**Pumping Test of W385R in the Laws Wellfield**
**Monitoring Plan (June 2018)**

## 1. Purpose:

The purpose of this document is to describe a monitoring plan for a pumping test of the modified production well W385R in the Laws Wellfield (Figure 1). Well W385R is the new designation of the existing well W385 that was modified and now has different hydraulic characteristics and significantly lower pumping capacity than its original design. The modification to Well W385 sealed the screened portion of the wells within the shallow aquifer (50-323 feet) to minimize potential impacts on the groundwater dependent vegetation. The hypothesis underlying this test is that by sealing the upper part of the well screen, pumping effects on the shallow aquifer and groundwater dependent resources will be reduced or eliminated. A sixty-day test was conducted on wells W385 and W386 in 1993-1994, and the test proposed here will provide data to compare with the prior test so that the effect of the modifications made to the well can be evaluated.

Because of the concerns expressed regarding potential impacts on nearby resources, LADWP is now treating modified well W385R and nearby W386R as new wells. LADWP is planning to conduct a two-month pumping test to collect necessary data for evaluating potential impacts of operating this well on nearby resources. The goal of this monitoring program is to assist in determining any potential long-term effects of pumping this well on nearby resources.

## 2. Setting:

A brief overview of the hydrogeology of the W385R/Five Bridges project area follows. The W385R/Five Bridges project area is located in the northern portion of the Owens Valley in the immediate vicinity of the confluence of the Owens River and Fish Slough.

In general, ground and surface water, originating from the Sierra, flows northeast from the Bishop Creek alluvial fan to the Owens River. Additional surface and groundwater flow enters the project area from the west along the Owen River. The Volcanic Tablelands and Fish Slough are located north of the project area and provide surface flow, and potentially groundwater flow, to the Five Bridges area. There are a series of north-south striking faults running north from Bishop through the project area into the Volcanic Tablelands. In other locations in the Owens Valley, faults generally interrupt groundwater flow across (perpendicular to) the axis of their strike while preferentially allowing flow along (parallel to) their strike. The north-south striking Fish Slough fault lies in the immediate vicinity of the project area.

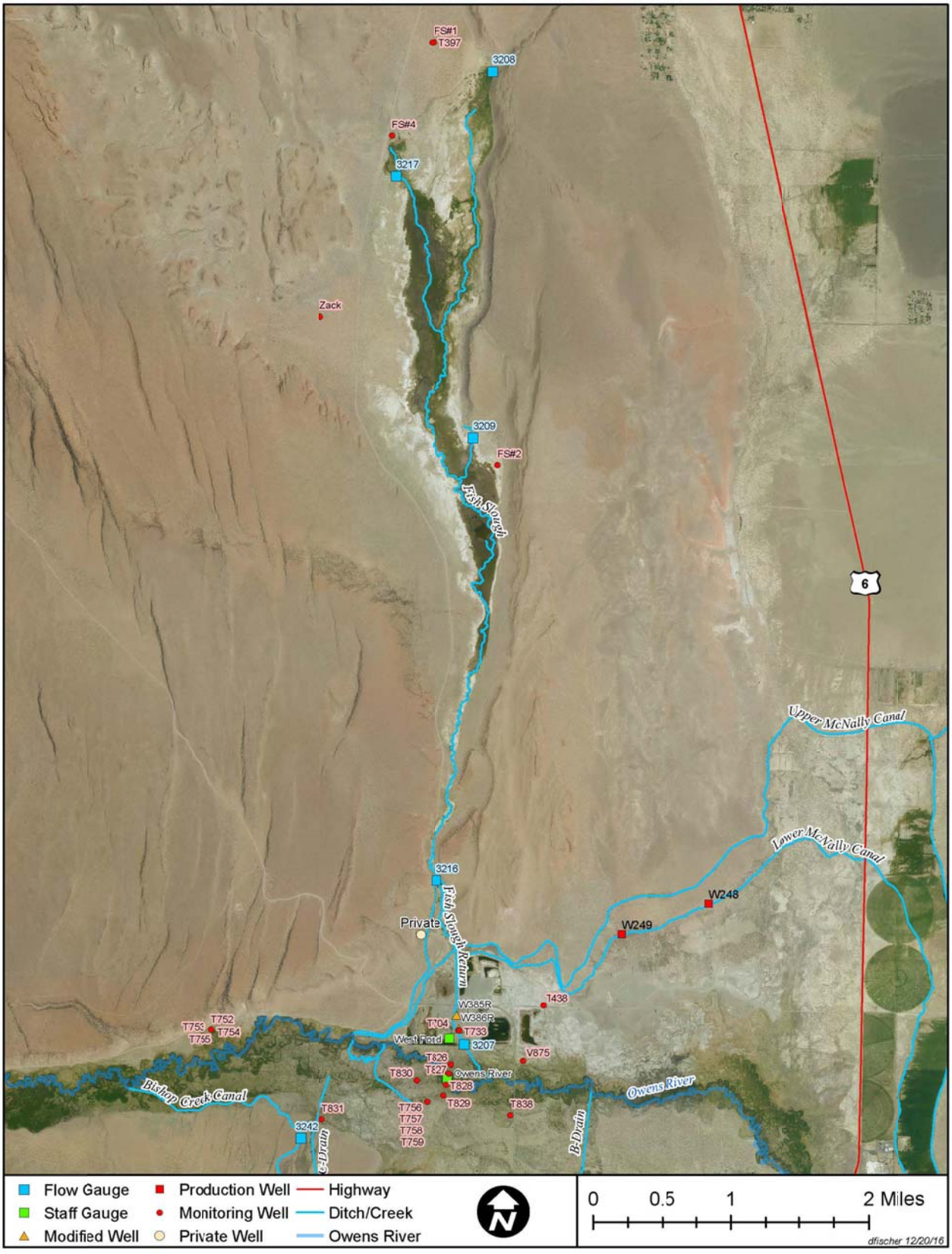


Figure 1 – Map of Monitoring Locations near Production Wells W385R

Flows in the Owens River are related to seasonal runoff and are largely controlled by LADWP operations. Surface and groundwater flow exits the project area to the east or southeast. Additional factors affecting groundwater levels include water diverted from the Bishop Creek Canal (west to south of the project) for irrigation, pumping on the Bishop Cone (notably LADWP production well W410 located approximately 1.5 mile south of the project area), evapotranspiration which peaks spring through fall, and precipitation which falls primarily fall through spring. Groundwater levels in the vicinity of the project are generally shallow (less than 15 feet below ground surface).

The subsurface layers in the vicinity of W385R, from shallow to deep, consist generally of poorly to moderately consolidated alluvial and fluvial sand and gravel deposits related to the Owens River flood plain; the buried Bishop Tuff related to the formation of the Volcanic Tablelands; and sands, silts and clays related to older fluvial and lacustrine deposits. The Bishop tuff and or clay layers at depth related to older lacustrine deposits can create confining or semi-confining layers which separate the recent alluvial and fluvial deposits ("shallow aquifer") from the older buried sediments ("deep aquifer").

Wetland and phreatophytic vegetation exists in the Owens River flood plain in the project area as does irrigated pasture. The Fish Slough ecosystem to the north is an Area of Critical Environmental Concern. It is hypothesized that groundwater from beneath the Volcanic Tablelands and Tri Valley region discharges at Fish Slough and sustains this groundwater-dependent ecosystem.

A three-dimensional finite-difference MODFLOW groundwater model was developed by MWH Americas Consulting Co in 2006 for the Bishop-Laws area, including the W385R area. This model was updated and calibrated with transient data in 2011. Data collected from this two-month operational test on W385R can be used to updated and recalibrate the Bishop/Laws groundwater flow model before using it to simulate long-term operation of this well.

Extensive USGS studies, DWR and University of California research, and LADWP data collection exists in the project area and can be found on the Inyo County Water Department's website www.inyowater.org or on LADWP's www.ladwp.com webpage.

**3. <u>Background</u>:**

Wells W385 and W386 were drilled in March 1987 and screened from approximately 50 to 550 feet. Their purpose was to supply or provide make-up water for enhancement/mitigation projects in Owens Valley and to dewater nearby gravel deposits to facilitate gravel mining. As originally designed, these wells were screened in both shallow and deep aquifers. Pumping from wells W385 and W386 occurred between 1987 and 1989, groundwater levels in the surrounding shallow aquifer were lowered, and as a result, approximately 300 acres of groundwater-dependent vegetation south of the Owens River, known as the Five Bridges Area, was impacted partially by operation of these wells. Therefore, LADWP stopped operating these wells.

Following signing of the Inyo County/ Los Angeles Water Agreement and in order to more accurately quantify the potential impacts of W385 and W386, in 1993 a series of shallow monitoring wells were installed in the Five Bridges area. Then, LADWP and Inyo County Water Department conducted a two-month pumping test of W385 and W386 from November 1993 to January 1994. Both wells were pumped simultaneously with a combined pumping rate of 16.5 cfs. Water levels were monitored in monitoring wells located on the north and south sides of Owens River. As shown in Figure 2, pumping W385 and W386 affected groundwater levels in all monitoring wells on either side of Owens River. The two wells, therefore, remained off with data collection continuing at the shallow monitoring wells to date.

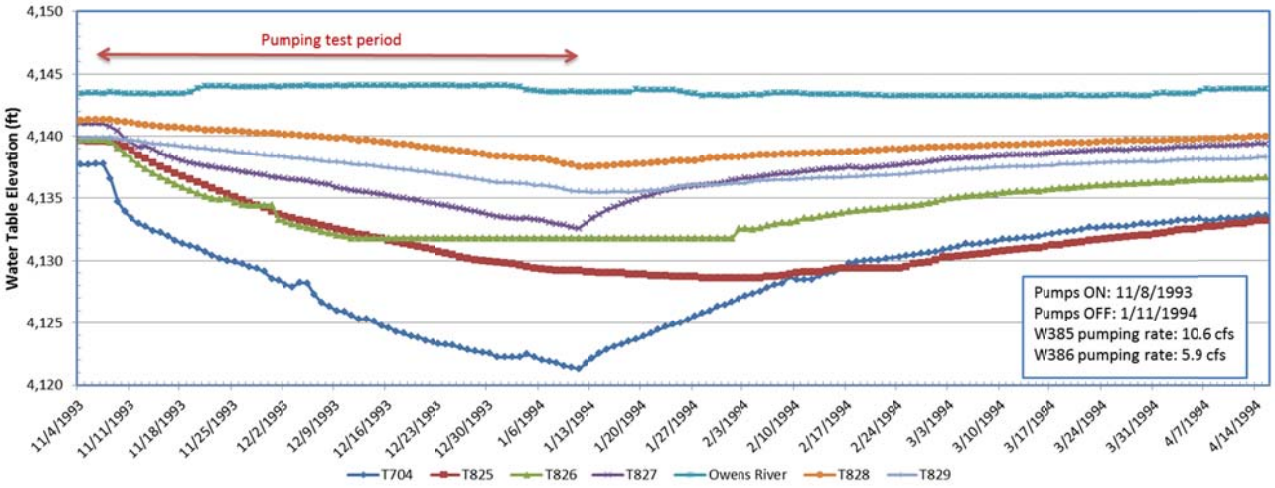


Figure 2. Result of Pumping Test of W385 and W386 in 1993-94 (Locations are shown in Figure 1)

LADWP modified W385 and W386 in 2013 (see Appendix A, *Owens Valley Well Modification Project*, January 2015) by pumping cement grout into the upper screened sections and sealing both wells to depths greater than 300 feet. After sealing the shallow portion of the screen, a 24-hour pumping test was conducted at each of these wells. This resulted in a substantial reduction in the pumping capacity of these wells (from 10.1 cfs to 2.8 cfs in W385 and from 6.2 cfs to 2.8 cfs in W386). Hydrographs of water levels in monitoring wells showing response to 24-hour pumping tests are presented in Figure 3. Groundwater monitoring during the 24-hour pumping tests did not show any effect of pumping on the groundwater levels in the shallow aquifer, either north or south of Owens River. Therefore, LADWP started the process of activating well W385R.

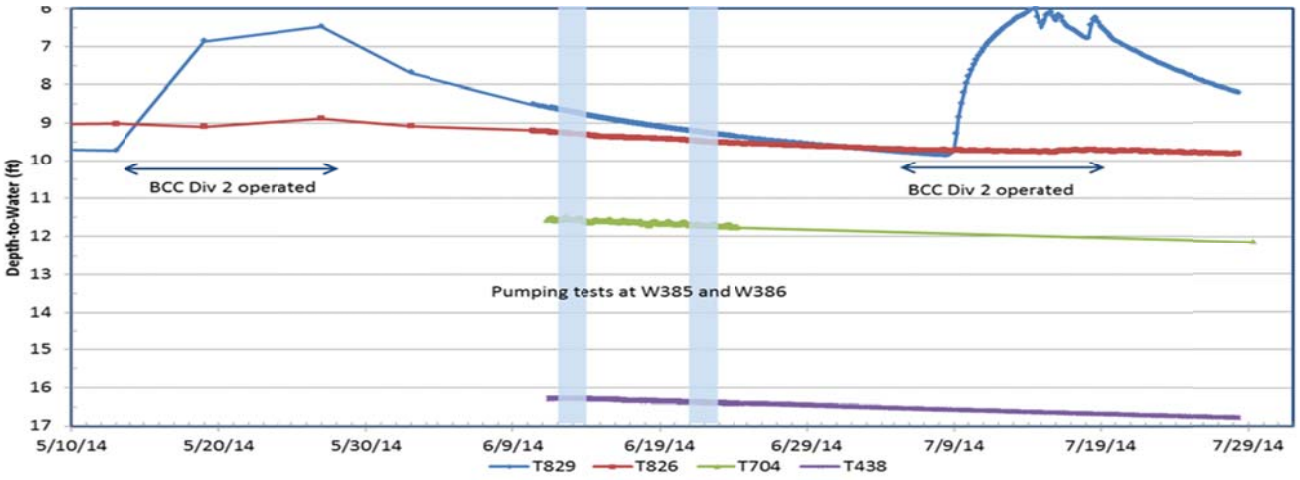


Figure 3 – 24-hour Aquifer Pumping Test of Wells W385R and W386R in 2014
(Locations are shown in Figure 1)

Following expressed concerns by the community regarding potential effects of pumping the modified wells, LADWP decided to treat these modified wells as new wells and to follow the process of activating new wells as outlined in the Water Agreement. While the new wells are located at the same locations as W385 and W386, characteristics of these wells have significantly changed because:

- Original wells W385 and W386 pumped from both shallow and deep aquifers while the modified wells W385R and W386R pumps water that is drawn only from the deep portion of the aquifer.
- The pumping capacity of the modified well W385R is only 2.8 cfs, compared with combined pumping capacity of the original wells W385 and W386 of 16.3 ( an 83% reduction of the overall pumping capacity)
- Wells W385 and W386 were pumped simultaneously in 1980s while W385R and W386R would pump simultaneously if evaluation and modeling shows that combined pumping would not have significant impacts on nearby groundwater-dependent resources.

To evaluate potential impacts of operating W385R, LADWP is planning to conduct a two-month pumping test and to monitor groundwater levels in select nearby monitoring wells and surface water features both north and south of W385R. This pumping test will be similar to the two-month pumping test that was conducted on W385 and W386 in 1993-94, only with a significantly reduced pumping capacity and possible isolation of the pumped zone from the shallow zone by confining layers. Comparison of groundwater level hydrographs from the two tests should provide a good indication of the expected effect of operating W385R on groundwater levels and consequently the nearby resources. Data from this pumping test will also be used to recalibrate the Bishop/Laws groundwater flow model before using it to simulate long-term operation of this well.

This monitoring plan includes mainly hydrologic monitoring but will also include monitoring vegetation through photo point monitoring and existing permanent vegetation transects.

## 4. Hydrologic Monitoring

The proposed two-month pumping test of W385R is planned for winter to be most comparable with the 1993/4 test conducted from November to January. Also during the winter months, other hydrologic variables such as irrigation to Five Bridges, significant changes in stage to the Owens River, and/or seasonal changes related to evapotranspiration, are less of a factor.

The main tool in determining potential effects of pumping W385R will be through hydrologic monitoring including both surface and groundwater north and south of the Owens River. Table 1 shows a list of wells that have historically been and currently are being monitored. These wells are a combination of shallow test wells (less than 40 feet deep) and deeper wells screened in the deeper aquifer. These wells will continue to be monitored both during and after the two-month test with increased frequency. Figure 1 shows the location of the monitoring wells.

All LADWP wells will be monitored by LADWP. The Inyo County Water Department (ICWD) can spot check the water levels in these wells. Majorities of the LADWP monitoring wells listed in Table 1 have been equipped with pressure transducers to record groundwater levels every 6 hours; all wells will have manual depth-to-water reads measured as per the schedule that follows. Background data is being collected and data collected during the pumping test will be downloaded on day 3, 7, 14, 21, 28, 42, and 60 after the start of pumping. After quality assurance and quality control on this data has been completed, they will be transmitted to ICWD. The ICWD has contacted the owner of the private well located northwest of well W385R, is currently monitoring groundwater level in this private well, and will continue to collect groundwater data during and after the pumping test. In addition, ICWD is currently monitoring four BLM monitoring wells in the Fish Slough area (Fish Slough #1, 2, 4 and Zack Well). ICWD will share data collected from these wells with LADWP.

Table 1. Monitoring wells to be monitored during the two-month pumping test of W385R (Locations are shown in Figure 1)

| Monitoring Well | Depth (ft) | Distance from W385 (ft) | Direction from W385 | Location relative to Owens River |
|---|---|---|---|---|
| T438 | 37 | 3,330 | NE | N. of River |
| T704 | 32 | 570 | S | N. of River |
| T733 | 674 | 585 | S | N. of River |
| T752 | 680 | 9,422 | W | N. of River |
| T753 | 100 | 9,422 | W | N. of River |
| T754 | 210 | 9,422 | W | N. of River |
| T755 | 490 | 9,422 | W | N. of River |
| T756 | 45 | 3,560 | SW | S. of River |
| T757 | 310 | 3,560 | SW | S. of River |
| T758 | 575 | 3,560 | SW | S. of River |
| T759 | 210 | 3,560 | SW | S. of River |
| T826 | 17 | 1,880 | S | N. of River |
| T827 | 16 | 2,220 | S | N. of River |
| T828 | 15 | 2,680 | S | S. of River |
| T829 | 17 | 3,090 | S | S. of River |
| T830 | 14 | 2,920 | SW | S. of River |
| T831 | 10 | 6,490 | SW | S. of River |
| T838 | 37 | 4,310 | SE | S. of River |
| V875 | 21 | 3,080 | SE | N. of River |
| W248 | 602 | 10,592 | NE | N. of River |
| W386R | 560 | 530 | S | N. of River |
| Private Well | 160 | 3,400 | N | N. of River |
| FS#1 | 61 | 7.1 miles | N | N. of River |
| FS#2 | 46 | 4.0 miles | N | N. of River |
| FS#4 | 8 | 6.4 miles | N | N. of River |
| Zack | 257 | 5.2 miles | N | N. of River |
| T397 | 180 | 7.1 miles | N | N. of River |

Besides groundwater level monitoring, it is also desirable to monitor surface water features near W385R. This is to measure and separate the effect of changes in the stage of surface water features from the effect of groundwater pumping on groundwater levels in the shallow aquifer. Table 2 list all surface water features that will be monitored as part of data gathering for the two-month pumping test. Discharge in the Owens River is controlled by releases from Pleasant Valley Reservoir, five miles to the west, and releases during the winter are typically in the 200-300 cfs range. Any decreases in the river flow due to capture by the pumping well would be too small to measure. LADWP personnel has installed a staff gauge along a transect connecting T827 and T828 to monitor water level in the Owens River. Water level in the pond located west of W385R will also be monitored using a staff gauge installed in the pond. Both staff gauges will be read daily during weekdays and will be included in the monitoring data provided to ICWD.

Table 2. Surface water monitoring during the two-month pumping test
(Locations are shown in Figure 1)

| Station | Name | Notes |
|---|---|---|
| 3208 | FISH SLOUGH SPRINGS BELOW POND #1 | Northern most station at Fish Slough |
| 3209 | FISH SLOUGH SPRINGS AT B.L.M. SPRING | Fish Slough near FS#2 |
| 3216 | FISH SLOUGH AT L.A. STATION #2 | Fish Slough at Upper McNally Canal |
| 3217 | Fish Slough Spring below Ponds 2 and 3 | Fish Slough Spring south of T397 |
| 3207 | FISH SLOUGH AT OWENS RIVER | Fish Slough at Owens River |
| 3242 | BISHOP CK CANAL DIV. TO 5 BRIDGES #2 | Diversion No.2 off Bishop Creek |
| | Owens River Staff Gauge | North shore of Owens River |
| 3343 | West Pont Staff Gauge | pond west of W385R |

Since early 2000, LADWP has been diverting water from Diversion #2 of Bishop Creek Canal three times a year to promote vegetation recovery in the Five Bridges Area. Operation of this diversion has shown to affect groundwater level in the Five Bridges Area south of the Owens River (see T829 data in Figure 2). Therefore, LADWP will not release water from Diversion #2 into the Five Bridges Area during the pumping test of W385R. This should help separate the effect of pumping from that of surface water operation on shallow groundwater elevation.

Fish Slough to the north of well W385R is another surface water feature in the vicinity of these wells. Given the concerns expressed regarding the potential effect of pumping from well W385R, A number of features in the Fish Slough area will be monitored before, during, and after the completion of the 2-month pumping test. These monitoring locations are shown in Figure 1 and tables 1 and 2. Figure 4 shows flow measurements in the four existing flumes in Fish Slough area. All these flow measurements show some seasonal effect and long-term declining flow, which could be the effect of the increased groundwater pumping in Tri-Valley area located northeast of Fish Slough. LADWP will also continue to monitor the Fish Slough Springs at BLM Springs weir (ID: 3209), Fish Slough Springs below Ponds #2 and #3 (ID: 3217), and the Fish Slough Springs below Pond #1 at flume (ID: 3208).

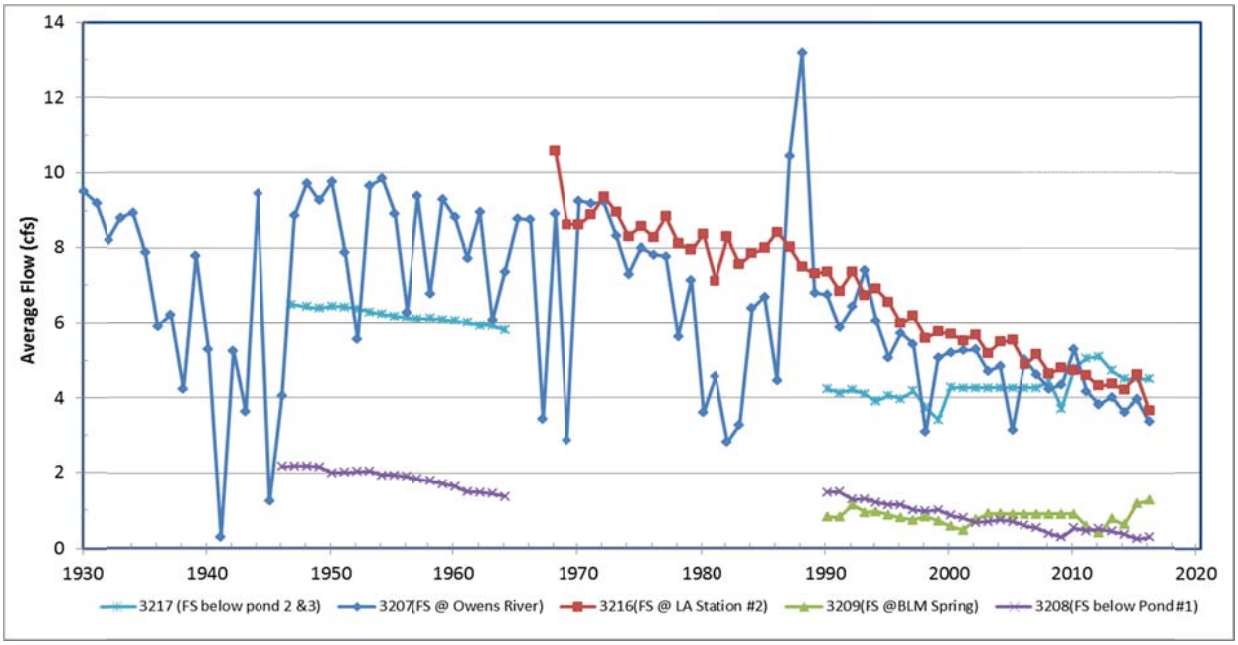


Figure 4. Hydrograph of flow monitoring in Fish Slough Areas. (Locations shown in Figure 1)

Operation of McNally canals affects groundwater levels in the vicinity of the canals. Therefore, LADWP will not operate McNally canals during the two-month pumping test of W385R to determine its potential effect on groundwater levels in the shallow aquifer, especially north of Owens River. Groundwater produced from W385R will be conveyed through the existing Fish Slough channel to the Owens River and should not affect nearby shallow groundwater levels. During the irrigation season following the test, water diversions to the Five Bridges Area will be conducted three times to promote vegetation recovery in the area. The amount of water diverted to the area will equal or exceed the amount of water pumped during the test.

Surface water flow measurements will be made either in average daily flow (cubic feet per second) or total daily volume (acre-feet) released.

After the two-month pumping test is completed, results will be tabulated and compared to the 1993/94 test. Flow and groundwater monitoring will continue on their pre-test schedules. If pumping test results and groundwater modeling indicate that W385R will not have a negative effect on nearby groundwater levels, additional testing or operations may be considered by the Technical Group.

**5. Trigger levels**

The purpose of groundwater level triggers is to prevent potential significant impacts to nearby vegetation, domestic wells, and the Fish Slough Area of Critical Environmental Concern due to water table decline related to 385R pumping. As of September 2017, groundwater levels at the two vegetation-related trigger wells are approximately three feet below ground surface, within the rooting zone of meadow vegetation. The groundwater level in the domestic trigger well is approximately 10 feet below ground surface. Groundwater depths at the wells listed in Table 1 of Appendix A will be measured within a week before the pumping test begins. The three triggers levels at FS #2, T830 and Private Well will be set based on those water levels and will take into account the expected hydrologic changes at each of the three wells for the ensuing two-month test period. Hydrologic changes unrelated to pumping include: seasonal changes in evaporation, transpiration, and recharge rates; temporary dynamic drawdown in the domestic well caused by use of the well; and changes related to surface water management by LADWP of the Owens River, McNally Canals, Five Bridges irrigation ditches, C-drain, and other conveyances.

As noted in the individual trigger descriptions, the two vegetation-related triggers will be set approximately 1-2 feet below the expected, non-pumping related water table change. In effect, triggers will represent 1-2 feet of drawdown caused by pumping. The trigger level for the domestic well (10 feet) represents a drawdown that is two feet less than the drawdown observed during the 1993/94 test (12 feet). The well owner states that the 1993/94 test did not cause a significant impact to his well's operability; therefore, the 10-foot trigger should not cause a significant impact. If LADWP and Inyo County are unable to agree upon the actual trigger levels, setting of the trigger levels shall be subject to the Water Agreement's dispute resolution procedure.

1. A trigger level in monitoring well T830 will be set immediately preceding the pumping test at a value agreed upon by LADWP and ICWD technical staffs. This trigger will be based on a measurable deviation below the expected seasonal change in groundwater level at this well. For example, if groundwater level in T830 is 8 feet below ground surface (bgs) before the test and the normal winter decline is 1 foot, the trigger would be set at 10 feet bgs. For comparison, during the 1993/94 pumping test groundwater in T830 declined approximately 5 feet.
2. A trigger level in the private well located northwest of W385R will be set immediately preceding the pumping test at 10 feet below the pre-pump testing static water level. For example, if static groundwater level in this well is 15 feet bgs before the test, the trigger will be

set at 25 feet bgs. Based on the well construction, pump depth, and dynamic drawdown caused by in-well pumping of the domestic well, a 10 foot drawdown trigger would be protective of well operability. For comparison, during the 1993-94 test the groundwater level in this well dropped approximately 12 feet without adversely affecting short-term well operability.

3. A trigger level at Fish Slough #2, the southern-most Fish Slough monitoring well (located southeast of BLM Springs), will be set using similar method as T830. This trigger will be set immediately preceding the pumping test at a value agreed upon by LADWP and ICWD technical staffs. This trigger will be based on a measurable deviation below the expected seasonal change in groundwater level. For example if water level in FS#2 is 4 feet bgs before the test and the normal winter trend is upward, the trigger can be set at 5 feet bgs. Data does not exist for other Fish Slough area wells from the 1993-94 time period.

In the event that water level in any of the three wells falls to the set trigger level for that well during the two-month pumping test, the pumping from W385R will stop and the data from the abbreviated test will be analyzed. Utilizing the trigger levels for the management of pumping W385R as stated above in items 1-3 will be limited only to the two month pumping test period. This work plan is neither an endorsement nor a limitation on the use of trigger levels for future testing and management of pumping from W385R.

## 6. Vegetation Monitoring

While hydrologic monitoring will be the primary mechanism for detecting potential change associated with pumping test of W385R, LADWP will also monitor vegetation through photo point monitoring and two permanent vegetation-transects linked to monitoring site Laws 4.

Photo point locations were previously established following the initial vegetation impacts to the Five Bridges Area and new photos are captured annually at the peak of the growing season as part of LADWP's mitigation monitoring. These photo point locations are Control, Overview, West Meadow, Exclosure, Multiple Completion Meadow, and Burn, and are shown in Figure 4 relative to the location of W385R and W386R. There is a considerable photo dataset showing a range of conditions over the past 18 years at these locations, as some of these points were established as early as 1988.

For the purposes of tracking potential vegetation impacts in response to the pumping test of W385R, LADWP will conduct photo point monitoring at 4 of the 6 Five Bridges Photo Points monthly during the growing season (April –September). These 4 locations are Overview, West Meadow, Multiple Completion, and Burn; it is unnecessary to conduct the monthly monitoring at the Control and Exclosure sites and these points will continue to be monitored at the peak of the growing season as in past years. Although there are significant photo records at each of these sites for many years, current conditions were documented in April 2016 as Baseline Conditions

prior to operating well W385R. These photos are provided in Appendix B. LADWP will conduct the monthly photo point monitoring for the duration of initial testing period per Section VI of the Water Agreement.

The two permanent vegetation transects associated with Laws 4 are monitored annually to track species composition and percent cover in the mitigation area. L4A and L4B are both located in alkali meadows; Transect L4A in the Multiple Completion Meadow, L4B in the West Meadow. At Transect L4A in 2014, live perennial cover was 8.7% composed of 5 native species. Perennial cover at Transect L4B in 2014 was 34.1% composed of 6 native species. Vegetation cover has declined at both of these sites in recent years due to successive dry years, pepperweed invasion and subsequent weed treatment, all occurring prior to this initial operation of W385R. However, this data is collected annually and will serve as an additional mechanism to track the effects of the well operation on vegetation if such an impact can be isolated from other influences. If there appears to be a significant decline in vegetation in response to well activity, provisions outlined in the Green Book will be followed.

Figure 5 – Photo Point and Vegetation Monitoring Sites for Pumping test of Well W385R