3).

Hydrographs for the permanent monitoring sites are presented on the ICWD website, and the DTW measured during the fall and winter before the 2017 and 2018 growing seasons are presented in Table 4.4. At most sites, the minimum DTW occurs near April 1. At site BP3 in Big Pine, usually the water table rises during the summer and reaches a minimum in the fall coinciding with the timing of diversions into the Big Pine canal for irrigation. The water table rose on average 4.6 ft in wellfields and 0.7 ft in control areas. Because pumping was relatively low and exeptional runoff, rising water levels were expected. Two wellfield and two control sites experienced minor water table declines largely because the 2018 levels were compared with spikes in water levels due to high precipition and/or spreading in January and February 2017. See the Groundwater section of this report for an assessment of water level changes using a larger set of monitoring wells.

At most sites it was easy to discriminate groundwater recharge from surface infiltration because of the relatively low precipition in the winter of 2017-18 (Tables 4.5 and 4.6). Infiltration due to precipitation in November and March if evident at all was usually limited to the top 30 or 50 cm of the soil.

Most sites experienced groundwater recharge into the root zone in 2017-18. The monitoring sites were grouped into simple categories to summarize the connection between soil water in the root zone and the water table. Brief descriptions of the three categories and the results are given below:

1. Connected: Water table fluctuations resulted in soil water recharge in the top half of the root zone at most monitoring locations within a site. Twelve wellfield and six control sites were placed in this category.

2. Partially connected: Water table fluctuations resulted in soil water recharge in the bottom half of the root zone at most monitoring locations within a site. Nine wellfiield and two control sites were placed in this category.

3. Disconnected: No recharge from groundwater occurred in the root zone. Four wellfield sites and no control sites were in this category.

Table 4.5. Soil depth below ground surface replenished by groundwater in 2017-2018 at control sites. Values are provided for each monitoring location within a site. Minimum DTW early in the growing season was measured in the associated test well. The minimum DTW in 2017 is color coded based on a comparion with historical water levels: highest ever recorded, within 0.3 m (1 ft) of the highest level, within 0.6m (2 ft) of the highest level, and more than 2 ft below the highest level.

Site	Dominant plant species	Root Zone (m)	Minimum DTW (m)	Groundwater recharge depth (m)
BC1	rabbitbrush, saltbush, greasewood, alk. sacaton	4	1.79	1.1, 1.3,1.1
BC2	rabbitbrush, saltgrass	2	3.68	0.3, 0.5, 0.5, 0.5
BC3	rabbitbrush, saltgrass, saltbush	2	1.09	0.5, 0.3, 0.3
TAC	saltbush, rye grass, saltgrass, alk. sacaton	2	0.84	0.3, 0.7, 0.3, 0.3
TSC	alk. sacaton, rabbitbrush, greasewood.	2	0.78	0.9, 0.7, 0.3
IC1	saltbush, saltgrass, rabbitbrush	2	1.19	1.1, 0.9, 1.1
IC2	rabbitbrush, alk. sacaton	2	2.20	1.7, 1.7, 1.5
BGC	saltbush, saltgrass	4	2.15	1.5, 1.5, 1.9

At the beginning of the 2018 growing season, the water table had suppied or was capable of supplying water to the root zone at 21 of the 25 wellfield monitoring sites (Figure 4.1). Niineteen sites were placed in a different category in 2018 compared with 2017. All sites were wetter except IC1. Nearly every site except BP2, IO2, SS1, and SS2 had ample retained water in the soil.

References

Dickey, G.L. 1990. Field calibration of neutron gauges: SCS method. p. 192-201. In S.R. Harris (ed.) Irrigation and drainage. Proc. 1990 National Conference. Durango, Co., July 11-13, 1990. Am. Soc. Civil Eng., New York, NY.

Horton, J.L. and S.C. Hart. 1998. Hydraulic lift: a potentially important ecosystem process. Tree 13:232-235.

Jackson, R.B., J.S. Sperry, and T.E. Dawson. 2000. Root water uptake and transport: using physiological processes in global predictions. Trends Plant Sci. 5:482-488.

Steinwand, A.L, 1996. Protocol for Owens Valley neutron probe soil water monitoring program. Report to the Inyo/Los Angeles Technical Group, August 6, 1996.

Table 4.6. Soil depth below ground surface replenished by groundwater in 2016-2017 at wellfield sites. Values are provided for each monitoring location within a site unless the identification of a specific depth was uncertain. Minimum DTW before the 2017 growing season was measured in the associated test well. The minimum DTW in 2017 is color coded based on a comparion with historical water levels: highest ever recorded, within 0.3 m (1 ft) of the highest level, within 0.6m (2 ft) of the highest level, and more than 2 ft below the highest level.

Site	Dominant plant species	Root Zone (m)	Minimum DTW (m)	Groundwater recharge depth (m)
L1	greasewood	4	0.79	0.3 at all three locatiions
L2	alk. sacaton, greasewood, saltbush	2	3.47	0.3 at all five locations
L3	alk. sacaton, saltgrass	2	1.90	0.3 at all six locations
BP1	saltbush, greasewood	3	1.63	0.7, 0.7, 0.9,ND, ND
BP2	saltbush, rabbitbrush	4	5.29	4.1, 3.9, >3.9
BP3	greasewood, rabbitbrush	4	2.94	2.5, 2.5,2.3
BP4	saltbush, greasewood	4	4.72	2.1, 3.1, 1.9
TA1	alk. sacaton, saltbush	2	0.95	0.3
TA2	alk. sacaton, saltbush, greasewood, rabbitbrush	2	0.95	0.3
TA3	saltbush, alk. sacaton, sagebrush	2	3.42	1.3, 1.9, 1.7
TA4	rabbitbrush, alk. sacaton	2	2.09	0.3 at all three locations
TA5	greasewood, alk. sacaton	2	3.85	1.7. 1.7, 3.1
TA6	saltbush, rabbitbrush	2	1.20	0.9, 0.5, 1.1
TS1	weeds, alk. sacaton	2	3.76	1.5, 2.5. 1.3, 2.5, 1.5
TS2	sagebrush, saltbush, alk. sacaton	2	2.82	1.1, 0.5, 0.9
TS3	saltgrass, alk. sacaton	2	2.32	1.1, 1.7, 0.9, 1.1, 0.7, 0.3
TS4	greasewood, alk. sacaton, saltbush, saltgrass	2	1.41	0.3, 0.3, 0.7, 0.3
TS6	alk. sacaton, saltbush, saltgrass	2	2.69	1.1
IO1	rabbitbrush, alk. sacaton, saltbush	2	3.08	1.1, 0.9, 1.1
IO2	saltbush	4	8.26	5.1, >3.9. >3.9
SS1	saltbush, greasewood	4	5.95	4.3, >3.9, >3.9
SS2	saltbush	4	NA	>5.5, >3.9, >3.9
SS3	saltbush	4	4.03	2.5, 2.5, 2.9
SS4	saltbush	4	6.18	3.3, 3.1, 3.5
BG2	inkweed, saltbush	4	2.69	1.7, 1.5, 1.5

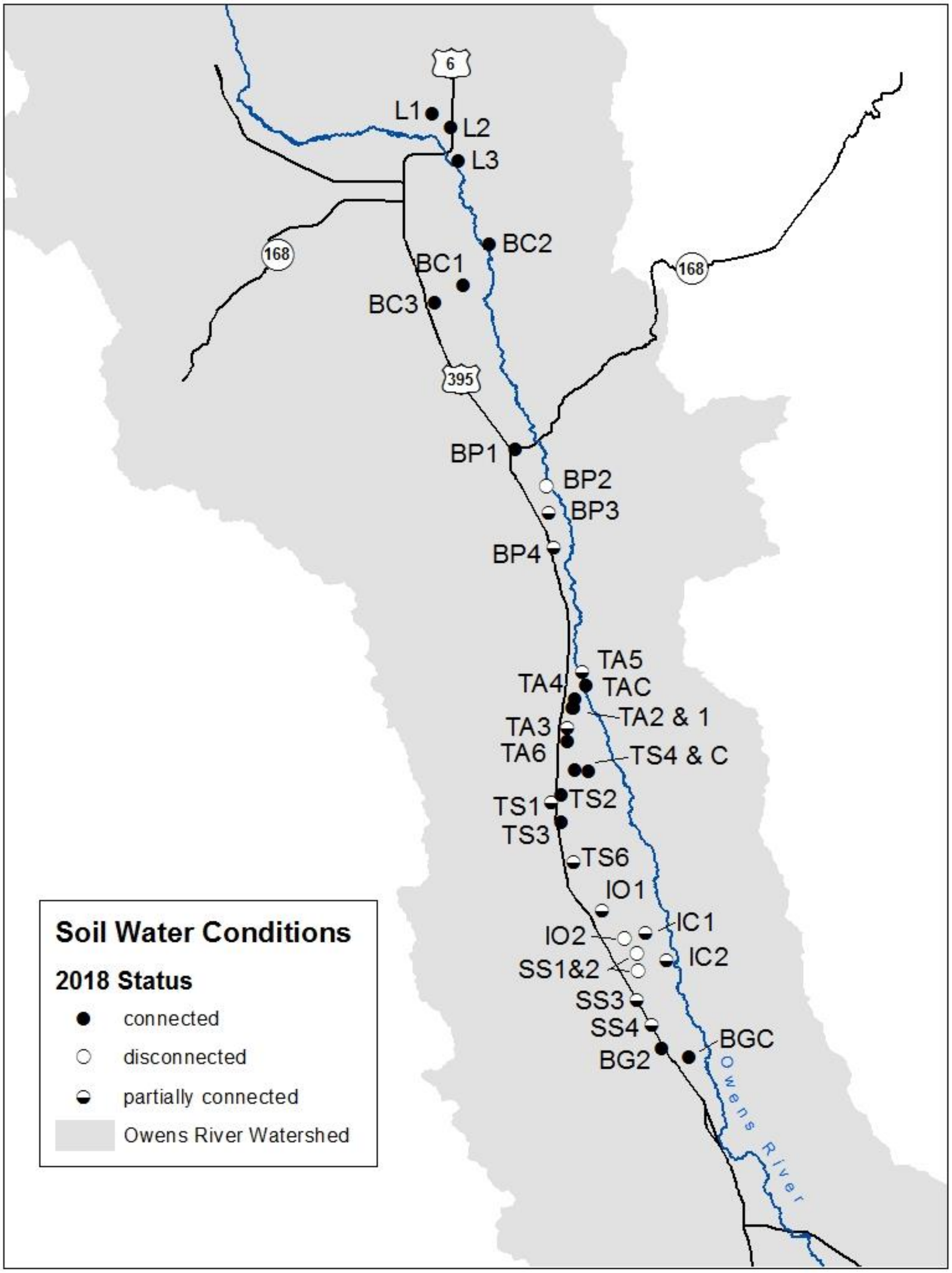


Figure 4.1. Owens Valley permanent monitoring sites and groundwater recharge classes. It is difficult to distinguish TA1 and TA2 on this map because of their proximity to one another. TA1 and TA2 are connected.

SECTION 5: VEGETATION CONDITIONS

A primary goal of the Water Agreement is to manage groundwater and surface water while maintaining healthy groundwater-dependent plant communities in the Owens Valley.

This section presents an analysis of the 2017 vegetation conditions

Introduction

Inyo County Water Department monitors trends in vegetation cover and species composition in groundwater-dependent vegetation parcels following protocols described in the Technical appendix to the Water Agreement (Green Book Box I.C.1.a.ii, revised 2017). The primary purpose of this monitoring is to detect any *"SIGNIFICANT DECREASES AND CHANGES IN OWENS VALLEY VEGETATION FROM CONDITIONS DOCUMENTED IN 1984 TO 1987"*. Vegetation management goals of the Agreement are based on canopy cover and species composition recorded during LADWP's 1984-87 parcel mapping and vegetation sampling effort. To evaluate the condition of the vegetation, field crews of ICWD and LADWP monitor vegetation at permanent locations within a subset of the groundwater-dependent parcels potentially affected by pumping.

Methods

From September 1984 to Nov 1987, LADWP inventoried and mapped vegetation into 2126 polygons of similar vegetation type, 'vegetation parcels' (223,168 acres). Most of these lands were characterized as nonphreatophytic plant communities (Green Book management type A). The Green Book vegetation monitoring program is focused on groundwater-dependent parcels (Green Book types B, C, D and some E) and primarily those potentially affected by groundwater pumping.

In the 2017 growing season, ICWD and LADWP jointly monitored 140 vegetation parcels, originally mapped as groundwater-dependent, using the line-point-intercept protocol described in the Green Book. Parcels were initially selected based on meeting one or more of the following criteria: (1) the parcel contained a permanent monitoring site where soil/vegetation water balance is calculated; (2) baseline data was collected for the parcel; (3) the parcel was in close proximity to a pumping well; (4) information of past and current land use for the parcel was available.

Parcels were classified as either belonging to a wellfield group or control group based on criteria derived from groundwater drawdown during the period of maximum pumping rate that occurred between 1987 and 1993. Parcels were assigned to the wellfield group if (1) kriged DTW estimates exceeded 1-m water-table drawdown during 1987-1993 or (2) they were located at sites corresponding to modeled drawdown contours greater than 10 ft. Parcels were assigned to the control group if (1) kriged DTW estimates were less than 1 m and (2) they were located at sites corresponding to modeled drawdown contours less than 10 ft. If the kriged DTW estimates were not reliable owing an inadequate test-well network near the vegetation parcel, then the groundwater-flow model estimate of the 10-ft drawdown contour was used as the sole criteria to designate parcels as either wellfield or control. An exception to the above criteria was applied to parcels associated with drawdown contours greater than 10-ft yet located near a surface water source (specifically, a canal, sewer pond, creek, river, or a ground water seepage source) that would lessen local drawdown effects—these parcels were classified as control. Some parcels currently in the wellfield group have higher water tables than during the 1987 to 1993 period, but remain in the wellfield group because of their close proximity to pumping wells and potential for pumping-induced drawdown. Each parcel is classified by its Green Book management type, Holland plant community type and by its status as either wellfield or control.

Most parcels were sampled in 1984-1987 using line-point-intercept sampling. Some parcels were not directly sampled but rather assigned cover and composition values from parcels with similar vegetation conditions. The sample of baseline transects is compared to reinventory data with Welch's t-test; and where only a single cover value has been assigned to the parcel, a one-sample t-test is used to compare monitoring year data to a single baseline value.

Data Sets

Field Data (line-point-intercept)

The number of parcels sampled each year as well as the number of transects sampled per parcel has varied due to fluctuations in annual staffing (Table 5.1). Thus, some parcels have varying numbers of transects sampled across time. Other parcels have not been sampled continuously during the entire monitoring period. In 2017, 140 parcels were sampled.

Perennial species cover is considered in this report, because annual species are not dependent on groundwater. Perennial cover was further aggregated into grass, non-gramminoid herbaceous (herb), and shrub. In order to analyze the changes in the composition of total perennial cover, the proportion of shrub, herb and grass cover as a fraction of total perennial cover was calculated. Transect data are summarized for each parcel and year using the arithmetic average, creating a history of cover over time for each parcel. For determinations of change from baseline, several subsets of the entire field-measured data set were used as follows:

Full transect data (n = 86):

The set of parcels with transect data from both the current year and at least one associated transect conducted during the baseline monitoring period (1984-1987). These parcels were further identified as belonging to the control (n = 33) or wellfield parcel group (n = 53).

Continuous parcel data (n = 36):

The subset of full transect data that was sampled in every year from 1992 to the current year. The year 1992 was chosen for the continuous parcel data because the sample size was greater than the set of parcels sampled each year from 1991 to the present. The baseline year was assigned to the nominal value of 1986 for these data. These data were further identified as either control (n = 12) or wellfield (n = 24) and by alkali meadow (n = 10, n = 15 respectively).

Regression data set (n = 111):

The subset of full transect data with at least 10 years of data including the nominal baseline year. This set also includes parcels that were not sampled in the current year if the time series contained at least 10 years of data (wellfield n = 71; control n = 40)

Table 5.1. Number of parcels sampled each year by ICWD (1991-2014), LADWP (2004-2014), and the Green Book ICWD-LADWP joint vegetation monitoring program (2015-ongoing).

Year	Number of Parcels Sampled
1985	47
1986	48
1987	89
1991	41
1992	115
1993	60
1994	60
1995	70
1996	97
1997	86
1998	85
1999	90
2000	102
2001	93
2002	96
2003	68
2004	97
2005	97
2006	134
2007	138
2008	124
2009	132
2010	134
2011	137
2012	137
2013	137
2014	136
2015	141
2016	140
2017	140

Remote Sensing

Landsat 5/7/8 and Sentinel 2

Normalized difference vegetation index (NDVI) derived from Landsat 5/7/8 was extracted from google earth engine and pixels were zonally averaged to the parcel polygons over the growing season creating a full history of remotely-sensed vegetation change starting during the baseline period in 1985. The LandSat dataset is produced by NASA/USGS, and the LandSat Science Team does the processing (masking clouds, preparing best images for 8-day,16-day images) before it is archived to the dataset on Google Cloud. MapWater consultants use the python API for Google's Earth Engine to provide parcel-scale time series to ICWD.

Precipitation

Precipitation dataset was acquired using the gridMET/METDATA dataset produced at the University of Idaho and provided by MapWater consultants. It is a daily dataset of historically observed meteorological variables from Jan 1, 1979 to 2-days lag from the current date. It is produced over the contiguous United States (CONUS). GridMet is produced by bias correcting the daily NLDAS2 dataset to monthly PRISM values producing values on a 4-km (1/24-deg) grid (climateengine.org).

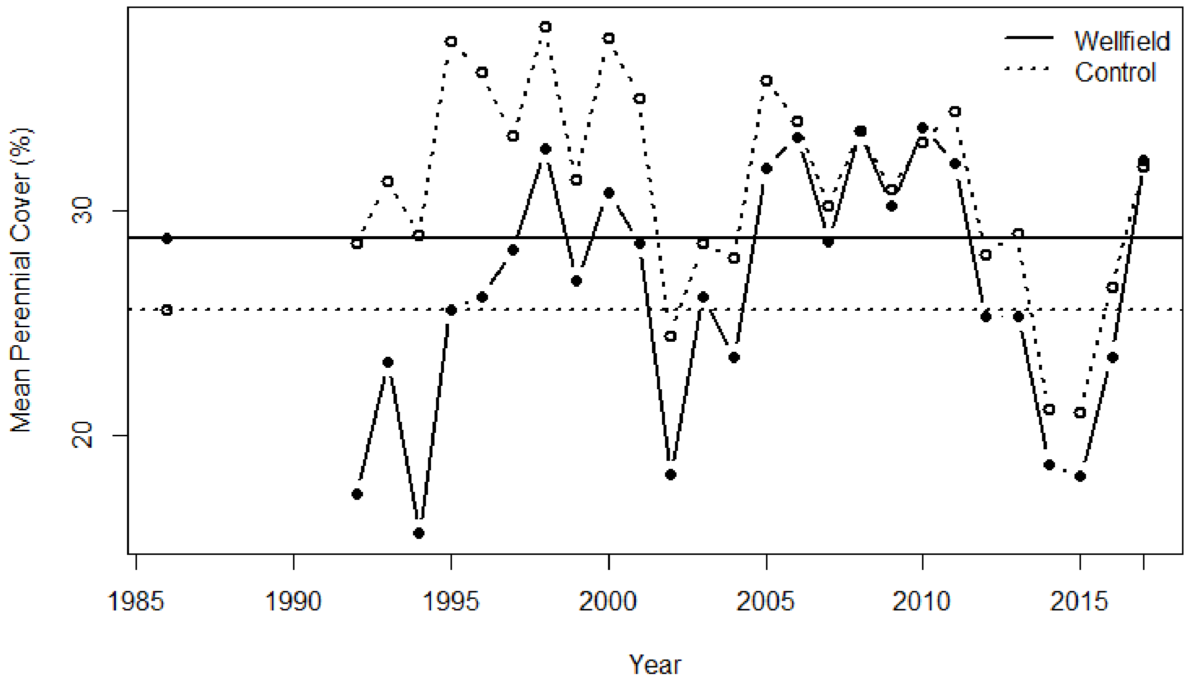


Figure 5.1. Mean perennial vegetation cover in rarefied (sampled every year) wellfield (n=12) and control parcels (n=24) 1992-2017 [Horizontal lines indicate baseline mean]. LADWP data 2004-2014 was combined with ICWD 2004-2014 for those years in which parcels were sampled by both agencies.

Wellfield and Control Areas Vegetation

To assess directly whether there was a change from baseline in areas affected by pumping (wellfield) and those outside the zone of influence of pumping (control), mean perennial cover and mean grass cover averages were aggregated to the wellfield and control parcel group and compared to baseline data. A paired t-test was used.

To characterize whether temporal trends in perennial differed between wellfield and control groups, analysis of covariance was used to model the interaction of slope and group type over the period (1986 and 1992-2017 = 27 years). The group-averaged perennial cover over time is plotted with linear model fits separately for wellfield and control groups for the visual interpretation of the ANCOVA model.

Parcel Vegetation Change

Welch's t-test for unequal variance was used to evaluate in which parcels and in which year(s) total perennial cover and perennial grass cover has significantly differed from baseline. Since the sample standard deviation is used to construct 95% confidence interval, this method can be used for parcels in which baseline data contained more than one transect or nonzero sample variance. Where unmeasured parcels during baseline subsequently inherited a single baseline value from nearby parcels, I used a one-sample t-test to determine significance from baseline.

The results of these tests, line-point data, parcel-averaged depth-to-water hydrographs, NDVI, and precipitation time series are plotted by parcel in the Appendix. Statistical significance was declared at the alpha = 0.05 level.

Results

Wellfield and Control Vegetation

Vegetation cover in wellfield areas increased slightly from 2015 to 2016 and dramatically in 2017 with anomalously high winter precipitation and rising groundwater levels. The control parcel group reached the baseline mean and the wellfield parcel group recovered to baseline for the first time since 2008 (Figure 5.1). Total perennial cover in the control group was approximately 15% higher than wellfield groups. Cover values have converged to a greater degree after the drought and high pumping in the early 1990s. Both control and wellfield groups that were below baseline from 2014-2016 exceeded baseline values in 2017. Perennial cover in the wellfield group has an increasing but not significant trend, while the control group has a decreasing but not significant trend (Figures. 5.2 and 5.3). Grass cover in the wellfield group has a decreasing trend but not statistically significant and the control group has a significant decreasing trend (Figure. 5.4). Shrub cover in the wellfield group has a significant increasing trend while control group shrub cover has remained at approximately 10% perennial cover (Figure 5.5). As of 2017 Control group change in shrub cover remained relatively flat on average, around 10% cover. Wellfield group shrub cover increased statistically from 10 to 15% cover ($R2 = 0.19$, $p = 0.02$, $n = 27$).

Taken together, wellfield parcels are getting shrubbier with slight decreases in grass cover over the period, and control parcels have lost grass cover since the late 1990s, but levels are currently slightly above baseline. These regressions are influenced by high cover in control parcels above baseline in the late 1990s wet period, while wellfield parcel regressions are influence by below baseline vegetation cover after a period of drought and high pumping in the early 1990s. Though simple linear regression averages over the increases and decreases associated with wet/dry climate cycles, they do present a simple statistic in determining overall trend over a 27 year time period.

Parcel Vegetation

At the individual parcel level, 21% of the 91 wellfield parcels were below baseline perennial cover while 35% were below baseline grass cover (in 2016, compare 49% and 66% respectively). In control parcels, 22% were below baseline perennial cover and 31% below baseline grass cover (compared to 40% and 52% in 2016). Change in perennial cover from baseline is tabulated for each parcel and shown for year 2011-2017 in Table 5.3. Change in perennial cover and grass cover from baseline is compared in Table 5.4.

Grass cover is 10 cover points below baseline in the following wellfield parcels: BLK075, BLK094, BLK099, FSL044, FSL051, FSL053, FSL116, FSP006_BGP182, IND019, IND021, IND026, IND029, LAW035, LAW043, LAW052, LAW070, LAW072, LAW078, LAW085, LAW108_FSL047, LAW122, LNP045, TIN050, TIN053, and TIN064.

Results from statistical tests on parcel means compared to baseline are translated to parcel polygon attributes and mapped for the north and south valley for perennial cover (Figure 5.6) and grass cover (Figure 5.7). Individual parcel time series plots of perennial cover, grass cover, depth to water, NDVI and precipitation are provided in Appendix 5.A.1.

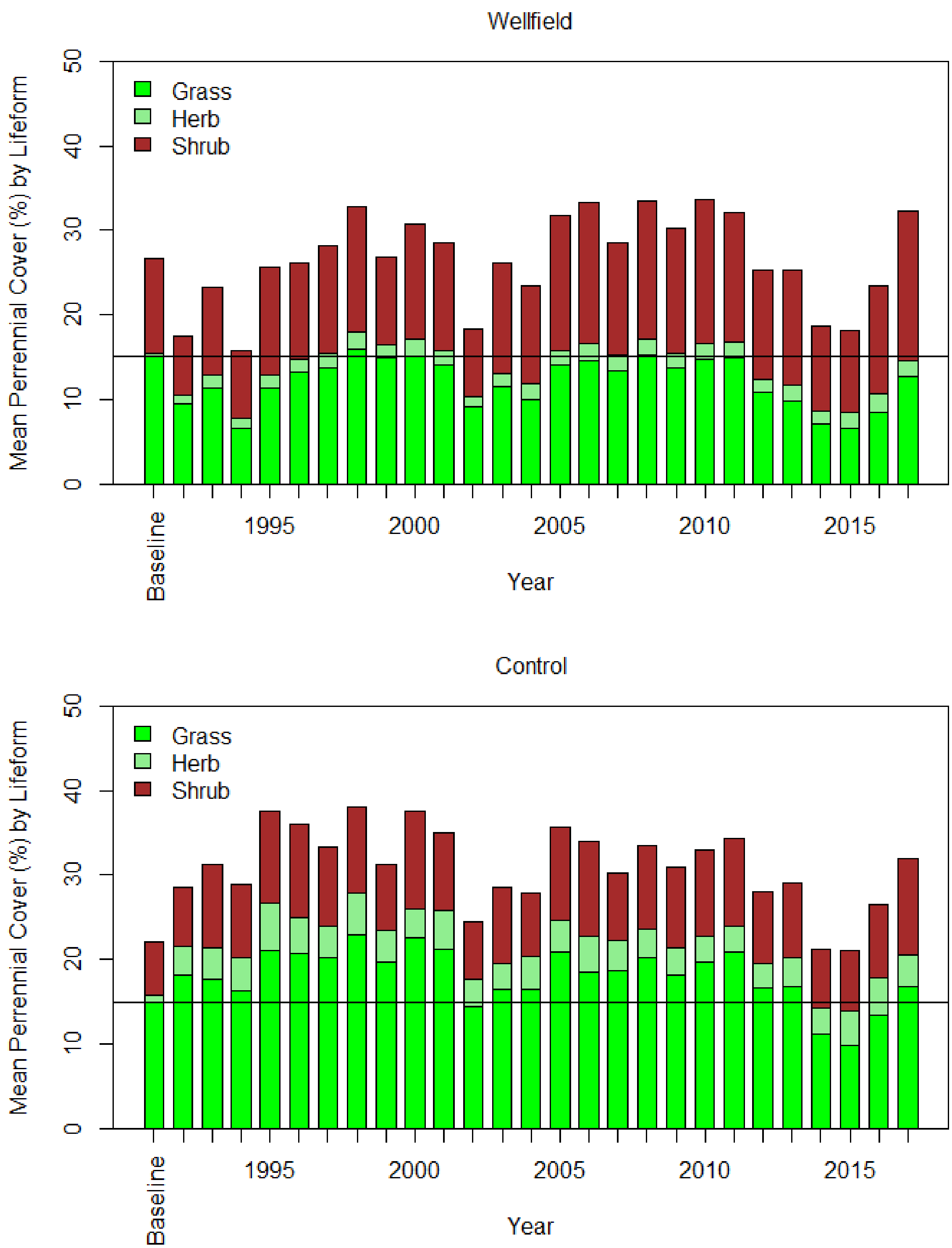


Figure 5.2. Time profile of grass, herb and shrub cover for baseline and each reinventory year for the control and wellfield parcel sampled each year between 1992 and 2017 (n = 24 wellfield parcels, n = 12 control parcels, n = 27 yrs including nominal baseline year). Horizontal line shows the mean baseline grass cover value.

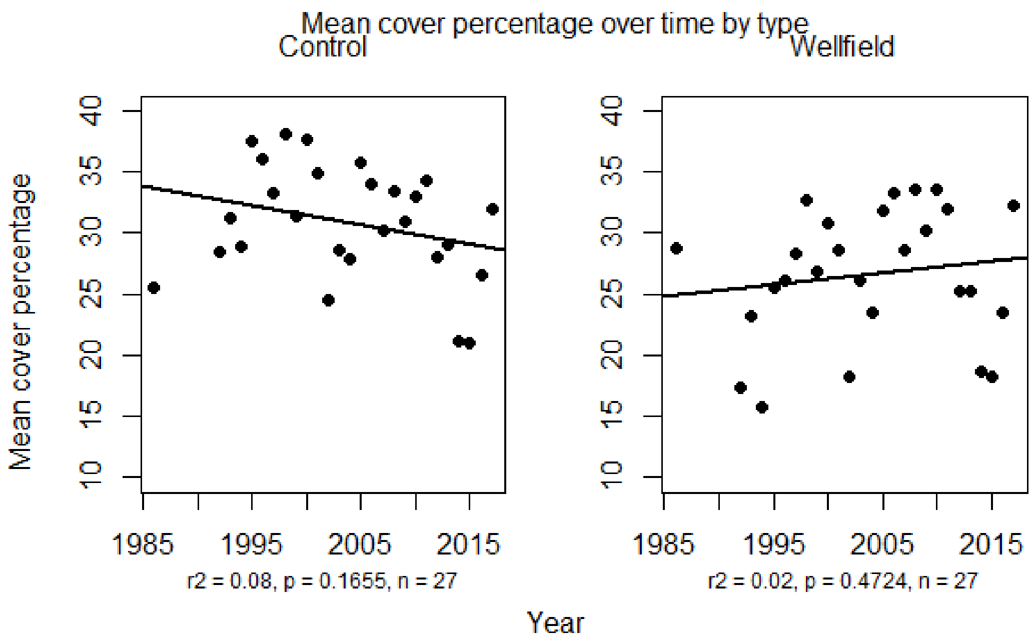


Figure 5.3. Mean perennial cover aggregated to parcel groups (wellfield and control) and plotted over the baseline and reinventory period. The baseline year is plotted at the nominal year 1986 for brevity. Variance in cover explained by linear temporal trend is reported in R2 values below plots, p-values less than 0.05 denote slopes statistically different from zero. Number of years input into regressions are provided below plots (n).

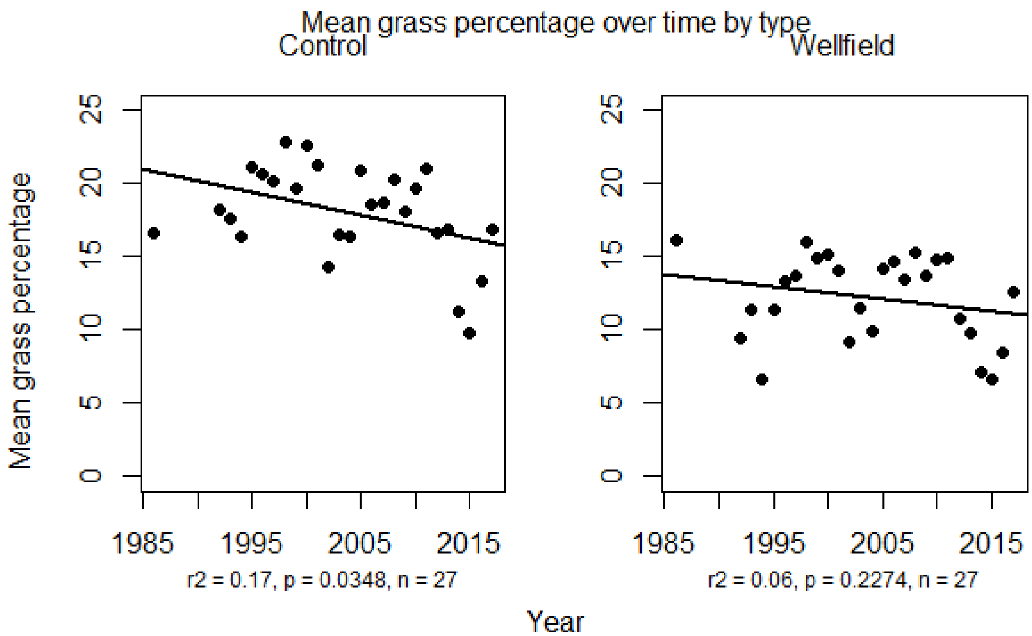


Figure 5.4. Mean perennial grass cover aggregated to parcel groups (wellfield and control) and plotted over the baseline and reinventory period. The baseline year is plotted at the nominal year 1986 for brevity. Variance in cover explained by linear temporal trend is reported in R2 values below plots, p-values less than 0.05 denote slopes statistically different from zero. Number of years input into regressions are provided below plots (n).

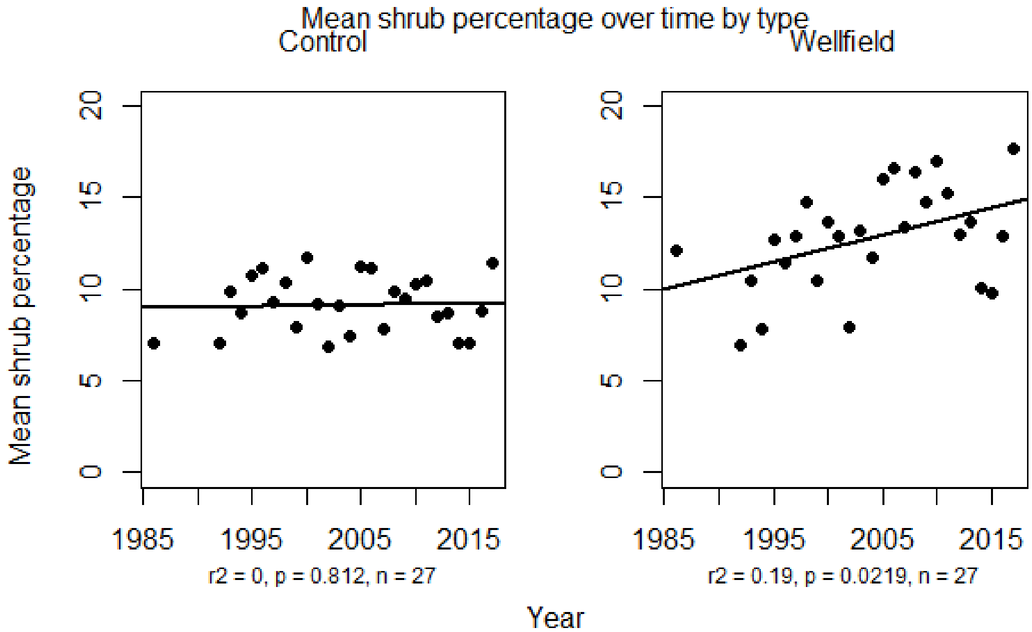


Figure 5.5. Mean perennial shrub cover aggregated to parcel groups (wellfield and control) and plotted over the baseline and reinventory period. The baseline year is plotted at the nominal year 1986 for brevity. Variance in cover explained by linear temporal trend is reported in R2 values below plots, p-values less than 0.05 denote slopes statistically different from zero. Number of years input into regressions are provided below plots (n)

Table 5.2 Wellfield parcel-average perennial cover 2011-2017. Parcels in which 2017 was greater than 5% cover below baseline are highlighted in red. For 2017, warmer colors signify greater declines from baseline. Years in which perennial cover exceeded baseline or declined less than 5% cover in green. 26 parcels that were below baseline in 2016 recovered to baseline perennial cover values in 2017. 25 out of 140 parcels were greater than 5% below baseline, even after a very wet year.

Parcel	2011	2012	2013	2014	2015	2016	2017
BGP162	-10	-14	-13	-22	-19	-15	-10
BLK021	-9	-11	-16	-14	-16	-10	-6
BLK094	-10	-16	-23	-21	-20	-16	-9
BLK096	-1	-10	-14	-15	-16	-10	-6
FSL044	-17	-32	-47	-45	-49	-40	-39
FSL051	11	-2	-22	-37	-33	-29	-26
FSL053	-1	-10	-10	-22	-23	-14	-6
FSL054	-23	-32	-44	-46	-54	-40	-20
FSP020				-11	-12	-9	-7
IND019	-12	-12	-22	-46	-46	-40	-20
IND021	-6	-21	-15	-41	-36	-25	-21
IND026	-15	-24	-16	-26	-24	-17	-9
LAW035	-24	-30	-31	-32	-32	-31	-27
LAW043	-51	-56	-58	-58	-55	-55	-47
LAW052	-19	-22	-24	-24	-24	-25	-23
LAW062	-11	-14	-16	-19	-19	-18	-9
LAW070	-38	-49	-54	-57	-56	-54	-47
LAW072	-49	-52	-55	-58	-59	-60	-27
LAW078	-14	-23	-21	-31	-29	-33	-17
LAW082	-7	-11	-11	-13	-12	-9	-8
LAW085	-14	-19	-19	-23	-26	-24	-17
LAW108_FSL047	1	-17	-22	-26	-29	-30	-14
LAW122	1	-4	-4	-18	-29	-27	-8
LNP045	-11	-16	-9	-28	-29	-23	-14
MAN037	-8	-19	-14	-29	-25	-16	-8
BGP086	3	-6	0		-16	-9	1

Parcel	2011	2012	2013	2014	2015	2016	2017
BGP088	9	0	-1	-2	-7	-3	1
BGP094	33	23	-6	-11	-9	3	19
BGP154	4	-5	-6	-13	-16	-12	-5
BGP157	16	3	4	-7	-9	-9	10
BIS085	-2	-12	-12	-14	-14	-7	-3
BLK002_TIN061	4	1	-1	-2	6	2	8
BLK009	-2	-11	-14	-14	-13	-12	-3
BLK011	27	21	16	14	13	20	26
BLK016	18	11	10	5	2	7	10
BLK024	2	-7	-4	-6	-8	0	7
BLK033	2	-7	-7	-8	-5	-1	0
BLK039	9	-4	-3	-4	-4	-3	5
BLK044	18	11	16	5	14	22	27
BLK069	3	-1	-2	-6	-4	-2	2
BLK074	17	2	10	-7	-5	7	13
BLK075	-2	-13	-19	-23	-20	-3	10
BLK077	0	-6	-8	-10	-9	-2	4
BLK093	6	2	7	-9	5	9	3
BLK095	8	0	4	-2	-4	4	6
BLK099	3	-4	-11	-10	-17	1	-3
BLK142	-1	-8	-3	-1	-4	-1	3
BLK143	24	7	20	15	16	20	20
FSL064	2	-4	1		-9	-5	10
FSL065	8	2	-1	-5	-7	-4	8
FSL116	-9	-11	-12	-21	-25	-17	2
FSL118	10	6	0	-1	0	3	5
FSL120	-9	-6	-8		-21	-20	11
FSL123	2	-19	-26	-32	-28	-23	11
FSL124	-1	-7	-21	-25	-35	-24	3

Parcel	2011	2012	2013	2014	2015	2016	2017
FSL130	11	4	-10	-9	-13	-3	11
FSP004_BGP188	15	-2	-1	-3	-9	-5	3
FSP006_BGP182	2	-8	-9	-14	-15	-12	-4
FSP015				-15	-17	-11	-1
IND011	22	22	17	-2	-10	-2	18
IND024_BLK103	-2	-3	2	-4	-5	-7	12
IND029	5	-2	4	-5	-3	5	11
IND035	5	0	-17	-19	-17	-11	8
IND106	16	13	16	8	5	8	17
IND111	2	-2	4	-12	-11	0	4
IND124	-1	-8	-24	-19	-26	-20	-4
IND132	-4	-11	-6	-16	-19	-16	-1
IND133	5	2	3	-3	-5	-1	4
IND139_MAN005	-5	-18	-14	-29	-28	-23	-4
IND205	52	49	29	26	18	25	36
IND231	15	7	8	1	1	3	11
LAW030	0	-9	-1	-12	-20	-10	-4
LAW063	5	-3	-5	-7	-7	-6	0
LAW065	-1	-5	-5	-6	-7	-6	-2
LAW105	16	18	1	-7	0	-3	7
LAW107	-6	2	6	-9	-10	0	14
LAW109	3	2	-1		-10		15
LAW112	11	5	-2	-6	-13	-11	0
LAW120	10	3	5	-2	4	-5	15
LAW137_PLC210	0	-6	-5	-8	-8	-5	1
MAN006_IND229	9	0	4	-3	-6	2	10
MAN007	1	-4	-7	-12	-11	-3	8
MAN034	25	21	-4	-8	-3	-5	3
MAN042	19	7	3	0	-2	0	9

Parcel	2011	2012	2013	2014	2015	2016	2017
PLC007	1	0	5	-10	-8	-1	3
TIN028_FSP022_FSP019	1	-4	-4	-4	-10	-5	-2
TIN030	11	3	1	-5	-9	-3	9
TIN050	5	-1	-4	-13	-6	-3	3
TIN053	11	-1	2	0	-8	0	11
TIN064	-2	-9	-12	-14	-16	-17	-5
TIN068	0	-5	-3	-4	-3	-5	1

Table 5.3. Total perennial cover (TPC) and perennial grass cover (PGRASS) measured in 2017 and change from baseline to 2017. Table is sorted by Contol and Wellfield parcel groups, then by PGRASS change from baseline (descending).

Parcel Name	TPC 2017	Δ Baseline	PGRASS 2017	Δ Baseline
CONTROL PARCELS				
LNP050	29	-19	2	-34
BLK059	40	-18	20	-32
BGP047	15	-31	9	-30
IND064	43	4	9	-27
MAN060	83	17	35	-26
PLC028	38	-1	8	-24
IND119	15	-19	11	-21
IND151	36	-10	26	-19
PLC070	20	-27	2	-16
IND067	24	-11	4	-13
IND087	32	-6	13	-11
FSL138	64	-7	52	-7
PLC106	18	-12	3	-7
LNP018	23	5	8	-7
PLC107	20	-20	1	-5
LNP095	30	2	19	-4
MAN014	24	2	6	-4
PLC056	20	3	4	-4
UNW029	19	3	8	-2
BIS055_FSL214	52	7	23	-2
IND163_BEE017	14	1	6	-1
BGP019	68	2	64	-1
PLC072	25	10	0	-1
IND122	43	13	4	-1
PLC092	18	8	1	-1
FSL126	55	-6	46	-1
PLC223	26	11	9	0
FSL129	54	5	36	0
ABD012_BLK029	11	-7	0	0
PLC097	46	10	32	0
PLC024	48	12	29	0
PLC088	57	13	38	0
UNW031	83	14	64	1
IND096	29	0	6	1
PLC136	23	11	8	1

Parcel Name	TPC 2017	Δ Baseline	PGRASS 2017	Δ Baseline
PLC137	44	16	18	3
PLC059	29	12	9	3
PLC121	50	9	39	4
BLK115	15	5	11	5
BGP031	24	7	19	5
FSL125	64	3	52	5
FSL128	77	28	50	10
BIS060	65	27	44	12
FSL187	28	13	27	13
LNP019	46	29	15	14
PLC144	50	18	37	16
UNW039	37	10	19	17
FSL166	83	26	77	31
FSL172	79	14	57	31
WELLFIELD PARCELS				
LAW043	14	-47	0	-60
FSL044	31	-39	17	-51
LAW070	12	-47	9	-49
IND026	40	-9	4	-45
LAW072	37	-27	25	-40
LAW108_FSL047	39	-14	26	-27
LAW078	35	-17	15	-27
LAW122	51	-8	34	-24
LAW035	6	-27	4	-23
FSL051	32	-26	27	-23
LAW052	5	-23	0	-22
FSL053	54	-6	30	-22
LAW085	13	-17	9	-21
IND021	47	-21	9	-19
FSP006_BGP182	20	-4	2	-19
TIN050	39	3	16	-18
LNP045	34	-14	4	-17
BLK094	32	-9	12	-17
IND019	55	-20	31	-16
TIN064	27	-5	7	-14
IND029	33	11	0	-14
BLK075	48	10	22	-14
BLK099	45	-3	28	-12
TIN053	46	11	19	-12

Parcel Name	TPC 2017	Δ Baseline	PGRASS 2017	Δ Baseline
FSL116	55	2	25	-11
BLK021	24	-6	1	-9
LAW137_PLC210	23	1	2	-9
BLK142	29	3	9	-9
IND139_MAN005	44	-4	10	-8
LAW065	8	-2	1	-8
LAW062	12	-9	0	-7
BGP154	20	-5	2	-7
LAW107	61	14	36	-6
BLK009	26	-3	12	-6
LAW082	8	-8	0	-6
BIS085	28	-3	15	-6
IND035	58	8	41	-5
FSL123	69	11	41	-5
TIN068	14	1	5	-5
BGP088	19	1	1	-4
BGP162	20	-10	1	-4
BLK033	14	0	4	-4
FSL065	30	8	14	-4
BLK044	49	27	5	-4
BLK039	27	5	12	-4
FSL064	57	10	32	-3
BLK024	32	7	5	-3
FSP020	10	-7	0	-2
MAN037	34	-8	2	-1
PLC007	30	3	1	-1
IND011	48	18	27	-1
BLK093	21	3	15	-1
IND132	32	-1	0	0
BLK002_TIN061	24	8	1	0
BLK011	35	26	5	0
IND133	17	4	0	0
IND231	19	11	0	0
BLK095	23	6	14	0
IND106	25	17	1	0
MAN042	27	9	2	0
LAW063	12	0	1	0
FSL130	36	11	15	0

Parcel Name	TPC 2017	Δ Baseline	PGRASS 2017	Δ Baseline
FSP015	23	-1	13	1
BLK096	15	-6	10	1
FSL118	15	5	1	1
BLK069	20	2	12	1
TIN028_FSP022_FSP019	15	-2	1	1
TIN030	40	9	12	1
LAW105	34	7	19	2
LAW112	21	0	7	2
FSP004_BGP188	19	3	7	2
FSL120	65	11	55	3
MAN034	18	3	12	3
BGP086	39	1	22	4
BLK016	32	10	12	4
MAN007	36	8	6	5
BLK077	20	4	14	5
IND111	45	4	16	6
MAN006_IND229	33	10	21	6
BGP157	38	10	14	8
LAW120	41	15	30	8
FSL124	64	3	56	9
BLK143	60	20	43	9
IND205	63	36	35	10
LAW109	33	15	27	11
LAW030	27	-4	19	11
BLK074	44	13	23	11
IND024_BLK103	55	12	39	12
IND124	37	-4	13	13
BGP094	68	19	50	16
FSL054	70	-20	52	42

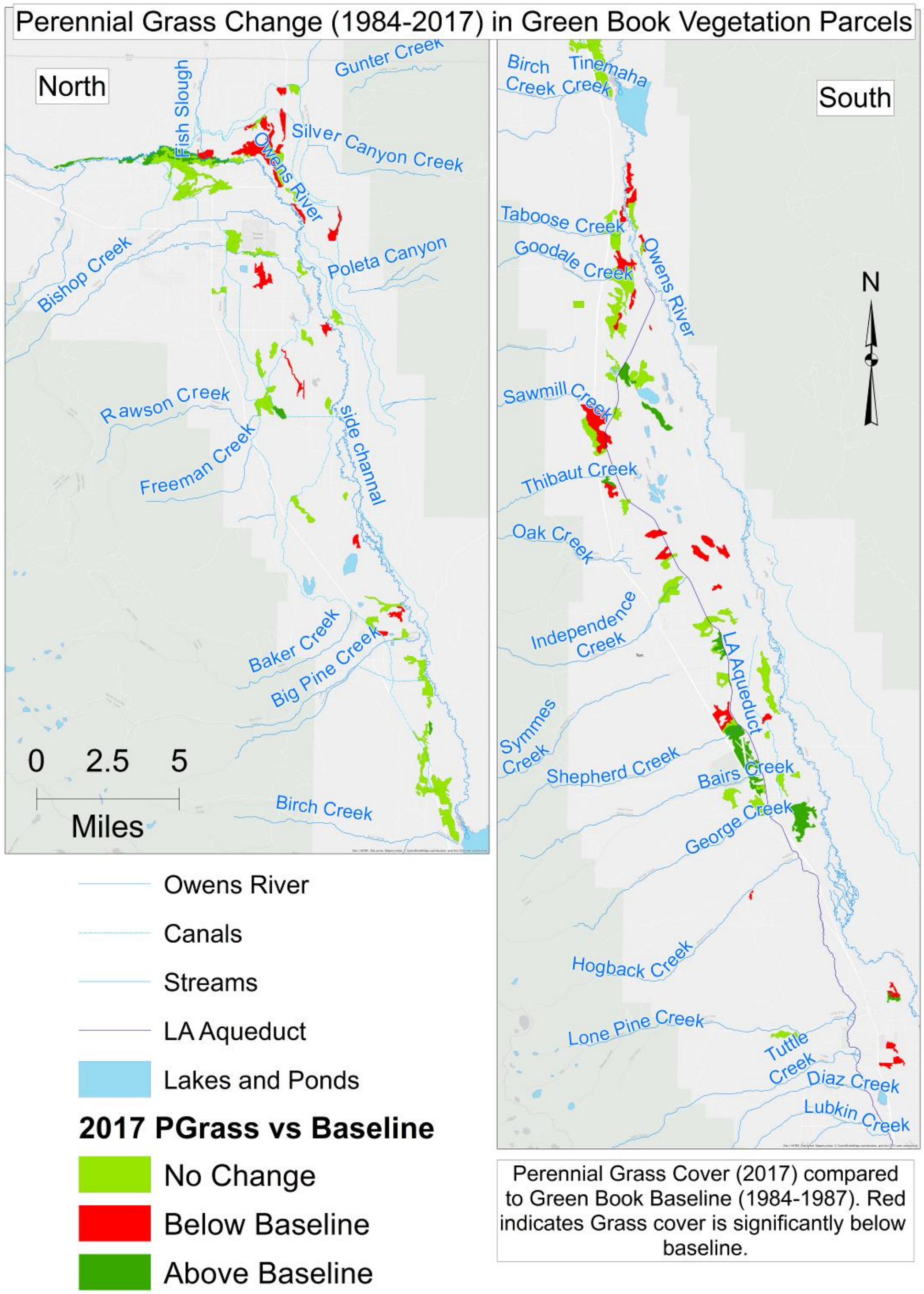


Figure 5.6. Perennial grass cover in 2017 compared to baseline. Significant declines in grass cover are highlighted in red ($p < 0.05$) using a two-sample t-test or one-sample t-test depending on the type of baseline data available.

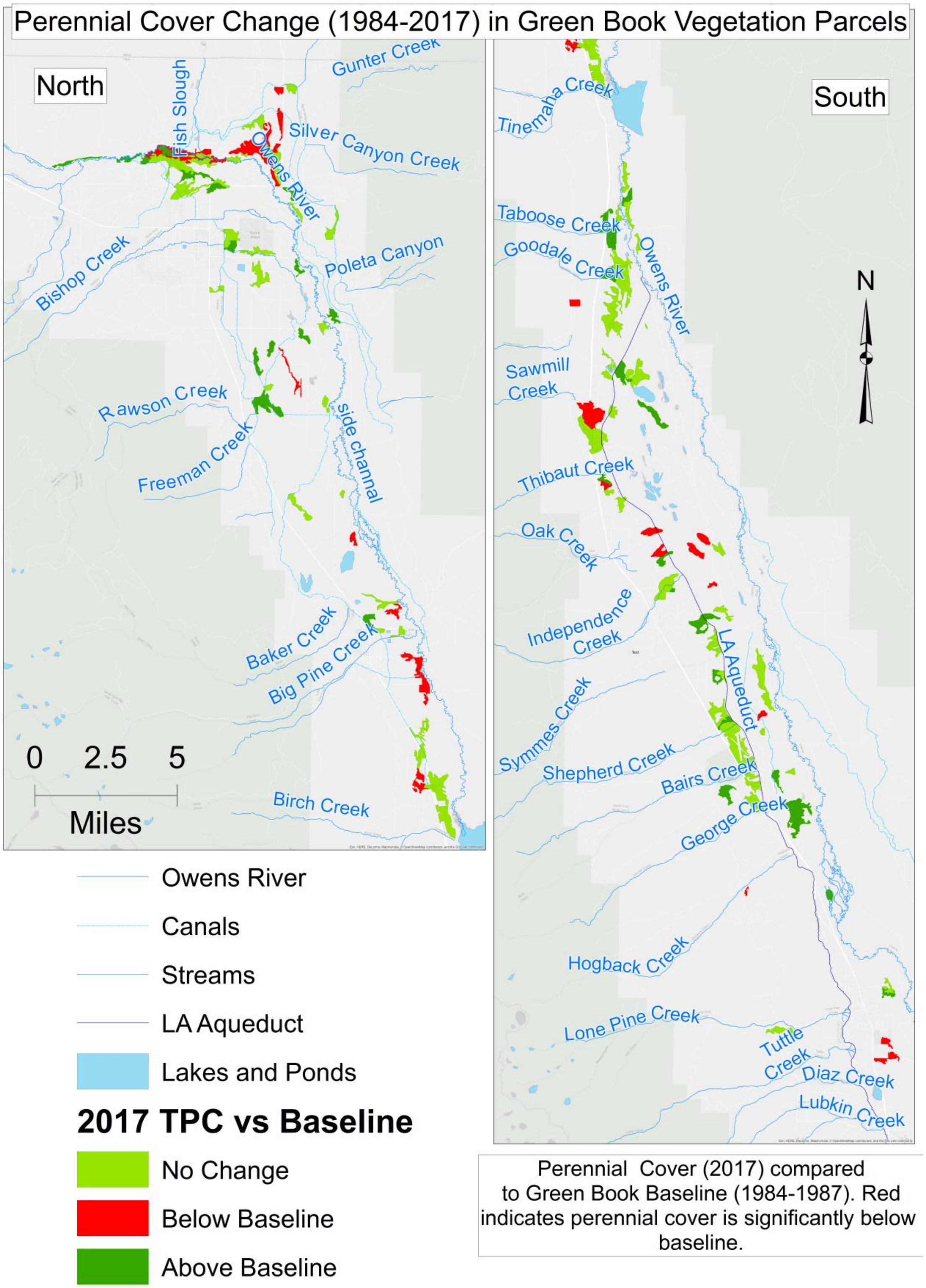


Figure 5.7. Total perennial cover in 2017 compared to baseline. Significant declines in perennial cover are highlighted in red(p < 0.05) using a two-sample t-test or one-sample t-test depending on the type of baseline data available.

Discussion

The primary type of vegetation change in both pumped and unpumped areas in 2016, was a decline in grass cover. In 2017, grass cover recovered in many parcels. Currently grass cover is below baseline in 35% of wellfield parcels and 31% of control parcels (Table 5.2).

On the whole wellfield and control parcels have largely converged and have been responding similarly in the past decade. Both groups were above the baseline group averages in 2017.

Areas in Blackrock (BLK075, BLK094, BLK099), Fish Slough and Laws (FSL044, FSL051, FSL053, FSL116, LAW035, LAW043, LAW052, LAW070, LAW072, LAW078, LAW085, LAW108_FSL047, LAW122), Fish Spring and south Big Pine/Tinemaha (FSP006_BGP182, TIN050, TIN053, and TIN064), Independence-Oak (IND019, IND021, IND026, IND029), and Lone Pine (LNP045) have depressed grass cover below baseline even after the wet 2017-2018 water year.

The increase in shrub cover in control parcels likely has several drivers including climate change, grazing, drought, lack of flooding and other disturbances that preclude shrub encroachment and dominance in dry meadows. The reversibility of woody dominance could be facilitated by rising water table to levels incompatible with shrub persistence, increased disturbance such as flooding and fire (prescribed or wildfire). Restrictions on timing of range burns and perceived risk of escape have limited the frequency prescribed burns are conducted and have limited the geographic extents to areas that can be safely burned with a low probability of unintentional escape and potential damage to resources such as groves of trees. Under these restrictions, the frequency and extent of recent burns is likely inadequate to facilitate reversing such woody dominance at scale. Flooding in 2017 caused widespread shrub mortality but the extent of this is largely unquantified. Grazing management, water table recovery and a long wet period offering natural cycles of flooding and wildfire could plausibly provide conditions compatible with regaining herbaceous dominance in shrub encroached meadows.

Table 5.4. Summary of the percentage of parcels below baseline perennial cover and grass cover in wellfield and control areas.

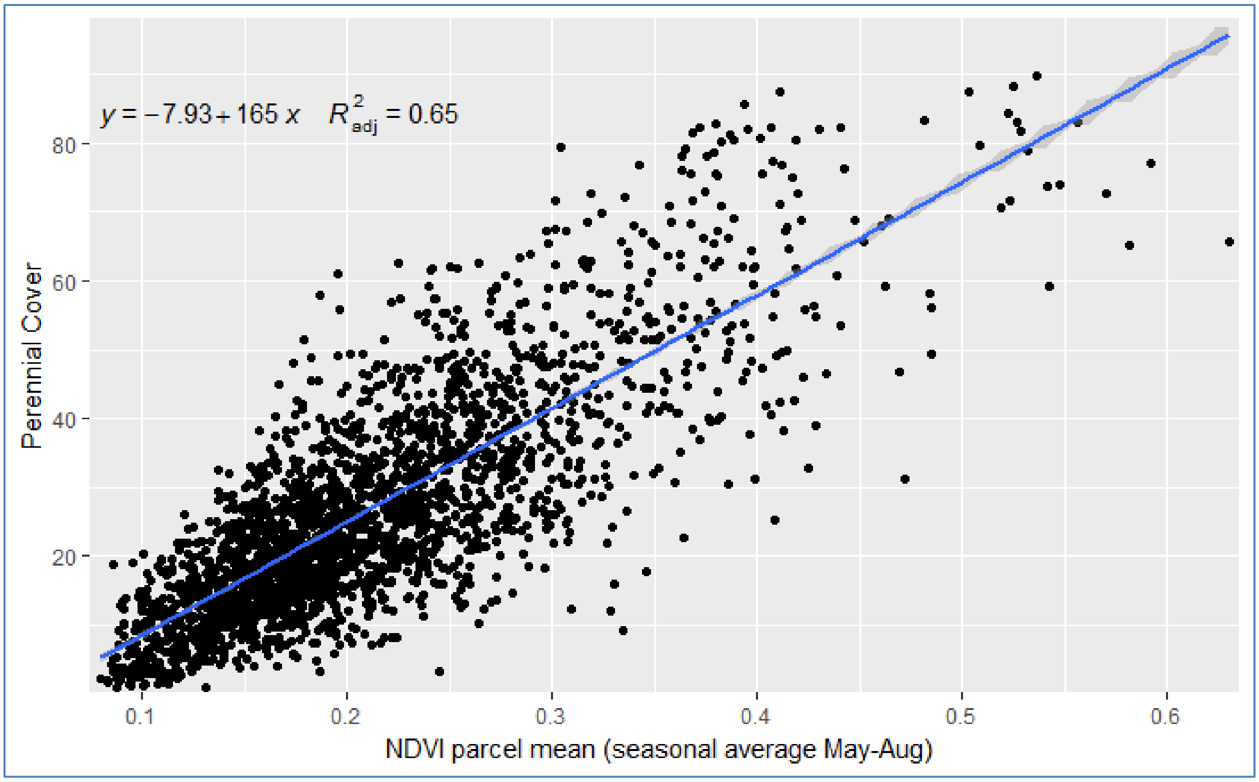
Change from Baseline		Total Perennial Cover	Perennial Grass Cover
Control Parcels (n = 49)			
	Below	**22%**	**31%**
	No Change	39%	55%
	Above	39%	14%
Wellfield Parcels (n = 91)			
	Below	**21%**	**35%**
	No Change	63%	58%
	Above	16%	7%

In addition to the ground based monitoring specified in the Green Book, the Water Dept. utilizes a variety of satellite and aerial imagery and data to examine areas not routinely sampled or with spatial detail not easily or quickly obtained with the other sampling programs.

SECTION 6: REMOTE SENSING

Vegetation Cover Monitoring

There is interest in measuring trends in vegetation cover with remote sensing to serve as a surrogate for field measured cover across a wider area and with more consistent frequency than field sampling allows. Here I quantify the relationship between field measured cover and NDVI. Field measured cover is averaged across transects to the parcel level. NDVI is averaged across a season for individual 30 x 30 m grid cells for the May-Aug period and then across all grid cells in the parcel to arrive at a seasonally and spatially aggregated surrogate for growing season vegetation cover at the parcel scale. NDVI was correlated to perennial cover (R2 = 0.65) with a regression equation shown in Figure 6.1. NDVI could be used to monitor trends in vegetation cover at the parcel scale freeing up staff resources to focus on field activities that can't be replaced with remote sensing. Because changes in species composition can't be monitored from NDVI, field sampling parcels need to continue, yet the frequency of visitation could occur every other year without sacrificing much information loss. Each agency, LADWP and ICWD currently share responsibility for monitoring 140 vegetation parcels annually, currently requiring each agency to visit every parcel where half the transects are measured by each agency. It has been proposed to divide the parcel set rather than the transect set between agencies each year, so that only 70 annual parcel visits are required by each agency, likely reducing the time required to complete the permanent monitoring. If each half of the 1600 transects are monitored every other year, only 35 annual parcel visits would be required for each agency and 400 transects would require measurement each year. This would represent a 75% reduction in the number of parcels visited each year and a 50% reduction in the number of transects measured without sacrificing much information loss.



Residuals:

```
    Min      1Q  Median      3Q     Max 
-38.567  -5.862  -0.797   5.496  37.241 
```

Coefficients:

```
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)  -7.9296     0.5547  -14.29   <2e-16 ***
NDVI_SUR    164.6722     2.4560   67.05   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
Residual standard error: 9.631 on 2403 degrees of freedom
  (174 observations deleted due to missingness)
Multiple R-squared:  0.6517,  Adjusted R-squared:  0.6515 
F-statistic:  4496 on 1 and 2403 DF,  p-value: < 2.2e-16
```

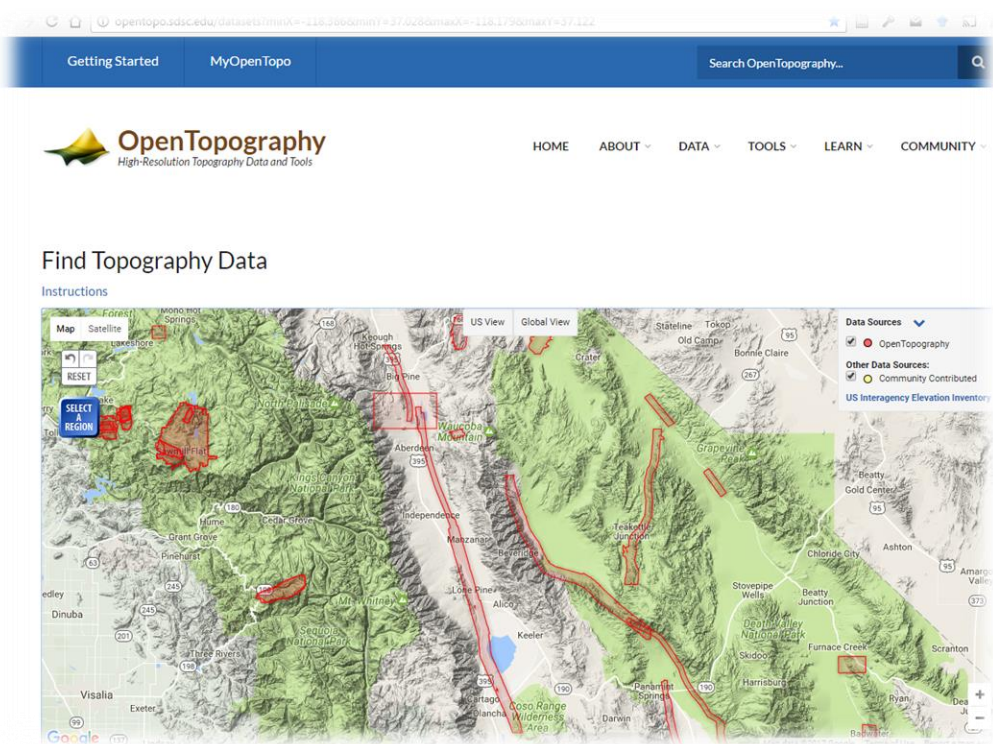
Figure 6.1. Relationship between NDVI and perennial cover and regression statistics for Owens Valley vegetation monitoring parcels.

Lidar Data for tree canopy enumeration and flow accumulation networks

An example is presented here of using readily available Lidar data to map mature trees for the Island area within the LORP. Data was downloaded from

(http://opentopo.sdsc.edu/datasets?minX=-118.386&minY=37.028&maxX=-118.179&maxY=37.122)

Two raster layers, bare earth and highest height are provided with the data set. To process the bare earth DEM, the 'fill' tool was used. To generate a 'height above bare earth' (i.e. tree canopies), I used raster calculator and subtracted bare earth from highest height. Lastly, I ran the 'flow direction' and then 'flow accumulation' tool to delineate drainages that are unresolvable with our courser DEM.



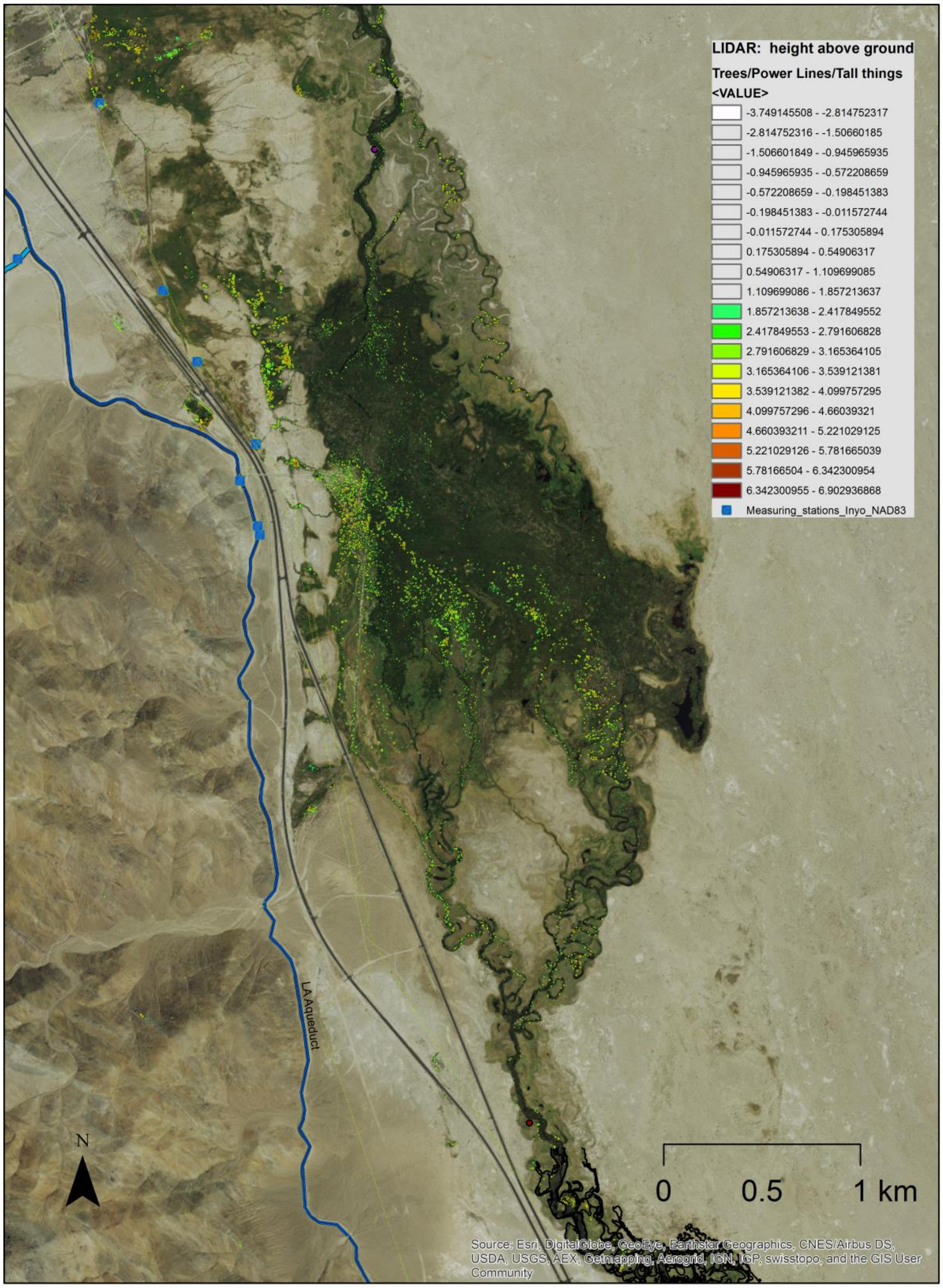


Figure 6.2. Tree canopy delineation using Lidar-derived height above bare earth with threshold set at 1.8 m.

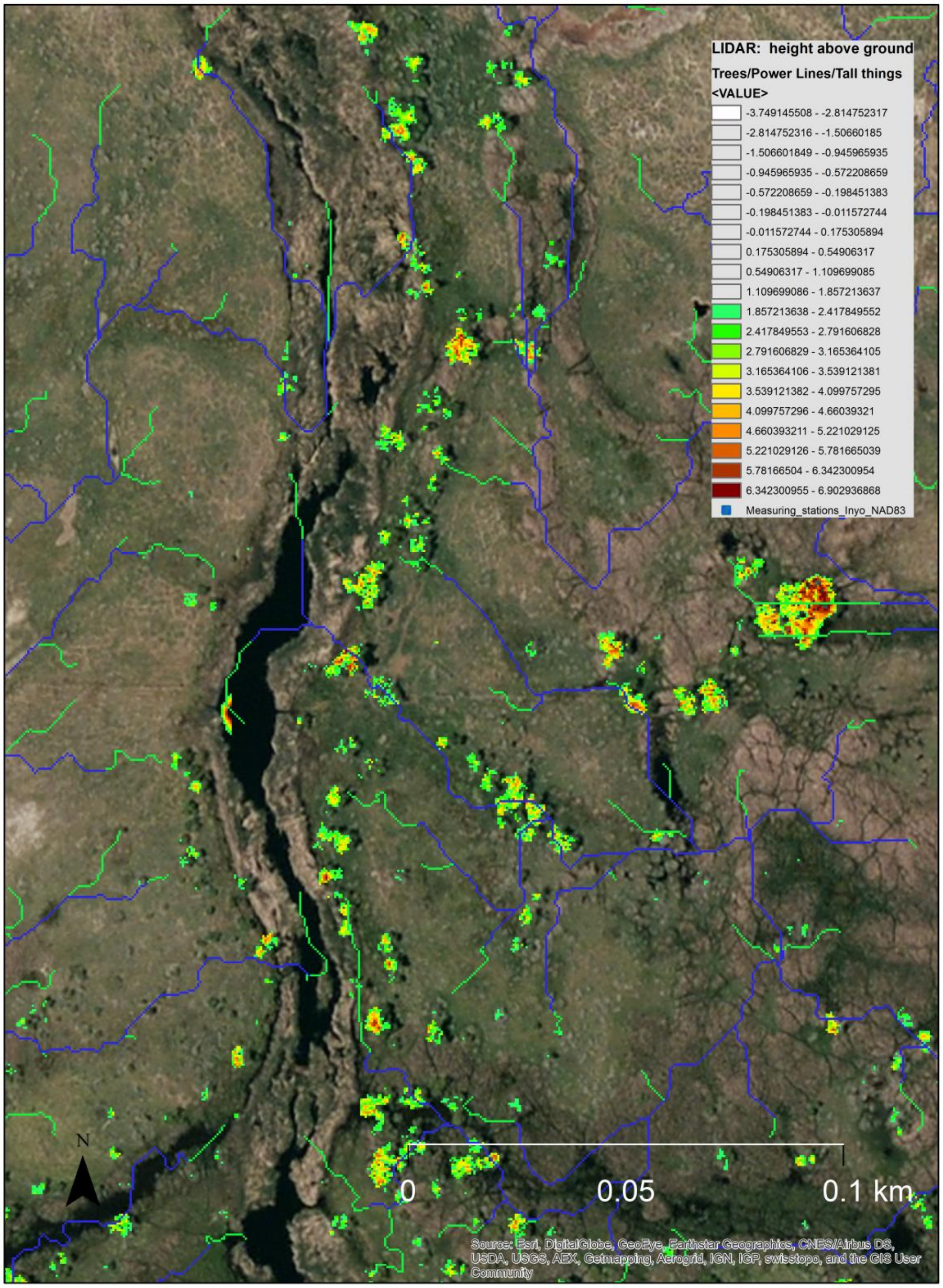


Figure 6.3. 1:1000 northern islands section. Tree canopies and flow accumulation computed from lidar rasters.

Pleasant Fire Mapping

Pleasant fire burned through the floodplain of Owens River between Pleasant Valley Reservoir to put Five Bridges Rd on February 19-20. A simple NDVI differencing of image composites before and after the fire were derived which delineated the burn extent, and within-burn patchiness. The final acreage of the burn using this method was approximately 1600 acres. Because the Landsat 5 record starts in 1984, post-hoc burn extent delineation is possible for fires or other disturbances that were not mapped shortly after the event. This type of post-hoc fire mapping is conducted at a national level through the monitoring trends in burn severity (MTBS) program, but only fires greater than 1000 hectares or 2741 acres are mapped and provided as data products. There has been some effort to collate historic fires into a file geodatabase for Owens Valley. This product should be available in 2018, including the Pleasant Fire.

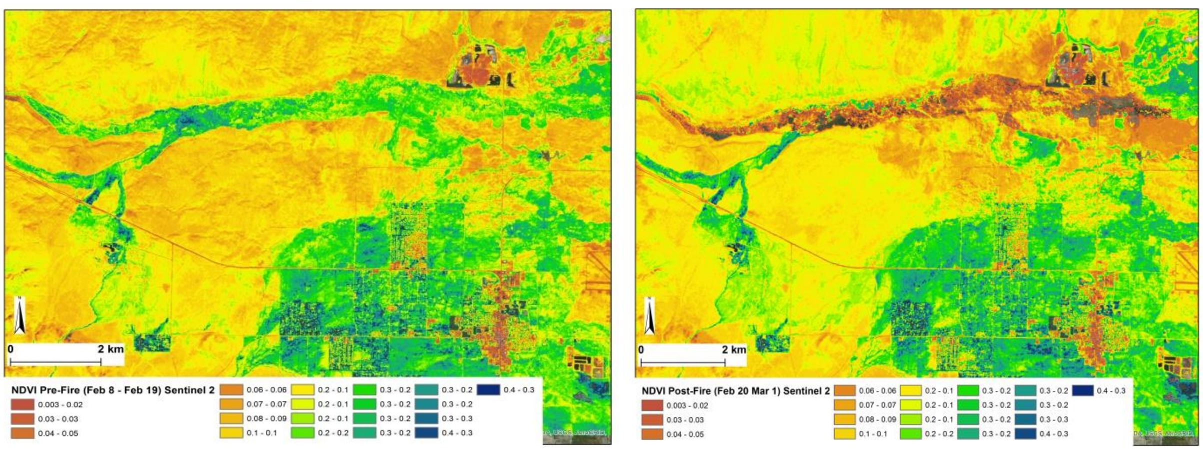


Figure 6.4. Mean NDVI over the period period Feb 8-Feb 19, 2018 (left) and Feb 20-Mar 1, 2018 (right), derived from Sentinel 2 satellite imagery.

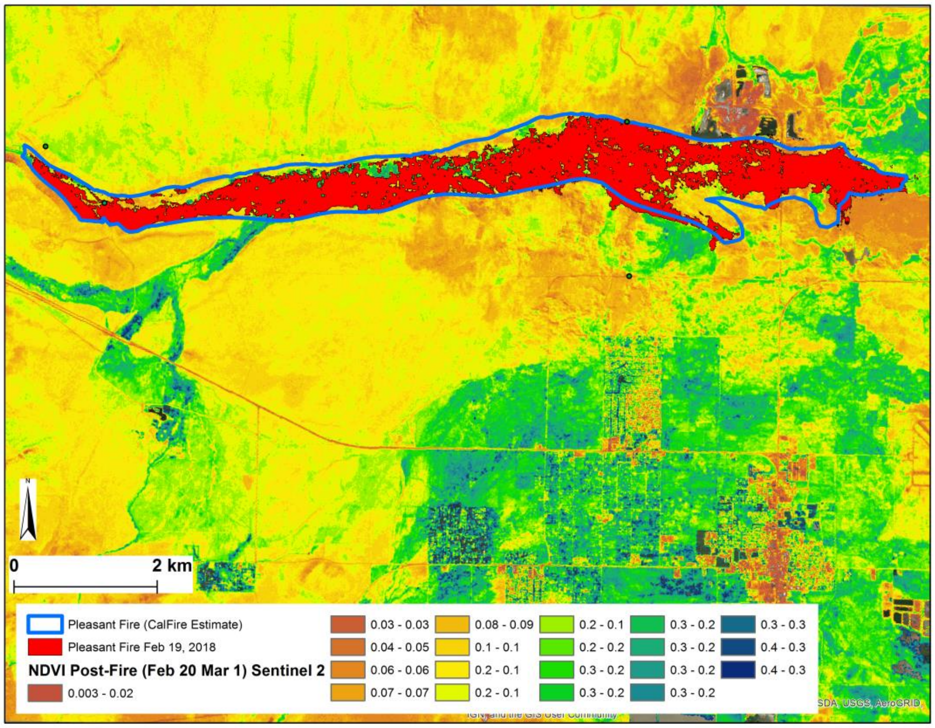
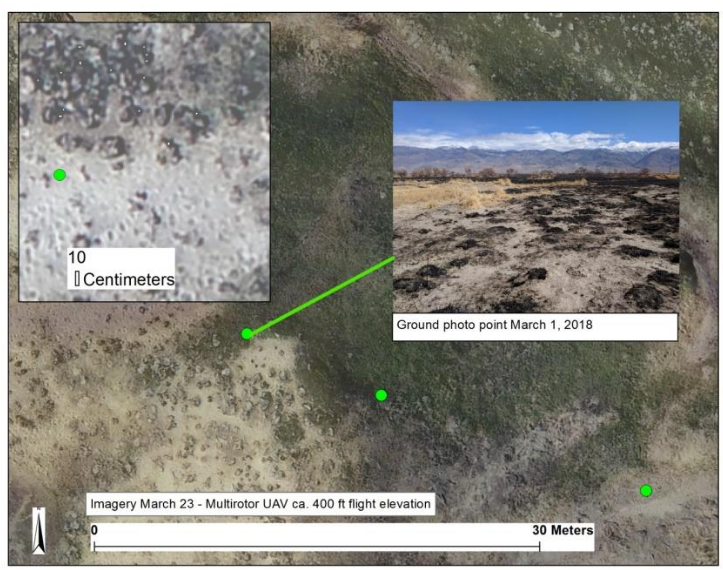


Figure 6.5. Burn extent of Pleasant Fire estimated from pre-fire and post-fire NDVI differencing. CalFire estimate was 2249 Acres. Estimate from NDVI differencing is approximately 1600 acres of burned area which excludes unburned patches within the fire perimeter.

Multirotor unmanned aircraft photography

Inyo County has contracted with Eastern Sierra Mapping, specializing in drone aerial imagery providing 4-cm resolution mosaics at 400-ft elevation from ground surface and a digital elevation model computed using sterophotogrammetry. The Five bridges area from Bishop Creek Canal intake to Five Bridges Rd was flown approximately 6 weeks after the Pleasant Fire. The Lower Owens River Water Trail was also flown. An example of this project is presented to the right where individual plants are resolvable.



SECTION 7: RARE PLANTS

The Long Term Water Agreement requires management of rare species to be consistent with applicable laws. The Water Dept. monitors populations of two plant species that could potentially be affected by groundwater pumping.

The Inyo County Water Department (ICWD) monitors populations of Owens Valley checkerboom (*Sidalcea covillei*) and Inyo County star-tulip (*Calochortus excavatus*) each year in accordance with Long Term Water Agreement goals to manage rare plants in manner consistent with State and Federal laws. *S. covillei* is listed as endangered by the state of California, and is a US Fish and Wildlife species of concern. Both species are listed under CNPS List 1B.1 (rare, threatened, or endangered in CA and elsewhere).

The Water Department has monitored, in total, up to 24 *S. covillei* sites and up to 28 *C. excavatus* sites from 1993-2017. In 2017, ICWD monitored six *S. covillei* sites and 28 *C excavatus* sites. Site abundance estimates are based on counts where attainable or estimates based on random sampling depending on the extent and size of populations.

Along with *C. excavatus*, and *S. covillei*, a few additional herbaceous perennial and shrub species are regularly documented on datasheets as associated species and during Owens Valley Vegetation Condition (OVVC) surveys. These species are noted as present or absent along with the phenology or counted as part of the vegetation cover. Species of interest are Silverleaf Milkvetch (*Astragalus argophyllus* var. *argophyllus*), Hall's Meadow Hawksbeard (*Crepis runcinata* ssp. *Hallii*), White Flowered Rabbitbrush (*Ericameria albida*), Torrey's Blazing Star (*Mentzelia torreyi*), Frog's-bit Buttercup, (*Ranunculus hydrocharoides*), and Alkali Cordgrass (*Spartina gracilis*).

Inyo County Star Tulip (Calochortus excavatus)

The genus *Calochortus* is distributed only in western North America from British Columbia to Guatemala (Ownbey 1940). *C. excavatus* is endemic to Inyo and Mono Counties occurring in snow-melt fed springs, seeps, riparian corridors and groundwater-dependent alkali meadows between 1300 - 2000 m. *C. excavatus* reproduces by seed and by offset bulbils from the main bulb. The seeds of *Calochortus* species are relatively large and lack obvious adaptations for long-distance dispersal, potentially facilitating genetic differentiation at small spatial scales and parallel adaptive radiations in geographically restricted clades (Patterson 2004). The relative proportion of

Table 7.1. C. excavatus site counts and sparkline from 1993 to 2017.

Site	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Time Series 1993-2017
ASR	0	0	0	0	0	0	0	0	0	0	0	0	166	296	18	567	34	350	135	107	8	50	0	17	196	
BC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	15	5	20	3	1	14	
BULL FIELD	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
C11	26	152	91	80	220	116	208	177	699	337	388	392	128	181	234	64	15	51	62	195	27	41	7	41	48	
C13	18	6	58	21	25	21	17	10	6	23	18	5	8	15	18	26	6	13	8	12	4	2	0	7	23	
C14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1974	13	6	6	2	0	
C15	72	46	50	104	45	100	133	98	27	13	103	7	140	112	143	68	1	0	5	29	1	1	0	0	26	
C16	282	31	500	450	400	250	0	687	658	991	1124	85	837	203	927	1227	68	94	38	257	190	375	20	27	901	
C16N																									232	
C17	105	77	180	200	111	92	114	236	432	340	286	214	408	262	167	269	145	0	198	389	541	317	0	127	0	
C18	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	35	57	31	10	0	39	98	
C19	15	0	0	57	45	2	19	6	88	65	173	7	77	95	51	37	1	14	6	0	0	0	0	1	6	
C20	12	33	42	31	6	3	7	14	10	0	19	16	34	42	6	30	10	39	21	18	0	9	6	14	36	
C21	0	0	69	9	3	10	0	0	14	0	51	0	39	19	0	49	7	14	6	12	0	3	0	7	73	
C22	78	0	315	19	100	200	41	54	124	21	348	30	186	40	54	213	62	183	62	22	0	2	0	1	29	
C28	0	2	5	1	2	4	4	0	4	0	2	0	0	1	0	1	0	0	2	0	0	0	0	0	0	
C30	120	26	450	32	14	23	0	0	1	0	2	0	260	99	0	355	2	380	151	0	0	0	0	4	59	
C31	0	200	400	92	90	90	100	318	627	527	1643	81	1502	506	263	1793	361	1220	814	81	36	357	36	626	1349	
C32	13	0	118	17	1	47	17	3	19	0	6	0	10	14	0	43	2	28	26	1	0	1	0	0	6	
C35	0	0	0	33	30	74	67	82	43	53	36	0	28	34	5	6	0	2	11	0	12	7	2	9	2	
C36	0	97	400	200	18	100	150	167	592	4	673	6	681	575	177	1162	0	61	165	2	0	1	0	2	128	
C37	15	1	56	55	50	17	64	76	45	20	13	7	16	86	26	59	6	42	55	4	2	8	0	0	24	
C38	0	0	36	7	2	15	17	3	1	0	3	2	17	8	5	4	3	2	0	1	0	0	0	0	2	
C39	1	0	21	3	4	15	6	5	6	5	8	4	17	6	5	14	4	3	11	3	3	2	3	3	2	
C44	55	1	380	150	50	100	248	689	548	90	368	90	321	130	171	320	5	155	92	11	12	36	0	11	67	
PLC024	0	0	0	0	0	0	0	0	0	345	1081	255	661	191	170	1616	505	448	141	60	222	287	45	164	256	
SR168																							0	0	7	
T581	0	0	0	0	0	50	0	44	84	96	296	82	290	457	76	183	23	276	265	40	11	32	5	43	539	
TL	0	0	0	0	0	0	0	0	0	0	0	0	852	662	399	780	174	626	516	533	568	474	112	356	1511	
TS2	0	0	0	0	7	16	2	0	4	1	6	0	8	8	1	8	1	7	3	0	0	0	0	0	1	

carbohydrate storage in below-ground bulbs and above tissues is presumably influenced by antecedent water regime and life stage. In dry years, *C. excavatus* can remain dormant in bulb form. The presence of a dormant seedbank is unknown. Plants may persist up to ten years.

Currently there are 58 known sites supporting *C. excavatus* being monitored, all of which are in the Owens Valley in Inyo County (Table 7.1). The Water Department monitors 27 *C. excavatus* populations annually, LADWP monitors approximately six populations and the Bureau of Land Management monitors eight populations. The 27 populations monitored by the Water Department are located on land owned by LADWP. Individual *C. excavatus* plants were counted using walking grids located within previously mapped population boundaries.

Owens Valley Checkerboom (Sidalcea covillei)

S. covillei occurs from about 1100 - 1300 m elevation in alkali meadows that are periodically wet from nearby streams, springs or ground water in the Owens River drainage. *S. covillei's* carbohydrate-rich roots allow it to survive drought periods but continuously dry periods are incompatible with population maintenance. *S. covillei* grows to 20-60 cm. The leaves are fleshy and waxy in texture. The inflorescence is an open panicle of several flowers. The leaves and flower sepals are coated in tiny branching hairs.

According to Halford (1993), *S. covillei* population demographics are influenced by annual precipitation, timing and intensity of cattle grazing, competition with shrubs and rhizomatous grass species, and activities that influence surface and groundwater sources. Owens Valley checkerbloom flowers from April through June. ICWD monitored six *S. covillei* sites and 28 *C. excavatus* sites within the Owens Valley in 2017 (Table 7.2). The number of sites monitored each year is determined by staffing levels in May.

S. covillei populations were sampled by first mapping known population locations into polygons and then either sampling individuals via randomly located quadrats, or via hand counts of flagged individuals within mapped sub-populations. Polygon boundaries were marked with flags and mapped by walking the perimeter with a GPS unit. Quadrats (approximately 1 m^2^) were randomly sampled within the polygon. Locations of quadrats were selected using a random bearing and a random number of paces (i.e. three sets of random paces were generated: 1-20, 1-30, 1-40 for small vs. larger polygons). The number of quadrats sampled increased with the size of the polygon; 10 was the minimum number of quadrats sampled. Annual population size estimates are for the non-dormant portion of the population (fiedler 1998) and are thus likely underestimates of the true population size, especially in dry years when dormancy is expected to be more prevalent.

Due to the abundant winter precipitation, many annuals grew in 2017. We took this opportunity to look for some rare annual species that are only found in the wetter years. Species of interest were Geyer's Milkvetch (*Astagalus geyeri* var. *geyeri*), Yellow Spinescape (*Goodmania luteola*), Nevada Orcytes (*Oryctes nevadensis*), Inyo Phacelia (*Phacelia inyoensis*), and Parish's Popcorn Flower (*Plagiobothrys parishii*).

Table 7.2. S. covillei site counts and sparkline for time series.

Site	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Time Series (1993-2017)
HANBY	0	0	0	0	0	0	0	0	0	0	5	5	5	2	2	2	0	0	1	0	0	0	0	0	0	
S06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
S07	0	46457	78817	64299	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11101	0	0	0				
S08	2000	2400	72156	27901	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9716	0	0	0				
S09	826	17356	10126	9674	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
S10	1800	2976	3657	10676	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62	0	0	0				
S11	66600	124714	169367	74003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	97343	0	0	0				
S12	64388	156288	84653	25149	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11285	0	0	0				
S18	0	0	181	221	350	520	625	586	754	918	921	872	834	808	715	503	350	0	400	682	2345	699	659	674	716	
S20	0	1100	1496	1582	1476	0	0	0	0	0	0	0	0	0	0	0	0	0	803	507	677	50				
S21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	335	758	149	95	130		
S22	92155	68126	198418	141568	0	0	0	0	0	0	0	0	0	0	0	0	8000	0	57590	57279	0	0				
S25	0	0	2000	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	110	93	120	144	172	16	
S27	3000	0	19396	8652	0	0	0	0	0	0	0	0	0	0	0	0	3000	0	6633	4663	9405	5348				
S28	22275	59999	77355	89502	0	0	0	0	0	0	0	0	0	0	0	0	80	4630	3444	2721	9070	0				
S29	0	600	9731	5545	0	0	0	0	0	0	0	0	0	0	0	0	0	323	378	257	9	0				
S31	5000	41239	51002	20196	0	0	0	0	0	0	0	0	0	0	0	0	1200	20655	19568	22924	53777	29973				
S32	0	35	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	61	45	51	25	70	55	
S33	150	115000	90974	0	69743	0	41275	42351	39938	0	0	0	0	0	0	0	5000	0	18829	17300	0	25843				
S34	106	67	171	131	129	152	223	94	113	53	75	44	72	91	70	44	0	14	8	1	0	0	0	0	0	
S35	35000	0	28668	12868	0	0	0	0	0	0	0	0	0	0	0	0	0	28582	24909	9278	0	0				
S36	0	0	97452	43438	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33144	0	0				
S37	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
S38	0	10	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0				
UNW031	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9059				

.

Geyer's Milkvetch (*Astragalus geyeri* var. *geyeri*)

Astragalus geyeri var. *geyeri* occurs from at about 1200-1900m elevation in sandy fast-draining soils associated with Shadscale (Atriplex confertiflora) to Single-needle pinyon (Pinus monophylla). *A. geyeri* is rare in California only occurring in SE Lassen County and Inyo County. The Lassen County records are from the 1993 & 1997. The Inyo County records are from 1973 in the Owens Valley, and a northern Panamint Mountains record from 1937 from the head of Wood Canyon at about 1939 m elevation. This is an annual herb, stems prostrate to ascending, minutely strigose. Leaves are pinnate compound, 1.5-10 cm long, leaflets 3-13 spaced 5-15 mm apart, linear to oblong, terminal leaflet often longer than others. Inflorescence is down in foliage, 3-8 flowers per cluster, flowers ascending to reflexed, petals white to lilac-blushed, keel tip purple, banner 5.2-7.6mm, recurved 45 degrees or more, keel 3.8-4.8.mm long. Fruit 15-25mm long and 6-10mm wide, inflated, distinctly curved, surface minutely strigose, thin papery, beak triangular.

Not since the 1973 Mary DeDecker records, has this species been recorded in Inyo County. The DeDecker location is not GPS'ed but only a general TRS location is given. The general area was searched for a few hours by Zach Nelson and Jerry Zatorski, on May 11, 2017, but no plants were found. The habitat appeared to be relatively stable with many expected shrub, and herbaceous species found, but *A. geyeri* var. *geyeri* is a relatively small plant about 10cm tall and 10-15cm wide, so plants could have been easily hidden behind a shrub and out of view. On May 25, 2017, a new population of *A. geyeri* var. *geyeri* was located near Farmers Pond in the Laws USGS quadrat.

A total of 18 plants were found, all were in fruit and a few had some senesced flowers. The plants were up to 10 cm tall and 10-15cm wide. The habitat is hummocky upland, the plants occurring on the sandy hummocks not in the small 'playa-ettes' in between. Associated species are a mix of woody shrubs and herbaceous perennials and annuals that are rain-water dependent, not wetland indicator species. The area is managed as range for cattle, and has likely been this way since the late 19th Century. The area is also frequented by cottontail rabbits and jack rabbits, rodents (squirrels, mice, rats) native to the Owens Valley, Tule elk and mule deer are year round residents, and some hawk moth larvae predation was noted on nearby plants.

Martin F. Wojciechowski & Richard Spellenberg 2017. Astragalus geyeri var. geyeri, in Jepson Flora Project (eds.) Jepson eFlora, http://ucjeps.berkeley.edu/cgi-bin/get_IJM.pl?tid=54745, accessed on November 01, 2017.

Yellow Spinescape (*Goodmania luteola*)

Goodmania luteola occurs in the Eastern Sierra of S Mono County and N Inyo County, and is also found in the W Mojave Desert and San Joaquin Valley. The Inyo County records are concentrated around Klondike Lake, north of Big Pine and the south end of Fish Slough. This is an annual herb, stems prostrate and spreading to about 5-15cm wide. Leaves are cauline, blade round, 2-7mm with petioles 2-4cm long. Flowers are in clusters along long flowering stems, the clusters are subtended by ovate, spine-tipped bracts, flowers 9-15mm across, perianth with 6 yellow lobes. Fruit single seed, light-brown, 1-1.2mm, glabrous, curved.

This species has been documented beginning in 1995 at a few *Calochortus* rare plant locations in spring and while surveying Owens Valley Vegetation conditions in summer, and it's noted as present or absent along with the phenology. In 2017 *G. luteola* has been documented at three such locations, and one location while surveying Owens Valley Vegetation in early July. Two locations are in the Klondike Lake area, one is east of US 395, and the other is north of Twin Lakes. In all locations the species is found in alkali meadows with a moderate amount of cover and desert or alkali sink habitats. For all locations the populations appear to be stable. Plants are only documented as associated species during rare plant surveys, and as vegetation cover during summer vegetation surveys.

James L. Reveal & Thomas J. Rosatti 2017. Goodmania luteola, in Jepson Flora Project (eds.) Jepson eFlora, http://ucjeps.berkeley.edu/cgi bin/get_IJM.pl?tid=27187, accessed on November 01, 2017.

Nevada Orcytes (*Oryctes nevadensis*)

O. nevadensis occurs in Inyo County of California. There are records from the Owens Valley (eastern Blackrock area north to Laws), Eureka Valley, and Deep Springs Valley, specimen records are only from Owens Valley locations. This is an annual herb, 5-20 cm tall and wide, stems branching near soil line from a taproot. Leaves are linear to ovate, 1-3 cm long, margin shallowly lobed and often wavy, petiole is 5-10mm with narrow wings. Flowers are in umbels emerging from upper leaf axils, flowers narrow urn-shaped 5-8mm long, purple to dusty pink. Fruit round two-valved capsule, 6-7mm across with 10-15 round, flat seed.

This species has been documented beginning in 1982 in the Owens Valley from SE of Lone Pine north to Laws, many sites along the old railroad line or powerline roads, likely due to the easy road access in these areas. The habitat is usually in desert sink on sandy hummocks within this habitat. A few of the known locations where checked and *O. nevadensis* was found in two of the five locations visited in 2017.

Plants were not fully documented just noted that they were present at certain locations.

Michael H. Nee 2017. Oryctes nevadensis, in Jepson Flora Project (eds.) Jepson eFlora, http://ucjeps.berkeley.edu/cgi-bin/get_IJM.pl?tid=35530, accessed on November 01, 2017.

Inyo Phacelia (Phacelia inyoensis)

P. inyoensis is endemic to Inyo and Mono Counties of California. There are records from the Owens Valley from Olancha to Laws, and southern Mono County. This is an annual herb, 3-10 cm tall and wide, stems decumbent to erect, branching at base with short stiff glandular hairs. Leaves are elliptic to obovate, 0.5-2 cm, margin entire to lobed. Flowers are on flowering stems, narrow bell-shaped 2-6 mm, pale-yellow. Fruit oblong capsule, 3-4 mm across with 18-25 small furrowed seed.

This species has been documented in the Owens Valley since the early 20th Century through the present. The habitat is usually in alkali meadows or desert sink meadows usually at the edges of or in depressions within the habitat. In 2017 *P. inyoensis* was documented as present at six *Calachortus* rare plant locations, along with two other *P. inyoensis* locations for a total of eight locations.

When found at *Calachortus* locations they are associated species, documented as present and the phenology is noted. For the two other *Phacelia* exclusive locations, plants were not fully documented just noted that they were present at these locations. For all locations the populations appear to be stable.

Genevieve K. Walden, Robert Patterson, Laura M. Garrison & Debra R. Hansen 2017. Phacelia inyoensis, Revision 1, in Jepson Flora Project (eds.) Jepson eFlora, http://ucjeps.berkeley.edu/cgi-bin/get_IJM.pl?tid=37496, accessed on November 01, 2017.

Parish's Popcorn Flower (*Plagiobothrys parishii*)

P. parishii is endemic to Inyo, Mono, Los Angeles and San Bernardino Counties of California. There are records from the Owens Valley from Olancha to Bishop, S Mono County, NE Los Angeles County, and C & SW San Bernardino County. This is an annual herb, 5-30 cm, stems prostrate ascending at ends, branching at base with short spreading hairs. Leaves linear to narrow lance-like, 1-5 cm, surface with hairs that have blisters at base. Flowers are on slender flowering stems, cup-shaped 3-7mm, 5 white petals with yellow base. Fruit nutlet, ovate, 0.8-1.4mm with a rib and ridges. This species has been documented in the Owens Valley since the early 20th Century through the present. The habitat is moist alkali meadows to mudflats around seasonal ponds. In 2017 *P. parishii* was noted in known locations from Lone Pine to Independence mostly east of the LA Aqueduct, as well as extensive stands the Blackrock Waterfowl Management Area. In 2017 the populations were not fully documented, just noted that they were present at these locations.

When found at other rare plant locations they are associated species, document as present and the phenology is noted. For all locations the populations appear to be stable.

Ronald B. Kelley 2017. Plagiobothrys parishii, in Jepson Flora Project (eds.) Jepson eFlora, http://ucjeps.berkeley.edu/cgi-bin/get_IJM.pl?tid=38518, accessed on November 02, 2017.

Silverleaf Milkvetch (Astragalus argophyllus var. argophyllus)

Astragalus argophyllus var. *argophyllus* is endemic to Inyo, Mono, and San Bernardino Counties of California. There are records from the N Owens Valley of Inyo County, S Mono County, and SC San Bernardino County. This is a perennial herb from an underground crown, to 15 cm, stems prostrate to matted with numerous silvery-grey soft hairs. Leaves pinnate compound, 2-15 cm, surface with silvery-grey soft hairs, leaflets elliptic to ovate, 9-21mm l x 4-15mm w, tips acute or obtuse. Inflorescence of 1-4 flowers ascending, flowers bright pink-purple, banner 22-24mm, keel 17-20mm. Fruit 15-25mm long and 7-12mm wide, lanceolate, straight to curved, surface with dense stringy hairs, fleshy when young maturing to stiff and leathery. This species has been documented in the Owens Valley since 1955 through the present. The habitat is alkali meadows. In 2017 *A. argophyllus* var. *argophyllus* was documented S of Laws at a rare plant site also annually checked for *Calochortus excavatus* and *Sidalcea covillei*, and has been documented here since 1993.

When found it is listed as an associated species, document as present and the phenology is noted. For this location the population appears to be stable.

Martin F. Wojciechowski & Richard Spellenberg 2017. Astragalus argophyllus var. argophyllus, in Jepson Flora Project (eds.) Jepson eFlora, http://ucjeps.berkeley.edu/cgi-bin/get_IJM.pl?tid=54626, accessed on November 02, 2017.

Hall's Meadow Hawksbeard (*Crepis runcinata* ssp. *hallii*)

C. runcinata ssp. *hallii* is endemic to Inyo, Mono, and Alpine Counties of California. There are records from the Owens Valley and Shoshone of Inyo County, Mono County, and C Alpine County. This is a perennial herb from a taproot, to 20-60 cm. Leaves oblanceolate to narrow obovate, 10-15cm l x 1.5-3cm w, green, margin toothed to lobed. Inflorescence of 1 to many heads on an erect branched stalk, flowers all ligulate, bright yellow with 5 small pointed teeth at end of each petal. Fruit a tapered achene with a feathery pappus attached. This species has been documented in the Owens Valley since the early 20th Century through the present. Inyo County Water Department has documented this species at 27 rare plant sites since 1993 and 13 vegetation parcels from the Owens Valley Vegetation Conditions (OVVC) surveys since 2000. The habitat is alkali meadows.

In 2017 *C. runcinata* ssp. *hallii* was documented at 12 rare plant sites surveyed in 2017. When found it is listed as an associated species, document as present and the phenology is noted. The OVVC surveys are conducted during the summer months (June-August) and the *C. runcinata* ssp. *hallii* were documented at four vegetation parcels in 2017 and they are listed in the cover data. The plants are often overgrown with taller species and are beginning to senesce by midsummer, so they can be difficult to find among the tall grasses of summer. For all locations the populations appear to be stable.

David Bogler 2017. Crepis runcinata subsp. hallii, in Jepson Flora Project (eds.) Jepson eFlora, http://ucjeps.berkeley.edu/cgi-bin/get_IJM.pl?tid=5977, accessed on November 02, 2017.

White Flowered Rabbitbrush (*Ericameria albida*)

E. albida is endemic to Inyo, Mono, and San Bernardino Counties of California. There are records from the Owens Valley, Saline Valley, N Death Valley, Amargosa Valley and Shoshone of Inyo County, S Mono County, and SW & NW San Bernardino County. This is a woody shrub, 30-150 cm, stems glabrous. Leaves linear, 2-3.5cm l, dark green, glabrous, gland dotted. Inflorescence heads in cyme-like clusters on an erect branched stalk, 5-7 disk flowers, 5-8mm, white. Fruit cylindrical to ellipsoid achene with a feathery white pappus attached. This species has been documented in the Owens Valley since 1974 through the present. Inyo County Water Department has documented this species at 24 locations mostly from Owens Valley Vegetation Conditions (OVVC) surveys. The habitat is alkali meadows.

In 2017 *E. albida* was documented during OVVC surveys which are conducted during the summer months (June-August) and *E. albida* was documented in 4 vegetation parcels in 2017 and they are listed in the cover data. The plants are easy to spot among the other vegetation because of the unique appearance of the shrubs. For all locations the populations appear to be stable.

Lowell E. Urbatsch 2017. Ericameria albida, in Jepson Flora Project (eds.) Jepson eFlora, http://ucjeps.berkeley.edu/cgi-bin/get_IJM.pl?tid=81725, accessed on November 02, 2017.

Torrey's Blazing Star (*Mentzelia torreyi*)

M. torreyi is endemic to Inyo and Mono Counties of California. There are records from the Owens Valley and S White Mts of Inyo County, and Mono County. This is a perennial herb from a belowground caudex, to 10-20 cm, stems erect to decumbent, hairy. Leaves broad ovate, 2-4cm, green, deeply pinnate-lobed with 0-7 lobes, margin rolled under. Inflorescence cluster of few flowers with 2-lobed bracts, flowers bright yellow to orange-yellow, 5 petals many protruding stamens. Fruit an urn-shaped capsule with persistent sepals on end with many fusiform spiral 3-ribbed seed.
This species has been documented in the Owens Valley since 1941 through the present. Inyo County Water Department has documented this species at 9 vegetation parcels from the Owens Valley Vegetation Conditions (OVVC) surveys since 1994. The habitat is desert sink often in bottoms of small playas. In 2017 *M. torreyi* was not documented during the OVVC surveys in 2017. In 2017 it was found during avian surveys, wetted extent surveys and the Rapid Assessment Survey in the southern Winterton unit and northern Drew Slough unit of the Blackrock Waterfowl Management Area. For all locations the populations appear to be stable.

Joshua M. Brokaw, John J. Schenk & Barry Prigge 2017. Mentzelia torreyi, in Jepson Flora Project (eds.) Jepson eFlora, http://ucjeps.berkeley.edu/cgi-bin/get_IJM.pl?tid=33291, accessed on November 02, 2017.

Frog's-bit Buttercup (Ranunculus hydrocharoides)

R. hydrocharoides is endemic to Inyo, Mono and Los Angeles Counties of California. There are records from the Owens Valley of Inyo County, Mono County, and WC Los Angeles County. This is a perennial herb growing as a wetland emergent, to 5-25 cm, stems erect to prostrate, rooting at nodes. Leaves ovate to broad ovate, 0.8-2.7cm l x 0.8-1.9cm w, base round to cordate, green, margin entire to dentate. Flowers solitary on stalks, 1cm across, 5-6 petals yellow. Fruit a lenticular achene, 1-1.4mm. This species has been documented in the Owens Valley since 1941 through the present. Inyo County Water Department has documented this species at two rare plant locations. The habitat is in creeks and ditches in slow moving water.

In 2017 *R. hydrocharoides* was not documented during rare plant surveys. It has only been found in two rare plant locations near Independence and Bishop. At the Bishop location, plants were found most years from 1995-2015, and at the Independence location, plants have only been found in 2011. The populations are susceptible to over grazing in the ditches they grow in and may not grow much during years with heavy grazing events.

Alan T. Whittemore 2017. Ranunculus hydrocharoides, in Jepson Flora Project (eds.) Jepson eFlora, http://ucjeps.berkeley.edu/cgi-bin/get_IJM.pl?tid=40909, accessed on November 02, 2017.

Alkali Cordgrass (S. gracilis)

S. gracilis is endemic to Inyo, Mono, Modoc and Siskiyou Counties of California. There are records from the Owens Valley, Little Lake & Deep Springs Valley of Inyo County, Mono County, E Modoc County and C Siskiyou County. This is a perennial grass, to 18-100cm tall, stems solitary, erect, emerging from a rhizome, rooting at nodes. Leaves linear, 15-27cm l x 2.6-6mm w, green, often inrolled when young, upper surface with ridges. Inflorescence 2-12 on single stalk, 4-25cm l x 5-12mm w, compact, spikelet 6-11mm. Fruit a small grain.
This species has been documented in the Owens Valley since 1911 through the present. Inyo County Water Department has documented this species at 16 rare plant locations since 1996. It has been documented in the Owens Valley Vegetation Conditions (OVVC) surveys since the baseline years of the 1980's, and there are 62 documented locations from Manzanar to Fish Slough. There are two locations that have been extirpated since the baseline years due to expansion of gravel mine operations. The habitat is alkali meadows.

In 2017 *S. gracilis* was documented during rare plant surveys at 6 locations, and it is documented as an associate species and its presents is noted and the phenology. In 2017 *S. gracilis* was documented in six locations during OVVC surveys, and it is documented as vegetation cover. The populations appear to be stable.

Alan T. Whittemore 2017. Ranunculus hydrocharoides, in Jepson Flora Project (eds.) Jepson eFlora, http://ucjeps.berkeley.edu/cgi-bin/get_IJM.pl?tid=40909, accessed on November 02, 2017.

The Water Agreement requires that irrigation continue on certain lands identified on 1984-87 baseline vegetation maps.

The Inyo County Water Department prepared this preliminary evaluation of conditions on irrigated lands.

SECTION 8: EVALUATION AND MONITORING OF TYPE E IRRIGATED LANDS

Introduction

The Inyo/Los Angeles Long-Term Water Agreement (Agreement) requires that water deliveries to Los Angeles-owned lands for irrigation, habitat, and recreation continue. Maintaining water use on these lands provides economic opportunities for ranching and farming in addition to enhancing recreation, aesthetics, air quality, and habitat for wildlife. Locations of irrigated lands generally referred to as Type E vegetation were shown on the baseline maps attached to the Agreement. Irrigated lands receive pumped groundwater, surface water or comingled pumped and surface water diverted from the Los Angeles Aqueduct system and usually receive their full allotment unless agreed to by Inyo County.

As part of the project to build the second Los Angeles aqueduct, irrigated acreage in the Owens Valley was reduced from 21,800 acres to 11,600 acres in the 1960's, and in exchange, the irrigated ranch leases were modified to provide a firm allocation of five acre-feet/acre. The reduction in irrigated acreage was identified as a potentially significant impact in the 1991 Environmental Impact Report (EIR) for the Agreement, but the report concluded that no mitigation was required due to the firm allocation of water (1991 EIR, pages 4-14 to 4-18). Protections for irrigated lands are based on vegetation conditions and land uses that existed in 1981-82. That year was selected because Los Angeles Department of Water and Power (LADWP) lessees received approximately normal allotments of irrigation water even though runoff was slightly below normal. The years 1982-1986 had above normal runoff and were immediately followed by a severe drought from 1987-92; water management in these years during the Agreement negotiations was not considered typical or suitable for future comparisons. The Agreement and EIR also require that Enhancement/Mitigation (E/M) and environmental projects begun since 1981-82 and irrigated lands in Olancha/Cartago will continue to be supplied with water (some E/M projects were allotted three acre-ft/acre).

Vegetation cover and composition data collected during the baseline mapping was used to divide the Owens Valley vegetation into five management Types to implement the Agreement's vegetation and irrigation provisions.

Types A through D grouped plant communities based on their dependence on groundwater to indicate their relative susceptibility to the effects of groundwater pumping. Irrigated lands were mapped from 1984-87 and identified on the baseline vegetation map for the Agreement as Type E. Since the adoption of the Agreement, Inyo and Los Angeles have formally agreed to modify the land use and baseline map for one ranch lease near Laws, but the remainder of the baseline map is officially unchanged. Presently, the baseline map does not depict several changes to land management or the implementation of mitigation projects; Olancha/Cartago irrigated lands were never depicted on the baseline map and have no agreed upon baseline cover data.

Type E lands are defined in the Agreement (Section II.E, p. 9) as:

> *Type E Classification*
> *This classification is comprised of areas where water is provided to City-owned lands for alfalfa production, pasture, recreation uses, wildlife habitats, livestock, and enhancement/mitigation projects. This classification is shown as blue on the management maps and includes approximately 18,830 acres.*

Figure 8.1 shows the location of Type E lands in Owens Valley (http://www.inyowater.org/wp-content/uploads/2018/08/2018-Annual-Report-ICWD-Type-E-Fig-8_1a.jpg, and http://www.inyowater.org/wp-content/uploads/2018/08/2018-Annual-Report-ICWD-Type-E-Fig-8_1b.jpg). Type E parcels span a wide range of vegetation classes including irrigated agriculture, lakes, ponds, meadows and woodlands (Table 8.1). Eleven individual Mojave Riparian Forest and Tamarisk scrub parcels usually considered Type D riparian vegetation were mapped as Type E as well. Refinements in measuring acreages since the Agreement was written allow a more precise estimate of 18,017 acres of Type E land.

Although the Agreement requires that water delivery to Type E lands be continued, it also recognized that during successive dry years, there may be insufficient water to meet all needs. In these circumstances, Los Angeles and Inyo County may agree to reduce irrigation or water supplied to enhancement/ mitigation projects. Such reductions can only take place with the concurrence of the Inyo County Board of Supervisors (Agreement, IV.A, page 17):

> *The Department shall continue to provide water for Los Angeles-owned lands in Inyo County in an amount sufficient that the water related uses of such lands that were made during the 1981-82 runoff year can continue to be made. The Department shall continue to provide water to Los Angeles-owned lands in the Olancha/Cartago area such that the lands that have received water in the past will continue to receive water. Additionally, the Department shall provide water to any enhancement/mitigation projects added since 1981-1982, unless the Inyo County Board of Supervisors and the Department agree to reduce or eliminate such water supply.*
>
> *It is recognized that successive dry years could result in insufficient water to meet all needs. During periods of dry year water shortages, the Technical Group will evaluate existing conditions. A program providing for reasonable reductions in irrigation water supply for Los Angeles-owned lands in the Owens Valley and for enhancement/mitigation projects may be implemented if such a program is*

Table 8.1. Holland Classes for Type E parcels denoted in digital map layer "all veg quads".

Holland Class	Name	Green Book Type
11000	Irrigated Agriculture	E
13100	Permanent Lakes/Reservoirs	E
13200	Intermittent Ponds	E
45330	Rush/Sedge Meadow	E
45500	Non-native Meadow	E
76100	Black Locust Woodland	E
61700	Mojave Riparian Forest	D †
63810	Tamarisk Scrub	D

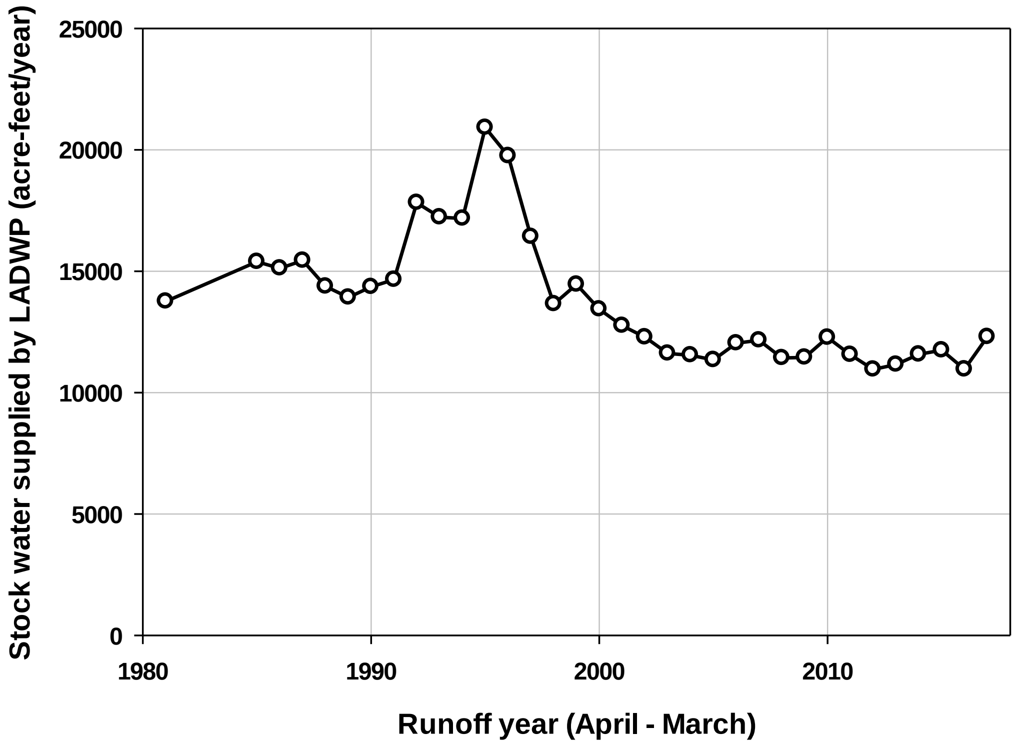
† Holland Class is designated type D but eleven parcels in these classes were designated as E because of LORP E/M project (61700) or are located in spreading basins (63810).

approved by the Inyo County Board of Supervisors and the Department, acting through the Standing Committee.

The dry year provisions and modifications of the ranch leases have influenced the historical supply of water to some Type E lands. Figure 8.2 shows trends in irrigation supply and stockwater supply over time (LADWP 2017 Annual Owens Valley Report). Annual irrigation has generally been in the 40,000 – 60,000 acre-feet per year range since the baseline year of 1981. Irrigation and stockwater varies with drought, but stockwater has declined since its peak in the mid-1990's. Because the Water Agreement requirements for Type E lands are based on vegetation conditions and maintaining water-related uses, the valley-wide water supply volumes may not directly indicate a violation; however, the steady decline in stockwater probably affects vegetation and water-related uses. Irrigation for 2016-2017 was 39,598 acre-feet. A regular program to monitor and assess vegetation conditions on Type E lands would provide a readily available dataset to assist the Technical Group complete its required evaluation of existing conditions when considering a program to reduce irrigation or to identify which lands will be unavoidably affected by low creek flow during droughts.

The Agreement sets several goals for managing Type E vegetation: 1) significant decreases or changes from the conditions that existed in runoff-year 1981-1982 should be avoided, 2) Los Angeles will provide water such that the water-related uses that were present in 1981-1982 can continue, and 3) recreation use and habitat dependent on water supplied by LADWP should not decrease (Agreement, pp. 16-18):

> *Type E Vegetation Classification. (Lands supplied with water.) These lands will be supplied with water and will be managed to avoid causing significant decreases and changes in vegetation from vegetation conditions which existed on such lands during the 1981-82 runoff year. Significant decreases and changes in vegetation will be determined as set forth in the management goals for Type B, C, and D vegetation; however, conversion of cultivated land be the Department or its lessee to other irrigated uses shall not be considered a significant decrease or change.*



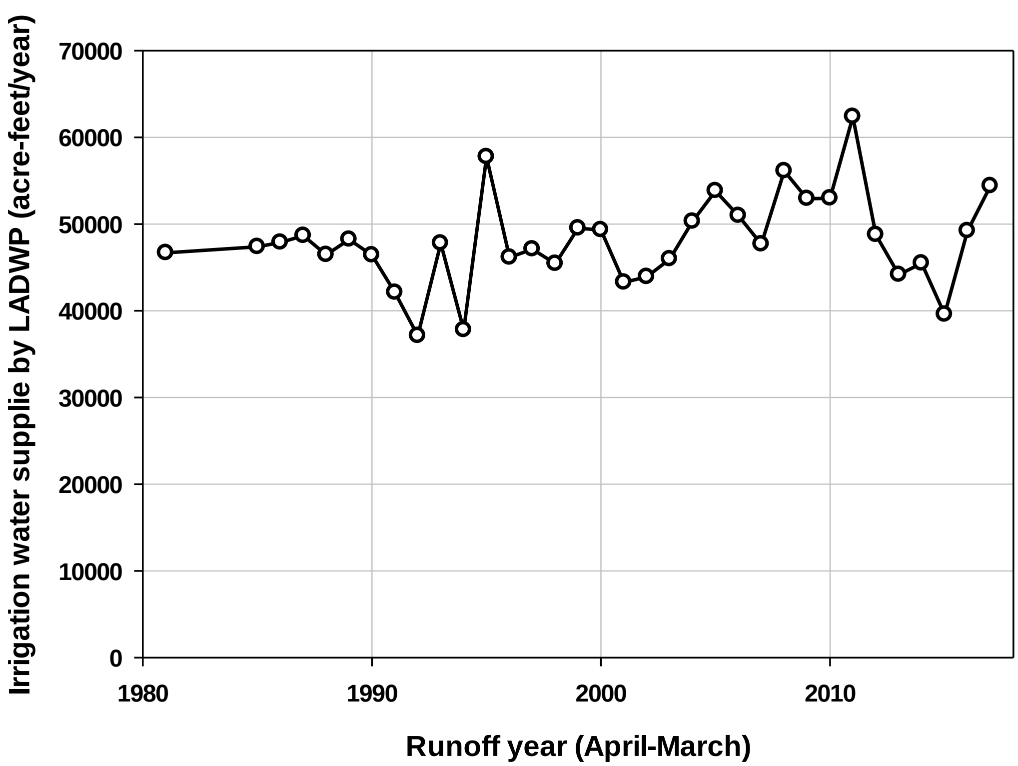


Figure 8.2. Trends in stockwater and irrigation deliveries in the Owens Valley 1981-2018.

> *Another primary goal is to avoid significant decreases in recreational uses and wildlife habitats that in the past have been dependent on water supplied by the Department.*

Evaluating whether the stated goals for Type E lands are being met is complicated by the discrepancy between the stated goal of maintaining uses and vegetation cover that existed in 1981-82 and the lack of quantitative data for that year. Vegetation cover and composition data were collected on some Type E lands during the 1984-87 baseline mapping. Where the baseline data were insufficient, a subsequent inventory was completed in 1998-99 (RCI, 1999) to comply with a provision in the 1997 Memorandum of Understanding that settled litigation over the adequacy of the 1991 EIR. The RCI survey focused on irrigated pastures with predominately native species for which no data were collected during the 1984-87 baseline mapping. Cultivated fields, miscellaneous Type E lands (e.g. spreading basins) and a few irrigated pastures were not surveyed. The results of the RCI survey were adopted as the baseline by the Inyo/Los Angeles Standing Committee on February 23, 2000 to supplement data collected in 1984-87.

The Inyo/Los Angeles Technical Group does not have a joint program for monitoring Type E land. Inyo County has traditionally relied on LADWP pasture monitoring data, LADWP water use reports and surface water gauging data, and reports from leasees to gauge Type E compliance. LADWP has instituted pasture scoring, utilization, and range trend monitoring programs in compliance with provisions of the Owens Valley Land Management Plan (LADWP, 2010), but data collected by those LADWP programs are not easily comparable to the cover and composition goals adopted as part of the Agreement. The inherent difficulties in developing a monitoring program without clear information on vegetation and uses in 1981 were described above, but another obstacle is the large number of Type E parcels (358) and diverse land use types in the group. Describing or assessing compliance for Type E lands quickly becomes unwieldy because of the variety of land use and land management requirements for parcels comprising the Type E. For instance, decisions whether to reduce irrigation water supply have very different implications for lands supplied solely from surface water sources compared with lands that have a secure groundwater supply or those which actually don’t require water diversions from either source (e.g. springs or subirrigated vegetation). Given the large acreage and number of locations (more than 200 pasture parcels alone), it is desirable to utilize aerial photo or satellite imagery to focus monitoring efforts to measure cover and composition to lands where questions about compliance are evident.

The purposes of this analysis were to assess the land use and irrigation status of Type E lands periodically since the Agreement was approved and to compare vegetation conditions in 2016 with baseline using remote sensing data. Based on these results, recommendations for additional on the ground monitoring and analyses to track compliance with the Agreement provisions were developed.

Methods

Because the ultimate purpose of this analysis was to assess the status of irrigation, the Type E parcels were divided into coherent groups with similar characteristics and land management. The overall approach employed for this analysis was to distinguish Type E lands supplied with water from other land uses, and then determine the irrigation status of lands

Table 8.2. Digital aerial imagery examined by this report and Owens Valley runoff for the years evaluated. All imagery was collected during the growing season.

Aerial imagery and Source	Year	Owens Valley Runoff % Normal
Natural color orthophotos digitized from prints obtained by LADWP	1981	85
Natural color orthophotos digitized from prints obtained by LADWP	1990	52
Natural color digital aerial photographs obtained by LADWP	2000	85
National Agriculture Imagery Program, USDA Farm Service Agency	2005	137
National Agriculture Imagery Program, USDA Farm Service Agency	2009	78
National Agriculture Imagery Program, USDA Farm Service Agency	2010	104
National Agriculture Imagery Program, USDA Farm Service Agency	2012	58
National Agriculture Imagery Program, USDA Farm Service Agency	2014	53
National Agriculture Imagery Program, USDA Farm Service Agency	2016	79

supplied with water over time by visually interpreting a set of aerial images to compare with conditions in 1981. In addition, remote sensing data of most flood irrigated parcels were then examined to compare measures related to vegetation conditions in the summer 2016 with those collected in the baseline year.

Aerial Photo Interpretation

Aerial photographs for eight years from a variety of sources were evaluated (Table 8.2). Images for 1981, 1990, and 2000 were digital versions of color air photos acquired by LADWP and provided (as prints or digitally) to the ICWD. Images for 2005, 2009, 2010, 2012, 2014, and 2016 were obtained from the National Agriculture Imagery Program (NAIP). A link to the NAIP program and specifics of the data acquisition are available at the NAIP website (https://www.fsa.usda.gov/programs-and-services/aerial-photography/imagery-programs/naip-imagery/index). Most of the images in this analysis represent years since 2005 in part due to availability of the aerial imagery, but also because the irrigation management in recent years is more relevant to describing the status of irrigated parcels for assessing compliance with the Agreement or to identify where more detailed monitoring is needed. Of the years examined, runoff was less than in 1981 for five years and greater than 1981 in three years (Table 8.2). In all but the most extreme dry years, irrigated leases should receive full allotments except where limited by low creek flow. Owens Valley runoff was less than 60% of normal for three years evaluated here, 1990, 2012, and 2014, and incomplete irrigation due to low creek flow probably occurred in these years.

The list of Type E parcels for evaluation was extracted from a digitized version of the 1984-87 baseline map and the vegetation map summaries used to assign vegetation Types (described in the Green Book, 1990, Chapter II). The digital version of the baseline map is referred to internally as “all veg quads” and is based on the original digitized AutoCad drawings provided to the Water Department by LADWP. The original baseline map naming convention of dividing similar vegetation types or pastures along U.S. Geological Survey quadrangle boundaries was retained in “all veg quads”. Two subsequent digital versions of the baseline map were also consulted. The “all veg parcels” version was prepared by the Water Department to combine adjacent parcels split by USGS quad boundaries. LADWP provided the County with a re-digitized version of the baseline map in 2011. In that version, the parcel list and names conforms with “all veg quads” except for a few instances where parcels were combined; additionally, the parcel boundary locations differ slightly. In this analysis, parcels split along quadrangle boundaries usually were evaluated as a single entity and listed with both parcel names in the tables below.

The original baseline mapping was completed in 1984-87 using prints of 1981 air photos (scale 1:12000) with acetate overlays as the mapping base (Green Book, pp. 36-39). The initial baseline map delineations were transferred from acetate to orthophoto quadrangles (scale 1:24,000). Conventional air photos contain image displacements caused by camera tilt, lens distortion, and topography (Paine 1981), and maps or measurements made from them will deviate from actual boundary locations or distances on the earth’s surface. The methods to account for image displacements and the change in scale in the transfer of the acetate maps to orthophoto quadrangles were not described in the Green Book. Because of the line transfers, changes in scale, manual rectification, and digitizing, the parcel boundaries on the baseline map often align imperfectly with recognizable field or pasture boundaries. In addition, lease or land management changes to irrigate or remove lands from production that occurred between 1981 and the time of the baseline mapping were sometimes represented on the baseline map. Similarly, changes to field alignment or irrigation methods have occurred after the Agreement was adopted (e.g. installation of center pivot sprinklers). For parcels where the actual field and baseline map boundaries do not coincide, the decision was made to interpret conditions within the visible field or pasture on the image. Instances where this mismatch conflicted with the baseline map parcel names are discussed below.

Air photo interpretation of land use, while subjective and qualitative, can be informative. The 1981 image was interpreted by two observers separately. The 1990, 2000, 2005, 2010, 2014, and 2016 images were examined by two observers sequentially, and the 2009 and 2012 images were examined by one observer after the process for assigning the interpretations to the parcels was prepared.

Type E vegetation is comprised mostly of irrigated lands, but also includes parcels with other land uses that prevents generalizing or making meaningful conclusions about the group as a whole. To address this problem, Type E was subdivided based on land use or land type to focus this assessment on the status of lands routinely supplied with water for pasture or cultivated agriculture. Each Type E parcel was assigned to a land use type, e.g. surface water bodies, cultivated land, or flood irrigated pasture. Some land use types do not require further photo interpretation to assess compliance with the Water Agreement, such as lakes mapped as Type E land.

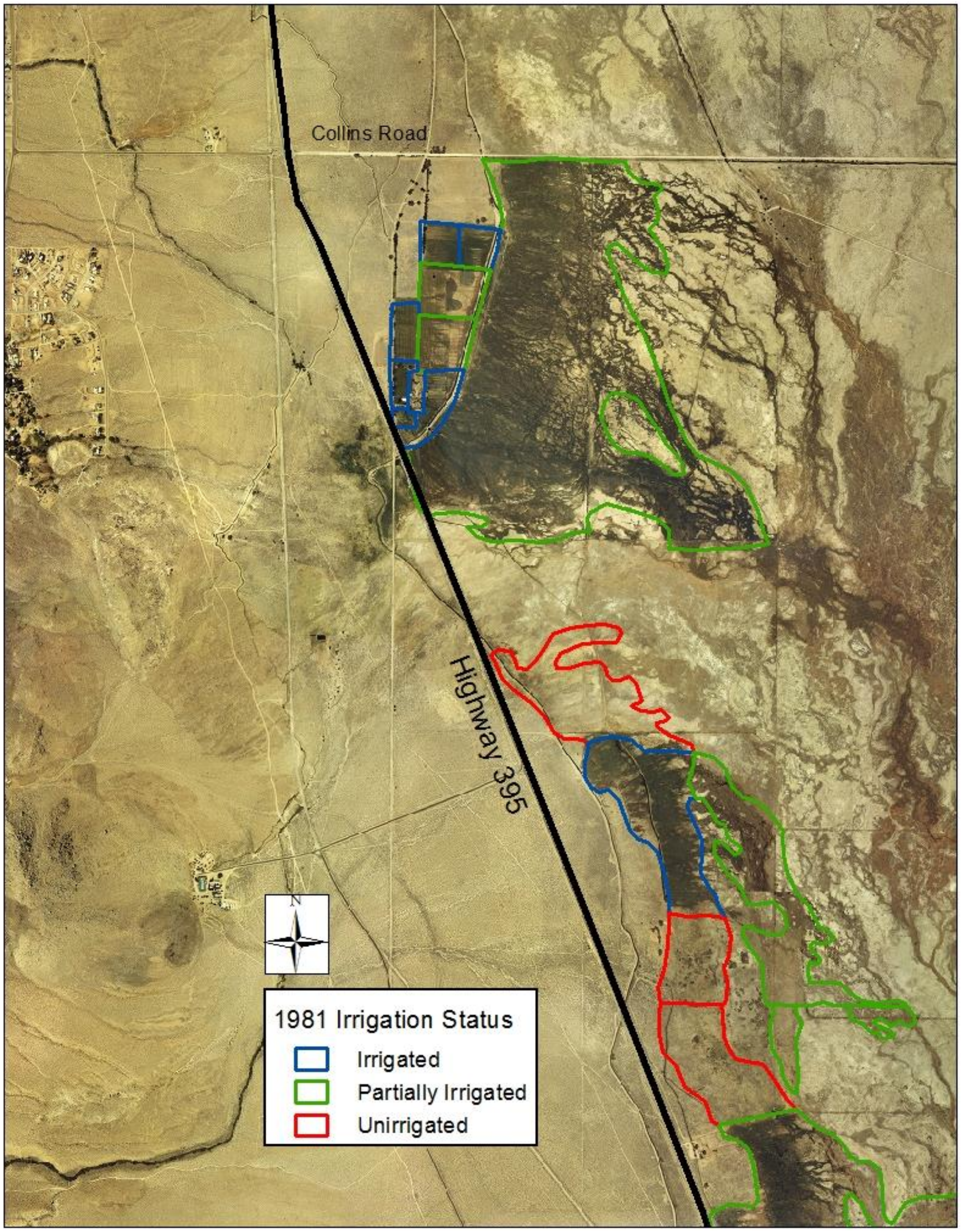


Figure 8.3. Example of irrigation status assigned to parcels based on interpretation of the 1981 photograph. Only boundaries of Type E vegetation are shown. Maps of the entire valley are at http://www.inyowater.org/wp-content/uploads/2018/08/2018-Annual-Report-ICWD-Type-E-Fig-8_3a.jpg and http://www.inyowater.org/wp-content/uploads/2018/08/2018-Annual-Report-ICWD-Type-E-Fig-8_3b.jpg

The condition of each flood irrigated parcel was further interpreted from photos as: irrigated, partially irrigated, or unirrigated primarily based on the relative green-ness of the parcel compared with surrounding vegetation in the image and the extent of irrigation within the parcel boundary (Figure 8.3). Care was taken to account for differences in hue, saturation, and brightness of the various images; parcels were evaluated within each image and not interpreted based on their appearance relative to images taken in other years. The partially irrigated condition does not necessarily mean reduced irrigation relative to 1981, only that irrigation does not appear to completely cover the parcel. Parcels can appear partially irrigated if natural topography prevents flood irrigation from completely irrigating the parcel.

The purpose for interpreting historic air photos was to determine where irrigation history appeared similar to 1981 from lands where the history has differed. The condition of each irrigated parcel varies over time for reasons such as runoff variability or operational decisions by LADWP or the lessee, which do not necessarily signal that a violation of the Agreement has occurred. The advantage of summarizing multiple years of information was to avoid identifying normal year to year variation as non-compliance with Agreement requirements; the challenge was distinguishing the range of acceptable variation from deficient irrigation. Interpreting the irrigation condition in any single year was relatively straightforward, but summarizing the history of multiple years to compare with conditions in 1981 was accomplished by classifying parcels based on the frequency and extent of irrigation through time. Criteria for classifying each parcel's history were developed and tested with the goal of producing coherent groups of parcels having similar irrigation history. An outline of the step-wise process employed for this analysis is described in more detail below.

1) Classification
   a) Segregate parcels for which no future land use, vegetation, or water supply monitoring is required, e.g. lakes or temporary ponds.
   b) Segregate Type E parcels with overlying E/M, mitigation, or environmental projects for habitat or recreation purposes. Projects to establish irrigated pastures were treated as other irrigated lands.
   c) Segregate Laws Ranch parcels for assessment according to the 2003 Mitigated Negative Declaration.
   d) Segregate cultivated and sprinkler irrigated fields.
   e) Segregate Type E subirrigated parcels, i.e. parcels with no obvious surface water delivery infrastructure.
2) On the remaining set of Type E flood irrigated parcels:
   a) Interpret whether each parcel in 1981 and in each subsequent year was irrigated, partially irrigated, or unirrigated based on appearance in the image.
   b) For each parcel after 1981, sum the number of years (n=8) identified as irrigated, partially irrigated, or unirrigated.
      i) Classify the parcels to summarize the irrigation history of the parcel (see discussion below)
         (1) Group parcels that were irrigated, partially irrigated, or unirrigated for all eight years into three main categories.

   (2) Group parcels with equal numbers of irrigated/partially irrigated years or partially irrigated/unirrigated years into two intermediate categories.
   (3) Group parcels that exhibit irrigation history ranging between fully irrigated and unirrigated conditions.
   (4) Refine criteria, and classify remaining parcels into one of the main or intermediate categories.

c) Compare the 1990-2016 irrigation history classification for each parcel with the air photo interpretation of the parcel in 1981.
   (1) Flag parcels with an irrigation history that suggests reduced water related uses since 1981 (i.e. in a drier category).

d) Assess whether the irrigation extent within each parcel has been consistent or variable over time.

The final classification for each parcel is summarized in Table 8.3.

Given that three years in this dataset had runoff less than 60% of normal (Table 8.1), it would not be unusual that some parcels experienced lower water deliveries three times solely due to runoff variation. For example, a normally fully irrigated parcel may have been partially irrigated in three years of the air photo dataset simply due to runoff variability without signifying a departure from typical land use or management. This suggests that those parcels with five or more irrigated or partially-irrigated years could be included in the Irrigated or Partially Irrigated categories and still represent the central concept of the group. Because the purpose of this exercise was to select parcels for additional scrutiny, a slightly more stringent criteria was adopted. The three main categories were comprised of parcels that had six or more years with the same irrigated condition. Parcels that had 3, 4, or 5 years with the same irrigated condition were placed in the intermediate categories. Placing these parcels in an intermediate (i.e. less irrigated) category should allow more parcels to be flagged for additional monitoring (see below). Setting the threshold criteria for the main categories at six years also retained meaningful interpretations for the Unirrigated group. For these infrequently irrigated parcels, more than five unirrigated years signifies that in at least one year the parcel wasn't provided water when availability was not limited by low runoff.

The final step was to compare the irrigation history of each parcel with the 1981 baseline status. If the irrigation history was in a "less irrigated" category than was evident in 1981, the parcel was flagged for further examination or identified as a candidate for field monitoring. For example, if the parcel was fully irrigated in 1981, but only partially irrigated most years since then, the parcel was flagged. Exceptions were made for a few parcels that were part of irrigation projects implemented in the 2000's (e.g. Laws) or for parcels where irrigation has been consistent with the 1981 interpretation each year since 2005 (a period that includes severe drought). These exceptions were included to account for the lag time to implement projects or for the lessee to improve the extent of irrigation over time on a new project. For parcels in the Irrigated-Unirrigated category, further evaluation was assigned if the number of unirrigated years was three or more or if the most common irrigation status was drier than 1981. All parcels in the Unirrigated category were flagged for further evaluation.

Table 8.3. Type E flood irrigated parcels summarized by irrigation history interpreted using aerial photo images for eight years between 1990-2016.

Parcel	Holland Class	1981 Status	Irrigated	Partially Irrigated	Unirrig.	1990-2016 Summary	Coverage over time	Further evaluation
			Years	Years	Years			
BIS043	45330	Partially irrigated	8	0	0	Irrigated	consistent	NO
BIS081	11000	Irrigated	8	0	0	Irrigated	consistent	NO
BIS105	11000	Irrigated	8	0	0	Irrigated	consistent	NO
BIS106	11000	Irrigated	8	0	0	Irrigated	consistent	NO
BIS107	11000	Irrigated	8	0	0	Irrigated	consistent	NO
BIS111	11000	Irrigated	8	0	0	Irrigated	consistent	NO
BIS113	11000	Irrigated	8	0	0	Irrigated	consistent	NO
BIS141	11000	Irrigated	8	0	0	Irrigated	consistent	NO
BIS142	11000	Irrigated	8	0	0	Irrigated	consistent	NO
FSL103	11000	Irrigated	8	0	0	Irrigated	consistent	NO
FSL149	11000	Irrigated	8	0	0	Irrigated	consistent	NO
LNP013	11000	Unirrigated	8	0	0	Irrigated	consistent	NO
PLC079	11000	Irrigated	8	0	0	Irrigated	consistent	NO
PLC152	11000	Partially irrigated	8	0	0	Irrigated	consistent	NO
PLC153	11000	Irrigated	8	0	0	Irrigated	consistent	NO
PLC154	11000	Irrigated	8	0	0	Irrigated	consistent	NO
PLC155	11000	Irrigated	8	0	0	Irrigated	consistent	NO
PLC156	11000	Irrigated	8	0	0	Irrigated	consistent	NO
PLC171	11000	Irrigated	8	0	0	Irrigated	consistent	NO
IND188east (IND219)	11000	Partially irrigated	8	0	0	Irrigated	consistent	NO
UNW044	11000	Irrigated	8	0	0	Irrigated	consistent	NO
BGP100	11000	Irrigated	7	1	0	Irrigated	consistent	NO
BGP103	11000	Irrigated	7	1	0	Irrigated	consistent	NO
BGP106	11000	Irrigated	7	1	0	Irrigated	consistent	NO

Parcel	Holland Class	1981 Status	Irrigated	Partially Irrigated	Unirrig.	1990-2016 Summary	Coverage over time	Further evaluation
BGP186	11000	Irrigated	7	1	0	Irrigated	consistent	NO
BIS025/FSL157	45500	Irrigated	7	1	0	Irrigated	consistent	NO
BIS027	11000	Irrigated	7	1	0	Irrigated	consistent	NO
BIS104	11000	Irrigated	7	1	0	Irrigated	consistent	NO
BIS122	11000	Irrigated	7	1	0	Irrigated	consistent	NO
BIS143	11000	Irrigated	7	1	0	Irrigated	consistent	NO
FSL104	11000	Irrigated	7	1	0	Irrigated	consistent	NO
FSL150	11000	Irrigated	7	1	0	Irrigated	consistent	NO
FSL151	11000	Irrigated	7	1	0	Irrigated	consistent	NO
FSL153/BIS031	11000	Irrigated	7	1	0	Irrigated	consistent	NO
BIS026/FSL156	11000	Irrigated	7	1	0	Irrigated	consistent	NO
FSL160	11000	Irrigated	7	1	0	Irrigated	consistent	NO
IND189 (flooded portion)	11000	Partially irrigated	7	1	0	Irrigated	consistent	NO
IND191	11000	Irrigated	7	1	0	Irrigated	consistent	NO
LNP035	11000	Unirrigated	7	1	0	Irrigated	consistent	NO
LNP055	11000	Irrigated	7	1	0	Irrigated	consistent	NO
LNP058	11000	Irrigated	7	1	0	Irrigated	consistent	NO
PLC149	11000	Irrigated	7	1	0	Irrigated	consistent	NO
PLC150	11000	Irrigated	7	1	0	Irrigated	consistent	NO
UNW045	11000	Irrigated	7	1	0	Irrigated	consistent	NO
UNW046	11000	Irrigated	7	1	0	Irrigated	consistent	NO
UNW047	45500	Partially irrigated	7	1	0	Irrigated	consistent	NO
BIS028	11000	Irrigated	6	2	0	Irrigated	consistent	NO
BIS116	11000	Unirrigated	6	2	0	Irrigated	consistent	NO
BIS117	45330	Partially irrigated	6	2	0	Irrigated	consistent	NO
BIS120	11000	Irrigated	6	2	0	Irrigated	consistent	NO

Parcel	Holland Class	1981 Status	Irrigated	Partially Irrigated	Unirrig.	1990-2016 Summary	Coverage over time	Further evaluation
BIS121	11000	Irrigated	6	2	0	Irrigated	consistent	NO
BIS210	11000	Irrigated	6	2	0	Irrigated	consistent	NO
BGP099	45500	Irrigated	6	2	0	Irrigated	variable	NO
BGP104	11000	Irrigated	6	2	0	Irrigated	consistent	NO
FSL098	11000	Irrigated	6	2	0	Irrigated	consistent	NO
FSL101	11000	Irrigated	6	2	0	Irrigated	consistent	NO
FSL154	11000	Irrigated	6	2	0	Irrigated	consistent	NO
IND108 (107west)	11000	Unirrigated	6	2	0	Irrigated	consistent	NO
IND197	11000	Irrigated	6	2	0	Irrigated	consistent	NO
IND200	11000	Irrigated	6	2	0	Irrigated	consistent	NO
IND219 east	11000	Unirrigated	6	2	0	Irrigated	consistent	NO
LNP053	11000	Irrigated	6	2	0	Irrigated	consistent	NO
LNP056	11000	Irrigated	6	2	0	Irrigated	consistent	NO
LNP057	11000	Partially irrigated	6	2	0	Irrigated	consistent	NO
MAN053	11000	Irrigated	6	2	0	Irrigated	consistent	NO
PLC033	11000	Irrigated	6	2	0	Irrigated	consistent	NO
PLC083/BIS094	11000	Partially irrigated	6	2	0	Irrigated	consistent	NO
IND202	11000	Irrigated	6	1	1	Irrigated	consistent	NO
BGP105	11000	Irrigated	5	3	0	Irrigated - Partially irrigated	consistent	YES
BIS050	11000	Unirrigated	5	3	0	Irrigated - Partially irrigated	variable	NO
IND192	11000	Irrigated	5	3	0	Irrigated - Partially irrigated	variable	YES
IND196	11000	Irrigated	5	3	0	Irrigated - Partially irrigated	variable	YES
IND199	11000	Irrigated	5	3	0	Irrigated - Partially irrigated	variable	YES
LNP012	11000	Unirrigated	5	3	0	Irrigated - Partially irrigated	variable	NO
MAN054	11000	Irrigated	5	3	0	Irrigated - Partially irrigated	consistent	NO
PLC040/BIS089	11000	Partially irrigated	5	3	0	Irrigated - Partially irrigated	variable	NO
PLC042/BIS091	45330	Partially irrigated	5	3	0	Irrigated - Partially irrigated	variable	NO

Parcel	Holland Class	1981 Status	Irrigated	Partially Irrigated	Unirrig.	1990-2016 Summary	Coverage over time	Further evaluation
BGP110	11000	Irrigated	4	4	0	Irrigated - Partially irrigated	consistent	YES
BGP111	11000	Irrigated	4	4	0	Irrigated - Partially irrigated	consistent	YES
BIS030	11000	Irrigated	4	4	0	Irrigated - Partially irrigated	variable	YES
BIS119	45500	Partially Irrigated	4	4	0	Irrigated - Partially irrigated	variable	NO
BIS144	11000	Partially Irrigated	4	4	0	Irrigated - Partially irrigated	variable	NO
BIS146	11000	Partially irrigated	4	4	0	Irrigated - Partially irrigated	variable	NO
FSL096	11000	Irrigated	4	3	0	Irrigated - Partially irrigated	variable	YES
IND193	11000	Partially irrigated	4	4	0	Irrigated - Partially irrigated	variable	NO
IND194	11000	Irrigated	4	4	0	Irrigated - Partially irrigated	variable	YES
PLC151	11000	Partially irrigated	4	4	0	Irrigated - Partially irrigated	variable	NO
BGP061	11000	Partially irrigated	3	5	0	Irrigated - Partially irrigated	consistent	NO
BGP101	11000	Irrigated	3	5	0	Irrigated - Partially irrigated	variable	YES
BIS023	11000	Partially irrigated	3	5	0	Irrigated - Partially irrigated	consistent	NO
BIS029	11000	Irrigated	3	5	0	Irrigated - Partially irrigated	variable	YES
BIS032	11000	Irrigated	3	5	0	Irrigated - Partially irrigated	variable	YES
BIS042	45330	Unirrigated	3	5	0	Irrigated - Partially irrigated	consistent	NO
BIS092	11000	Partially irrigated	3	5	0	Irrigated - Partially irrigated	variable	NO
BIS110	11000	Partially irrigated	3	5	0	Irrigated - Partially irrigated	consistent	NO
BIS112	11000	Partially irrigated	3	5	0	Irrigated - Partially irrigated	consistent	NO
PLC146	11000	Partially irrigated	3	5	0	Irrigated - Partially irrigated	consistent	NO
BGP119	11000	Partially irrigated	2	6	0	Partially irrigated	variable	NO
BIS041	45330	Partially irrigated	2	6	0	Partially irrigated	consistent	NO
FSL159	11000	Partially irrigated	2	6	0	Partially irrigated	consistent	NO
PLC013	11000	Partially irrigated	2	6	0	Partially irrigated	variable	NO
UNW031	45330	Partially irrigated	2	6	0	Partially irrigated	consistent	NO
FSL073	11000	Partially irrigated	1	7	0	Partially irrigated	consistent	NO
FSL081	11000	Partially irrigated	1	7	0	Partially irrigated	consistent	NO
FSL147	11000	Partially irrigated	1	7	0	Partially irrigated	consistent	NO

Parcel	Holland Class	1981 Status	Irrigated	Partially Irrigated	Unirrig.	1990-2016 Summary	Coverage over time	Further evaluation
FSP3/BGP187	11000	Irrigated	1	7	0	Partially irrigated	variable	YES
LNP030	11000	Unirrigated	1	7	0	Partially irrigated	consistent	NO
LNP032	11000	Partially Irrigated	1	7	0	Partially irrigated	consistent	NO
LNP043	11000	Partially irrigated	1	7	0	Partially irrigated	variable	NO
LNP069	11000	Partially irrigated	1	7	0	Partially irrigated	consistent	NO
UNW043	11000	Partially irrigated	1	7	0	Partially irrigated	consistent	NO
BIS039	11000	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
BGP015	45330	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
BGP016	11000	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
BGP091	11000	Partially irrigated	0	8	0	Partially irrigated	variable	NO
BGP093	11000	Partially Irrigated	0	8	0	Partially irrigated	variable	NO
BGP096	11000	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
BGP109	11000	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
BGP183	11000	Partially irrigated	0	8	0	Partially irrigated	variable	NO
BIS044	45500	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
BIS076	45330	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
BIS100	11000	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
BLK134	45330	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
FSL072	45330	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
FSL075	11000	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
FSL083	45330	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
FSL086	45330	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
FSL091	11000	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
FSL095	11000	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
FSL109	45330	Partially irrigated	0	8	0	Partially irrigated	Variable	NO
FSL110	45330	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
FSL148	11000	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
FSP007	45330	Partially irrigated	0	8	0	Partially irrigated	Variable	NO

Parcel	Holland Class	1981 Status	Irrigated	Partially Irrigated	Unirrig.	1990-2016 Summary	Coverage over time	Further evaluation
IND107	11000	Unirrigated	0	8	0	Partially irrigated	consistent	NO
IND155	45330	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
IND187	11000	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
LNP016	11000	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
LNP036	11000	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
LNP042	11000	Partially irrigated	0	8	0	Partially irrigated	variable	NO
LNP064	45330	Partially irrigated	0	8	0	Partially irrigated	variable	NO
MAN044	11000	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
MAN052	45500	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
PLC030/BIS069	11000	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
PLC164	45330	Unirrigated		8	0	Partially irrigated	consistent	NO
PLC172/BGP10	45330	Unirrigated	0	8	0	Partially irrigated	consistent	NO
PLC257	11000	Partially irrigated	0	8	0	Partially irrigated	variable	NO
UNW040	45330	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
UNW054	45330	Partially irrigated	0	8	0	Partially irrigated	consistent	NO
BGP077	45330	Partially irrigated	0	7	1	Partially irrigated	variable	NO
BGP156	11000	Partially irrigated	0	7	1	Partially irrigated	consistent	NO
BIS095	45330	Unirrigated	0	7	1	Partially irrigated	variable	NO
BIS108	11000	Partially Irrigated	0	7	1	Partially irrigated	consistent	NO
BIS118	45330	Unirrigated	0	7	1	Partially irrigated	variable	NO
IND014	45500	Partially irrigated	0	7	1	Partially irrigated	variable	NO
IND177	45330	Partially irrigated	0	7	1	Partially irrigated	consistent	NO
IND204/BK105	11000	Partially irrigated	0	7	1	Partially irrigated	variable	NO
IND205	11000	Unirrigated	0	7	1	Partially irrigated	consistent	NO
LW141/PLC201	45330	Unirrigated	0	7	1	Partially irrigated	variable	NO
LNP063	11000	Partially irrigated	0	7	1	Partially irrigated	variable	NO
PLC174/BP012 &BGP014	45330	Partially irrigated	0	7	1	Partially irrigated	variable	NO

Parcel	Holland Class	1981 Status	Irrigated	Partially Irrigated	Unirrig.	1990-2016 Summary	Coverage over time	Further evaluation
BIS086	11000	Partially irrigated	0	6	2	Partially irrigated	variable	NO
BIS088	45330	Partially irrigated	0	6	2	Partially irrigated	variable	NO
BLK004	11000	Partially irrigated	0	6	2	Partially irrigated	consistent	NO
FSL105	11000	Partially irrigated	0	6	2	Partially irrigated	variable	NO
IND109	11000	Unirrigated	0	6	2	Partially irrigated	variable	NO
LAW006††	11000	Unirrigated	0	4	2	Partially irrigated	variable	NO
BIS207	11000	Partially irrigated	0	5	3	Part. Irrigated - Unirrigated	variable	YES
BIS134	11000	Partially irrigated	0	4	4	Part. Irrigated - Unirrigated	variable	YES
LAW053	11000	Unirrigated	0	4	4	Part. Irrigated - Unirrigated	variable	NO
BIS133	11000	Unirrigated	0	3	5	Part. Irrigated - Unirrigated	consistent	YES
BIS072	11000	Irrigated	0	2	6	Unirrigated	consistent	YES
BIS138	11000	Partially irrigated	0	2	6	Unirrigated	consistent	YES
PLC031	11000	Unirrigated	0	2	6	Unirrigated	consistent	YES
BIS075	45330	Partially irrigated	0	1	7	Unirrigated	consistent	YES
BIS136	11000	Partially irrigated	0	1	7	Unirrigated	consistent	YES
BIS096	11000	Unirrigated	0	0	8	Unirrigated	consistent	YES
BIS126	11000	Unirrigated	0	0	8	Unirrigated	consistent	YES
LNP059	11000	Unirrigated	0	0	8	Unirrigated	consistent	YES
LNP060	11000	Unirrigated	0	0	8	Unirrigated	consistent	YES
IND203	11000	Irrigated	5	2	1	Irrigated - Unirrigated	variable	NO
TIN037†	11000	Partially irrigated	5	2	1	Irrigated - Unirrigated	consistent	YES
IND010	45500	Irrigated	4	3	1	Irrigated - Unirrigated	variable	NO
IND198	11000	Irrigated	4	3	1	Irrigated - Unirrigated	variable	NO
BIS035	11000	Irrigated	4	1	3	Irrigated - Unirrigated	variable	YES
IND007	45330	Partially irrigated	3	4	1	Irrigated - Unirrigated	variable	NO
IND201	11000	Partially irrigated	3	4	1	Irrigated - Unirrigated	variable	NO
IND008	45500	Irrigated	3	4	1	Irrigated - Unirrigated	variable	YES
LNP033	11000	Irrigated	3	4	1	Irrigated - Unirrigated	variable	YES

Parcel	Holland Class	1981 Status	Irrigated	Partially Irrigated	Unirrig.	1990-2016 Summary	Coverage over time	Further evaluation
LNP034	11000	Partially irrigated	3	4	1	Irrigated - Unirrigated	variable	NO
PLC008/BIS064	11000	Unirrigated	3	4	1	Irrigated - Unirrigated	variable	NO
FSL099	11000	Irrigated	2	5	1	Irrigated - Unirrigated	variable	YES
IND020	45330	Partially irrigated	2	4	2	Irrigated - Unirrigated	variable	NO
IND195	11000	Partially irrigated	2	3	3	Irrigated - Unirrigated	variable	YES
BGP102	11000	Partially irrigated	2	2	4	Irrigated - Unirrigated	variable	YES
IND013	45500	Partially irrigated	1	6	1	Irrigated - Unirrigated	variable	NO
IND115	45330	Partially irrigated	1	5	2	Irrigated - Unirrigated	variable	NO

†: TIN037 (Tule Elk field) was apparently dry in 2009, but hydrographic data suggest water was delivered to the project, possibly after the image was taken. Tule Elk field is an Environmental Project not fully implemented in 1981.

††: LAW006: Mono County parcel irrigated from Piute Cr. Outside NAIP image boundary two years. In the majority of years with data it was partially irrigated.

Remote Sensing Evaluation

The Water Department recently acquired spatially averaged spectral data and indices derived from Landsat data for most Type E parcels in the Owens Valley. Scientists at the Desert Research Institute and Western Regional Climate Center developed a software application to process and extract Landsat satellite imagery for the entire archive of Landsat 5, 7, and 8 data (Huntington et al., 2016). Previously, acquiring and processing satellite data was time consuming and cumbersome with large data storage requirements which often restricted analyses to a few scenes (e.g. Elmore et al, 2003). Processing of the raw satellite data included methods to account for variations in the satellite sensors over time, radiometric and atmospheric corrections (Huntingtion et al, 2016), filtering scenes for quality control (e.g. cloudy scenes), as well as plotting and pairing vegetation and climate model data for specific parcels. The dataset consisted of a 31-year time series for several spectral indices (NDVI, EVI, NDWI, surface temperature, albedo, tassel-cap brightness, spectral index /greenness/wetness) for 166 of the 196 flood-irrigated parcels through 2016. An example of the dataset showing one spectral index for one parcel is shown in Figure 8.4. Additional data for 2017 and for the 30 parcels not included in the original set will be acquired in 2018. Summary statistics (e.g. minimum, maximum, average) for the May-August peak of the growing season were calculated to allow year to year comparison of the indices and ground measurements of vegetation cover. The density of the dataset would allow assessment of variation due to plant phenology or irrigation timing during the growing season, but that level of analysis was beyond the scope of this report.

This evaluation of the remote sensing data for flood irrigated Type E parcels relied on the widely used Normalized Difference Vegetation Index (NDVI) as the measure of vegetation vigor. NDVI was the index most strongly correlated with cover measured by the Inyo/Los Angeles vegetation reinventory program and was better correlated with cover than previously generated late summer SMA estimates from Landsat data (Figure 8.5, Table 8.4). The Enhanced Vegetation Index (EVI) correlation with ground measured cover was approximately the same as NDVI, but at high cover, the EVI values were persistently below ground-measured values in this dataset. NDVI is known to be related to leaf area index (Vina, et al., 2011), but the relationship non-linearly levels off above LAI of approximately 3. This ‘plateau’ is not apparent at high cover values in Figure 8.5, but few reinventory parcels have cover above 80% whereas most irrigated parcels attain 80%. It is possible that NDVI will have limited ability to detect small changes at very high cover, but NDVI should be sufficient to assess whether cover is above a high threshold indicating nearly or complete irrigation. If this hypothesis is true, the different irrigation classifications of parcels based on visual interpretation of aerial photos should group categorically along the NDVI axis from unirrigated at low NDVI to irrigated at the high NDVI range.

For each parcel, NDVI in 2016 was compared with NDVI in the corresponding year that on-the-ground baseline data were collected, either in 1984-87 or 1998-99. If no baseline data were available, NDVI in the parcel during the year the vegetation quad was mapped (Green Book, Table II.A.1) was the basis for comparison.

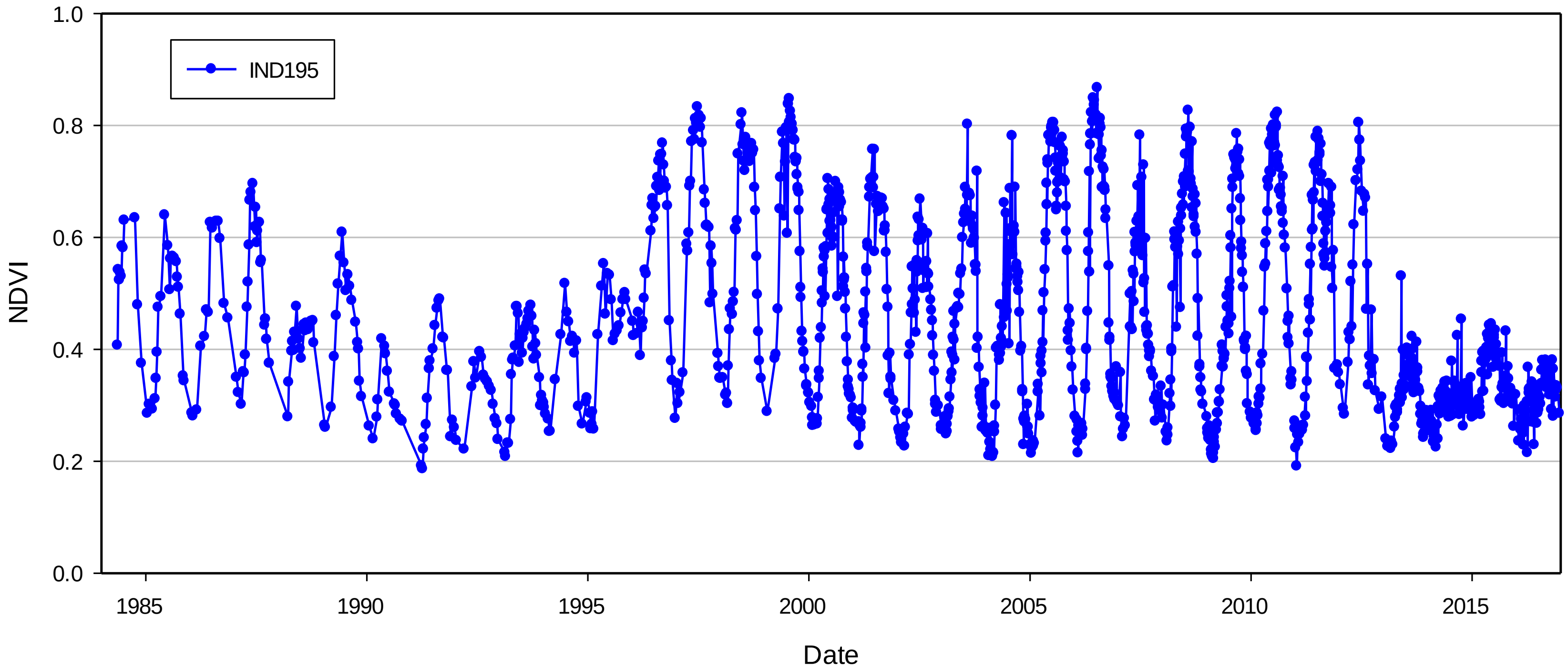


Figure 8.4: Example time series of spatially averaged NDVI within parcel IND195 derived from Landsat data. Quality control measures included with the processing software were used to filter the data set to remove unacceptable images (e.g. cloudy days). Note the marked change in average NDVI during the recent drought.

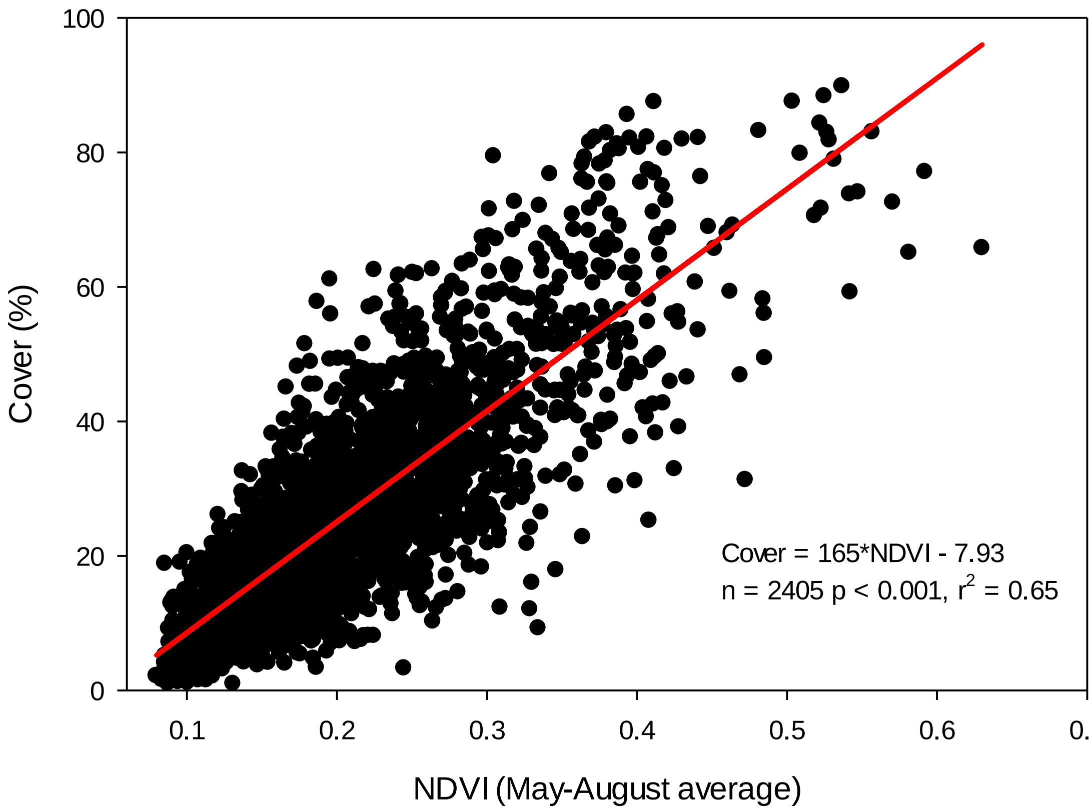


Figure 8.5. Relationship between average May-August NDVI for parcels where % cover has been measured using the line point technique.

Table 8.4. Correlation of vegetation cover and various remote sensing indices related to vegetation for parcels included in the Inyo/Los Angeles reinventory program. Remote sensing indices are average for the parcel for the months of May-August; SMA derived from a single scene in August or September.

Remote Sensing Measure	**r^2**
NDVI, Normalized Difference Vegetation Index	0.65
NDWI, Normalized Difference Wetness Index (green and NIR† bands)	0.61
NDWI, Normalized Difference Wetness Index (NIR and SWIR bands)	0.52
EVI, Enhanced Vegetation Index ††	0.66
SMA, Spectral Mixture Analysis (Elmore et al, 2003)	0.40

†: NIR, Near Infrared; SWIR, Shortwave Infrared

††: Slightly higher r^2 than NDVI, but the points largely occur below the regression line at EVI > 0.35 or approximately 65% cover.

Table 8.5. Type E land use types and number of parcels assigned to each in this analysis. Some parcel names refer to multiple parcels. Two parcels, IND189 and IND219east, are represented in both flood irrigated and cultivated fields categories.

Land Use Type	Number of Parcels
Lakes and intermittent ponds	11
Laws ranch	22
Cultivated fields	30
Overlying E/M or environmental project	42†
Subirrigated	41
Flood irrigated	196

†: parcels split by quadrangle boundaries not counted separately. Multiple parcels with the same name counted separately.

Results and Discussion

Aerial Photo Interpretation

Type E lands as presently constituted and mapped can't be described accurately as "lands supplied with water." Most Type E lands are supplied with water using a varitey of methods; some are for agriculture, some are for habitat and recreation, and many parcels are not actually supplied with water. Much of the difficulty in describing land management or prescribing monitoring for Type E lands stems from grouping a variety of land uses and vegetation types into one category. Six subdivisions of Type E based on land use (Table 8.5) were created to facilitate this analysis, future monitoring, and management discussions for irrigated lands. Locations of parcels in these subdivisions are presented in Figure 8.6a (http://www.inyowater.org/wp-content/uploads/2018/08/2018-Annual-Report-ICWD-Type-E-Fig-8_6a.jpg) and Figure 8.6b (http://www.inyowater.org/wp-content/uploads/2018/08/2018-Annual-Report-ICWD-Type-E-Fig-8_6b.jpg).

Spreading basins that are infrequently supplied with water as part of Los Angeles aqueduct operations or that are non-vegetated playas were placed into the Intermittent Ponds group. It is not necessary for groundwater or surface water management to include these barren areas as part of the vegetation baseline for the Agreement (Table 8.6). These parcels should be reassigned to a new Miscellaneous land use class along with parcels of Abandoned Agricultural lands and Urban lands already shown on the baseline map. Tinnemaha reservoir is a water feature and should be labeled as such. The small pond north of Buckley ponds project is managed presently for recreation like the other nearby ponds. The Technical Group and Standing Committee should consider adding it to the Buckley ponds project or labeling it as a water feature on the baseline map (it is labeled as a water feature in Figure 8.6a).

Table 8.6. Type E parcels in the Permanent lakes/reservoirs and Intermittent pond categories. These areas have not been included in environmental or mitigation projects. All parcels in this category are Holland Classes 13100 or 13200.

Parcel	Land use/Land type	Recommended Designation
FSL136	Spreading basin	Spreading/Playa
LAW126	Spreading basin	Spreading/Playa
LAW170	Spreading basin south of US 6	Spreading/Playa
LAW172†	Spreading basin south of US 6	Spreading/Playa
LAW183	Spreading basins below Farmers Pond	Spreading/Playa
PLC051	Small pond north of Buckley Ponds	Add to Buckley ponds project
BGP055	Playa	Spreading/Playa
TIN025	Tinemaha Reservoir	Water feature, remove from vegetation Type classification
IND048	Playa	Spreading/Playa

†: Includes parcels FSL070, FSL071 from adjoining USGS Quadrangle.

Enhancement/Mitigation and other mitigation or environmental projects that have land management and monitoring requirements that supersede Agreement baseline requirements for Type E vegetation were placed in a separate group (Table 8.7). Most of these projects were implemented after completion of the vegetation baseline map, and the parcel boundaries no longer reflect conditions on the ground. Many parcels in this group are water bodies or parcels located within the Lower Owens River Project (LORP) or Blackrock Water Fowl Management Area (BWMA). It may be advantageous to create a new vegetation Type defined as lands that are part special projects supplied with water for habitat and recreation. The original vegetation boundaries on the baseline map should be preserved for history, but new maps and parcel designations of the project areas should be prepared and overlain on the baseline map. Type E parcels that occur in projects to establish irrigated pastures or fields were evaluated in this report along with the other irrigated lands.

Table 8.7. Type E parcels designated as part of environmental, recreation, or habitat projects

Parcel	Holland Class	Name	Project Type
FSL059	13200	Farmer's Pond	1991 EIR Environmental Project
PLC054	13100	Buckley Ponds	1991 EIR Environmental Project
PLC061	13100	Saunders Pond	1991 EIR Environmental Project
BGP080	13100	Klondike Lake	1991 EIR Env. and E/M Project
LNP068	13100	Diaz Lake	1991 Env.-1997 MOU Ad Hoc
LAW061	13200	McNally Ponds	1991 EIR E/M project
LAW064	13200	McNally Ponds	"
LAW067	13200	McNally Ponds	"
LAW071	13200	McNally Ponds	"
IND188 west	11000	Ind.Regreening & woodlot	"
BLK087	11000	Drew Slough	LORP, BWMA management unit
IND048/BLK108	13200	Thibaut pond	"
IND048/BLK109	13200	Thibaut pond #6 †	"
IND048	13200	Thibaut pond #7	"
IND048	13200	Thibaut pond #5	"
IND048	13200	Thibaut ponds #3 and #4	"
IND048	13200	Thibaut pond #2	"
IND048	13200	Thibaut pond #1	"
IND048/ BLK111, 112	13200	Thibaut pond #10	"
IND048/BLK107	13200	Thibaut Pond #8	LORP, Off Riv. Lakes and Ponds
BLK117	13100	Lower Twin Lake	"
IND240	13100	Billy Lake	"
BLK140	61700		LORP, Riverine/Riparian
IND061 (4) ††	63810		"
IND103 (2)	61700		"
UNW065 (2)	61700		"
UNW070	61700		"
LNP085	61700		"
DOL016	61700		"
LNP130 (5)	11000		"
BEE022	61700		"
BGP070	13100	Warren Lake	1997 MOU Ad Hoc Project
FSL033	11000	Laws Woodlot	Discontinued before 91 EIR

†: Pond number on maps corresponds to designation for BWMA avian surveys.

††: Number in parentheses denotes multiple parcels with same designation

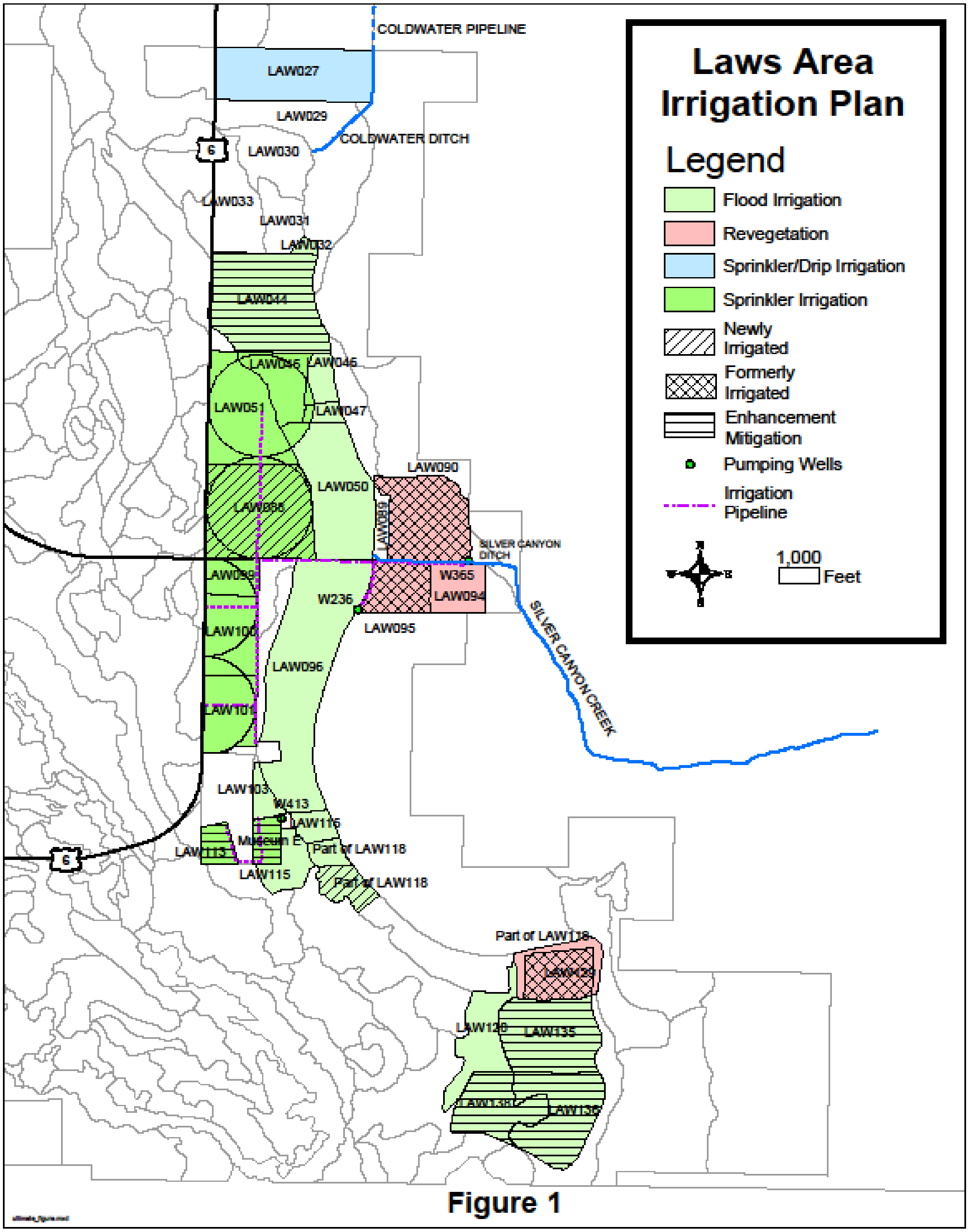


Figure 8.7. Laws Ranch irrigated lands and methods specified in the 2003 MND. Original baseline map names and boundaries shown. Field boundaries for parcels along Highway 6 should be redrawn to conform with actual boundaries.

Table 8.8. Type E parcels requiring irrigation in the Laws Irrigation Project, March 2003.

Parcel	2005-2016 Irrigation History	Out of Compliance	Notes
LAW027	Partially irrigated, consistent		
LAW032	Unirrigated	X	
LAW044	Partially irrigated, consistent		West half of parcel remains unirrigated however, this was the practice in 1981
LAW045	See LAW051		Majority of parcel converted to center pivot
LAW046	Partially irrigated, variable		Regular flood irrigation began 2014-16
LAW047	Unirrigated - Partially irrigated		Regular flood irrigation began 2014-16
LAW050	Unirrigated - Partially irrigated	X	Irrigation of small portion began in 2012
LAW051	Irrigated		
LAW088	Partially irrigated, consistent		Vegetation under center pivot typically not uniform. Additional water needed?
LAW096	Irrigated		
LAW099	Irrigated		
LAW100	Irrigated		
LAW101	Irrigated		
LAW103	Unirrigated	X	Rabbitbrush dominated. Diversion present?
LAW113	Irrigated		
LAW115	Partially irrigated, consistent	X	Only a small portion of parcel has been irrigated
LAW116	Irrigated - Unirrigated		Full irrigation began 2013-2014
LAW118	Unirrigated - Partially irrigated	X	Irrigation began in 2014, but still incomplete
LAW128	Partially irrigated, consistent		
LAW135	Partially irrigated, consistent		
LAW136	Partially irrigated, consistent		
LAW138	Partially irrigated, consistent		

Laws Ranch was assessed separately because the parcels receiving irrigation, field boundaries, and irrigation methods were changed by the Inyo/Los Angeles Standing Committee in 2003. The parcel naming convention of 1984-87 baseline map was retained on the revised map (Figure 8.7). The basis for comparison is the 2003 Mitigated Negative Declaration for re-establishing irrigation following litigation with the previous lessee. Images from 2005-2016 were interpreted using similar methods described above, but the irrigation history was compared with the map in Figure 8.5. Five parcels in the Laws Ranch have not yet been fully or consistently irrigated (Table 8.8). Allowances were made for parcels where consistent irrigation has been recently established. The ranch consists of both flood and cultivated/sprinkler irrigated fields consistent with the definition of Type E vegetation, but the baseline map should be redrawn to conform to the field and pasture boundaries and the irrigation methods agreed upon in 2003.

The appearance of cultivated/sprinkler irrigated fields (Table 8.9) on the images varies substantially between years largely reflecting the more intensive agriculture practices on those parcels. Relying on air photo interpretation of the "green-ness" of these fields based on a single summer scene was not sufficient to judge compliance and yet account for normal practices such as reseeding, crop rotation, fallowing, or harvest. Most fields were clearly irrigated in the aerial photos. In years when cultivated parcels appeared unirrigated, it was not possible to determine if it was left fallow due to lack of water or if it had been prepared for seeding or recently seeded. However, five fields in southwest Bishop were fallow for at least two years during the 2012-2016 drought because of the lack of a secure water source to justify the expense of reseeding. These fields were reirrigated in 2017.

Cultivated fields were not assigned baseline vegetation cover and composition values to allow the leasee flexibility to reseed and rotate crops as desired. As such, monitoring methods necessary to gauge compliance with the Agreement are distinct from other Type E parcels. Periodic field visits to determine whether a field is still in production along with water use/supply information will probably be sufficient for compliance monitoring.

The boundaries of several cultivated fields have changed since the 1984-87 baseline map was completed, and the baseline parcel numbering scheme no longer corresponds with the current configuration. Field boundaries and irrigation method for several fields south of Big Pine have changed since 2000. Approximately 900 acres of Type E land formerly irrigated with wheel lines in Big Pine were converted to 860 acres irrigated with center pivots. Since both values exceed the 635 irrigated acres visible in the 1981 image, the baseline map should be revised to reflect these changes in field boundaries and parcel identification to correspond with the current layout of irrigation and cultivation.

Subirrigated parcels were Type E parcels that are not regularly supplied with irrigation water. Most subirrigated parcels were originally mapped as rush/sedge meadow which were all was designated as Type E regardless of irrigation management. Meadows that are not actually irrigated or part of an irrigated lease should be redesignated as Type C vegetation (Table8.10) and managed and monitored like other phreatophytic meadows as required by the Agreement.

Table 8.9. Type E lands under cultivation with sprinkler irrigation.

Parcel	Notes
BGP163	Combined with BGP164, BGP165 in the center pivot by 2000
BGP164	
BGP165	
BGP167	Combined with BGP166 (not Type E) in the center pivot by 2005
BGP168	Converted to 2 center pivots and wheel line sprinkler by 2009
BGP169	Combined with BGP171 in center pivot by 2005
BGP171	Combined with BGP169 in center pivot by 2005
BGP173	Combined with BGP172 (not Type E) and part of BGP163 in center pivot by 2000
BGP174	Combined with part of BGP172 and BGP175 in center pivot by 2000
BGP175	West side is irrigated with wheel line sprinklers
BIS101	
BIS103	
BIS123	
BIS124	
BIS125	
BIS127	
BIS128	
BIS131	
BLK082	Eight mile ranch
BLK083	Eight mile ranch yard. Parcel boundary inaccurate
IND189	Both cultivated and flood irrigated fields. Only the sprinkler irrigated field assessed
IND190	
IND219 west	Ind. Regreening. Baseball field condition not included in the assessment
IND230	Symmes-Shepherd fields E/M project
IND219 east	Cultivated portion of Independence Pasturelands E/M project
TIN034	
TIN036	
FSP025	See TIN034
FSP026	See TIN036
MAN003	See IND230

Twelve subirrigated parcels were previously classified on the baseline map as irrigated agriculture (Holland Class 11000). Nearly all of these parcels were lands downstream of springs that are not connected to the LAA system or were lands bisected by a creek or canal and were not obviously surface irrigated.

Table 8.10. Type E parcels judged to be subirrigated.

Parcel	Holland Class	Notes
BGP019	45330	Slough between BP canal and fault north of Klondike Lake. Not irrigated in 1981. Spreading area.
BGP075	45330	Adjacent to Warren Lake and Big Pine canal. Field check nec.
BGP114	76100	Fault riparian straddling Glacier Lodge Rd.
BGP123	45330	Baker Creek area
BGP125	45330	Baker Creek meadow
BIS040	11000	Field check needed
BIS056	45330	Adjacent to FLS083
BIS071	45330	May be irrigated; ditches not evident in photo. Field check needed
BIS073	45330	Field check needed
BIS083	45330	Depression in BIS076, east of golf course
BIS084	45330	Depression in BIS076, east of golf course
FSL011	45330	Fish Slough
FSL018	45330	Fish Slough
FSL085	11000	Adjacent to Bishop Creek but not irrigated
FSL138	45330	Relict or active spreading/seepage collection ditches?
FSL145	11000	Adjacent to C-drain but not irrigated
FSL158	45330	Unirrigated at NW corner of irrigated Bishop cone lands
FSL178	45330	Owens River, low terraces below Pleasant Valley
FSL185	45330	Terrace above Horton Creek confluence with Owens River
FSL206	45330	McGee Creek
FSL213	45330	Horton Creek/McGee Creek confluence downcut
FSP038	11000	Perlite mine orchard, located outside 1981 image
FSP060	11000	McMurray Meadow, springfed
FSP063	11000	Fuller Meadow, springfed
FSP064	11000	Fuller Meadow, springfed
IND150	45330	Adjacent to Locust spillgate at LORP
IND158	45330	Irrigation or spreading out of Stevens Canal may affect site, but mostly subirrigated
IND171	45330	Tailwater out of Dean spillgate may affect this parcel, but mostly subirrigated
LAW043	45330	McNally Canal diversion #13, suggest water diverted to this parcel 1996-2002. Is that correct?
LAW070	45330	Meadow adjacent to LAW071, McNally Ponds spreading basin
LAW111	45330	Owens River terraces NW of Laws
LAW121	45330	Owens River terrace west of monitoring site Laws 3
LAW155	45330	Williams Waste
LNP037	11000	Lone Pine Cr below O.H.#10 bisects this parcel, but not irrig.

Parcel	Holland Class	Notes
LNP040	76100	Unirrigated locust trees
MAN059	11000	Hogback Creek. Type E below Type D parcels?
PLC157	45330	Pasture below Freeman Creek and Hot Ditch
UNW041	45330	North but not connected to Reinhackel Spring
UNW056	11000	Subirrigated Owens Valley fault spring
UNW063	11000	Subirrigated Owens Valley fault spring
UNW064	11000	Subirrigated Owens Valley fault spring

These parcels near springs could be reclassified into one of the native vegetation Types A-D based on cover and composition or information contained in the spring and seep inventory (ESI, 2001), but additional guarantees to continue the historic land management of flows downstream of the springs would be required.

The majority of Type E parcels and acreage consist of 196 flood irrigated parcels (Tables 8.3 and 8.11 and Figure 8.8 (http://www.inyowater.org/wp-content/uploads/2018/08/2018-Annual-Report-ICWD-Type-E-Fig-8_8a.jpg and http://www.inyowater.org/wp-content/uploads/2018/08/2018-Annual-Report-ICWD-Type-E-Fig-8_8b.jpg). The flood irrigated group was composed predominately of Irrigated Agriculture (Holland class 11000), but 42 rush/sedge meadow or non-native meadow parcels were also included (Holland class 45330, or 45500). The meadow parcels had obvious ditches or water diversions to the parcel or are known to be included in irrigated leases. The number of parcels in this group that were interpreted each year as irrigated, partially irrigated, or unirrigated is shown in the top portion of Figure 8.9. The number of unirrigated parcels is relatively small and diminishes in higher runoff years (Figure 8.9, bottom). The trends in numbers of irrigated and unirrigated parcels as a function of runoff essentially mirror one another suggesting that approximately 30-35 parcels are subject to fluctuation in their irrigation amount as runoff varies.

The irrigated status through time for each flood irrigated parcel was summarized using the classification procedure described above to compare with the 1981 photo interpretation for each parcel (Table 8.3). Twenty-six of the parcels apparently were not irrigated in 1981. These parcels were probably observed being irrigated during field mapping in 1984-87 or were classified as Type E based on lease information. Twelve of these twenty-six were partially or fully irrigated in all eight subsequent years examined; another seven were irrigated more than six of the eight years. The remaining seven were infrequently irrigated and were flagged as possible violations. For these parcels, it would not be informative to evaluate whether water supply and uses in 1981 were maintained. Fortunately, most parcels have baseline vegetation measurements from 1984-87 or 1998-99 as a basis for comparison should additional monitoring be required.

Sixty-eight flood irrigated parcels were classified as Irrigated (Table 8.3). Only one parcel in the Irrigated category, IND202 in the Fort Independence area, was not irrigated in a single drought year (1990). Water in the Ft. Independence area is supplied solely by Oak Creek and many parcels were unirrigated

Table 8.11. Number of flood irrigated parcels each summary category based on aerial photo interpretation. Parcels split by quadrangle boundaries included in the count as one parcel.

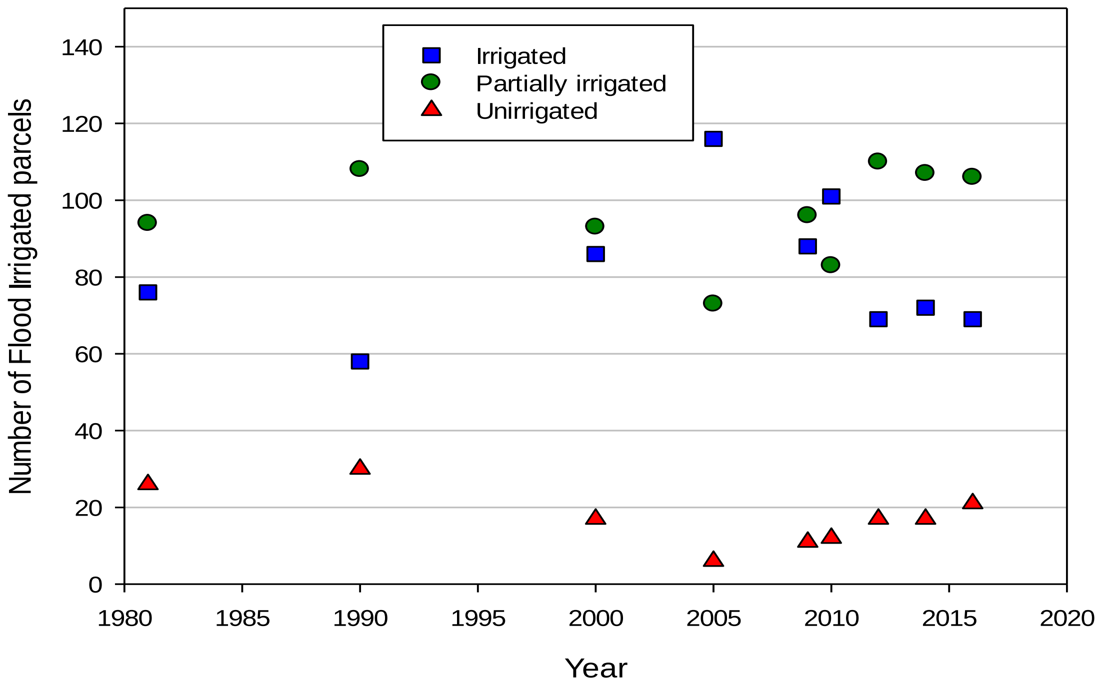
Irrigation History	Number of Parcels
Irrigated	68
Irrigated-Partially Irrigated	29
Partially Irrigated	69
Part. Irrigated-Unirrigated	4
Unirrigated	9
Irrigated-Unirrigated	17
Sum	196

or partially irrigated that year largely due to drought. No parcels in the Irrigated category were flagged as possible violations of the Agreement needing further evaluation.

Twenty-nine parcels were placed in the intermediate Irrigated/Partially Irrigated category; 12 were flagged as potential violations of the Agreement (Figure 8.10, http://www.inyowater.org/wp-content/uploads/2018/08/2018-Annual-Report-ICWD-Type-E-Fig-8_10a.jpg and http://www.inyowater.org/wp-content/uploads/2018/08/2018-Annual-Report-ICWD-Type-E-Fig-8_10b.jpg). Several of the flagged parcels (BGP099, BGP105, IND192, IND196, and IND194) are dependent on creek flow. These were irrigated in 1981 as well as most years since then, but they were only partially irrigated during the 2012-2016 drought. The Agreement recognizes that insufficient creek flow could result in less irrigation for some parcels, and if that was the case for these parcels, it would not necessarily constitute a violation of the Agreement. Determining the reason each parcel was less irrigated than in 1981 is the subject of further evaluation. Sixty-nine parcels were classified as Partially Irrigated. No parcel had more than two unirrigated years and most of the instances when the parcels appeared to be unirrigated occurred during severe droughts (<60% normal OVR). Only one parcel was flagged in the Partially Irrigated category for further evaluation (Figure 8.10).

No parcel in the Partially Irrigated/Unirrigated-or Unirrigated categories was ever fully irrigated in the eight years examined. Four parcels were classified as Partially Irrigated/Unirrigated; three were flagged for further evaluation. Nine parcels have been chronically Unirrigated (Table 8.3). Only three parcels have never been irrigated since 1981; two in Lone Pine (LNP059 and LNP060) and one in Bishop (BIS126). All parcels in the Unirrigated class were flagged for further evaluation in 2018 (Figure 8.10).

The photo interpretations of 17 parcels ranged between irrigated and unirrigated, with no one condition dominant (i.e. > 6 years). Four are located in the Bishop area, one in Big Pine, two in Lone Pine, and the majority (10) in the Fort Independence area. Most parcels in the Fort Independence area were unirrigated in 1990 and in 2016. These parcels are solely dependent on Oak Creek and widely varying irrigation may simply reflect drought. Only BGP102 was not irrigated in the majority of years evaluated; all other parcels were usually



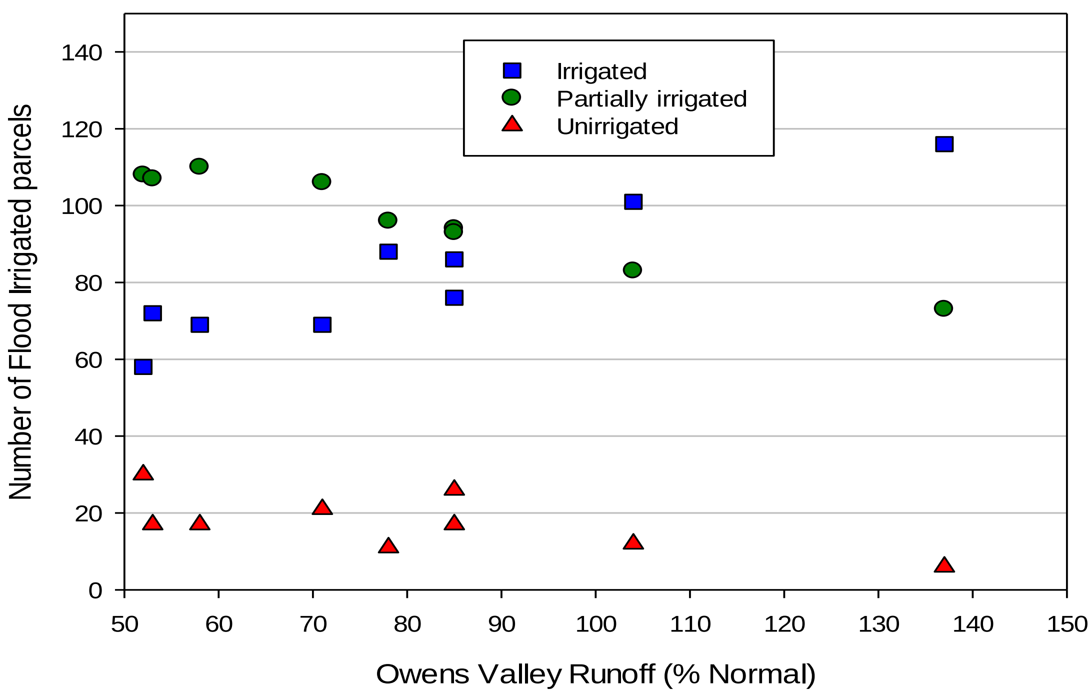


Figure 8.9. Irrigation status of flood irrigated parcels each year after 1981 and as a function of Owens Valley Runoff. (n= 196, duplicates/split parcels not counted separately).

irrigated or partially irrigated. Eight parcels in this category were flagged for further evaluation (Figure 8.10)

In total, 33 flood irrigated parcels were flagged as overall "less irrigated" than in 1981 based on air photo interpretation of eight years since 1990. Most of these parcels were in located west Bishop, north Big Pine, and Fort Independence areas. Parcels in these areas are dependent on creek flow for irrigation and the drier conditions probably reflect less water availability during the disproportionate number of drought years in the set of images examined. An additional six parcels in the Laws Ranch appear insufficiently irrigated.

Remote Sensing

Evaluation of the condition of vegetation on irrigated parcels using remote sensing is potentially more quantitative, objective, and quicker than air photo interpretation. This is particularly true with developments in cloud based computing that allow querying the entire Landsat archive for a number of indices spatially-averaged at the parcel scale. As a first step in assessing the utility of the method to track changes in irrigated lands in the Owens Valley, Landsat data and aerial photo interpretations were compared for each parcel and each year to assess if the annual aerial photo interpretation and Landsat data provide comparable or complimentary results. In general, an irrigated parcel will have higher NDVI than an unirrigated parcel but the relationship between NDVI and cover is rather noisy (Figure 8.5). For example, the average May-August NDVI for an Irrigated and an Unirrigated parcel are shown in Figure 8.11 and for a parcel that varied between Irrigated and Unirrigated status in Figure 8.12. Average NDVI when parcels were irrigated, partially irrigated, and unirrigated based on air photo interpretation corresponded with the status of irrigation based on air photo interpretation. Figure 8.13 presents the paired NDVI/aerial photo interpretation results compiled for each parcel and each year. The sample populations for each condition were skewed slightly so differences between groups were tested using Kruskal-Wallace ANOVA on ranks. The medians of the groups were statistically different from one another ($p<0.05$). Despite the significant differences in the medians, there was considerable overlap between adjacent groups preventing selection of general threshold between the groups. There was almost no overlap between the Irrigated and Unirrigated groups, however. All parcels in the Unirrigated group with NDVI greater than 0.4 were parcels with considerable growth of green trees (based on air photos) with a brown understory of lower stature vegetation suggesting it will be necessary to consider site specific conditions including limiting the spatial NDVI estimates to treeless areas in subsequent investigations of parcels flagged for further evaluation.

Average NDVI in 2016 (0.524) among all parcels was only slightly less than average NDVI for the baseline year (0.588) but the difference in means was statistically significant ($p<0.01$, paired t-test). Runoff in the years preceeding and duing the baseline and RCI measurements was above normal; runoff in 2013-2015 was between 48-53% of normal suggesting antecedent drought effects may have suppressed 2016 cover beyond what can be ameliorated by single-year normal runoff alone. For most parcels, 2016 NDVI was approximately the same as in the baseline year (Figure 8.14); however, twenty seven parcels were flagged for additional evaluation and monitoring because 2016 NDVI was lower than baseline by more

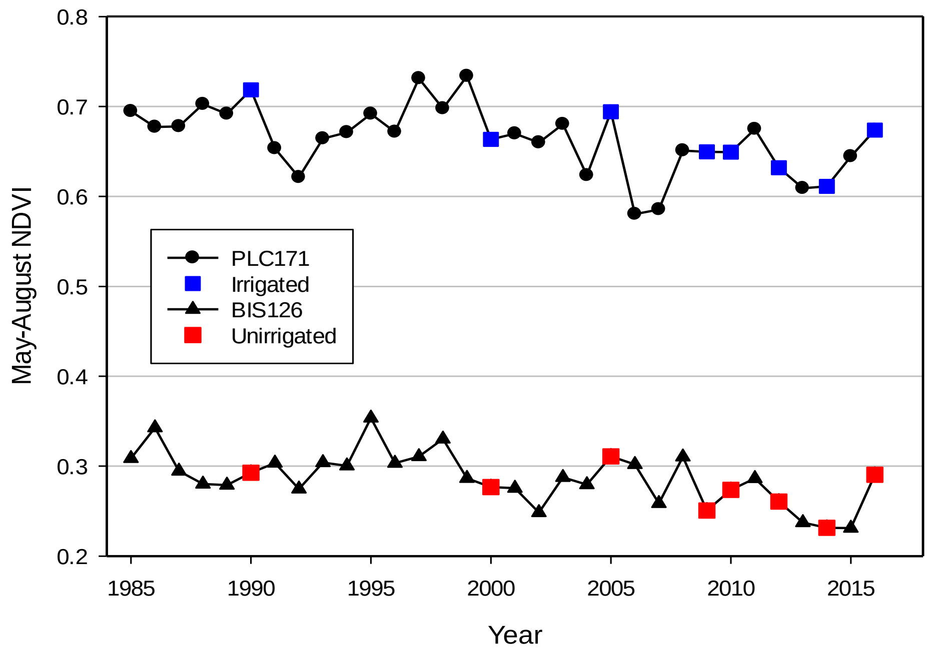


Figure 8.11. Examples of average NDVI for the May-October period each year derived from Landsat data for an Irrigated parcel, PLC171, and an Unirrigated parcel, BIS126. Annual condition based on aerial photo interpretation also shown for each parcel.

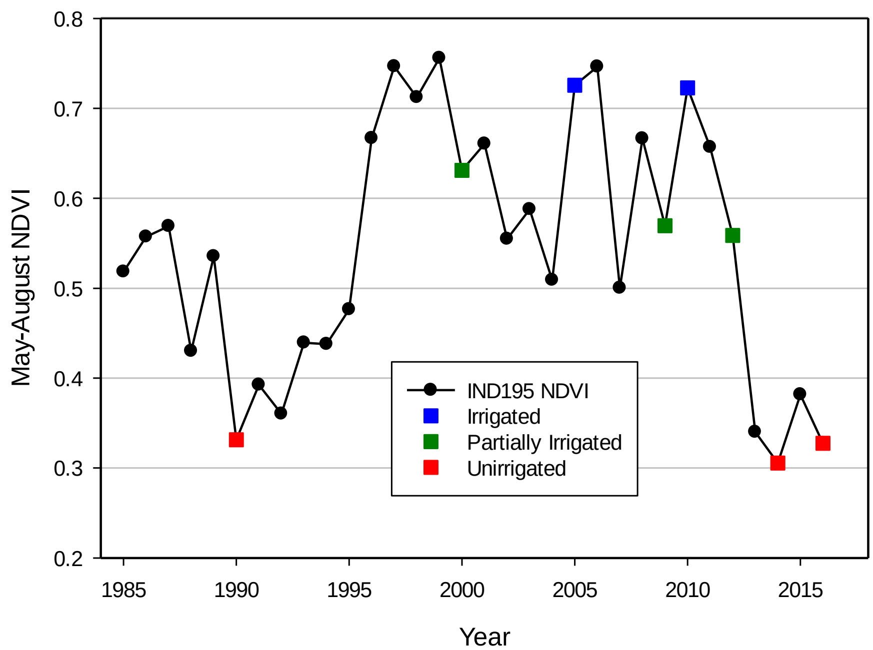


Figure 8.12. Example of average NDVI for May-August each year derived from Landsat data for a parcel that varies from irrigated to unirrigated conditions based on aerial photo interpretation.

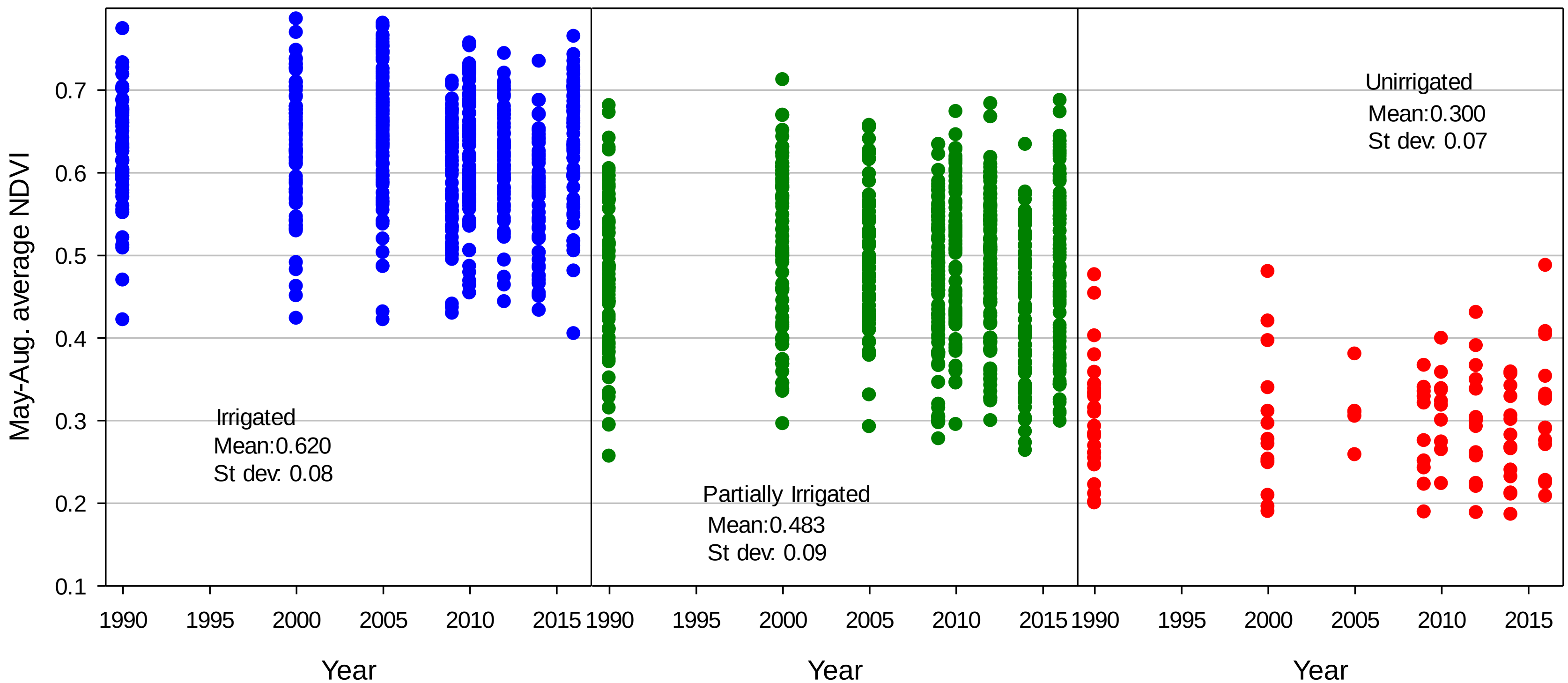


Figure 8.13. Average NDVI from May-August for flood irrigated parcels categorized by the aerial photo interpretation. Data include all parcels in all years except for nine parcels in years where the cloud score >10. Average standard deviation of irrigated and partially irrigation groups was 0.168.

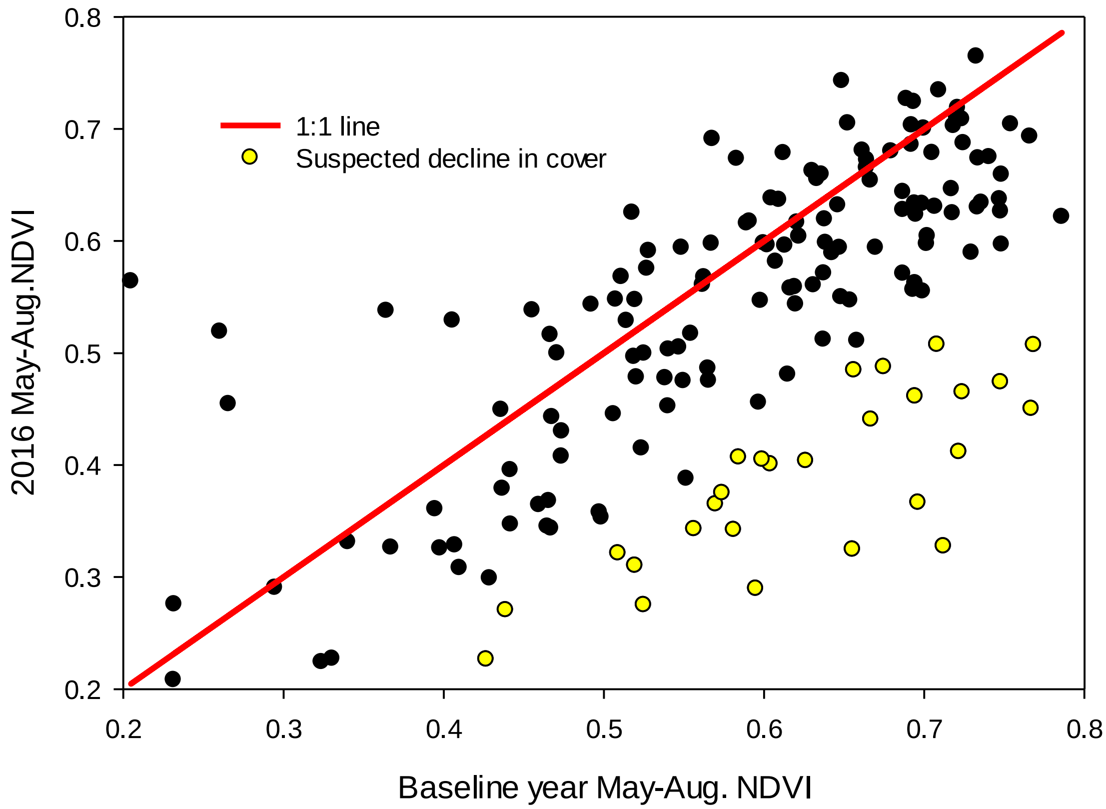


Figure 8.14. Comparison of 2016 May-Aug. average NDVI and NDVI measured during the baseline year. Parcels where NDVI declined more than two times the standard deviation of irrigated and unirrigated classes (Figure 8.13) are highlighted in yellow.

than twice the standard deviation of the average for the Irrigated and Partially Irrigated classes (Figure 8.15, http://www.inyowater.org/wp-content/uploads/2018/08/2018-Annual-Report-ICWD-Type-E-Fig-8_15a.jpg and http://www.inyowater.org/wp-content/uploads/2018/08/2018-Annual-Report-ICWD-Type-E-Fig-8_15a.jpg). The reasoning behind the selected threshold (decline in NDVI > 0.168) was that parcels with declines in NDVI of that magnitude probably deviated from irrigation or land uses that existed in 1981 based on the air photo results. The NDVI threshold equates to a decline in cover of approximately 27% using the relationship in Figure 8.5. Baseline cover for many irrigated parcels is typically high, often near 90%, and a decline between 20-30% cover should be measurable with ground based methods. The choice of this threshold based the air photo analysis is subjective and other thresholds can be reasonably devised, for example based on a statistical simulation of the least significant difference in cover that could be measured based on the baseline data for each parcel. Selection of the best rendition of Landsat data to use in the future (e.g. an index or measurement of leaf area index or cover) as well as an appropriate threshold to detect suspected vegetation declines from baseline will be the subject of additional analysis.

Type E Monitoring and Additional Evaluations

Future monitoring will be tailored to the requirements for parcels based on the proposed Type E subdivisions. Parcels in the Intermittent ponds and Lakes category generally will not require monitoring. Type E parcels that have overlying environmental or habitat projects will be monitored and assessed in accordance with the requirements of the specific project description. Subirrigated parcels depend primarily on access to shallow groundwater to persist and are not supplied with irrigation water. Several parcels identified as subirrigated may receive water in high runoff years, however. The list of parcels in this category may be refined following additional field checks and inspection of remote sensing, surface water measurements, precipitation, or depth to water data. Subirrigated parcels that are at risk from the effects of groundwater pumping are candidates for inclusion in the Technical Group phreatophytic vegetation monitoring program. Parcels not at risk may be good candidates to serve as controls for meadow parcels occurring in wellfields. The land use of cultivated/sprinkler irrigated fields is plainly visible from the ground. Intensive agricultural management on these parcels is expected and crop type is allowed to vary over time making the establishment of baseline vegetation conditions unnecessary. Cultivated fields will be evaluated visually during field visits to determine that irrigation water is being applied and that the land is still in production.

The Agreement Type E goals apply to approximately 211 flood irrigated parcels that require monitoring (including 15 from Laws Ranch). Approximately 157 of these have quantitative cover and composition goals based on ground measurements. This number of parcels far exceeds the resources of the ICWD to monitor each year using field methods similar to those used to acquire the baseline dataset. Information in this report and continued analysis of recent remote sensing data can be used to prioritize the list of parcels to evaluate further.

Parcels flagged in this report will be evaluated further using the sequence of data acquisition and evaluation methods outlined below. Parcels judged as fully irrigated in all years in this report visually varied little over time and probably won't be high priority. Further scrutiny is warranted for Partially-Irrigated parcels. The definition of that category is particularly broad and could represent natural variability in topography or reduction in irrigation supply. Parcels where the irrigation extent is limited by topography would be expected to exhibit a relatively consistent pattern over time if the irrigation supply is consistent. The irrigation pattern in parcels with changing irrigation supply would be expected to vary over time. Visual air photo interpretation is qualitative and relying on visual methods to assess the extent of irrigation within a parcel over time is difficult. Parcels where the extent of flood irrigation varies (n=71, Table 8.3) are candidates for more quantitative methods using remote sensing methods described below.

Additional evaluation for parcels flagged in this report and future monitoring of Type E will proceed in steps from qualitative to quantitative and data intensive methods on a case by case basis. The Water Department periodically acquires color imagery either from publically accessible sources or LADWP. These images will be visually examined, and along with field visits used to identify substantial changes in irrigation. Additionally, Landsat imagery will be employed to detect trends in vegetation vigor for parcels in question. The preliminary analysis using the Landsat dataset in this report will be expanded in 2018-19 to include recent years and the Type E parcels that were not included in the original data acquisition. Additional analyses to select the most informative rendition of the Landsat data (e.g NDVI or some other measure) as well as appropriate change detection methods and thresholds remain to be completed.

Monitoring and analysis of flood irrigated parcels will proceed on to more detailed evaluations if requested by the lessee or if qualitative air photo assessment, field visits, or Landsat data suggest substantial management changes have occurred or that a negative trend in the vegetation vigor is occurring. First, available hydrologic data will be acquired and evaluated. Previous attempts to rely on reported flow totals for surface water gauging stations to monitor irrigation deliveries have met with mixed success (Jackson 2009). In many instances, flow through a canal or ditch is divided up among several parcels downstream. Without detailed information on the timing of water deliveries to irrigated leases and distribution to parcels within a lease, and the quantity of water exiting a lease, an assessment based solely on flow totals is usually not conclusive. If conditions in a parcel warrant additional investigation or if restrictions in water deliveries are reported or suspected, the data sharing provisions of the Agreement allow the County to request the necessary water use data from LADWP. The lessee will be consulted before water use reports are requested and before on-the-ground monitoring of a suspected impact is initiated. On-the-ground monitoring will be initiated if requested by the lessee, Inyo County, LADWP, or the Technical Group. Field monitoring will be conducted according to the line point monitoring procedures in the Green Book and will be designed to provide the best measure to compare with baseline vegetation cover and composition. In order of preference, either the RCI inventory data, LADWP baseline mapping transect data, or the summary data used to assign vegetation types will be used as the baseline cover and composition. Results of evaluations for specific parcels will be provided to the Technical Group and the lessee.

References

Elmore, A.J., Mustard, J.F., Manning, S.J., 2003. Regional patterns of plant community response to changes in water: Owens Valley, California. Ecological Applications 13:443-460.

Ecosystem Sciences, 2001. Lower Owens River Project Springs and Seeps Inventory, Phase I. Report prepared for Los Angeles Department of Water and Power and Inyo County Water Department.

Huntington, J., K. McGuire, C. Morton, K. Snyder, S. Perterson, T. Erickson, R. Niswonger, R. Carroll, G. Smith, and R. Allen. 2016. Assessing the role of climate change and resource management on groundwater dependent ecosystem changes in arid environments with the Landsat archive. Remote Sensing of Env. 185:186-197.

Inyo County and City of Los Angeles. 1990. Green Book for the Long-Term Groundwater Management Plan for the Owens Valley and Inyo County.

Jackson, R.J., 2009. Feasibility of a Type-E water use audit using current ICWD GIS information and Totals and Means database at the Inyo County Water Department. Draft memorandum report, ICWD November 2009.

Los Angeles Department of Water and Power. 2003. Irrigation Project in the Laws Area. Mitigated Negative Declaration.

Los Angeles Departement of Water and Power and Ecosystem Sciences. 2010. Final Owens Valley Land Management Plan. City of Los Angeles Water and Power, Bishop, Ca.

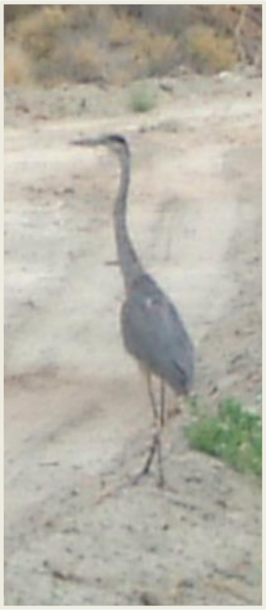
Los Angeles and Inyo County, 1991. Final Environmental Impact Report- Water from the Owens Valley to Supply the Second Los Angeles Aqueduct. State Clearing House #89080705.

Resource Concepts, Inc. 1999. 1998 and 1999 Type “E” vegetation parcel inventory. Report prepared for Inyo County Water Departement and Los Angeles Department of Water and Power, November 1999.

Paine, D.P. 1981. Aerial Photography and Image Interpretation for Resource Management. John Wiley and Sons, New York.

Vina, A., A. Gitelson, A. Nguy-Robertson, and Y. Peng. 2011. Comparison of different vegetation indices for the remote assessment of green leaf area index of crops. Remote Sensing of Env. 115:3468-3478.

SECTION 9: MITIGATION



The Inyo County Water Department monitors and reports on the staus of environmental mitigation projects in the owens Valley.

Inyo County is also a partne in funding and implementing the Lower Owens River Project.

Introduction

A central role of the Inyo County Water Department (ICWD) is to monitor and report on the status of environmental mitigation projects in the Owens Valley. More than 64 projects, spread throughout the Valley, mitigate for a range of environmental impacts due to abandonment of irrigated agriculture and groundwater pumping in the Owens Valley. These improvements range in size from single-acre spring projects to the 78,000-acre Lower Owens River Project (LORP). The majority of these projects are described in the Water Agreement and associated 1991 EIR (*Water from the Owens Valley to Supply the Second Los Angeles Aqueduct*), and in the 1997 MOU (*Resolving conflicts and concern over the 1991 EIR*), which can be found on the ICWD website (www.inyowater.org).

ICWD participates in the development of new projects, evaluates the effectiveness of ongoing mitigation, and oversees modifications of existing projects that have been changed by the Inyo/LADWP Standing Committee or the courts.

This report provides background and status on all mitigation projects and other commitments in the Water Agreement. This section includes tables summarizing the origin and status of projects described in the 1991 EIR and other documents (Table 9.1).

Projects where Inyo and Los Angeles staff disagree on the status are depicted in table. Table 9.2 summarizes the status of other obligations in the Water Agreement that were not identified as mitigation. Many of these obligations are ongoing assistance, consultation, land management, and planning efforts that LADWP has committed to. In addition, this chapter described two projects in Big Pine and the LORP overseen by the Water Department that are not mitigation under the Water Agreement but could benefit existing mitigation projects. In addition, several potential E/M project concepts prepared by Inyo County and presented to the Technical Group are desribed.

Mitigation Projects Origins and Background

The Los Angeles Department of Water and Power (LADWP) is legally obligated to implement mitigation projects to enhance recreation, diversify land use, improve or create habitat for wildlife and vegetation, and mitigate for a range of impacts in the Owens Valley. Descriptions of mitigation projects are found in the collection of documents that govern.

the activities of the LADWP in the Owens Valley. These documents were developed over time and include the 1991 Long Term Water Agreement and associated EIR, the 1997 MOU, and other court stipulations and orders

The Los Angeles Department of Water and Power (LADWP) is legally obligated to implement mitigation projects to enhance recreation, diversify land use, improve or create habitat for wildlife and vegetation, and mitigate for a range of impacts in the Owens Valley. Descriptions of mitigation projects are found in the collection of documents that govern the activities of the LADWP in the Owens Valley. These documents were developed over time and include the 1991 Long Term Water Agreement and associated EIR, the 1997 MOU, and other court stipulations and orders.

Although the environment of the Owens Valley had begun to suffer the effects of large-scale water diversions to supply water to Los Angeles Aqueduct beginning in 1913, all of the mitigation projects described in this report mitigate for impacts after 1970 that resulted from the operation of the second Los Angeles Aqueduct. These mitigation projects will to a certain degree repair, restore and compensate for adverse impacts from the operation of the second aqueduct.

More than 58,000 acres of groundwater dependent vegetation is found in the Owens Valley. Between 1970 and 1990, increased groundwater pumping, and the resulting fluctuations in groundwater table, has had a significant effect on more than 1,000 acres; 655 acres of groundwater dependent vegetation has entirely died-off. Most of the mitigation projects include goals to improve vegetation in the Owens Valley.

Mitigation Alternatives

With respect to mitigation, the Water Agreement generally follows the framework of the California Environmental Quality Act (CEQA), which allows several alternative forms of mitigation. These are generally considered in sequence (i.e., with preference given to avoidance first and compensation last). These actions include:

- **Avoiding the impact altogether by not taking a certain action or parts of an action.**
  Local example: Well on/off provisions. When soil water and projected contribution from precipitation is inadequate to maintain vegetation, wells are not operated.
- **Minimizing impact by limiting the degree or magnitude of the action and its implementation.**
  Local example: Shutting down pumping wells, as was done at Five Bridges when groundwater drawdown degraded nearby vegetation.
- **Rectifying the impact by repairing, rehabilitating, or restoring the impacted environment.**
  Local example: Revegetation and regreening projects, which compensate for the effects of the abandonment of irrigated agriculture leading to areas of blowing dust and dirt.
- **Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.**
  Local example: Salt cedar control, ongoing irrigation of fields
- **Compensating for the impact by replacing or providing substitute resources or environments.**
  Local example: Lower Owens River Project, civic projects, recreational

facilities, habitat enhancement projects, and fish hatcheries.

Origin of Mitigation Efforts

Mitigation planning, development, and implementation are ongoing activities that are undertaken cooperatively with LADWP; Inyo County and LADWP developed the majority of mitigation projects in the Owens Valley during three discrete periods of time in response to judgments or potential legal and administrative actions:

Environmental Projects (EP), 1970-1984

Between 1970 and 1984, LADWP committed about 10,000 acre-feet of water annually to implement twelve environmental projects (Table 6.1). The primary purpose of these projects was to restore habitat that had been negatively affected or lost due to water gathering. These areas may have exhibited vegetation changes, or reduction in wildlife using a particular habitat. The goal was to provide a regular water supply to habitats such as ponds, lakes, sloughs, springs, and the Lower Owens River (LOR). Objectives differed between the projects, depending on the type of the impact that had occurred, but the overall goal of the environmental projects was to improve wildlife, forage, fisheries, and public recreation facilities.

In many instances it was impractical to mitigate at the original impact site, or the affected area was not well defined, or the impact was sporadic. In these cases a project was constructed at a site that would best accommodate the goals of the mitigation.

Enhancement/Mitigation Projects 1985-1991

The Enhancement Mitigation (E/M) projects are environmental projects that were implemented prior to adoption of the 1991 EIR (Table 6.2). The Water Agreement required that all E/M project continue. Some of these projects were included in the 1991 EIR as mitigation for impacts due to LADWP's water gathering activities.

These projects addressed a number of environmental impacts and filled community needs. Projects include the revegetation of abandoned agricultural lands and lands that experienced vegetation loss due to groundwater pumping, delivery of water for public parks, improved wildlife habitat, and a partial rewatering of the lower Owens River. For each project, specific goals and objectives were established and environmental documentation was prepared in accordance with CEQA.

Additional Mitigation Projects, 1997 MOU and 2004 Amended Stipulation and Order

The 1997 MOU identifies *Additional Commitments* that include studies, evaluations and commitments to specific issues (Section III.A). One of the issues brought forward in the MOU in Section III.A.3. is *Additional Mitigation.* This requires that LADWP allocate 1,600 acre-feet of water per year to implement on-site mitigation measures at Hines Springs that were identified in the 1991 EIR, and on-site or off-site mitigation at Fish Springs, Big and Little Seeley Springs and Big and Little Blackrock Springs. Also assigned is a commitment to improve wildlife habitat

- **Yellow-Billed Cuckoo (YBC) Enhancement Mitigation Project:** These projects located near Big Pine on Baker Creek and Hogback Creek near Lone Pine were designed to enhance vegetation conditions and direct land management actions to enlarge and enhance existing YBC habitat.

Table 9.1 Status of Environmental Projects.

Description	Impact	Status
Farmers Ponds: Water is provided each fall of each year to offer habitat for migrating waterfowl. The Project is two miles north of Bishop just off Highway 6.	The Laws area has lost all or part of its vegetation cover due to increased groundwater pumping, abandonment of irrigated agriculture to supply water to the second aqueduct, livestock grazing and drought.	East of the main Farmers Pond are a series of four cascading spreading basins that drain overflow from the main Farmers Pond. These additional basins, which are typically dry, along with another spreading basin two miles west, where the C-Drain intersects Riverside Road, might be used as replacement or substitute mitigation for the McNally ponds. It is expected these additional ponds could be supplied annually, as opposed to the existing McNally Pond, which now receives water only when providing water would satisfy LADWP's operational needs. A formal mitigation substitute proposal will be developed and presented to the Technical Group. A substitute or replacement project would need to provide equal or greater mitigation value.
Buckley Ponds: Water is provided for a warm-water fishery and waterfowl area, which is located three miles southeast of Bishop.	Non-specific compensation.	This main pond and string of other ponds were created in the 1950's. In 1976 LADWP and CDFW created a Habitat Management Plan. The string of ponds were treated and excavated in 2012-14 to remove emergent vegetation.
Saunders Pond: Water is provided to a warm-water fishery and waterfowl area, which is located five miles southeast of Bishop.	Non-specific compensation.	Implemented and ongoing.
Millpond Recreation Area: Water is provided either by creek flow or a well at the site. The project is located five miles northwest of Bishop.	Non-specific compensation.	Implemented and ongoing.
Klondike Lake: Improve waterfowl habitat and provide recreation in the Big Pine area. The project is located 2 mile north of Big Pine.	Non-specific compensation.	Motorized recreation on the lake has been limited to prevent the introduction of the freshwater quagga mussel. LADWP reports runoff year 2017-18 water supplied was 1,496 af

		In 2004 the water supply allocated the lake was reduced from 2,500 to 1,700 af, while still requiring that LADWP maintain a described lake level, and also assure that native pasture and wetland habitats adjacent to Lyman ditch, which feeds the lake, were preserved. The 800 af difference was made up by providing water to seasonally fill the Big Pine Ditch, and by providing 200 af of water for flood irrigation immediately south of the Lake to attract shore birds and waterfowl .
Klondike South Shore Waterfowl Management Area (160 acres):	Compensation for the inability to supply a full allocation of water to the Klondike Lake Project.	The elevation between the Lake and the Project is minimal and sediment in the water conveyance limited flow to the project. A new water gate was installed and from the 2011-12 runoff year to present, a full 200 af allocation was supplied. With the use of the new water gate new habitat has been created and is being used by desired species; however the original project area receives little water and is almost completely tule chocked. The County requested that LADWP prepare a habitat management plan prepared for the project. It has been the practice of LADWP to release water to the project area during waterfowl migration season, usually beginning releases in late winter.
Tule Elk Field: Provides water in summer to field used by Tule Elk. Located between Fish Springs Road and Tinemaha Reservoir.	Non-specific compensation.	The water supply to this project has been reduced since 2002. ICWD does not believe the project water provided is sufficient in all years to meet project goals, especially in the area east of highway 395. In 2016-17 high runoff allowed flooding of the fields east of cultivated fields east of Highway 395.
Big and Little Seeley Spring: Two miles south of Tinemaha Reservoir LADWP well number 349 near the Owens River discharges water into a pond approximately one acre in size. This pond provides a temporary resting place for waterfowl and shorebirds when the pumps are operating or Big	Non-specific compensation.	Riparian vegetation has become established around this pond.

Seely Spring is flowing.		
Calvert Slough: Water is provided to maintain habitat in a small pond and marsh area near LADWP Aqueduct Intake.	Non-specific compensation.	LADWP reported that low flows in the creek do not allow supplying the project because of high ditch losses and the off status of the two wells upstream of the project. No water was supplied to this project for seven years (1998-2004). The enhancement of the Calvert Slough wetland was a possible Additional Mitigation measure, but was not selected as one of the final 1600 acre-foot projects.
Little Blackrock Spring: Water is diverted from ditch to maintain wetland area at original spring site; west of the aqueduct intake.	Ground water pumping has lowered depth to water to a level where springs and seeps no longer flow. Associated riparian and wetland vegetation is lost.	The Technical Group does not have a plan for monitoring flows or vegetation at springs and seeps. Ecosystem Sciences had developed an inventory of springs and seeps. According to the MOU, the inventory should provide baseline data adequate for monitoring change.
Lone Pine Pond: Water is provided by natural seep or spring flow in river with supplemental releases from Alabama Gates (now incorporated in the Lower Owens River E/M Project). The project is located just north of Lone Pine Narrow Gauge Road.	Non-specific compensation.	Included in the LORP. The Lone Pine Ponds are managed under the LORP Monitoring, Adaptive Management, and Reporting Plan as a component of the River-Riverine system. With the 40 cfs maintained flow, the ponds have largely converted to marsh.
Lower Owens River Rewatering Project: Water releases began in 1975 to provide year-long minimal flows along the lower Owens River, as well as releases to Twin Lakes, Billy Lake, and Thibaut Ponds. The goal is to maintain	The Lower Owens Rewatering Project was initiated in 1986 by the LADWP and Inyo County to improve habitat for shorebirds, waterfowl, and fish in the river	Superseded by the Lower Owens River Project. Billy lake is managed under the LORP Monitoring, Adaptive Management, and Reporting Plan as an Off River Lake.

waterfowl, marsh, shorebird, and upland gamebird habitat, as well as provide for a warm-water fishery. The project has now been replaced by the Lower Owens River E/M Project, which provides water to all of the formerly dry stretch of the Owens River. The 78,000-acre project site is located east of the towns of Aberdeen, Independence, and Lone Pine.	corridor and at the Delta. The project was one of 25 E/M Projects jointly implemented between 1985 and 1990.	
Diaz Lake: A supplemental water supply is provided to Diaz Lake recreational area. The accounting of water supplied to this project has been revised as part of the MOU 1600 ac-ft. projects described below. The lake is three miles south of Lone Pine.	Non-specific compensation.	Under the Additional Mitigation project description, Diaz Lake will be supplied a secure source of water, which reduces dependence on water pumped by Inyo County up to 250 afy. LADWP's lease with Inyo County (Lease No. 1494, in effect until June 30, 2015) has been updated to reflect these additional water supply commitments and accounting requirements of this project agreed to by LADWP.

Table 9.2 Status of E/M Projects.

Description	Impact	Status
Millpond Recreation Area Project: Located west of Bishop, was the first E/M measure to be completed. Since October 1985, funds have been provided to operate the recreation area's sprinkler irrigation system that waters 18 acres of the community park, including two softball fields.	Non-specific compensation.	Implemented and ongoing.
Shepherd Creek Alfalfa Lands Project: Revegetated 198 acres of abandoned cropland adjacent to U.S. Highway 395 with sprinkler-irrigated alfalfa and windbreak trees. The property between Lone Pine and Independence had only sparse annual vegetation since 1976, and was a source of blowing dust creating a traffic hazard.	Primarily Dust mitigation.	Alfalfa planted and maintained on approx. 185 acres. LADWP reports that water supply for runoff year 2017-18 was 926 af
Klondike Lake Project: Previously, the 160-acre lake located north of Big Pine had been filled only during above-normal runoff years. Now, less than 1,700 af of water maintains the lake year-round. Benefits include nesting and feeding areas for waterfowl, and recreation including skiing, windsurfing, and other water sports in summer months. Due to	Non-specific compensation.	Due to the shape and size of the Klondike lakebed, the full volume of water (2,200 af) allocated to the project was more than the lake required, so the project was modified to permanently reduce the water allotment. The balance of this unused water allocation was apportioned the Big Pine Ditch System and the Klondike South Shore Habitat Area. LADWP reports that water supply for runoff year 2017-18 was 1,552 af

the shape and size of the Klondike lakebed, the full volume of water (2,200 af) allocated to the project was more than the lake required, so the project was modified to permanently reduce the water allotment. The balance of this unused water allocation was apportioned the Big Pine Ditch System and the Klondike South Shore Habitat Area.		
Laws Historical Museum Project: Provides a regular water supply to improve the native vegetation on a 21-acre parcel, provide for irrigated pasture on 15 acres, and establish windbreak trees, all adjacent to the museum.	Non-specific compensation.	Implemented and ongoing.
640 acres near Laws: Revegetate with non-groundwater dependent native plants (potential project that would require Standing Committee approval to implement).	Between 1987 and 1988, two wells in the Five Bridges area that were pumped to supply water to enhancement mitigation projects contributed to a lowering of the water table under riparian and meadow areas along Owens River. Approximately 300 acres of vegetation were affected, and within this area, approximately 36	The Standing Committee has not evaluated the need for mitigation of this area. Desert Aggregates expanded gravel mine operation includes at least 174 acres in the western part this potential mitigation site.

	acres lost all vegetation due to a wildfire. EIR v1 (10-58).	
Laws-Poleta Native Pasture Project: Provides water for irrigation of approximately 216 acres of sparsely vegetated land to reestablish native vegetation on abandoned pasturelands and increase livestock grazing capabilities.	The Laws area has lost all or part of its vegetation cover due to increased groundwater pumping, abandonment of irrigated agriculture to supply water to the second aqueduct, livestock grazing and drought.	One pasture, 2.5 miles north of Laws and just east of Hwy. 6 (160 acres, parcel 44) has achieved good pasture cover on 65-70% of the eastern half of the parcel. The other 60-acre pasture two miles southeast of Laws (parcel 138) adjoins the McNally Ponds and Pasture project. Due to the configuration of release points and topography, not all of this pasture can be effectively irrigated. LADWP had reported that they couldn't separate this project's water accounting from adjacent irrigated parcels. LADWP reports that water supply for runoff year 2017-18 was 1,573 af
McNally Ponds and Pasture: To provide a regular water supply to existing ephemeral ponds (60 acres) in the Laws area to create waterfowl habitat, and to provide spring and summer irrigation to enhance and maintain existing vegetation on 300 acres of pastureland.	The Laws area has lost all or part of its vegetation cover due to increased groundwater pumping, abandonment of irrigated agriculture to supply water to the second aqueduct, livestock grazing, and drought.	The ponds served as a flooding basin this year and the ponds, as well as adjoining basins were filled to capacity. The adjacent 100-acre pasture to the east is maintaining patchy grass cover. The ponds have received their full share of water only 3 times since 2004. Water for the pasture, east of the ponds, can only be supplied infrequently when the Lower McNally Ditch is run. To provide substitute mitigation, the Inyo Supervisors have approved diversion of water from Bishop Creek Canal to supply pasture north Riverside Drive. During the 2017-18 runoff year the ponds received 753 af. McNally Ditch losses were estimated by LADWP to be 1,603 af.
Independence Pasture Lands/and Spring Field Projects: Provides approximately 910 acres of abandoned croplands and sparsely vegetated land with irrigation to create native pasturelands and provide water to native vegetation. Flood irrigation converted sparsely vegetated land east of Independence into	Revegetation project to mitigate for impacts including dust in town caused by groundwater pumping and surface water diversions. Provides irrigation for pasture or alfalfa.	Site topography prevents flood irrigation from reaching some portions of the project. LADWP reports runoff year 2017-2018 water use was 1,931 af for the pastureland and 1,196 af for the Springfield.

productive native pasture. The project mitigated a source of blowing dust and stabilized soil previously affected by severe wind erosion.		
Lone Pine Riparian Park/Richards Field: Provides a continuous water supply to a ditch running through Russell Spainhower Park then east under the highway to supply water to Lone Pine Woodlot and Richards and Van Norman Fields projects.	Water conveyed through the park provides irrigation to lands formerly removed from irrigation.	LADWP, in their annual Owens Valley Report, lists water use for this project and Richards Field together. In 2017-18, water use reported for these projects was 450 af, which includes conveyance losses.
Van Norman Field (170 acres) and Richards Field (160 acres): Provides surface and pumped water to establish pastureland and increase livestock grazing capabilities on abandoned agricultural land.	Regreening project implemented to enhance the aesthetics of abandoned agricultural or pasture lands in areas around the town. Water is supplied from LADWP to promote and maintain vegetation.	A replacement well was drilled in the fall of 2012 and began production in April 2014. The new well is located in a position that should allow the establishment of additional acres of pasture. In 2013, as part of an E/M evaluation, Inyo County and LADWP agreed to expand the project to include irrigating an adjacent 10 acre parcel operated as a school farm by Lone Pine High School. On April 29, 2014 the Standing Committee agreed to modify the Van Norman Field Enhancement/Mitigation (E/M) Project by adding approximately ten acres of the Lone Pine High School Farm on to the Van Norman Field E/M Project. The total acreage of the modified Van Norman Field E/M Project is now 170 acres. The additional acres will be irrigated pasture. The total annual water supply for the project will remain 480 acre-feet, which will result in an annual water distribution within the project boundaries of approximately 2.8 acre-feet per acre. LADWP reports water use for runoff year 2017-2018 was 453 af
Lone Pine Sports Complex: At the request of the community, portions of the Lo-Inyo Elementary School and vacant	Community enhancement project.	Includes 3 irrigated ball fields and two multipurpose fields, with an irrigated area totaling 12.5 acres Asphalt replaced the former dirt parking area in 2013 and 139 parking spaces

LADWP property were converted to an outdoor sports complex consisting of baseball fields, soccer fields, and related parking, picnic and park areas.		were outlined
Independence and Lone Pine Woodlots: Two irrigated projects in Lone Pine and Independence provide a greenbelt and are harvested as sustainable source of firewood for those in need.	Regreening project implemented to enhance the aesthetics of abandoned agricultural or pasture lands in areas around the town. Water is supplied from LADWP to promote and maintain vegetation.	Lone Pine FFA is managing both woodlot projects, with some wood going to Independence residents and other wood being sold in Lone Pine to support FFA activities. An operations plan is needed based on management guidelines agreed to by Inyo Co. and LADWP. Drought stress resulted in dieback of cottonwood in both lots. Many of the larger trees show dieback. LADWP thinned the trees in 2016-17. The Independence lot was supplied 92 af and Lone Pine 61 af during 2017-18.
Independence Roadside Rest: This project consisted of planting and maintaining shade and windbreak trees and grass, installation of an irrigation system, and placement of picnic table on a 1/2-acre site south of the town of Independence. The project improves a previously barren parcel at the entrance to town.	Enhancement project to improve aesthetics on LADWP lands near towns.	Implemented and ongoing.
Eastern California Museum: This project enhanced the appearance of the Eastern California Museum grounds in Independence. It consisted of a small pond, trees, expanded lawn areas, and installation of an irrigation	Community project.	Implemented and ongoing. Flooding in 2017 resulted in natural stream alteration.

system.		
Town Regreening Projects: Three projects designed to enhance the aesthetics of abandoned agricultural or pasture lands in areas around the towns of Big Pine, Independence, and Lone Pine. Lone Pine has been implemented; Big Pine and Independence should come into operation in 2014.	Non-mitigation E/M project. These projects were implemented to enhance the aesthetics of abandoned agricultural or pasture lands in areas around the towns of Big Pine, Independence, and Lone Pine. Water was supplied from LADWP facilities to promote and maintain vegetation.	In 2015-2016 it was evident that many trees have died in Lone Pine, Big Pine, Independence, and Bishop due to reductions or elimination of irrigation during recent years of drought.
Lower Owens River Rewatering E/M Project: This project provided up to 18,000 AFY of continuous flow of water in the previously dry (1913-1986) portion of the river channel, creating a warm water fishery and wildlife habitat in the southern Owens Valley. The project also supplies water to five small lakes along the river route providing improved waterfowl habitat in the region. This project has been superseded by the Lower Owens River Project, which was fully implemented in December 2006.	The Lower Owens Rewatering Project was initiated in 1986 by the LADWP and Inyo County to improve habitat for shorebirds, waterfowl, and fish in the river corridor and at the Delta. The project was one of 25 Enhancement/Mitigation Projects jointly implemented between 1985 and 1990.	Superseded by the Lower Owens River Project. Billy lake is managed under the LORP Monitoring, Adaptive Management, and Reporting Plan as an Off River Lake.
Hines Springs: Create 1-2 acres of aquatic, riparian, and marshland habitats. Project will serve as a	Ground water pumping has lowered depth to water to a level where	The initial concept, to provide water at the spring vent, proved impractical. MOU Parties entered into an ad hoc process and agreed to build two projects at the spring site; 1) water from Well 355 now supplies water to a small pond

research project on how to reestablish a damaged aquatic habitat.	springs and seeps no longer flow. Associated riparian and wetland vegetation is lost.	used by livestock. The solar power source designed to power Well 355 would be insufficient, so the project was modified to include a new above-ground power line to the project; 2) Aberdeen Ditch. A 2700’ pipeline now supplies water to a ditch just southeast of the former spring to be used by livestock. The ground in the area is highly permeable so conveyance of the water along natural contours has proven challenging. To overcome the losses LADWP installed PVC pipe to extend the flow, but even this has proven ineffective. ICWD has suggested installing T-valves along the length of the extension pipe to better direct water. This was rejected by LA. 1600 acre-feet were released to the projects in 2017-18, so no water was required to be released at Warren Lake.

- **1600 acre-feet of water:** Commits 1600 acre-feet of water at seven sites. The initial project recommended by the MOU consultant was replaced by seven projects prepared by an Ad Hoc group of Inyo, LADWP, and CFG staff, local lessees, and representatives of the Owens Valley Committee and the Sierra Club. A report describing these projects can be found on the ICWD website.

Additional Mitigation Projects 2016 Annual Monitoring Report

The Additional Mitigation Projects directed a five-year monitoring program for the eight projects. These projects were monitored for water deliveries, and assessed using pedestrian surveys, photo points, and vegetation and flooded extent is mapped. Data collections, and monitoring, were tasks shared by Inyo County and LADWP. LADWP was required to document the five-year finding in a report. This report is found in their 2017 Annual Owens Valley Report (Section 3.2.1.1).

Revegetation projects in the 1991 EIR and Irrigation in the Laws Area MND

Revegetation projects mitigate for environmental damages due to groundwater pumping and/or discontinuation of agriculture. The 1991 EIR identified land that had become barren due to changes in surface or groundwater management (Figure 9.1). A mitigation plan prepared by the Inyo/Los Angeles Technical Group for these projects dates was submitted to the Standing Committee in 1999 (www.inyowater.org).

2018 Revegetation Status Table

The Environmental Impact Report (EIR) pertaining to the second Los Angeles aqueduct identified land that had become barren due to changes in surface or groundwater management (City of Los Angeles Department of Water and Power and County of Inyo 1990). Table 9.3 shows the status of revegetation projects relative to prescriptions found in the 1999 *Revegetation Plan for Impacts Identified in the LADWP, Inyo County EIR for Groundwater Management (99 Plan)*, as well as projects related to the 2003 *Irrigation in the Laws Area* MND (ILA).

In 2016-17, the County and LADWP had disagreed over the authority of the 99 Plan. Although the MOU required such a plan be developed by 1999, LADWP claimed that the 99 Plan was an unapproved draft. This assertion, if accurate, would have relieved LADWP from the requirement that wells W385 and W386, in the Five Bridges area, be permanently shut off. Operation of these wells in the late 1980's led to significant native vegetation decline. The 99 Plan includes prescriptions to recover the Five Bridges vegetation; including permanently shutting off W385 and W386. In 2018, after further consideration, LADWP agreed with the County that the 99 Plan was developed by the Technical Group and presented to the Standing Committee.

LADWP, in their annual report has asserted that a number of the revegetation projects have been completed, including the Five Bridges revegetation project. In 2018, Inyo County made a site assessment of the Five Bridges Impact Area and based on multiple lines of evidence it is shown that the Five Bridges Impact Area has not achieved 99 Plan goals. This evidence includes vegetation cover and species composition measurements along field transects, satellite remote sensing of vegetation indices, vegetation community mapping from aerial photography, and comparison of conditions within the Impact Area to nearby areas of similar vegetation.

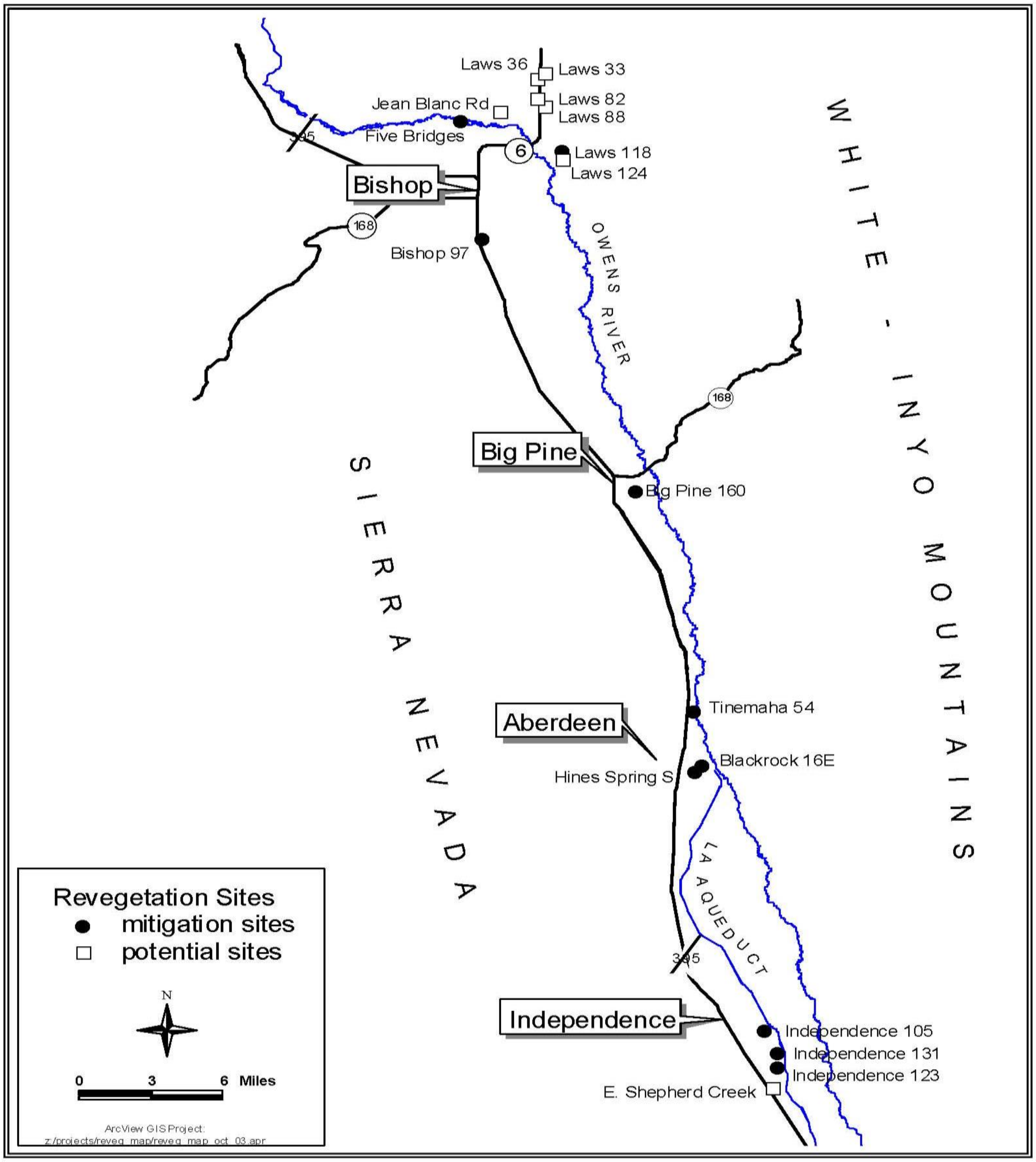


Figure 9.1. Locations of revegetation projects in the Owens Valley described in the 1991 EIR.

Table 9.3. Status of Revegetation Projects 2018

					Percent Live Native Cover		Number of Species		Recruitment Success
Guidance*	**Project name**	**Acres**	**Impact[3]**	**Met goal**	**Goal % (90%)**	**Reported % (survey year)**	**Goal (75%)**	**Reported**	**25% of surveyed hits**
91 EIR/99 MP	LAWS 118	107	ABAG	NO	11.5 (10.4)	2	11 (8.25)	Not reported	Not reported
91 EIR/99 MP	BISHOP 120	124	ABAG	NO	15 (13.5)	11 (2017)	12 (9)	4	Not reported
91 EIR/99 MP	FIVE BRIDGES	300	GP	NO	60 (54)	7/35 at 2 sites (2016)	4 (3)	2/6 at 2 sites	Not reported
91 EIR/99 MP	BIG PINE 20	20	ABAG	NO	17.7 (15.9)	Not surveyed	10 (7.5)	Not surveyed	Not reported
91 EIR/99 MP	BIG PINE 160	211	ABAG	NO	17.7 (15.9)	3 (2016)	10 (7.5)	9	Not reported
91 EIR/99 MP	TINEMAHA 54	0.4	GP	NO	33 (29.7)	1 (2016)	3 (2.3)	Not reported	Not reported
91 EIR/99 MP	BLACKROCK 16E	7.5	GP	NO	34 (31.5)	31 (2010)	6 (4.5)	5	Not reported
91 EIR/99 MP	HINES SPRINGS SOUTH	9	GP	NO	35 (31.5)	Assessed 2015	4 (3)	Not surveyed	Not reported
91 EIR/99 MP	INDEPENDENCE 105	13.4	GP	UNK	17 (15.3)	23 (2017)	4 (3)	3	Not reported
91 EIR/99 MP	INDEPENDENCE 123	42	GP	UNK	17 (15.3)	17 (2006)	4 (3)	4	Not reported
91 EIR/99 MP	INDEPENDENCE 131 N	23	GP	UNK	17 (15.3)	16.2 (2012)	4 (3)	5	Not reported
91 EIR/99 MP	INDEPENDENCE 131 S	50	GP	NO	17 (15.3)	6.2 (2012)	4 (3)	Not reported	Not reported
ILA	LAWS 90	101	ABAG	NO	10 (9)	Not surveyed	10 (7.5)	Not surveyed	Not reported
ILA	LAWS 94	40	ABAG	NO	10 (9)	Not surveyed	10 (7.5)	Not surveyed	Not reported
ILA	LAWS 95	46	ABAG	NO	10 (9)	Not surveyed	10 (7.5)	Not surveyed	Not reported
91 EIR/99 MP	LAWS 118	140	ABAG	NO	10 (9)	3 (2016)	8 (6)	Not reported	Not reported
ILA	LAWS 118/129	65	ABAG	NO	10 (9)	3 (2016)	8 (6)	Not reported	Not reported
ILA	LAWS 27 (SEED FARM)	118	ABAG	NO	10 (9)	Not surveyed	8 (6)	Not surveyed	Not reported

YES	Meeting Goals
YES	Cover and composition reported to have met goals, but will need to be verified by ICWD. Recruitment goal has not been established
NO	Not meeting goals

*1991 EIR; 99 Mitigation Plan for revegetation; ILA, Irrigation in the Laws Area MND

Bishop 120—mitigated area vs. unmitigated area (June 2016)


Bishop 120—unmitigated south section. (April 2015)

Bishop 120—eastern drip irrigated native vegetation planting (May 2018)

Laws 118— (April 2015)

Big Pine 160 (April 2015)

Mitigation Project Status Table

The current status of all mitigation measures and other requirements of the Water Agreement and associated documents is summarized in Tables 6.1 and 6.2. The tables below contains general information about mitigation projects identified in the 1991 EIR and other agreements including their origin, description, impact mitigated, and status as of April 2017.

The Mitigation Origin columns list the project starting point and any subsequent consideration of the project over time. Many of the Enhancement Mitigation projects (E/M) that were implemented prior to the 1991 EIR were continued. Some of the pre 1985 Environmental Projects (EP) are identified as mitigation in the EIR. The Impact Number, if provided, is the 1991 EIR, and associates the mitigation measure with the pre-project setting and type of environmental impact being mitigated; it also describes the significance of the environmental impact.

Inyo County and LADWP agreed on the status of all but four of the mitigation projects, and one of the other outside commitments. Our disagreements stem from different interpretations of project goals, mitigation requirements, and commitments to obligations. The County contends that Calvert Slough should be provided a year-round flow of water in order to maintain habitat, while LADWP only provides water when it is operationally convenient. In the case of the Independence 131 revegetation project, the disagreements stems over whether the revegetation requirement is confined to one or two sections of the parcel. Disagreement over the LORP is in regard to achieving project goals. LADWP indicates that the LORP can be considered as meeting goals, while the County contends the project has not achieved a healthy, functioning riverine-riparian ecosystem, and has not met a number of specific goals including the continuation of sustainable livestock grazing and recreation. For the reason that McNally Ponds and Pasture has received water only five times in 27 years and is not providing the mitigation values specified in the 1991 EIR, Inyo County deems this project as not meeting goals. LADWP argues that past practices of not supplying the McNally Ponds and Pasture project due to limited water availability relieves them of meeting goals in all years. Finally, Inyo County believes the water agreement requires LADWP to open Haiwee Reservoir to the public for recreation. LADWP contends that security threats exist that prohibit public access. The County argues that if Haiwee is off-limits to the public then a substitute recreation plan be developed on another water body in the southern Owens Valley.

The Mitigation Project Status table is an active document. This reporting is as of 2016-17. The standing of projects relative to goals, or changes in mitigation requirements, will result in a reassessment of individual project status. For example, it is not clear if any of the 91 EIR revegetation projects can be considered complete. The mitigation plan for revegetation sets goals for recruitment. No recruitment studies have been performed on any of the parcels. A revision of the revegetation plan may move some of the revegetation projects from not meeting goals to complete. Or, in another example, the development of substitute mitigation for the McNally Ponds and Pasture could satisfy both Inyo and LADWP that the project is implemented and ongoing.

1991 EIR	1991 EIR Env Proj	1991 EIR E/M Proj	Rev Proj	1997 MOU	LADWP MITIGATION PROJECT COMMITMENTS	Com.	Ongo Nec/ Req[2]	Imp and Ongo-ing[3]	Fully Imp but not at goals[4]	Not fully imp[5]
				X	Aberdeen Ditch Project (Additional Mitigation Projects Developed by the MOU Ad Hoc Group (MOU Section III.A.3))			X		
X	X				Big and Little Seely Springs (1 acre pond near Well W349; EIR Impact 10-14, EIR Table 5-2)			X		
X			X		Big Pine Area Revegetation Project (160 acres; EIR Impact 10-19)				X	
X			X		Big Pine Area Revegetation Project (20 acres; EIR Impact 10-19)				X	
X					Big Pine Ditch System (EIR Impact 10-19)			X		
X		X	X		Big Pine Northeast Regreening (30 acres; EIR Impact 10-11, EIR Table 5-3)			X		
X			X		Bishop Area Revegetation Project (124 acres; EIR Impact 10-16)				X	
X			X		Blackrock 16E Revegetation Project (EIR Impact 10-11)	X				
X	X				Blackrock Hatchery (EIR Impact 10-14)			X		
X	X				Buckley Ponds (EIR Impact 10-5 and 11-1, EIR Table 5-2)			X		
X	X				Calvert Slough (EIR Impact 10-5, EIR Table 5-2)			X		
X					Olancha-Cartago Irrigated Fields			X		
X	X			X	Diaz Lake (EIR Table 5-2, Additional Mitigation Projects Developed by the MOU Ad Hoc Group (MOU Section III.A.3))			X		
X		X			Eastern California Museum (EIR Tables 4-3 and 5-3)			X		
X	X				Farmers Pond (EIR Impact 10-5, 10-18, 11-1, EIR Table 5-2)			X		
X	X				Fish Springs Hatchery (EIR Impact 10-14)			X		
X			X		Five Bridges Area Revegetation Project (300 acres; EIR Impact 10-12)				X	
				X	Freeman Creek Project (Additional Mitigation Projects Developed by the MOU Ad Hoc Group (MOU Section III.A.3))			X		
X				X	Hines Spring (1 to 2 acres, EIR Impact 10-14), implemented as the Additional Mitigation Projects Developed by the MOU Ad Hoc Group (MOU Section III.A.3)			X		
X			X		Hines Spring South (EIR Impact 10-11)				X	
				X	Hines Spring Well 355 Project (Additional Mitigation Projects Developed by the MOU Ad Hoc Group (MOU Section III.A.3))			X		
				X	Homestead Project (Additional Mitigation Projects Developed by the MOU Ad Hoc Group (MOU Section III.A.3))			X		
X			X		Independence 105 (EIR Impact 10-13)	X				
X			X		Independence 123 (EIR Impact 10-13)	X				

X			X		Independence 131 (EIR Impact 10-13)	LA			IC	
X		X			Independence Ditch System (EIR Table 4-3)			X		
X		X	X		Independence East Side Regreening Project (23 acres; EIR Impact 10-11, EIR Table 5-3)			X		
X		X			Independence Pasturelands and Native Pasturelands (610 acres; EIR Impact 12-1, EIR Tables 4-3 and 5-3)			X		
X		X			Independence Roadside Rest Area (0.5 acres; EIR Tables 4-3 and 5-3)			X		
X		X			Independence Springfield (286 acres; EIR Impact 12-1, EIR Tables 4-3 and 5-3)			X		
X		X			Independence Woodlot (20 acres; EIR Impact 10-11, EIR Table 4-3)			X		
X	X	X			Klondike Lake Aquatic Habitat (160 acres; EIR Impact 10-5 and 11-1, EIR Tables 4-3, 5-2, and 5-3)			X		
					Klondike SSHA (Big Pine Ditch System MND)			X		
			X		LAWS 118 (19 acre portion) (Laws Type E Transfer MND)				X	
			X		LAWS 129 (Laws Type E Transfer MND)				X	
			X		LAWS 27 (Native Seed Farm) (Laws Type E Transfer MND)					X
			X		LAWS 90 (Laws Type E Transfer MND)				X	
			X		LAWS 94 (Laws Type E Transfer MND)				X	
			X		LAWS 95 (Laws Type E Transfer MND)				X	
X			X		Laws Area Revegetation Project (140 acres; EIR Impact 10-18)				X	
X		X			Laws Historical Museum Pasturelands (21+15 acres; EIR Impact 10-18, EIR Table 5-3)			X		
X		X			Laws/Poleta Native Pasture (216 acres; EIR Impact 10-16, EIR Tables 4-3 and 5-3)			X		
X	X				Little Blackrock Springs (EIR Impact 10-14, EIR Table 5-2)			X		
X		X			Lone Pine East Side Regreening (11 acres; EIR Impact 10-16, EIR Table 5-3)			X		
X		X			Lone Pine-North Lone Pine Clean Up (EIR Table 4-3)	X				
X		X			Lone Pine Riparian Park (320 acres, EIR Tables 4-3 and 5-3)			X		
X		X			Lone Pine Sports Complex (EIR Table 5-3)	X				
X		X			Lone Pine West Side Regreening (8 acres; EIR Impact 10-16, EIR Tables 4-3 and 5-3)			X		
X		X			Lone Pine Woodlot (12 acres; EIR Impact 10-11, EIR Table 4-3)			X		
X	X	X		X	LORP Project (60 miles, perhaps more than 1,000 acres)/ Lower Owens Rewatering Project)			LA	IC[6]	
X		X			McNally Ponds and Native Pasturelands (300 acres pasture, 60 acres ponds; EIR Impact 10-5 and 10-18, EIR Tables 4-3 and 5-3)			LA	IC	
X	X	X			Millpond Recreation Area (EIR Impact 10-5, EIR Table 5-2 and 5-3)			X		
				X	North of Mazourka Canyon Road Project (Additional Mitigation Projects Developed by the MOU Ad Hoc Group (MOU Section III.A.3))			X		
X					Reinhackle Spring (EIR Impact 10-14)			X		
X		X			Richards Fields (160 acres; EIR Impact 10-16, EIR Table 4-3)			X		

X	X				Saunders Pond (EIR Impact 10-5, EIR Table 5-2)			X		
X		X			Shepherd Creek Alfalfa Field (198 acres; EIR Impact 10-11, EIR Tables 4-3 and 5-3)			X		
X		X			Shepherd Creek Potential (60 acres; EIR Impact 10-11, EIR Table 5-3)	X				
X					Steward Ranch (EIR Impact 9-14)	X				
X			X		Tinemaha 54 Revegetation Project (EIR Impact 10-11)				X	
X		X			Tree Planting along Roadways (EIR Table 4-3)			X		
X	X				Tule Elk Field (EIR Table 5-2)			X		
X		X			Van Norman Fields (170 acres; EIR Impact 10-16, EIR Table 4-3)			X		
				X	Warren Lake Project (Additional Mitigation Projects Developed by the MOU Ad Hoc Group (MOU Section III.A.3))			X		
				X	Well 368 Project (Additional Mitigation Projects Developed by the MOU Ad Hoc Group (MOU Section III.A.3))			X		
64 TOTAL MITIGATION COMMITMENTS					**LADWP Totals**	**8**	**0**	**43**	**12**	**1**
					Inyo County Totals	**7**	**0**	**41**	**15**	**1**

[1]*Project has no additional commitments required (no water allotment or other financial or environmental mitigation; no continual monitoring and reporting)*
[2]*These measures are only applied when necessary (monitoring and reporting for mitigation measures for new projects, construction, etc.)*
[3]*Project is fully implemented and is currently meeting goals; however, there may be ongoing water or financial commitments or monitoring and reporting requirements*
[4]*Project is fully implemented but has not yet met prescribed goals or success criteria*
[5]*Project under development or under construction, but not fully implemented*
[6]*Inyo County- Most but not all LORP goals have been achieved (see LORP Annual Report)*

Water Agree-ment	91 EIR	91 EIR Env. Proj	91 EIR E/M Proj)	Reveg Proj	97 MOU	LADWP OTHER OBLIGATIONS	Com [1]	Ongo-ing Nec/ Req [2]	Imp and Ongo-ing [3]	Fully Imp but not at goals [4]	Not fully imp [5]
					X	Aerial Photo Analysis (MOU Section III.E)	X				
					X	Annual Report on the Owens Valley (MOU Section III.H)			X		
X						Cooperative Studies (Water Agreement Section IX)			X		
X						Dispute Resolution (Water Agreement Section XXVI)		X			
					X	Dispute Resolution and Litigation (MOU Section VI)		X			
X						Enhancement/ Mitigation Projects (Water Agreement Section X)			X		
X						Exchange of Information and Access (Water Agreement Section XVII)			X		
X						Financial Assistance- Big Pine Ditch System (Water Agreement Section XIV.E)			X		
X						Financial Assistance- General Financial Assistance to the County (Water Agreement Section XIV.D)			X		
X						Financial Assistance- Park & Environmental Assistance to City of Bishop (Water Agreement Section XIV.F)			X		
X						Financial Assistance- Park Rehabilitation, Development, & Maintenance (Water Agreement Section XIV.B)			X		
X						Financial Assistance- Salt Cedar Control (Water Agreement Section XIV.A)			X		
X						Financial Assistance- Water and Environmental Activities (Water Agreement Section XIV)			X		
					X	Financial Provisions (MOU Section IX)	X				
					X	Fish Slough (MOU Section IV)			X		
X						Groundwater Management (Water Agreement Section II)			X		
X						Groundwater Pumping on the Bishop Cone (Water Agreement Section VII)			X		

X						Groundwater Recharge Facilities (Water Agreement Section VIII)		X			
					X	Habitat Conservation Plan (MOU Section III.B)	X				
X						Haiwee Reservoir (Water Agreement Section XIII)	LA	IC			
					X	Inventory of Plants and Animals at Spring and Seeps (outside LORP Planning Area) (MOU Section III.C)	X				
	X					Laws Area Potential Mitigation-Consideration by Standing Committee (640 acres; EIR Impact 10-18)		X			
X						Legislative Coordination (Water Agreement Section XVI)			X		
					X	LORP Agency Consultation and Public Involvement (MOU Section II.D)	X				
					X	LORP EIR (MOU Section II.F)	X				
					X	LORP Implementation (MOU Section II.H)	X				
					X	LORP Monitoring and Adaptive Management Plan (MOU Section II.E)			X		
					X	LORP Permits Approvals and Licenses (MOU Section II.I)	X				
					X	LORP Plan (MOU Section II.A)	X				
					X	LORP Planning Area- Inventory of Plants and Animals at Spring and Seeps (MOU Section III.A.2)	X				
					X	LORP Pumpback System (MOU Section II.G)	X				
					X	Lower Owens Off River Lakes and Ponds (MOU Section II.C.3)			X		
X						Lower Owens River (financial commitment) (Water Agreement Section XII)			X		
					X	Lower Owens River Delta Habitat Area (MOU Section II.C.2)			X		
					X	Lower Owens River Project 1500-Acre Blackrock Waterfowl Habitat Area (MOU Section II.C.4)			X		
					X	Lower Owens River Riverine- Riparian System (MOU Section II.C.1)			X		
					X	Mitigation Plans for Impacts Identified in the 1991 EIR and the Water Agreement (MOU Section III.F)					X
X						New Wells & Production Capacity (Water Agreement Section VI)					X
X						Owens River Recreational Use Plan (Water Agreement XV.B)					X[6]

					X	Owens Valley Land Management Plans (MOU Section III.B)			X		
X						Release of City Owned Lands - Lands for Public Purposes (Water Agreement Section XV.D)		X			
X						Release of City Owned Lands- Bishop (Water Agreement Section XV.B)	X				
X						Release of City Owned Lands- Inyo County (Water Agreement Section XV.A)	LA				IC
X						Release of City-owned lands- Additional Sales (Water Agreement Section XV.C)	X				
					X	Technical Group Meetings (MOU Section III.G)		X			
X						Town Water Systems (Water Agreement Section XI)	X				
					X	Type E Vegetation Inventory (MOU Section III.D)	X				
					X	Yellow-billed Cuckoo Habitat (MOU Section III.A.1)			X		
48 TOTAL OTHER OBLIGATIONS						**LADWP Totals**	**17**	**6**	**22**	**0**	**3**
						Inyo County Totals	**15**	**7**	**22**	**0**	**4**

[1]*Project has no additional commitments required (no water allotment or other financial or environmental mitigation; no continual monitoring and reporting)*
[2]*These measures are only applied when necessary (monitoring and reporting for mitigation measures for new projects, construction, etc.)*
[3]*Project is fully implemented and is currently meeting goals; however, there may be ongoing water or financial commitments or monitoring and reporting requirements*
[4]*Project is fully implemented but has not yet met prescribed goals or success crieria*
[5]*Project under development, or under construction, but not fully implemented*
[6]*Inyo County Commitment*

Water Supplied to Enhancement/Mitigation Projects ROY 2004-2018

This table documents the amount of water applied to E/M projects in acre-feet in runoff years 2004-2017. The source of the data is LADWP's Annual Owens Valley Report. The *Normal Year Water Supply* is the allocation afforded the project in the 1991 EIR and is 14,420 acre-feet per year. That figure is what might be expected if all E/M projects were supplied their entire allocation (91 EIR Table 4-3). The totals for all years are less than expected due in part to drought and not supplying water to the McNally Ponds. From 2006-2017, the Big Pine Ditch used an average of 460 acre-feet per year, and from 2007-2013 the Klondike South Shore Habitat Area used on average 99 acre-feet per year. These projects, each of which use a portion of the original 2,500 acre-foot allocation for Klondike Lake, are not presented in the table.

The *14-Year Average Supplied* is the average supply of water provided each project. The *14-Year Actual* represents the total amount of water supplied a project over the course of 14 years. The *14-Year EIR Total* is amount of water that would have been supplied the individual projects given their full allocation over 14 normal years.

Water allocations over the past 14 years are about 30% less than expected if all years were "normal." If the McNally Ponds and Pasture project had received their full allocation in all years, the difference between expected and recorded water use would be on the order of 10% of expected total.

Table 9.4. History of water delivered to E/M projects.

Water Supplied to Enhancement/Mitigation Projects 2004-2018 in acre-feet (source LADWP Annual Owens Valley Reports)

		Runoff Year																	
Project	**Normal Year Allocation (EIR)**	**2004-05**	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**14-Year Average *Supplied***	**14-Year *Actual***	**14-Year EIR Total**	**% of EIR expected**	**Diff AF expected**
McNallyLaws/Poleta Native Pasture Lands	660	1,682	1,269	1,241	1,396	1,320	1,764	1,267	2,306	1,460	1,149	1,376	1,259	1,530	1,573	**1,471**	**20,592**	**9,240**	**55%**	**11,352**
McNally Ponds	4,000	0	1,522	1,491	0	0	0	368	857	0	0	0	0	1,500	753	**464**	**6,491**	**56,000**	**-763%**	**-49,509**
Laws Historical Museum	150	32	59	99	147	63	131	152	105	138	112	119	101	113	105	**105**	**1,476**	**2,100**	**-42%**	**-624**
Klondike Lake	1,700	1,278	1,203	314	1,201	1,195	1,169	1,195	1,086	1,144	1,515	1,600	1,411	1,496	1,552	**1,240**	**17,359**	**23,800**	**-37%**	**-6,441**
Big Pine NE Regreening	150	0	0	0	0	0	0	0	0	0	0	103	75	110	102	**28**	**390**	**2,100**	**-438%**	**-1,710**
Independence Pasture Land	2,350	2,489	3,330	2,785	3,272	2,588	1,962	2,397	2,545	2,324	1,852	1,932	1,731	1,900	1,931	**2,360**	**33,038**	**32,900**	**0%**	**138**
Independence Springfield	1,500	280	519	1,850	1,962	1,554	1,530	1,356	1,136	1,188	958	1,427	1,569	1,476	1,196	**1,286**	**18,001**	**21,000**	**-17%**	**-2,999**
Independence Ditch System	725	451	356	359	380	515	446	497	496	165	129	343	65	260	577	**360**	**5,039**	**10,150**	**-101%**	**-5,111**
Independence Woodlot	120	276	190	226	237	335	220	569	175	334	150	186	64	110	92	**226**	**3,164**	**1,680**	**47%**	**1,484**
Independence East Regreening	150	0	0	0	0	0	0	0	0	0	0	63	71	70	73	**20**	**277**	**2,100**	**-658%**	**-1,823**
Shepherd Creek Alfalfa Lands	990	1,072	1,152	1,206	1,100	1,183	1,166	1,212	1,073	1,019	884	980	872	920	926	**1,055**	**14,765**	**13,860**	**6%**	**905**
Lone Pine Park/Richards Field	1,230	916	1,085	870	570	1,012	1,037	1,037	1,194	481	416	429	344	644	450	**749**	**10,485**	**17,220**	**-64%**	**-6,735**
Lone Pine Woodlot	120	76	100	120	78	51	58	123	120	156	70	74	55	60	61	**86**	**1,202**	**1,680**	**-40%**	**-478**
Lone Pine Van Norman Field	480	337	474	512	306	28	147	102	116	97	79	343	426	481	453	**279**	**3,901**	**6,720**	**-72%**	**-2,819**
Lone Pine Regreening	95	238	180	107	232	228	283	257	298	223	216	233	211	230	107	**217**	**3,043**	**1,330**	**56%**	**1,713**
Total	**14,420**	**9,127**	**11,439**	**11,180**	**10,881**	**10,072**	**9,913**	**10,532**	**11,507**	**8,729**	**7,530**	**9,208**	**8,254**	**10,900**	**9,951**	**9,945**	**139,223**	**201,880**	**-45%**	**-62,657**

Recycled Water to Supply the Big Pine Area Revegetation (160 acres) Project in Trade for Big Pine Community Projects

Inyo County submitted a Proposition 84 grant application to the State of California Department of Water Resources (DWR), through the Integrated Regional Water Management Program (IRWMP), Round Three Implementation Funding. The County's proposed a Recycled Water for Restoration and Community Projects in Big Pine. The project was recommended by DWR for funding on October 29, 2015.

A Feasibility Study and Report (Reclaimed Water of Restoration and Community Projects in Big Pine, CA. December, 2017) was released in February 2018. The Report recommended using treated water from the Big Pine Community Services District (BPCSD) to supply LADWP with water to the Big Pine 160 acres revegetation project (BP 160) located 0.4 miles south of the BPCSD facility. The BP 160, (1991 EIR Impact 10-19) has been implemented, but is not meeting goals. LADWP stated in their 2016 Owens Valley Report that, "LADWP is in the process of developing a drip irrigation system for this site. However, a water source must be determined for this site. Potential water sources are currently being evaluated for this site."

Despite LADWP's need to develop a water supply for BP 160, and an agency-wide commitment to using recycled water, staff refused to participate in project selection, project review, or consultations concerning a potential water swap. LADWP Northern Division leadership took the position that the Feasibility Study must be completed before considering any proposal. The Feasibility Report was presented to LADWP at the January 23, 2018 Technical Group Meeting. The proposal was represented as a mutually beneficial project for the County and LADWP, in which the community of Big Pine will receive fresh water that is needed for community improvements, and LADWP will be provided recycled water to complete a mitigation project. All engineering, CEQA, and permitting, is paid for under the grant. The project could be shovel-ready by the summer of 2019.

The County requested that LADWP present its comments on the Feasibility Study to the County no later than March 16, 2018, so that the RWRCP schedule could be adhered to. On April 11, 2018 the County received a letter from LADWP responding to the Feasibility Report with blanket objections to the recycled water project. The County asked the consultant, RO Anderson Engineering, to review LADWP's comments. The consultant found many flaws in LADWP's characterization of the project, and presented these in a draft memo to the County on April 24, 2018. The County presented the consultant engineer's response to LADWP on May 10, 2018. The County seeks to work with LADWP to resolve their concerns. Project CEQA and engineering will proceed.

LORP Recreation and Habitat Improvement -- Owens River Water Trail (ORWT) Status

Inyo County produced a draft Recreation Use Plan (RUP) for the LORP in 2012. The plan was developed through an extensive community and stakeholder process. When asked what type of recreation was most needed in the LORP the majority asked for more opportunities for in-river recreation. This reaction was in part related to frustration of now not being able to access water in parts of river that were accessible pre-LORP.

With the return of a regular flow of water in the river, cattails and Bulrush (collectively referred to as “Tules”) had formed extensive thickets along the bank, effectively walling off the river and encroaching deep into the channel. This emergent vegetation limits access to areas such as the Lone Pine Ponds, which had been an open water recreation area. Respondents to the RUP questionnaire clearly wanted more open water on which to canoe, kayak, and fish. The RUP responded to this need by recommending that a key component of the RUP would be a paddle trail for non-motorized watercraft.

In 2015 the County was approached by a group looking for accessible water for disabled veterans. Outdoor activities, especially self-guided, independent recreation opportunities are therapeutic to those with limited mobility.

The Wounded Warriors Project identified the Lower Owens River just east of Lone Pine as the preferred stretch of water for developing all-abilities access to water. The group was attracted to this 6.3 mile stretch of river because it was close to services, nearer to Southern California users than other bodies of water in the Eastern Sierra, and above all it offered gentle predictable flows in a National Park like setting. The section of river was also one of the two stretches of water identified in the 2012 RUP as being able to offer the best watercraft experience. The County decided to support the Wounded Warriors project and branded the paddle route the “Owens River Water Trail.”

In order to create a proper, all-abilities water trail, tules will need to be initially cleared from parts of the river channel and periodic maintenance will be required to keep the river open. The goal is create an open water corridor of at least 10’ width throughout the trail.

Developing the ORWT by opening up blocked section of river has potential to improve water quality and reestablish diverse river-riparian habitat. The area proposed for a water trail is in a section of the Lower Owens River that has recurring water quality problems that kill fish and invertebrates. This portion of the river is mostly open, but it’s punctuated by at least 40 cross-channel tule blockages. Some of the blockages developed pre-LORP under low flow conditions; other obstructions formed when the newly rewatered river transported large woody debris that collected and formed logjams.

Upstream of these blockages the river flow slows and deep beds of fine organic sediment settle out. Under certain conditions, when the water temperature rises above mid 20˚C, and flows are elevated, these carbon rich sediments are liberated and fuel microbial growth. The resultant rise in microbial activity reduces dissolved oxygen to level that can suffocate fish.

It is hypothesized that by clearing a continuous channel, dissolved organic compounds will be transported freely and less will accumulate. The result to opening up the channel may be a more resilient river protective of the warm water fishery. This type of thinking led to the development of a proposal to the California Wildlife Conservation Board to fund a study, to explore the feasibility of clearing channel in the Islands reach of the river (seven river-miles upstream of the ORWT) for the purpose of improving water quality and creating more diverse river-riparian habitat.

It is also expected that by opening up sections of channel, some of the wet meadows that existed pre-LORP will be recovered. Removing blockages and entraining the flow should lower the water table somewhat in the adjacent floodplain. The expected effect is a return to a more diverse mix of wetland marsh, open saltgrass meadow, and woodland.

The County sought grant funding for the paddle trail, and on July 16, 2016, the California Natural Resources Agency, seeing tremendous support for the project, and the potential of this development for the region and for the State offered the County $500,032 to build the ORWT. The County accepted the grant on May 16, 2017, with the condition that before grant funds were expended CEQA would need to be completed and the County and LADWP have a lease and access agreement. Such an agreement is subject to LADWP's review of the CEQA document.

The County developed a CEQA Initial Study that indicated that the appropriate environmental analysis for the ORWT was a Mitigated Negative Declaration. LADWP however had a list of concerns that led them to require that an Environmental Impact Report be prepared. At the February 2, 2017 Standing Committee meeting LADWP agreed to underwrite the cost of completing CEQA.

The County, through an RFP process, selected Environmental Science Associates (ESA) as the CEQA consultant. The County Board agreed to contract with ESA at their September 19, 2017 meeting—contingent upon an approved CEQA funding agreement with LADWP.

The CEQA analysis will address all concerns raised by LADWP and others. The draft EIR is expected to be released in early spring 2019.

This California State Parks, Division of Boating and Waterways, held a Commissioner's meeting in the Eastern Sierra, and took a field trip to the proposed ORWT site on August 9, 2017. The Commission was impressed by the project and encouraged the County to submit a grant application to fund the improvements at the launch site of the river trail at Lone Pine Narrow Gauge Road, and at the water exit point near Keeler Bridge and Highway 136.

The County submitted a proposal and was awarded $110,000 to be used for planning, permitting, and an engineer's estimate to develop a non-motorized boat launch and take-out. Improvements include parking areas along the access roadway, turnarounds for vehicle-trailers, launch ramps, staging areas, stilling bays, vault restroom at the launch, information kiosk, fee station, and project credit signs. Any unused funds will be available for construction of work designed by this grant if work is completed within the grant term. A separate application will be sought to fund construction and installations. The improvements envisioned include short all-weather surfaced access roads that end in a vehicle turnabout.

County Proposed Additional Mitigation Projects

The Long Term Water Agreement, Section II.X. allows that, "

> *All existing enhancement/mitigation projects will continue unless the Inyo County Board of Supervisors and the Department, acting through the Standing Committee agree to modify or discontinue a project. Periodic evaluations of the projects shall be made by the Technical Group. Subject to the provisions of section VI, enhancement/mitigation projects shall continue to be supplied by enhancement/mitigation wells as necessary. New enhancement projects will be implemented if such projects are approved by the Inyo County Board of Supervisors and the Department, acting through the Standing Committee."*

Under the provisions of the Long Term Water Agreement, Inyo County proposed the following new E/M projects to the Standing Committee on May 31, 2018:

RESTORE THE VAN NORMAN FIELD WATER ALLOCATION

Need: To establish a full share of irrigation for the *Van Norman Field E/M Project*

Background: On April 22, 2014, the Standing Committee expanded the boundary of the Van Norman Field E/M project (160 acres) to include a ten-acre pasture at the high school farm; however, the project's water allocation was not increased. The project now receives 2.8 acre-feet per acre (af/ac) duty rather than 3 af/ac.

Project Description: Revise allowable pumping from sole-source exempt well 425 to allow the modified Van Norman Field E/M project (170 acres) a full allocation of 3 af/ac.

Project Scope: Amend the scope of the Van Norman Field E/M Project, to increase the water commitment from 480 af/ac to 510 af/ac.

Water requirement: Up to 30 af of additional pumping from exempt sole-source well 425. The amount of water supplied to the farm may be adjusted in any year depending on the total amount of water used for the Van Norman E/M Project. During drought conditions, water supplies may be reduced as described in the Long Term Water Agreement, sections IV.A, and X.

Effectiveness of the project: Returning a 3 af/ac duty to the Van Norman Field E/M Project will fully implement restoring abandoned pastureland at the school farm and restore full agricultural production throughout the Project.

Impact of Project: This project will create no significant impacts to the environment and will improve native vegetation and allow increased livestock production.

Project Costs: Cost of energy to pump water, which is above and beyond that which would be required to supply the existing project.

REGREEN THE BARTELL AND BLAKE PARCELS IN BIG PINE

Need: To restore irrigation to regreen two barren parcels in Big Pine. These are a 5.6 acre LADWP property on Main Street in Big Pine, and a 7.2 acre parcel at Blake and School Street.

Background: These Los Angeles-owned parcels had historically been provided irrigation, but LADWP and the County disagree over LADWP's obligation to maintain irrigation on the parcels. Rather than potentially dispute the status of these parcels under the LTWA, this project would dedicate a 3 af/ac water allocation to the parcels for a yet to be identified use.

Project Description: Develop a source of water and conveyances needed to irrigate the Bartel and Blake parcels.

Project Scope: The *Big Pine Bartel E/M Project* would provide irrigation, and conveyances, to regreen pasture, or otherwise supply water needs for vegetation on up to 12.8 acres.

Water requirement: This is a water neutral proposal in that it restores water previously allocated to the properties. Furthermore, the County offers an alternative water-neutral solution, in which recycled water supplied from the Big Pine Community Service District's wastewater ponds would be used to charge an underground drip irrigation system to the Big Pine 160 revegetation project, which is not meeting goals and is in need of a water supply. In trade a volume of water equal to that supplied Big Pine 160 would be available to irrigate the Bartel and Blake parcels and potentially provide water for other community projects.

Effectiveness of the project: Establishing irrigation and regreening these vacant weed-filled parcels in the town of Big Pine and adjacent to the Big Pine Paiute Reservation would provide civic improvement and eliminate a source of dust from abandoned agriculture.

Impact of Project: Town beautification, economic development on abandoned land, reduction of dust and weed species, and elimination of a potential future dispute.

Project Costs: TBD

PROVIDE A FIRM WATER SUPPLY FOR BISHOP COUNTRY CLUB (170 ACRES) AND MOUNT WHITNEY GOLF CLUB COURSES (60 ACRES)

Need: Provide a dedicated allocation of water for the two golf courses.

Background: These golf courses have served the area for years with a water supply that meets management requirements. Recently LADWP has threatened to cut off water to the courses or charge a rate for the water that would make it infeasible to continue operation of these community recreational resources.

Project Description: Provide a dedicated on-going water allowance for recreation, landscape, and water features.

Project Scope: The *Water for Golf Courses E/M Project* would assure that the Bishop County Club (170 acre) would have on-going seasonal irrigation. Up to 5 af/ac of pumped water could be withdrawn without charge to irrigate greens, fairways, and landscape, and the Mount Whitney Golf Club would be assured seasonal irrigation, and ditch water is readily available to maintain water features throughout both facilities.

Estimated water requirement: Water neutral, in that the *Water for Golf Course E/M Project* simply assures that water is available to these recreational resources, as it has in the past, without interruption.

Effectiveness of the project: The land associated with these recreation facilities is arguably Type E vegetation under the LTWA. This project would resolve uncertainties over their future irrigation supply caused when LADWP curtailed and threatened to begin charging for the facilities' water, and eliminate a potential LTWA dispute regarding Type E Vegetation. It would also maintain environmental benefits and water supply protections provided by the golf courses.

Impact of Project: A firm water allocation will reduce the uncertainty that landscape and water features can be maintained, allowing a greater investment in the property by the lessees. Both golf clubs along Highway 395 welcome northbound visitors and serve as a source of civic pride. Assuring a water supply would eliminate a potential future dispute.

Project Costs: No additional cost given observance of past practices.

PROVIDE A FIRM WATER SUPPLY FOR COUNTY PARKS AND CAMPGROUNDS

Need: To create a new E/M Project similar to the golf courses to ensure an ongoing water supply for County parks (total 143 aces) and campgrounds (total approximately 293 acres) not identified in the Long Term Water Agreement (LTWA), but for which LADWP has historically committed to providing water.

Background: The County operates a number of parks and campgrounds for which LADWP has already agreed to supply water, but that have no firm water allocation. Most are supplied with just enough water to maintain a sparse landscape.

Project Description: Assign a firm water supply to allow the County to continue to ensure the operation and maintenance of its parks and campgrounds throughout the County.

Project Scope: The *Water for Parks and Campgrounds E/M Project* would identify the existing source and conveyance required to improve and maintain an attractive landscape for these regionally important recreation resources. Underserved campgrounds include Portagee Joe, Independence Creek, Taboose Creek, Tinnemaha Creek, Triangle, Glacier View, Baker Creek, and Schober Lane; parks include Izaak Walton, Bishop City, Starlite, Mendenhall, Big Pine, Dehy, Independence, and Spainhower.

Estimated water requirement: Current use.

Effectiveness of the project: Providing water for recreational resources not already identified in the LTWA would eliminate a potential LTWA dispute regarding Type E vegetation and resolve uncertainties over LADWP's indication that it wants to begin charging for water.

Impact of Project: A dedicated water supply will allow for desired improvements to campgrounds and parks. Enhanced parks and campgrounds will increase visitation and contribute positively to the local economy. A firm water commitment would eliminate potential future disputes.

Project Costs: No additional cost given observance of past practices.

MAINTAIN WATER TO MONO COUNTY AGRICULTURAL LEASES (6,400 ACRES)

Need: Prevent profound ecological and economic impacts related to withdrawal of established water supply from 6,400 acres of regional ranchlands.

Background: Water has been supplied these ranchlands for the past 100-150 years. LADWP has proposed to withdrawal irrigation from thousands of widespread ranchlands in Mono County. At risk are rancher's livelihoods, and endangered species recovery plans. Based-on past experience of LADWP's agricultural irrigation withdrawal in Inyo County, we can expect that lands removed from irrigation in Mono County will dry and liberate dust, with the resulting emissions impacting the health of area residents and visitors. LADWP ratepayers have already spent millions of dollars mitigating impacts caused by withdrawing irrigation from agriculture in Inyo County. As demonstrated in the Owens Valley, it's extremely difficult and expensive to mitigate soil loss and dust emissions. In our County it has taken decades to reestablish vegetation where agriculture was abandoned. The majority of these project are still not finished, and LADWP claims that these projects are expected to take decades more to complete. This action will also impact lease operations in the Owens Valley creating compliance issues with the Long Term Water Agreement and associated plans.

Project Description: Maintain status-quo historic levels of irrigation to agricultural leases in Mono County

Project Scope: Establish a guaranteed on-going water allowance for existing agricultural leases in Mono County.

Estimated water use: Current use.

Effectiveness of the project: Although not subject to the Inyo/Los Angeles Agreement, agricultural leases in Mono County are economically linked to Inyo County lessees (which are subject to the LTWA) and the County as a whole, and affect the viability of Inyo County leases that are subject to the Water Agreement. Many of the Mono County leases serve as summer pasture for Inyo cattle. As such, the viability of Inyo County agriculture contemplated in the LTWAs is tied to the viability of the Mono County leases. Maintaining irrigation on Mono County leases will maintain an economic and environmental enhancement for Inyo County, and avoid potential disputes and/or lawsuits.

Impact of Project: Continuation of productive agricultural operations in Mono County, and environmental protections in Inyo and Mono counties.

Project Costs: No additional cost given observance of past practices.

CONSTRUCT THE BIG PINE VETERANS PATH PROJECT

Need: Build a pedestrian path linking the town of Big Pine to the Triangle Campground and visitors' center to route pedestrian traffic off the Highway 395 shoulder.

Background: This proposed pedestrian path, which has had the support and approval of past LADWP leadership, has not been implemented.

Project Description: The 310-meter paved path would link the triangle campground and visitors station to the town. It will route pedestrian traffic off Highway 395. This water-neutral project could be approved, constructed, and maintained by LADWP as an enhancement/mitigation for Big Pine, which is LADWP's most heavily pumped wellfield in the Owens Valley.

Project Scope: Implementing the *Veteran's Path E/M Project* requires surveying, engineering, and constructing an all-weather path connecting the Triangle Park Visitor's Center and the existing town sidewalk.

Water use: Water neutral.

Effectiveness of the project: Provides a safe and attractive pedestrian/bike path for visitors and the community that links the campground and visitors center with town.

Impact of Project: Improved pedestrian safety and provides an important transportation link between tourist facilities and town services.

Project Costs: Approximately $125,000 in funding was available to the County, but that funding source that is now unavailable due to delays in obtaining a land use agreement with LADWP.

PROVIDE AN ADEQUATE WATER ALLOCATION FOR TOWN WATER SYSTEMS

Need: To enhance the town's residents' ability to maintain vegetation on in-town properties.

Background: In 2005, LADWP transferred to Inyo County the ownership of the town water systems in the communities of Lone Pine, Independence, and Laws. An evaluation of water use at that time underestimated community water needs. The current allocation has proven to be inadequate for establishing and maintaining residential, commercial, and civic landscaping. A portion of the allocation is also used to provide water to other E/M projects. These enhancement projects should be supplied with their own dedicated water source.

Project Description: Based on a reassessment of water needs, the *Town Water Fulfillment E/M Project* would increase the amount of water allocated to these three communities.

Project Scope: Increase water allocations to town water systems based on established need.

Estimated water requirement: That which is adequate to fulfill current uses for Lone Pine Sports Complex and other E/M projects. Additional community water needs will be determined.

Effectiveness of the project: A proper water allocation would provide enough water to maintain civic landscape including street trees, and provide adequate water to satisfy residential landscape needs, and recognize source of water for other E/M projects such as the Lone Pine Sports Complex.

Impact of Project: Residents would have adequate water to maintain landscape, and street trees would be well-maintained and preserved.

Project Costs: No additional cost given observance of past practices (water is already being pumped and used in excess of short-sheeted allocations).

PROVIDE A FIRM WATER COMMITMENT FOR THE COUNTY FARM PROPERTY IN BIG PINE

Need: Provide adequate irrigation for the County Farm property in Big Pine (80 acres).

Background: The County Farm property cannot be efficiently irrigated with the County's Big Pine Water Association (BPWA) shares as currently interpreted and managed by LADWP. LADWP could and should dedicate a supply of water to the County Farm sufficient to fully irrigate the Farm.

Project Description: The *County Farm E/M Project* provides water to fully irrigate the County Farm property.

Project Scope: Assure adequate irrigation to maintain pasture throughout the County Farm property.

Water use: Fill the deficit by supplying annual total of 240 af from the BPWA conveyances.

Effectiveness of the project: Pasture will be fully irrigated allowing increased ranch yields with return water going back the LADWP conveyance system.

Impact of Project: Full irrigation of the County Farm pastures.

Project Costs: A full allocation is consistent with historic uses.

ALLOCATE A FIRM IRRIGATION COMMITMENT TO THE BISHOP AND BIG PINE SADDLE CLUBS

Need: To minimize dust, provide stock water, and maintain quality horse pastures at both the Bishop Saddle Club (25 acres) and Big Pine Saddle Club (2.5 acres) for grazing.

Background: Traditionally LADWP has supplied water to the horse pasture south of and adjacent to the Bishop Saddle Club. That practice has been discontinued and water is only available intermittently. As a result, pasture grass is spotty and the barren ground has become a source of fugitive dust. The development of a 2.5 acre pasture at the Big Pine Saddle Club would enhance the use of the facility and reduce dust emissions that are affecting the surrounding residential properties.

Project Description: Assure adequate irrigation to grow and maintain pastures adjacent to these two community equestrian centers.

Project Scope: The *Saddle Club E/M Project*, will provide adequate and regular irrigation to the Bishop Saddle Club pastures; and develop, irrigate, and maintain a pasture adjacent to the Big Pine Saddle.

Water use: A total of 83 af assuming 3 af/ac duty, derived from a combination of pumped and surface water.

Effectiveness of the project: An assured water allocation will develop and maintain pasture used by lessees to graze horses, improve the look of the facilities, and provide a vegetated cover to control dust.

Impact of Project: Improved operations and reduction in dust.

Project Costs: The Bishop Saddle Club allocation would be water neutral at 3 af/ac. The Big Pine Saddle Club would require field preparation and the installation of water conveyance and sprinklers at a cost to be determined. In addition the Big Pine Saddle Club will require a new allocation of 3 af/ac irrigation duty on 2.5 acres.

PROVIDE EXPANDED AND REPLACEMENT WATER-BASED RECREATION

Need: Open Tinemaha Reservoir (610 acres) and Pleasant Valley Reservoir (105 acres) to non-contact, non-motorized watercraft for recreation, to provide expanded access for on-water recreational opportunities in the Owens Valley.

Background: Boating opportunities in the Owens Valley are limited to small bodies of water including Klondike Lake (176 acres), Diaz Lake (76 acres), Buckley Ponds (total 46 acres), Farmers Ponds (31 acres), Saunders Pond (15 acres), and Millpond (7 acres). Combined, these Owens Valley water bodies total 351 acres. The actual acreages are less if waters congested by cattail and bulrush are considered. The County had expected expanded water-based recreation under the Long Term Water agreement. The Agreement identifies Haiwee Reservoir (642 acres) as an opportunity for water recreation, but Haiwee is closed to boating and fishing based on alleged security concerns.

Project Description: Open Tinemaha Reservoir and Pleasant Valley Reservoir to non-motorized watercraft for on-water recreational use.

Project Scope: The *Boating Recreation E/M Project* permits use of non-motorized watercraft on Tinemaha Reservoir and Pleasant Valley Reservoir. By comparison, in Mono County, Crowley Lake Reservoir alone offers 4,742 acres of boating opportunities. Opening Tinemaha Reservoir and Pleasant Valley Reservoir would add 715 acres of year-round open water recreation in the Owens Valley; off-setting the loss of Haiwee (a potential LTWA dispute).

Estimated water requirement: Water neutral.

Effectiveness of the project: Doubles the acreage of open-water boating opportunities in the Owens Valley. This E/M project mitigates for the loss of recreational opportunities at Haiwee Reservoir, and potentially eliminates a dispute over the closure of Haiwee reservoir.

Impact of Project: Provides a substitute for water-based recreation at Haiwee Reservoir that was anticipated in the LTWA, but denied. Greatly expands opportunities for sought after, on-water recreation in the Owens Valley. This project will attract visitors and provide a boost to the local economy.

Project Costs: TBD

PROTECT AND RESTORE THE OWENS VALLEY WOODLANDS

Need: Maintain, protect, and enhance the cottonwood, willow, and locust woodlands throughout the Owens Valley.

Background: Trees beautify the valley, provide habitat for wildlife, and provide summer shade for cattle and residents. Valley-wide reductions in pasture irrigation allotments, and more rigorous ditch maintenance on LADWP lands is contributing an overall reduction in the number of healthy trees throughout the Owens Valley. Larger trees, some planted by ranchers and homesteaders more than a hundred years ago are reaching the end of their 70-120 year lifespan. Fewer trees are recruiting naturally then are being lost leading to an overall decline in wooded land.

Project Description: The *Owens Valley Woodland Protection E/M* Project will assess current arboreal conditions in the Owens Valley, and develop a written plan to maintain, protect, and enhance the valley woodlands. Implement that plan.

Project Scope: A plan would be developed and implemented to maintain, protect, and enhance the Owens Valley woodlands.

Estimated water requirement: Water neutral to maintain current canopy. Approximately 400 af groundwater is required to maintain 160 acres of fully mature cottonwood.

Effectiveness of the project: The Owens Valley woodland will be maintained, protected, and enhanced.

Impact of Project: The richness of the Owens Valley environment is in great part related to the beauty and environmental benefits of trees. This project assures that trees are maintained, protected, and enhanced to provide continued aesthetic and habitat benefits.

Project Costs: TBD

IMPROVE THE LOWER OWENS RIVER THROUGH THE ISLANDS

Need: Improve efficiency of the river flow through the Islands swampland to restore the diverse habitats that pre-existed the LORP.

Background: The Lower Owens River is naturally a low gradient system. One area in particular, the 450-acre "Islands," located 4.5 miles north of Lone Pine was not addressed during design and construction of the LORP and has backed up the river and created an ever-expanding marsh monoculture of emergent vegetation. There is no distinct channel through the Islands and the force and volume of the season habitat flow is attenuated for 25 miles downriver. When flushed, the organic load contributed by acres of dying and decaying plant material can lead to low dissolved oxygen levels that have caused multiple incidents of fish kill.

Project Description: The *Islands Habitat Enhancement E/M Project* would seek to implement a plan to improve and maintain water conveyance through the islands to encourage more diverse river-riverine habitat for a range of terrestrial and aquatic species. It is expected that restoring the historic river channel will improve flow rates, save water for the City of Los Angeles, and restore pasture required by LTWA and LORP.

Project Scope: Conduct a study to explore the feasibility of opening channel through the islands. If feasible, and of benefit to the goals of the LORP, produce and implement a plan to improve conveyance.

Estimated water requirement: Water neutral and/or water savings due to reduction in evapotranspiration.

Effectiveness of the project: TBD

Impact of Project: Goals would include the restoration of a diverse mosaic of habitat types in the Islands area and water quality improvement through improved flow.

Project Costs: Feasibility study cost TBD. Implantation costs TBD.

ASSIST DEVELOPMENT AND IMPLEMENTATION OF THE OWENS RIVER WATER TRAIL

Need: Restore lost opportunities for the use of watercraft in the Lower Owens River.

Background: The Lower Owens River Project (LORP) has expanded river-riparian habitat in the Owens Valley, but that's come at the expense of recreational access. Large portions of the Lower Owens River, which were accessible for boating and fishing at pre-LORP low flows, are now choked with emergent vegetation. Open water opportunities have been declining year after year as a result of design and construction oversight. The river channel was not prepared before water was reintroduced, and as a result, marsh in the channel, which developed pre-project under low-flow conditions, is now impeding flow, backing up water, and creating an aggrading condition. Mechanically removing about 2.25

miles of blockage would create a 6-mile section of open water east of Lone Pine.

Project Description: Assist the County in developing and constructing an Owens River Water Trail.

Project Scope: The *Owens River Water Trail E/M Project* removes channel blockages to create 6.3 miles of open-water for recreational use by non-motorized watercraft.

Water requirement: Water neutral to water saving.

Effectiveness of the project: The project would mitigate for the unexpected loss of on-water recreational opportunities in the LORP due to emergent vegetation overgrowth and address design and construction flaws in the project.

Impact of Project: Provides mitigation for unanticipated loss of on-water recreational opportunities. Achieves a key LORP goal of sustainable recreation and improves river-riparian habitat. Provides opportunities for economic development in the southern Owens Valley

Project Costs: Currently grant funded.

INYO COUNTY WATER DEPARTMENT

135 South Jackson St.
PO Box 337
Independence, California 93526

Tel 760-878-0001

Fax 760-878-2552

www.inyowater.org