The Los Angeles Department of Water and Power's Closing Report to the Technical Group Regarding Vegetation Changes in Blackrock 94

March 27, 2014

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LIST OF ACRONYMS

1991 EIR	Environmental Impact Report: Water from the Owens Valley to Supply the Second Los Angeles Aqueduct: 1970-1990; 1990 Onward, Pursuant to a Long-Term Groundwater Management Plan
AF	Acre feet
AFY	Acre feet per year
BLK094	Vegetation parcel Blackrock 94
BLK099	Vegetation parcel Blackrock 99
Danskin (1998)	USGS Water-supply Paper 2370-H
DTW	Depth to water
EIR	Environmental Impact Report
ft	Feet
F Well	Flowing well
fmsl	Feet above mean sea level
Green Book	Green Book for the Long-Term Groundwater Management Plan for the Owens Valley and Inyo County (June 1990)
Hatchery	Blackrock Fish Hatchery
ICWD (2011)	Analysis of Conditions in Vegetation Parcel Blackrock 94
ICWD (2014)	Inyo County Response to LADWP Evaluation of Attributability and Significance of Vegetation Changes in Blackrock 94. February 14.
ICWD	Inyo County Water Department
LAA	Los Angeles Aqueduct
LADWP (2013)	Evaluation of Attributability and Significance of Vegetation Changes in Blackrock 94. December 18
LADWP	Los Angeles Department of Water and Power
m	Meters
SMA	Spectral Mixture Analysis
T Well	Observation well
Technical Group	Comprised of LADWP and ICWD technical staff and receives direction from the Standing Committee
USGS	United States Geological Survey
VIF	Variance inflation factor
W Well	Production well
Water Agreement	Inyo/Los Angeles 1991 Water Agreement

EXECUTIVE SUMMARY

This report represents Los Angeles Department of Water and Power's (LADWP) closing report to the Technical Group regarding vegetation changes in Blackrock 94. It has been prepared for submittal to the Technical Group and Arbitration Panel to address selected remaining matters concerning the issue submitted to dispute resolution pursuant to stipulation and order for judgment in case number 12908 and in compliance with the Arbitration Panel's October 21, 2013 Order. It contains the LADWP response to the Inyo County Water Department's (ICWD) February 2014 report entitled, *"Inyo County Response to LADWP Evaluation of Attributability and Significance of Vegetation Changes in Blackrock 94"* (ICWD, 2014 or ICWD (2014)). ICWD (2014) was prepared in response to LADWP's December 18, 2013 report entitled, *"Evaluation of Attributability and Significance of Vegetation Changes in Blackrock 94"* (LADWP, 2013 or LADWP (2013)).

This Executive Summary presents key information from this report and is organized along the following topical areas:

- Measurability, attributability, and significance
- Areas or agreement and disagreement
- Hydrology
- Vegetation
- Soil Moisture

Measurability, Attributability, and Significance

Measurability. The questions are if certain measureable changes in vegetation within Blackrock 94 are attributable to LADWP's groundwater pumping and/or ***changes*** in LADWP's surface water management practices since 1970. If measureable changes are found to be attributable to groundwater pumping or ***changes*** in past surface water management practices since 1970, then it must be determined whether those measurable changes are or are not significant.

As of March 2014, the Technical Group has determined that measurable changes in vegetation within vegetation parcel Blackrock 94 have occurred, and the Technical Group is currently evaluating whether these measurable changes in vegetation are "*attributable to groundwater pumping, or to a change in surface water management practices*" pursuant to the Inyo/LA Water Agreement (1991) (Water Agreement).

Attributability. The ICWD analysis of attributability concentrated primarily on how changes in vegetation correlated with groundwater pumping. ICWD conducted almost no evaluation of the extent to which other factors unrelated to the effects of groundwater pumping, including fluctuations in wet/dry climatic cycles or drought, have contributed to vegetation change as required by the Green Book. With limited evaluation of the effects of the 1987-1994 drought and other wet/dry climatic cycles on the water table, ICWD concluded that "*pumping induced declines on the water table 1987-1990 corresponded to decreases in vegetation cover...*" (ICWD, 2011, page 56) and "*these changes occurred between baseline and 1991...*" (ICWD, 2011, page 66). ICWD did not evaluate or present any evidence to support an allegation that LADWP may have changed surface water management practices. ICWD also changed its 2011 determination of attributability from being "*...reduced surface water diversions into the vicinity of Blackrock 94*" (ICWD, 2011, page 66), which is not necessarily a change in LADWP's past surface water management practices or violation of the Water Agreement, to "*...changes in surface water management practices*" (ICWD, 2014, page 85), without providing any evidence to support this new allegation.

The LADWP analysis of attributability evaluated the influence of all factors required by the Green Book, including: groundwater pumping, changes in surface water management, drought, wet/dry climatic cycles, flooding, fungal blight, range management practices, wildfire, off-road vehicles, and other factors relative to vegetation changes in Blackrock 94. LADWP's attributability analysis concluded: "*Changes in vegetation cover and composition from that measured in LADWP's 1986 initial vegetation inventory are attributable to fluctuations in wet/dry climatic cycles and not attributable to groundwater pumping or to changes in past surface water management practices*" (LADWP, 2013, page 233).

Significance. The Water Agreement Section IV.B requires that "*if the decrease, change, or effect is determined to be attributable to groundwater pumping or to changes in past surface water management practices, the Technical Group then shall determine whether the decrease, change, or effect is significant.*"

ICWD provided conflicting conclusions regarding significance:

- ICWD (2011) did not conclude that a significant change had occurred, but instead found a significant change to be occurring: "*the factors prescribed in the LTWA and Green Book for assessing the significance of an impact were evaluated and **indicate that a significant change is occurring in Blackrock 94***" (ICWD, 2011, page 66, emphasis added).

- Without presenting any additional evidence to modify its previous claim that a significant change was occurring, ICWD then altered its significance determination to be that a significant change had already occurred: "*Ample evidence exists that a measurable change in vegetation in Blackrock 94 has occurred, that the change is attributable to LADWP's groundwater pumping operations, and that **the change is significant**... the County requests the Standing Committee... to find that **a significant effect has occurred in** Blackrock 94...*" (Inyo County's September 20, 2012 request for resolution, page 12, emphasis added).

- In ICWD, 2014, ICWD once again altered its significance conclusions to "*...a measureable and significant change and decrease in vegetation **has occurred or is occurring at Blackrock 94** that is attributable to LADWP's groundwater pumping and to its changes in surface water management practices*" (ICWD, 2014, page 85, emphasis added) and attempted to change the question presented to the Arbitration Panel.

In summary, without offering any additional evidence to support its claims, ICWD has changed its significance determination from "*a significant change is **occurring***" to "*a significant effect has **occurred***" and finally to "*a significant change... **has occurred or is occurring***".

LADWP's analysis of significance was based upon the provisions of Water Agreement Section IV.B and Green Book Section I.C.1.c. LADWP concluded that "*changes in vegetation cover and composition from that measured in LADWP's 1986 initial vegetation inventory are attributable to fluctuations in wet/dry climatic cycles and not attributable to groundwater pumping or to changes in past surface water management practices*" (LADWP, 2013, page 233). "*Water Agreement Section IV.B allows for the evaluation of significance only after it has been determined that measurable changes are attributable to groundwater pumping or changes in surface water management... Therefore, pursuant to the terms of the Water Agreement, a determination of significance cannot be made*" (LADWP, 2013, page 234).

Areas of Agreement and Disagreement

The following table (**Table ES-1**) presents LADWP's summary regarding key areas of agreement and subjects of disagreement pertaining to the Blackrock 94 issue.

Hydrology: Variation in Groundwater Levels at Blackrock 94

Variations in vegetation cover and composition within Blackrock 94 since the 1986 vegetation inventory are due primarily to fluctuations in wet/dry climatic cycles (including runoff, water spreading, and precipitation) and not due to groundwater pumping since the 1986 vegetation survey. ***Hydrology data demonstrate that Hatchery Pumping could not have caused vegetation changes since the 1986 vegetation inventory.***

ICWD states that over the period of 1970 to present groundwater pumping has been the primary cause of changes in groundwater levels in Blackrock 94. However, this is not relevant. What is relevant is changes in vegetation since 1986, and whether those changes are caused by groundwater pumping from the Blackrock Fish Hatchery, which since 1998, amounts to 95 percent of the pumping from the Thibaut-Sawmill Wellfield.

Pumping for the Blackrock Hatchery began in 1972 and has been maintained at a nearly constant rate. Hydrologic effects of this pumping would have reached a steady-state condition long before the 1986 vegetation inventory. Since 1986, water levels and vegetation have varied, and vegetation cover in Blackrock 94 has surpassed 1986 levels during wet periods – all while pumping has been relatively constant. For example, field measurements of vegetation cover in Blackrock 94 taken by the ICWD found that in 1998, vegetation cover was 20% higher than measured during the 1986 baseline. These facts indicate that factors other than pumping are responsible for changes in vegetation at Blackrock 94. Data presented by LADWP (LADWP, 2013) conclusively demonstrate that changes in runoff-driven recharge are largely responsible for changes in groundwater elevation beneath the Blackrock 94 parcel since prior to 1986, not pumping.

Table ES-1
Summary of Areas of Agreement and Disagreement Relative to the Blackrock 94 Issue

Subject	Agree	Disagree
Runoff, Surface Water Spreading, and Precipitation Are All Highly Correlated and Drive Water Availability and Vegetation Cover	●	
A Measurable Change in Vegetation Has Occurred in Vegetation Parcel Blackrock 94	●	
Vegetation Data from Line-Point Vegetation Transects Shall Be Used in Cases of Suspected Vegetation Changes	●	
High-Runoff Conditions Resulted in Relatively High Water Tables beneath Blackrock 94 During the mid-1980's	●	
Currently-Available Groundwater Models Have Limited Ability to Accurately Estimate Depth to Water or Simulate Groundwater Changes beneath Blackrock 94	●	
Rare and Endangered Plant Species Have Not Been Adversely Affected	●	
No Data Indicate that Air Quality Has Been Adversely Affected	●	
Attributability of Measured Change in Vegetation within Blackrock 94		●

Table ES-1 (continued)
Summary of Areas of Agreement and Disagreement Relative to the Blackrock 94 Issue

Subject	Agree	Disagree
Significance of Measured Changes in Vegetation within Blackrock 94		●
ICWD Unsubstantiated Allegation that LADWP May Have Changed its Surface Water Management Practices since 1970		●
Most Applicable Method for Determining Depth to Water or Changes in Groundwater Elevation beneath Blackrock 94		●
How to Properly Represent Blackrock Fish Hatchery Pumping in the Groundwater Model Simulations Pertaining to Blackrock 94		●
Magnitude of Changes in the Water Table beneath Blackrock 94		●
The 1991 Environmental Impact Report or Water Agreement Requires LADWP to Maintain Baseline Water Levels		●
Selection of Control Sites		●
ICWD Application of Spectral Mixture Analysis (SMA) to Determine Attributability		●
Changes in Soil Water due to LADWP Pumping Caused Vegetation to Decline at Monitoring Sites TS1 and TS2		●

Furthermore, the use of Blackrock 99 as a control site for comparative purposes is inappropriate because of key differences in the hydrologic regime of the two sites that is not related to pumping.

Relative to regression modeling, ICWD misapplied LADWP's vegetation regression model. Furthermore, ICWD's new multiple regression model is fundamentally flawed. The ICWD regression model used 1) modeled DTW values instead of physically-measured DTW values and 2) modeled vegetation cover values instead of physically-measured vegetation cover values.

It Is Clear that Owens Valley Hydrology Is Characterized by Wet/Dry Cycles that Affect Groundwater Levels. Owens Valley runoff is characterized by a cyclic nature and subject to wide variations in wet/dry climate cycles. In turn, runoff-driven recharge is the primary driver influencing depth to groundwater, referred to as "depth to water" or "DTW." The Owens Valley hydrology has included a suite of wet/dry cycles as shown in **Figure ES-1**. In this figure, hydrographs for monitoring wells near Blackrock 94 are plotted with Owens Valley runoff through time. Wet and Dry periods from 1972 through 2013 are highlighted to illustrate the cyclic nature of these climatic cycles. Knowing that pumping from the Hatchery wells was relatively constant from 1972 to present, it is clear that wet and dry periods are the most significant factors affecting depth to water.

It Is Clear that Hatchery Pumping Affects Water Levels, but the Effects Stabilized Long Before the 1986 Vegetation Inventory. LADWP agrees that pumping from the Blackrock Hatchery wells affected groundwater levels after pumping began in 1972, but this is not the point. The question is, if pumping has caused a measurable and significant change in vegetation since the 1986 vegetation inventory in violation of the provisions of the Water Agreement. The purpose of the two Hatchery groundwater production wells W351 and W356 is to supply Blackrock Hatchery. The wells began pumping in 1972, pumping a relatively constant amount of approximately 12,000 acre-feet per year (AFY).

Because Hatchery groundwater pumping had been relatively constant at approximately 12,000 AFY for 14 years prior to the 1986 vegetation inventory, its effects on DTW were in place and established well before 1986. Hatchery pumping affects DTW, but those effects were established early on after pumping initiated. Given the constant nature of Hatchery pumping, those effects are stable and relatively unchanging. Therefore, Hatchery pumping could not have caused water table fluctuations in the late 1980s when vegetation declined (or since).

This conclusion is further supported by the fact that the groundwater table was exceptionally high during the 1986 vegetation inventory due to spreading and repeated years of high runoff. A 8-year drought followed, but by 1998 (with constant Hatchery pumping still in place), vegetation levels were even higher (~20%) than the 1986 vegetation inventory due to a 4-year wet period with average runoff at 141% of the long-term average, and its response to runoff-driven recharge. Therefore, in fact, Hatchery pumping could not have caused any post-1986 change.

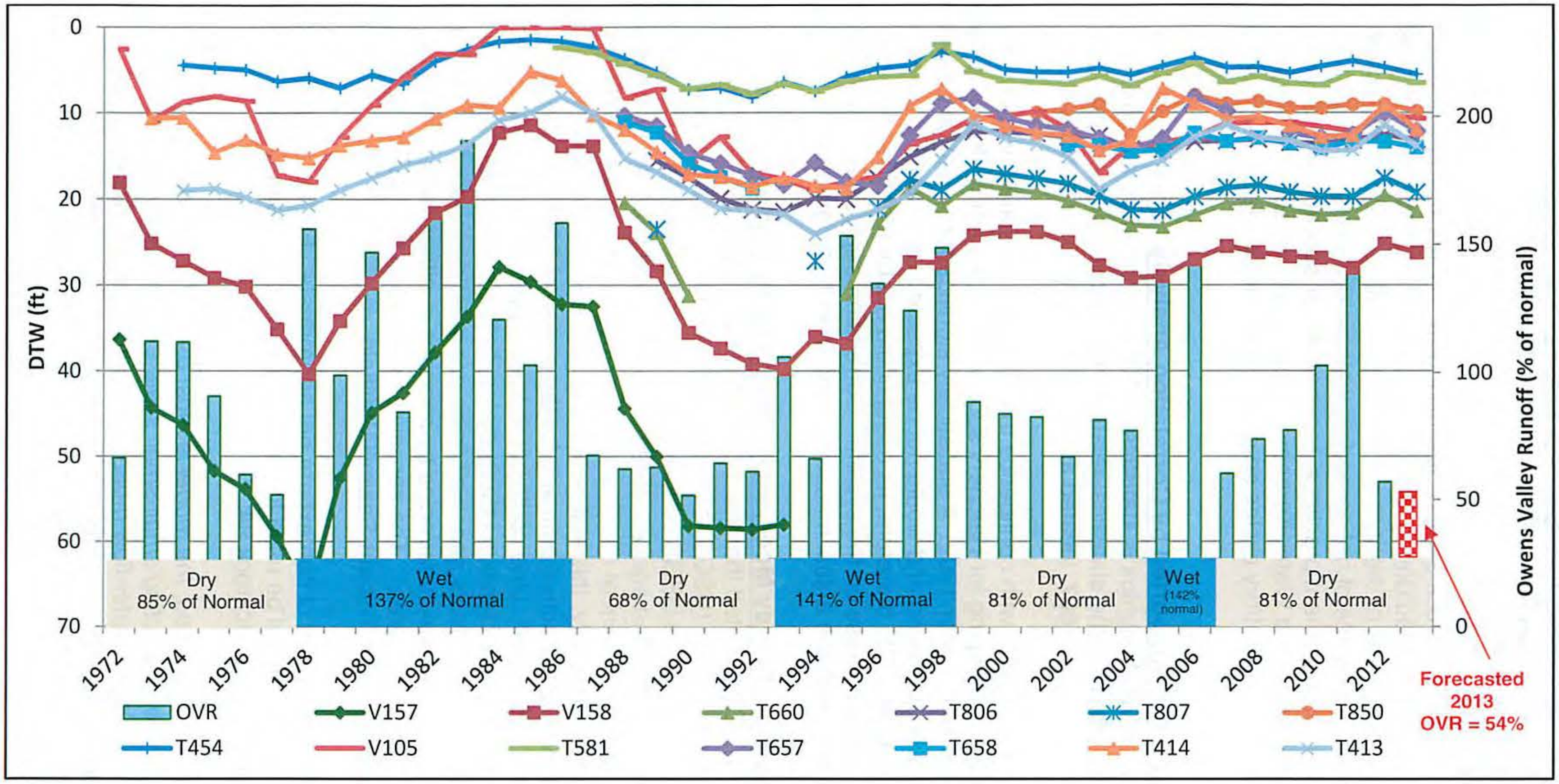


Figure ES-1
Demonstration of the Relationship Between Wet/Dry Cycles and Groundwater Levels

LADWP Has Not Changed Surface Water Management Practices Since 1970. There is a strong correlation between percent of normal runoff and water spreading that indicates LADWP's practice of spreading pre-Water Agreement and post-Water Agreement has not changed as shown on **Figure ES-2**. LADWP has not changed its surface water management practices since 1970 in the area of Blackrock 94 and Sawmill Creek. Water from Sawmill Creek is spread during high runoff and not spread during drought or low runoff. Reductions in surface water spreading in dry years and periods of drought are in keeping with LADWP's surface water management practices. Since the practice of not spreading water in dry years is not a change in LADWP's past surface water management practices, reduced water spreading in Blackrock 94 during dry years is permitted under the Water Agreement. Because surface water spreading occurs during wet cycles, the effect of wet/dry cycles on groundwater levels (and soil moisture) is amplified at Blackrock 94.

Visual Graphic Relationships Are Supported by Correlation Analysis. Another useful analytical tool to establish causal relationships is statistics. LADWP conducted a correlation analysis to utilize statistics to determine the statistical relationships between runoff, pumping, and DTW at monitoring wells T806 and T807, located at monitoring sites TS2 and TS1.

Not surprisingly, the results demonstrate with confidence that DTW is correlated with Owens Valley runoff, specifically because pumping for Hatchery supply was constant while pumping from non-Hatchery wells was minimal after 1992. A statistically significant correlation between Hatchery pumping and DTW was not found and would not be expected because this pumping had been stable and in place since 1972; therefore, its effect could not be identified through statistics as it represents a constant stress on the system. Correlation analysis is valid, makes sense, and its results are aligned with the actual measured data from hydrographs.

The Reference to U.S. Geological Survey Modeling Is Taken Out of Context. On page 16 (paragraph 3) of ICWD, (2014), ICWD noted that the modeling results were consistent with the conclusion of the U.S. Geological Survey (USGS) concerning the relative effects of pumping and recharge in Owens Valley, where the USGS concluded "*...the ground-water model showed that pumpage is the dominant stress in the aquifer system both near well fields and in recharge areas.*" (Danskin, 1998, p. 138). As a point of clarification, this quotation from the ICWD response is taken out of context. In reality, this statement is in reference to the sensitivity analysis of the USGS model, where the actual pumping for the period of 1963 to 1988 is compared with pumping at the 1963 level. One could come to an opposite conclusion based on reference to the USGS report. On p.88, Danskin (1998) states, "*effects in recharge areas are most dependent on recharge, and the effects near well fields are most dependent on pumpage. Away from either area, heads are relatively unaffected by changes in either recharge or pumping...*" (Blackrock 94 is a recharge area). The sensitivity analysis in the USGS report did not consider recharge or pumping in the Thibaut-Sawmill Wellfield.

Citations from the USGS report taken out of context are not appropriate. Furthermore, the USGS did ***not*** recommend that the model be used for small-scale modeling simulations such as simulating water table changes under Blackrock 94:

> *"Because of the way it was calibrated, the model is most useful for evaluating valleywide conditions, not for predicting small-small scale effects covering a few model cells. Site-specific ground-water flow models or multivariate regression models, such as developed by P.B. Williams (1978) and Hutchison (1991), can give more accurate predictions at selected sites"* (Danskin, 1998, page 79, right hand column, paragraph 2*)*.

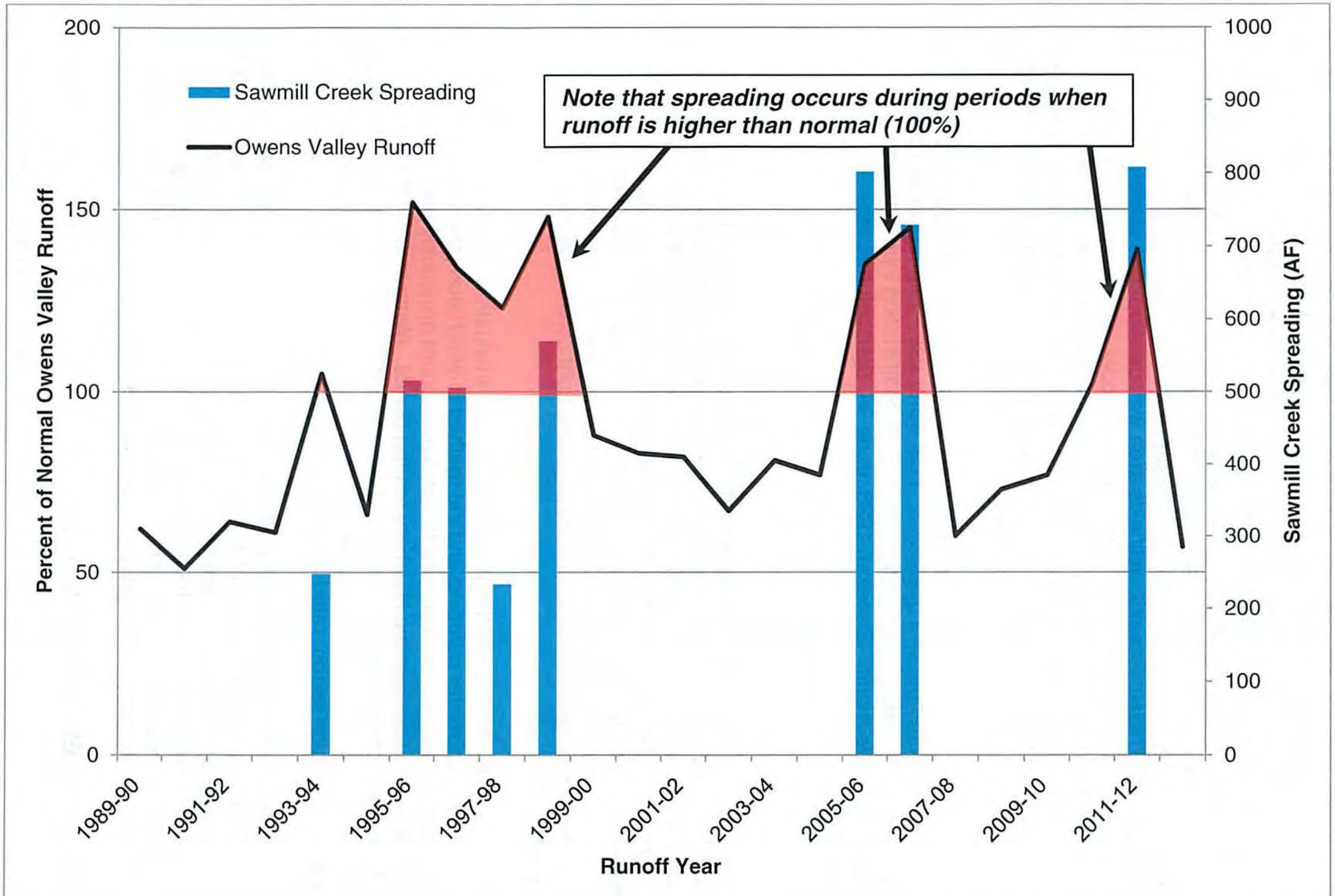


Figure ES-2
Relationship Between Sawmill Creek Spreading and Owens Valley Runoff

Groundwater Modeling Was Applied Inappropriately by ICWD. A groundwater model is a numerical representation of the groundwater system developed for a specific objective and can be a useful tool for evaluating a variety of groundwater scenarios. Both LADWP and ICWD agree that neither previously-developed model was developed for an evaluation of this type and both models suffer from limitations, which means that they should not be relied upon as the sole basis for evaluating the effects of pumping on the Blackrock 94 parcel. The Owens Valley model, originally developed by the USGS and adopted/modified by ICWD, was developed to evaluate management decisions on a valley-wide scale. LADWP's model for the Taboose-Aberdeen and Thibaut-Sawmill wellfields area was developed to evaluate groundwater management decisions at a wellfield-wide scale. Neither model was developed to evaluate groundwater management decisions for an area as small as Blackrock 94 (approximately 333 acres). Both models are similar, with differences in grid cell size and stress periods (time increments). The USGS notes that use of the basin-wide model is inappropriate for evaluation of small-scale features such as Hatchery pumping:

> *"Future analysis of these smaller-scale features or issues-such as a volcanic deposit , a facies change, or a question of local water use – might best be done by use of smaller-scale models or field studies, in combination with simulations from the valleywide model"* (Danskin, 1998, page 94, right column, top paragraph).

and;

> *"The most appropriate use of the valleywide model is best illustrated by the results presented in this report. The goal in designing both water-management alternatives and figures was to maintain the "regional" character of the model, focusing on larger issues, over longer periods of time...The specific value of drawdown at a well (pl.1) or for an area of the basin (fig. 23 is far less important than the relative value (more drawdown or less drawdown) in comparison with other areas of the basin"* (Danskin, 1998, page 94, right column, second paragraph).

The main difference between the ICWD and LADWP model evaluation is how the models were used to account for groundwater pumping and the method in which pumping was applied. LADWP used a "net discharge" concept, which took into account previously-measured spring flow discharge and infiltration from the Hatchery rearing ponds. Meanwhile, ICWD ignored the reduction of discharge from Blackrock Spring, and the amount of water returning to the aquifer from the Hatchery rearing ponds, and considered only the "gross discharge" from the Hatchery wells in its evaluation, which exaggerated the effects of pumping.

Furthermore, in order to estimate DTW under Blackrock 94 for the no-pumping scenario, ICWD used only two monitoring wells to represent the entire parcel, whereby the differences in DTW between actual and no-pumping were based on the average from two points, T807 and T806/T582, and the average value was then subtracted from ***the ICWD's kriging DTW estimates*** under Blackrock 94. This approach introduces cumulative error and uncertainty, such that ICWD DTW estimates **could be off by as much as *18 feet*.**

Blackrock 99 Is Not an Appropriate Control Site. LADWP and ICWD agree that scientific controls are a part of the scientific method. A control, when evaluating the effects of groundwater pumping on an area, should be designed to isolate the effects of pumping, with all other variables that could affect groundwater levels (and vegetation) being equal, or at least similar. ICWD's selection of Blackrock 99 as a control parcel or use for any comparative purposes is not reasonable as it does not meet this definition.

Blackrock 99 has two groundwater production wells that automatically exclude it from being a control site because pumping cannot be controlled for. Furthermore, there are fundamental hydrologic differences between the two parcels that affect water availability (for reasons other than pumping). In the context of the Water Agreement, the concept of a control site is one that has similar vegetation and hydrologic conditions, but is unaffected by pumping. The following significant differences in the hydrologic regime of the two sites make Blackrock 99 unsuitable for use as a control site:

- Blackrock 99 is irrigated, Blackrock 94 is not;
- Blackrock 99 has two flowing wells that contribute to soil moisture, Blackrock 94 has none;
- Blackrock 99 receives recharge from the unlined LAA and unlined well channels, Blackrock 94 does not; and
- Blackrock 99 has a shallower water table and is less sensitive to changes in runoff-driven recharge because it is topographically lower and relatively flat.

For these reasons, it is clear that Blackrock 99 is not comparable to Blackrock 94 and should not be used as a control site. The effects of climate (wet/dry cycles) cannot be differentiated from the effects of pumping for a particular area if the area being compared is affected by pumping and is buffered from the effects of climate by having an artificially wet regime. As a result, the differences between the two parcels unrelated to pumping render Blackrock 99 an unsuitable control site.

<u>ICWD's Critique of LADWP's Vegetation Regression Model Is Misapplied</u>. In its 2014 report, the ICWD misapplied LADWP's vegetation regression model of Blackrock 94 presented in the LADWP, 2013 (Section 5.2.2.3). ICWD erroneously asserted that (page 41-45):

1. LADWP's vegetation regression model of Blackrock 94 is ineffective because it cannot explain vegetation cover changes in Blackrock 99;
2. LADWP's vegetation regression model did not consider DTW; and
3. Runoff is an indirect variable such that it does not directly affect vegetation cover.

LADWP disagrees to each of these three points raised by ICWD. First, LADWP's vegetation regression model was developed specifically for Blackrock 94 and was not designed to be extrapolated to other parcels. Second, runoff sufficiently explains the effect of DTW on vegetation cover. Lastly, runoff as an indirect variable asserts significant influence on vegetation cover and cannot be discarded.

ICWD misapplied LADWP's Blackrock 94 vegetation regression model by attempting to use it to model Blackrock 99. The Blackrock 94 vegetation regression model was not designed to be applied to Blackrock 99, which experiences totally different hydrologic and ecological processes and had a distinctly different initial environmental condition. ICWD's attempt at implementing a model developed under one set of criteria to a completely different application with a different set of criteria is scientifically invalid. ICWD agreed with LADWP that a strong correlation exists between runoff and vegetation cover and was due to the fact that runoff contains information of all three variables (precipitation, DTW, and spreading). Moreover, runoff remained as the significant factor even after removing the influence of all other variables. The effect of wet years cannot be effectively represented by any one direct variable. High runoff normally means wetter conditions within the valley through winter and spring months and increased stream flows, which in turn results in increased recharge, and a fuller Los Angeles Aqueduct (LAA), which results in water spreading from Sawmill Creek. This cascade of events during in wet years is precisely the reason that runoff is more suitable than other reasons to explain vegetation changes over time.

ICWD's New Multiple Regression Model Is Fundamentally Flawed. ICWD introduced a new multiple regression model in ICWD, 2014 and devoted several pages (pages 45 to 50) to discuss this model. Two of the model inputs, modeled DTW and modeled vegetation cover using spectral mixture analysis (SMA), are fundamentally flawed. Therefore, predictions resulting from this model are too unreliable to use for reaching any meaningful conclusions. Further, ICWD completely ignored the important role of surface water spreading in the new model.

The new model introduced by ICWD is based on flawed data sets (ICWD's kriging and SMA data). The hypothetical world of no pumping is also based on a flawed data set (ICWD's kriging data) and inadequate number of modeled DTW points (TS1 and TS2) with unknown quantity of uncertainty or error. Real-world analysis or management decisions cannot be based on simulated vegetation cover in this hypothetical set of circumstances constructed by ICWD.

Vegetation: The ICWD Relies on Flawed Vegetation Data - Modeled Vegetation Cover Data Is No Substitute for Physically-Measured Vegetation Cover Data

Green Book Box I.C.1.a.ii (2) states that "*vegetation transects shall also be used in cases of suspected vegetation changes due to groundwater pumping. However, rather than using the intensive sampling technique of Section III.D for calculating evapotranspiration, plant cover shall be measured by the line-point technique described below.*" Instead of using plant cover values based on the line-point technique (line-point monitoring), the ICWD (2014) substitutes Spectral Mixture Analysis (SMA) for this requirement in its most recent attempts to estimate or model vegetation cover in Blackrock 94. The reason cited by ICWD for deviating from the Green Book requirement is "*that it is difficult to make comparisons to baseline data because of certain characteristics of the baseline data*" (ICWD, 2014, page 8).

ICWD Relies on SMA as Vegetation Data. ICWD makes use of SMA in their estimation of plant live cover at Blackrock 94. SMA is a method of matching color spectral bands from satellite photographs to spectral "signatures" characteristic of various surface conditions. The ICWD's reference for the methodology used is Elmore et al. (2000). SMA is a commonly-used method for mapping using satellite imagery. ICWD's SMA approach has the following fatal flaws and issues:

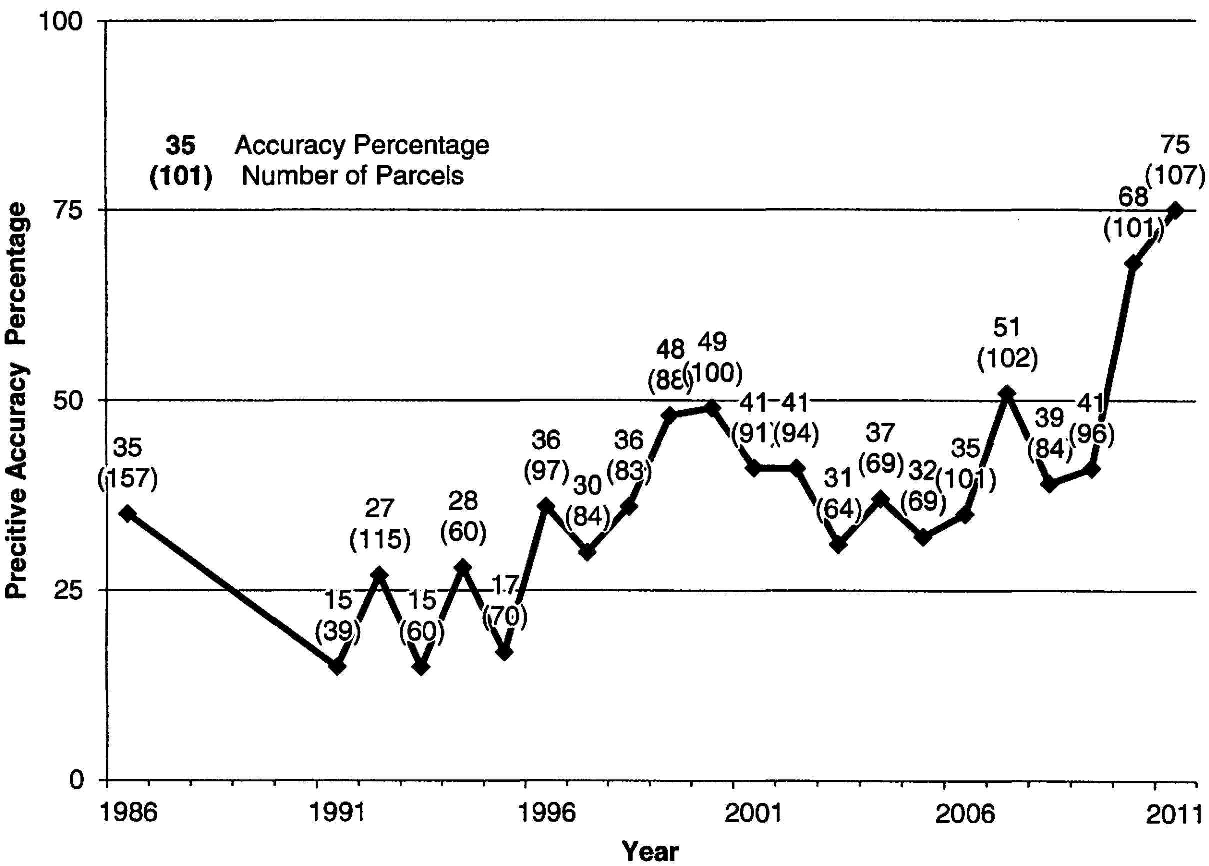
- There is an inherited limitation and uncertainty with SMA model output as demonstrated by the available literature;
- Persistent inaccuracies of SMA-estimated cover exists;

- There is variability in SMA estimates of cover because the SMA model was not designed to be used for estimating vegetation cover in areas other than 33 specific monitoring sites, and it is expected that errors introduced by attempting to apply the model outside of its intended design parameters make the model inadequate to estimate vegetation cover in Blackrock 94;

- Comparison of SMA estimates of cover to LADWP line-point transect data reveals persistent inaccuracies;

- Comparison of SMA estimates of cover to ICWD line-point transect data reveals consistent inaccuracies, and SMA estimates of cover are consistently less than 50% accurate and should be discounted (see **Figure ES-3**); and

- SMA is unable to predict actual cover.



Note - Graph shows predictive accuracy of the ICWD SMA model at Owens Valley parcels through time. Accuracy values were calculated using regression analysis. The predictive accuracy of the SMA model is less than 50% based upon ICWD field measurements.

Figure ES-3
Graphical Display Showing Predictive Accuracy of the SMA Model

While SMA analysis can be a useful tool when used within its design parameters, its general accuracy at best is 45% to 75%. The SMA model used by ICWD was designed to measure 33 specific monitoring sites and is not applicable for extrapolation to Blackrock 94 or for the analysis of other Owens Valley vegetation parcels. The SMA model yields poor estimates of vegetation cover when compared to physical measurements of vegetation cover obtained using the line-point method as prescribed by the Green Book. Discrepancies between the actual measured peak growing season vegetation cover and modeled SMA-estimated cover values are not only large, but also highly variable and unpredictable because the SMA analytical method employed by ICWD provides inconsistent estimates of actual cover. The SMA model should not be given more credibility than physical field measurements of vegetation.

It is also worth noting that SMA estimated cover for Blackrock 94 failed to detect the actual measured recovery of vegetation cover observed in the parcel in the late 1990s. The SMA estimated cover in 1998 was 20% lower than the actual cover values measured by ICWD using the line-point method (28.8% estimate using SMA compared to 49.6% measured by ICWD using the line-point method).

The SMA model as applied by the ICWD in ICWD, 2014 was inappropriate for use in comparing vegetation change in Blackrock 94. Therefore, ***all conclusions, results, and inferences based on the SMA data are flawed and should be discounted. Modeled SMA-estimated cover cannot be used as a substitute for physical line-point measurements of vegetation cover.***

<u>Vegetation Composition at Blackrock 94 Is Highly Heterogeneous</u>. ICWD disregards LADWP's conclusion that Blackrock 94 is highly heterogeneous in its species composition and that the southeastern portion of the parcel has remained relatively similar to the baseline condition because LADWP's analysis was based on the data set collected after the change has occurred. ICWD simulates vegetation cover between 1986 and 1991 by the improvised use of an SMA model that was not designed to simulate vegetation changes in Blackrock 94 (a detailed discussion of ICWD's SMA analysis is included in Section 5).

Evaluation of the available data convincingly demonstrates that parcel heterogeneity existed prior to and during the baseline years, and LADWP makes the following key points:

- Measuring changes in species composition using absolute cover is inappropriate;
- The high cover grass dominated baseline condition is not due to high water table, but due to surface water spreading (and increased precipitation);
- Vegetation cover in 1998 was 20% higher than 1986 cover as a result of a period of above normal runoff;
- Fluctuations in the vegetation conditions are largely driven by water spreading that occurs during high-runoff years, and generally does not occur during low-runoff years;
- The vegetation conditions of the parcel are expected to return to baseline conditions when similar climatic conditions reoccur; and
- There is evidence of vegetation recovery during wet cycles.

ICWD's most recent attempts to corroborate its theory that vegetation conditions in Blackrock 94 have permanently and irreversibly changed from those described during the initial inventory fail for many reasons. In these attempts, ICWD has moved from using actual data collected through time to utilizing output from models that utilize output from other models as its "data". LADWP convincingly refutes these "findings" using actual physically-measured data.

The Control Parcels Selected by LADWP Meet the Prescribed Requirements and the ICWD's Comparison with Blackrock 99 is Not Appropriate. ICWD claims that vegetation parcel Blackrock 99 is an appropriate control parcel for comparison with Blackrock 94 *"because soils, precipitation, baseline vegetation cover and composition, and initial depth to water are known to be similar"* (ICWD, 2014, page 84). However, ICWD left out the most important criteria for selecting a control parcel when attempting to control for the effects of pumping: ***the control parcel should not be affected by pumping***, but Blackrock 99 ***is*** affected by pumping.

In addition, as described previously, Blackrock 99 has a unique set of hydrologic attributes that Blackrock 94 does not, rendering them incomparable. LADWP determined that ICWD should have chosen a more appropriate parcel to be compared with Blackrock 94. However, this was not the case, and ICWD inexplicably chose an irrigated wellfield parcel that is also affected by groundwater pumping to compare to Blackrock 94 in order to evaluate the effects of groundwater pumping. The choice of Blackrock 99 does not make scientific sense.

In order to fill in missing data years between 1986 and 1991 and to deal with *the "...problematic comparison between baseline data in which the transect locations are unknown..."* ICWD chose to use modeled vegetative cover data using SMA of satellite imagery. However, the predictive accuracy of ICWD's SMA model ranged from 0% to 43% (when compared to line-point transects in Blackrock 94, Blackrock 99, and control parcels PLC106, LNP018, and UNW029), and modeled SMA cover was found to differ wildly from actual measured cover (ICWD line-point data) in the majority of year-to-year comparisons.

In comparison, LADWP clearly demonstrates that its chosen control parcels not only control for the effects of groundwater pumping, but are also more comparable to Blackrock 94 than any other of the 198 parcels monitored throughout the Owens Valley since 1991. To make its selection, LADWP implemented procedures in accordance with the Green Book.

Vegetation parcel Blackrock 94 is one of 198 parcels monitored by either ICWD or LADWP since 1991. Vegetation monitoring is performed using the same methods across all 198 parcels. Of the 198 parcels, 113 parcels are classified as wellfield parcels, the same designation as Blackrock 94. The remaining 85 parcels are classified as control, which are unaffected by groundwater pumping. Because Blackrock 94 was classified as Type C during the baseline inventory, the choice of any parcel other than a Type C control parcel would be inappropriate. Since 1991, only 42 Type C control parcels have been monitored by either ICWD or LADWP. This pool of potential parcels is further narrowed to 27 parcels by removing those dominated by Nevada saltbush and those located on river floodplains, both of which are characteristics not comparable to Blackrock 94. Of the remaining 27 parcels, only four contained complete data sets from 1992 to present, and of those only two were monitored in 1991.

In summary, the four remaining parcels contained the following characteristics: control classification, Type C classification, are not dominated by saltbush, are not located on a river floodplain, and contain a complete data set. These four potential control parcels are IND163, LNP018, PLC106, and UNW029. Of these four control sites, IND163 was most dissimilar in initial vegetation cover. The three parcels selected by LADWP ***control* for the effects of groundwater pumping**, and therefore meet the basic requirements of a control parcel. Second to this most basic requirement, is the need for the selected control parcels to be comparable to Blackrock 94 in regard to initial vegetative conditions, soil characteristics, and vegetative cover over time. These similarities were clearly demonstrated to have been met in LADWP, 2013.

ICWD overlooked the most glaring aspect in determining meaningful conclusions on the effect of groundwater pumping on vegetation at Blackrock 94, which is ***controlling for the effects of groundwater pumping***. This premise is the fundamental basis on which all credible research is built, controlling for confounding variables.

Soil Moisture: Surface Water Spreading, Runoff-Driven Recharge, and Precipitation Govern Soil-Water Content in Blackrock 94

Surface Water Spreading (as a result of runoff) and Precipitation Play Significant Role in Recharge of Soil-Water Content. The ICWD (2014) found the LADWP's (2013) soil water analysis inaccurate and incomplete. In particular, ICWD claims that groundwater pumping is the primary factor for the reduction of soil moisture and the subsequent decline in vegetation cover at Blackrock 94. LADWP counters that in addition to groundwater levels, both surface water spreading, which is dependent on the amount of runoff, and precipitation play significant roles in recharge of soil-water content and hence vegetation cover. The ICWD (2014) did not adequately consider these variables and their relation to vegetation cover. By solely subscribing that groundwater pumping is the primary reason for the decline in vegetation considerably oversimplifies the issue at Blackrock 94.

Unlike ICWD's (2014) analysis, which contends that local groundwater levels are the primary mechanism that drive soil moisture, LADWP counters that surface water spreading, runoff-driven recharge, and precipitation exerts a stronger influence on soil-water content. In years of high runoff, water is spread unevenly across Blackrock 94 leading to variations in local soil moisture levels. Additional change is related to fluctuations in annual precipitation. The annual variation in both runoff and precipitation, combined with spatial variability related to spreading, provides a clear and straightforward explanation for the trends in vegetation cover at Blackrock 94. Lastly, the conditions at the TS3 monitoring site, which ICWD offers as what the soil moisture and vegetation cover would be at TS1 andTS2 had groundwater pumping never occurred, is erroneous, as it fails to account for the natural variability in groundwater and soil moisture replenishment stemming from wet and dry periods. Soil moisture is highly variable both across the sites and throughout time.

1 INTRODUCTION

This report has been prepared for submittal to the Inyo/Los Angeles Technical Group (Technical Group) and Arbitration Panel to address selected remaining matters concerning the issue submitted to dispute resolution pursuant to stipulation and order for judgment in case number 12908 and in compliance with the Arbitration Panel's October 21, 2013 Order. It contains the Los Angeles Department of Water and Power's (LADWP) response to the Inyo County Water Department's (ICWD) February 2014 report entitled, *"Inyo County Response to LADWP Evaluation of Attributability and Significance of Vegetation Changes in Blackrock 94"* (ICWD, 2014). ICWD, 2014 was prepared in response to LADWP's December 18, 2013 report entitled, *"Evaluation of Attributability and Significance of Vegetation Changes in Blackrock 94"* (LADWP, 2013).

The questions for the Technical Group, Inyo/Los Angeles Standing Committee, or arbitrators to determine are if certain measureable changes in vegetation within Blackrock 94 are attributable to LADWP's groundwater pumping since the 1986 vegetation survey and/or ***changes*** in LADWP's surface water management practices since 1970[1]. If measureable changes are found to be attributable to groundwater pumping or ***changes*** in past surface water management practices since 1970, then it must be determined whether those measurable changes are or are not significant.

The Blackrock 94 study area is shown on the location map provided as **Figure 1**. Blackrock 94 is a 333-acre parcel, located approximately eight miles north of Independence, California. It is positioned in an upland area along the western flank of the Owens Valley near Sawmill Creek. Other key pertinent features are also shown on this map, including the Blackrock Hatchery, Blackrock 99, geographic features, wells, creeks, and the Los Angeles Aqueduct (LAA).

This document is organized into the following sections:

- Section 1 - Introduction
- Section 2 - The Blackrock 94 Dispute - This section provides an overview of the Blackrock 94 disagreement, including a summary of relevant documents and how they fit together.
- Section 3 - Areas of Agreement and Disagreement - This section provides an overview of areas of agreement and disagreement between LADWP and ICWD related to the subject dispute.

[1] Water Agreement Section IV.B, page 19, provides the standard to be met in order to make a determination of "attributable" when following the procedures for "*Determination of "Significant" and "Significant Effect on the Environment"* is "*if the decrease, change, or effect is determined to be attributable to groundwater pumping or to **changes in past surface water management practices**...*" (emphasis added). Green Book Section I, page 1, provides "*when reference is made to changes in **past surface water management practices**, changes will be determined in comparison with **past practices since 1970***" (emphasis added). LADWP's past surface water management practices pertaining to water spreading include spreading water during high runoff periods and not spreading water during low runoff periods or periods of drought (LADWP, 2013, Section 5.7). Since it is a documented past surface water management practice for LADWP to not spread water during periods of drought or low runoff, reductions in surface water spreading during low-runoff periods is permitted under the Water Agreement.

- Section 4 - Hydrology: Variations in Groundwater Levels at Blackrock 94 - This section focuses on hydrology issues by summarizing LADWP's analysis and presenting a response to hydrology-related issues put forth in ICWD (2014).
- Section 5 - Vegetation - The ICWD Relies on Flawed Vegetation Data - Modeled Vegetation Cover Data is No Substitute for Physically-Measured Vegetation Cover Data: This section focuses on vegetation of the Blackrock 94 area, including a review of LADWP's key points complemented by specific responses to the ICWD's Vegetation section presented in ICWD (2014).
- Section 6 - Soil Moisture - Surface Water Spreading, Runoff-Driven Recharge, and Precipitation Govern Soil-Water Content at Blackrock 94. This section focuses on the drivers behind soil water content.
- Section 7 - References

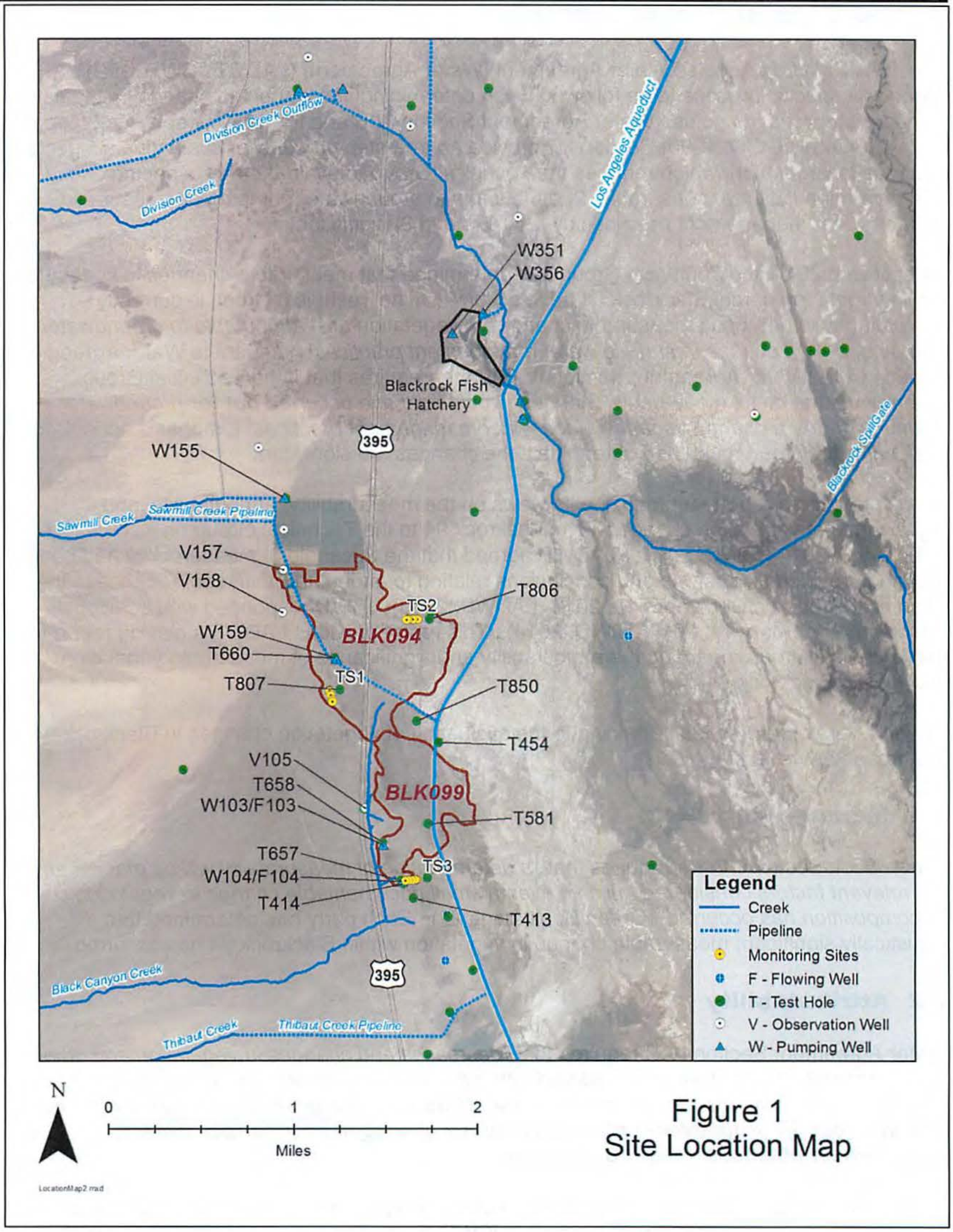


Figure 1
Vegetation Parcel Blackrock 94 Site Location Map

2 THE BLACKROCK 94 DISPUTE

The 1991 Inyo/Los Angeles Water Agreement (Water Agreement) (LADWP/ICWD, 1991) requires a specific process to be followed when determining if a suspected change in vegetation is inconsistent with its goals. Water Agreement Section IV.B and the 1990 Green Book (Green Book) (LADWP/ICWD, 1990) Section I.C provide a three-step process for evaluating suspected changes in vegetation, which requires the Technical Group to evaluate the suspected change and determine if it is 1) measurable, 2) attributable to groundwater pumping or a change in surface water management practices by LADWP, and 3) significant.

As of March 2014, the Technical Group has determined that measurable changes in vegetation within vegetation parcel Blackrock 94 have occurred. The Technical Group is currently evaluating whether these measurable changes in vegetation are "*attributable to groundwater pumping, or to a change in surface water management practices*" pursuant to Water Agreement Section IV.B. Water Agreement Section IV.B further requires that if the Technical Group determines that these measurable changes "*would not have occurred **but for** groundwater pumping and/or a change in past surface water management practices*" (emphasis added), then the Technical Group must then determine if the changes are significant.

ICWD provided a report summarizing its views on the measurability, attributability, and significance of vegetation change within Blackrock 94 to the Technical Group on February 3, 2011 (ICWD, 2011). LADWP agreed that the threshold of measurability had been met and provided its analysis and conclusions relating to attributability and significance to the Technical Group on December 18, 2013 (LADWP, 2013). ICWD responded with additional analysis on February 14, 2014 (ICWD, 2014). This report provides LADWP's closing report to the Technical Group regarding the attributability and significance of measurable vegetation changes in Blackrock 94.

Observations of key issues pertaining to the evaluation of vegetation changes in Blackrock 94 are presented herein.

2.1 Measurability

Green Book Section I.C.1.a requires that *"a determination of measurability will be made if any of the relevant factors considered indicate even a small documentable change in vegetation cover or composition has occurred"* (Green Book, page 21). Each party has determined that a statistically significant measurable change in vegetation within Blackrock 94 has occurred.

2.2 Attributability

Water Agreement Section IV.B requires that "*decreases and changes in vegetation and other environmental effects shall be considered "attributable to groundwater pumping, or to a change in surface water management practices," **if the decrease, change, or effect would not have occurred <u>but for</u> groundwater pumping and/or a <u>change</u> in past surface water management practices***" (page 18, emphasis added).

- The ICWD analysis of attributability concentrated primarily on how changes in vegetation correlated with groundwater pumping. ICWD conducted a negligible evaluation of the extent to which other factors unrelated to the effects of groundwater pumping, including fluctuations in wet/dry climatic cycles or drought, has contributed to vegetation change as required by Green Book Section I.C.1.b.v (page 24). With limited evaluation of the effects of the 1987-1994 drought and other wet/dry climatic cycles on the water table, ICWD concluded that "*pumping induced declines on the water table 1987-1990 corresponded to decreases in vegetation cover...*" (ICWD, 2011, page 56) and "*these changes occurred between baseline and 1991...*" (ICWD, 2011, page 66). ICWD did not evaluate or present any evidence to support an allegation that LADWP may have changed surface water management practices[2].

ICWD also changed its 2011 determination of attributability from being "*...reduced surface water diversions into the vicinity of Blackrock 94*" (ICWD, 2011, page 66), which is not necessarily a change in LADWP's past surface water management practices or violation of the Water Agreement, to "*...changes in surface water management practices*" (ICWD, 2014, page 85), without providing any evidence to support this new allegation.

- The LADWP analysis of attributability evaluated the influence of all factors required by Green Book Section I.C.1.b including: groundwater pumping, changes in surface water management, drought, wet/dry climatic cycles, flooding, fungal blight, range management practices, wildfire, off-road vehicles, and other factors relative to vegetation changes in Blackrock 94. LADWP's attributability analysis concluded: "*Changes in vegetation cover and composition from that measured in LADWP's 1986 initial vegetation inventory are attributable to fluctuations in wet/dry climatic cycles and not attributable to groundwater pumping or to changes in past surface water management practices*" (LADWP, 2013, page 233).

2.2.1 Significance

Water Agreement Section IV.B requires that "*if the decrease, change, or effect is determined to be attributable to groundwater pumping or to changes in past surface water management practices, the Technical Group then shall determine whether the decrease, change, or effect is significant.*"

ICWD provided conflicting conclusions regarding significance:

- ICWD (2011) did not conclude that a significant change had occurred but instead found a significant change to be occurring: "*the factors prescribed in the LTWA and Green Book for assessing the significance of an impact were evaluated and* ***indicate that a significant change <u>is occurring</u> in Blackrock 94***" (ICWD, 2011, page 66, emphasis added).
- Without presenting any additional evidence to modify its previous claim that a significant change was occurring, ICWD then altered its significance determination to be that a significant change had already occurred: "*Ample evidence exists that a measurable change in vegetation in Blackrock 94 has occurred, that the change is attributable to LADWP's groundwater pumping operations, and that* ***the change is significant***... *the County requests the*

[2] As presented in LADWP, 2013 (Section 5.7), reductions in surface water diversions for water spreading during low-runoff years and periods of drought is a long established practice of LADWP since prior to 1970. Therefore, reductions is surface water spreading during low-runoff years and periods of drought does not constitute a *"change in surface water management practices"* and is permitted under the Water Agreement.

Standing Committee… to find that ***a significant effect*** ***has occurred in*** *Blackrock 94…"* (Inyo County's September 20, 2012 request for resolution, page 12).

- In ICWD, 2014, ICWD once again altered its significance conclusions to *"…a measureable and significant change and decrease in vegetation* ***has occurred or is occurring*** ***at Blackrock 94*** *that is attributable to LADWP's groundwater pumping and to its changes in surface water management practices"* (ICWD, 2014, page 85, emphasis added) and attempted to alter the question to the Arbitration Panel.

In summary, without offering any additional evidence to support its claims, ICWD has changed its significance determination from *"a significant change is* ***occurring****" to "a significant effect has* ***occurred****"* and finally to *"a significant change…* ***has occurred or is occurring****".*

- LADWP's analysis of significance was based upon the provisions of Water Agreement Section IV.B and Green Book Section I.C.1.c. LADWP concluded that "*changes in vegetation cover and composition from that measured in LADWP's 1986 initial vegetation inventory are attributable to fluctuations in wet/dry climatic cycles and not attributable to groundwater pumping or to changes in past surface water management practices"* (LADWP, 2013, page 233). "*Water Agreement Section IV.B allows for the evaluation of significance only after it has been determined that measurable changes are attributable to groundwater pumping or changes in surface water management… Therefore, pursuant to the terms of the Water Agreement, a determination of significance cannot be made"* (LADWP, 2013, page 234).

2.2.2 Hydrological Analysis

- ICWD provides conflicting conclusions regarding its analysis of water table changes between the mid-1980s and late 2000s. For example:
  - ICWD (2011) concluded that "*water tables in 2007 were about 2 ft below mid-1980's levels…*" (ICWD, 2011, page 52);
  - ICWD (2011, Figure 13) shows the water table in 2007 to be about 11 feet deeper than the mid-1980's levels (page 38); and
  - ICWD (2014) concludes the "*water table declines attributable to groundwater pumping have been about 10 to 15 feet or more*" (page 83).
- ICWD bases its hydrological conclusions on computer simulations of changes in the groundwater table: "*Groundwater modeling is the most applicable tool available to determine how groundwater pumping has affected the water table*" (ICWD, 2014, page 19), while admitting that "*…the groundwater model is not equipped to reproduce localized short-lived* (water) *spreading events*" (ICWD, 2011, page 51).
- ICWD uses the U.S. Geological Survey (USGS) regional groundwater flow model for the Owens Valley for simulating small-scale changes in the groundwater table at Blackrock 94 (ICWD, 2014, page 50). However, the USGS stated that the USGS Owens Valley-wide model is not appropriate for simulating small-scale effects:

- "*Because of the way it was calibrated, the model is most useful for evaluating valleywide conditions, not for predicting small-scale effects covering a few model cells. Site-specific ground-water flow models or multivariate regression models, such as developed by P.B. Williams (1978) and Hutchison (1991), can give more accurate predictions at selected sites*" (Danskin, 1998, page 79).

- "*Future analysis of these smaller-scale features or issues-such as a volcanic deposit, a facies change, or a question of local water use – might best be done by use of smaller-scale models or field studies…*" (Danskin, 1998, page 94).

- ICWD contradicts itself by simultaneously concluding that "*…according to the groundwater model, recharge fluctuations are sufficient to explain current deviations from baseline depth to water*" (ICWD, 2011, page 56) and "*groundwater model results show that water table fluctuations due to recharge alone are relatively small (a few feet) and water table declines attributable to groundwater pumping have been about 10 to 15 feet or more*" (ICWD, 2014, page 83).

- LADWP bases its hydrological conclusions on the analysis of physical measurements of the water table taken at numerous monitoring wells within and nearby Blackrock 94. Based upon the analysis of depth to water measurements, LADWP found groundwater levels beneath Blackrock 94 since 1998 have remained between 9 and 12 feet higher than following the 1970-1977 dry cycle, and between 7 and 11 feet lower than those following the 1978-1986 wet cycle (LADWP, 2013, Figure b.i.10, page 35).

2.2.3 Vegetation Analysis

Green Book Box I.C.1.a.ii (2) provides: "*vegetation transects shall also be used in cases of suspected vegetation changes due to groundwater pumping. …plant cover shall be measured by the line-point technique…*" (page 22).

- ICWD presented conflicting conclusions regarding vegetation changes. For example:
  - ICWD's physical measurements of vegetation cover in Blackrock 94 using the line-point method (which is required by the Green Book) found vegetation cover in Blackrock 94 to be approximately 50% in 1998 (ICWD, 2011, Figure 6).
  - Based upon a satellite analysis technique that is an extrapolation of a model not intended to estimate vegetation cover within vegetation parcels, ICWD found vegetation cover in Blackrock 94 to be approximately 30% in 1998 (ICWD, 2011, Figure 8, page 30), ***a disparity of 20% from actual field measurements.***
  - In accounting for the disparity between the vegetation cover values obtained by its own physical measurements and its estimates based on its improvised satellite model, ICWD acknowledged "*…the line point and remote sensing data show similar trends, but the absolute values of the two measurement techniques do not always agree*" and admitted that "*errors* [in its spectral mixture analysis (SMA)] *may still arise from co-registration of images, spectral calibration to ground points, error in the SMA model, and atmospheric corrections*" (ICWD, 2011, page 29).

- LADWP concluded: "*The measureable change in vegetation at Blackrock 94 is comparable to change in vegetation measured at the three selected vegetation control parcels. Analytical results indicate that this change is primarily driven by wet and dry climatic cycles. Trends in total perennial cover at both the control parcels and at Blackrock 94 display this pattern*" (LADWP, 2013).

3 AREAS OF AGREEMENT AND DISAGREEMENT

The dispute resolution procedures contained in the Water Agreement (Section XXVI) require "*in the event that the Technical Group is unable to resolve a matter, or is unable to make a unanimous recommendation to the Standing Committee, the Technical Group shall make a written report to the Standing Committee explaining the areas of agreement, if any, the subject or subjects of disagreement...*" (Water Agreement, page 55, paragraph 1). ICWD provided its perspective on the general areas of agreement and disagreement concerning the attributability and significance of vegetation change in vegetation parcel Blackrock 94 on pages 7-10 of ICWD, 2014. This section presents LADWP's summary regarding key areas of agreement and subjects of disagreement pertaining to the Blackrock 94 issue.

3.1 Key Areas of Agreement

This section provides a review of key areas of agreement.

3.1.1 LADWP and ICWD Agree that Runoff, Surface Water Spreading, and Precipitation Are All Highly Correlated and Drive Water Availability and Vegetation Cover

LADWP's evaluation of the attributability of vegetation change in Blackrock 94 concluded:

> *"An analysis of variations in vegetation cover and composition within Blackrock 94 found these fluctuations to be primarily the result of fluctuations in grass cover within the parcel. Variations in grass cover within the parcel are predominantly the result of fluctuations in wet/dry climatic cycles. ...the primary driver of decreases in vegetation cover are periods of decreased precipitation and runoff, which limit the amount of water available for grasses within the parcel. Grass cover within the parcel has also been shown to rebound during multiple years of increased precipitation and runoff" (LADWP, 2013, Section 5.12, page 216).*

The ICWD agrees that:

> "*Runoff influences soil water through recharge of the aquifer or direct infiltration, and is thus highly correlated to depth to water (r=-0.85), runoff is also positively correlated with surface water spreading; and at a valley-wide scale, runoff and precipitation are also highly correlated. It is not surprising that runoff is correlated to vegetation cover because the information contained in the runoff variable combines information contained in depth to water, surface water spreading, and precipitation variables which actually drive water availability and vegetation cover*" (ICWD, 2014, page 43, paragraph 2).

3.1.2 LADWP and the ICWD Agree that a Measurable Change in Vegetation Has Occurred in Vegetation Parcel Blackrock 94

LADWP and ICWD agree that a measureable change in vegetation within vegetation parcel Blackrock 94 has occurred.

3.1.3 LADWP and the ICWD Agree that Vegetation Data from Line-Point Vegetation Transects Shall Be Used in Cases of Suspected Vegetation Changes

The Green Book provides that "*vegetation transects shall also be used in cases of suspected vegetation changes due to groundwater pumping*...(and) ...*plant cover shall be measured by the line-point technique*..." (Box I.C.1.a.ii(2), page 22). Both the ICWD, 2011 and LADWP, 2013 reports analyze vegetation data collected using the line-point method.

3.1.4 LADWP and the ICWD Agree that High-Runoff Conditions Resulted in Relatively High Water Tables beneath Blackrock 94 During the mid-1980's

Owens Valley runoff between 1978 and 1986 averaged approximately 135 percent of normal (LADWP, 2013, Section 4.3, page 12). In accordance with its past surface water management practices during high runoff years, LADWP spread water from Sawmill Creek and Black Canyon Creek in the area of Blackrock 94 when runoff exceeded the capacity of the Los Angeles Aqueduct (LAA) (LADWP, 2013, Section 5.7.1.4, pages 184-185). LADWP estimated water spreading and associated infiltration from Sawmill Creek averaged about 2,200 acre-feet per year (AFY) between 1978 and 1986 (LADWP, 2013, Table b.vii.4, page 200). In effect, "*water spreading causes short-term increases on groundwater levels under Blackrock 94 as water mounds during spreading operations then dissipates*" (LADWP, 2013, page 30, paragraph 2). LADWP found that "*the increased precipitation and runoff between 1978 and 1986, and resultant increases in water spreading, caused groundwater levels in the area of Blackrock 94 to increase*" (LADWP, 2013, page 13, paragraph 1). Groundwater elevations in the area of Blackrock 94 were at or near their highest recorded levels when LADWP conducted its 1986 vegetation inventory (LADWP, 2013, Figure b.i.7, page 31).

The ICWD's analysis (2011) agreed with LADWP's findings that the high-runoff conditions and corresponding groundwater recharge during the 1978-1986 wet period resulted in high water table conditions during the mid-1980s: "*These results indicated that high runoff and recharge conditions during the mid-1980's baseline period resulted in relatively high water tables at that time, consistent with the high surface water uses and losses in the mid-1980's*..." (ICWD, 2011, page 52, paragraph 2).

3.1.5 LADWP and the ICWD Agree that Currently-Available Groundwater Models Have Limited Ability To Accurately Estimate Depth to Water or Simulate Groundwater Changes beneath Blackrock 94

LADWP stated that "*it should be noted that none of the currently-available computer models, including the regional USGS model of Owens Valley, were developed for the specific purpose of simulating the groundwater beneath Blackrock 94 or at the Hatchery. Current Models have either very large cell size, long stress periods, or the time period that was used for steady-state and transient conditions calibration that does not allow simulation of Blackrock Spring flow under the no Hatchery pumping condition, thereby precluding more detailed analysis of the effect of pumping on the Blackrock 94*" (LADWP, 2013, page 41, paragraph 2).

Subsequently, ICWD concurred: "*we agree with LADWP's comments regarding the limitation of either groundwater model to accurately simulate drawdown at Blackrock 94 (LADWP, 2013, p. 41)...*" (ICWD, 2014, page 14, paragraph 2). ICWD also acknowledged that its USGS groundwater model is unable to account for groundwater recharge due to water spreading: "*it should be noted that the groundwater model is not equipped to reproduce localized short- lived spreading events*" (ICWD, 2011, page 51). Furthermore, ICWD noted the uncertainty associated with the accuracy of its groundwater modeling results: "*uncertainty exists as to the accuracy of the various sources of vegetation information, groundwater model results, and the degree to which baseline conditions were a result of water spreading within the parcel*" (ICWD, 2011, page 3).

The USGS points out that "*Because of the way it was calibrated, the [USGS] model is most useful for evaluating valleywide conditions, not for predicting small-small scale effects covering a few model cells. Site-specific ground-water flow models or multivariate regression models, such as developed by P.B. Williams (1978) and Hutchison (1991), can give more accurate predictions at selected sites.*" (Danskin, 1998 page 79, right hand column, paragraph 2).

3.1.6 LADWP and the ICWD Agree that Rare and Endangered Plant Species Have Not Been Adversely Affected

ICWD and LADWP agree that there has been no effect on rare plants due to groundwater pumping or changes in surface water management practices at Blackrock 94. In its evaluation of rare and endangered species and other species of concern, LADWP concluded that "*changes in rare plants within Blackrock 94 are driven by changes in precipitation and are not significant*" (LADWP, 2013, page xiv). Similarly, ICWD concluded that "*plant condition has been noted as good to robust, and high percentages of the plants observed have been reproductive. Overall, the rare plant data are insufficient to document any trend or impact related to LADWP surface water or groundwater management*" (ICWD, 2011, page 58).

3.1.7 LADWP and the ICWD Agree that No Data Indicate that Air Quality Has Been Adversely Affected

Based on available data, ICWD and LADWP agree that air quality has not been negatively impacted at Blackrock 94 (ICWD, 2011, page 58, paragraph 2; LADWP, 2013, page 221, Section 6.4).

3.2 Key Areas of Disagreement

This section provides a review of key subjects of disagreement.

3.2.1 LADWP and the ICWD Disagree as to the Attributability of Measured Change in Vegetation within Blackrock 94

LADWP (2013) concluded that variations in vegetation cover in Blackrock 94 were predominantly caused by fluctuations in wet/dry climactic cycles[3]. LADWP found that vegetation

[3] LADWP also found "*other factors including periods of excessive grazing within Blackrock 94 prior to 2006, wildfires in 1990 and 2007, and the expansion of Highway 395 in 2008, have all had substantial influence on reductions in vegetation cover since LADWP's 1986 initial vegetation inventory*" (LADWP, 2013, page 214).

cover within Blackrock 94 increased in response to wet cycles, wherein increased precipitation, surface water infiltration, and surface water spreading yielded increased soil moisture[4]. Conversely, vegetation cover decreased in response to dry cycles and periods of drought, with decreases in soil moisture attributable to decreased precipitation, surface water infiltration, and surface water spreading[5]. A summary of LADWP's findings of attributability of vegetation change within Blackrock 94 follows:

> *"An analysis of variations in vegetation cover and composition within Blackrock 94 found these fluctuations to be primarily the result of fluctuations in grass cover within the parcel. Variations in grass cover within the parcel are predominantly the result of fluctuations in wet/dry climatic cycles. Factors including grazing, wildfire, and the expansion of Highway 395 have adversely affected vegetation cover within the parcel. However, the primary driver of decreases in vegetation cover are periods of decreased precipitation and runoff, which limit the amount of water available for grasses within the parcel. Grass cover within the parcel has also been shown to rebound during multiple years of increased precipitation and runoff.*
>
> *Groundwater pumping in the area of Blackrock 94 has for all intents and purposes been limited to groundwater pumping to supply the Blackrock Fish Hatchery since 1992. While other wells in the area have operated since 1992, the amount of pumping from these other wells has been minimal, only a few percent of the total pumping in the Thibaut-Sawmill and central and southern Taboose-Aberdeen Wellfields, so as not to be attributable to vegetation changes since that time. While the effects of a major drought between 1987 and 1994 combined with increased groundwater pumping between 1987 and 1992 resulted in decreases in the groundwater table beneath Blackrock 94, a four-year period of increased precipitation and 140% of average snowpack runoff between 1995 and 1998, in combination with reduced groundwater pumping, resulted in total perennial vegetation cover within Blackrock 94, by 1999, to be 21.3% higher and grass cover to 7.2% higher than that observed during LADWP's 1986 initial vegetation inventory.*
>
> *The principal source of groundwater pumping in the Blackrock area, pumping for the Blackrock Fish Hatchery, has been persistent and relatively constant since 1972. Any suppression on the water table caused by Blackrock Fish Hatchery supply pumping was in place and had stabilized during the 14 years prior to LADWP's 1986 initial vegetation inventory and any effect on vegetation cover and composition caused by hatchery pumping was reflected in the 1986 inventory. Moreover, Blackrock Fish Hatchery supply pumping has caused no further suppression or fluctuations in the groundwater table since the 1986 initial vegetation inventory, therefore Blackrock Fish Hatchery pumping is not attributable to vegetation changes since that time.*

[4] One of LADWP's long-standing surface water management practices is to spread surface water during wet cycles when surface water runoff volume exceeds the capacity of the Los Angeles Aqueduct (see Section 5.7 of LADWP, 2013, pages 182 through 207).

[5] Decreased surface water spreading in low runoff/dry years and periods of drought conforms with LADWP's past surface water management practices and is performed in compliance with the Water Agreement (see Section 5.7 of LADWP, 2013, pages 182 through 207).

Using numerous analytical methods, it has been conclusively demonstrated that LADWP has not changed its surface water management practices since 1970, either in the overall area of Blackrock 94 or on Sawmill Creek, the principle creek that could affect Blackrock 94. Therefore, changes in LADWP's surface water management practices are not attributable for measurable changes in vegetation within Blackrock 94. LADWP's water spreading practices both in the overall area surrounding Blackrock 94 and on Sawmill Creek, which is adjacent to Blackrock 94, are highly correlated with runoff. Water is reliably spread during wet periods of high runoff and not spread during periods of low runoff" (LADWP, 2013, Section 5.12, page 216).

LADWP's conclusion is based on in-depth analysis of vegetation and hydrologic data, including long-term records of precipitation, snowpack, runoff, water spreading, groundwater pumping, and other pertinent data collected in the Blackrock 94 area. In comparison, both ICWD (2011) and ICWD (2013) focused on groundwater pumping with little consideration given to other factors. ICWD provided almost no analysis of the effects of wet/dry climatic cycles on vegetation in either its February 2, 2011 or February 14, 2014 reports, incorrectly claiming that the data necessary for such analysis does not exist:

"*The Green Book lists several other factors to be considered in the attributability analysis, ostensibly to more clearly ascribe the observed vegetation change to one or more specific causes. Other factors include precipitation, grazing, plant disease, **wet/dry cycles**, wildfire, and vehicle traffic. **Unfortunately, quantitative data do not exist to permit evaluation of most of these factors***" (ICWD, 2011, page 53, paragraph 2, emphasis added).

Not only did ICWD ignore data related to wet/dry cycles, it also did not conduct an evaluation pertaining to changes in surface water management practices in either its 2011 or 2014 reports[6]. As demonstrated by LADWP (LADWP, 2013, Section 5.7, page 182), surface water spreading is closely related to high-runoff periods.

ICWD's groundwater modeling simulations found that changes in the water table beneath Blackrock 94 since 1986 can be explained by fluctuations in wet/dry cycles: "*... according to the model, recharge fluctuations are sufficient to explain current deviations from baseline depth to water*" (ICWD, 2011, page 56, paragraph 1); however, the ICWD 2014 report appears to conflict with its earlier conclusions: "*Groundwater model results show that water table fluctuations due to recharge alone are relatively small (a few feet) and water table declines attributable to groundwater pumping have been about 10 to 15 feet or more*" (ICWD, 2014, page 83).

[6] The ICWD's 2011 report did include a rudimentary evaluation of "uses and losses" on Sawmill Creek that suggested uses and losses on the creek were higher during high-runoff years and lower during low-runoff years, but that evaluation did not demonstrate (or allege) that LADWP may have changed its surface water management practices. The ICWD 2014 report did not evaluate surface water management at all. Reductions in surface water spreading during dry cycles and periods of drought are in conformance with LADWP's past surface water management practices and are permitted by the Water Agreement. As demonstrated in LADWP (2013, Section 5.7, pages 182 – 207), LADWP has not changed its surface water management practices in the area of Blackrock 94.

3.2.2 LADWP and the ICWD Disagree as to the Significance of Measured Changes in Vegetation within Blackrock 94

LADWP concluded that measurable changes in vegetation cover within Blackrock 94 "*were attributable to periods of drought and fluctuations in wet/dry climatic cycles*" (LADWP, 2013, page 228). "*During the "dry" periods of lower precipitation and decreased runoff, specifically the years between 1987 and 1994 and the years since 1999, vegetation cover has tended to decrease... During the "wet" periods of increased precipitation and snowpack runoff between 1978-1986 and 1994-1998, vegetation cover in Blackrock 94 increased substantially*" (LADWP, 2013, page 214). It must be noted that since 1997 and 1998, when the ICWD line-point measurements of Blackrock 94 quantified vegetation cover to equal or exceed baseline cover values[7], groundwater pumping in the Thibaut-Sawmill Wellfield has been essentially steady-state[8] while vegetation cover values have fluctuated between 50% and 15%[9]. It is unreasonable for ICWD to conclude that this steady-state groundwater pumping caused fluctuations in the water table or changes in vegetation cover.

A measurable change in vegetation due to drought or fluctuations in wet/dry climatic cycles cannot be determined to be significant because the Water Agreement Section IV.B (page 19) provides for a determination of significance to be made only if a measurable change in vegetation was determined to be attributable to groundwater pumping or a change in past surface water management practices:

> "*If the decrease, change, or effect is determined to be attributable to groundwater pumping or to changes in past surface water management practices, the Technical Group then shall determine whether the decrease, change, or effect is significant.*"

Because LADWP found that measurable changes in vegetation within Blackrock 94 were attributable to periods of drought and fluctuations in wet/dry climatic cycles, these changes are not significant pursuant to the provisions of the Water Agreement. Nevertheless, LADWP did conduct a complete analysis of significance of the measurable changes in Blackrock 94 pursuant to the Arbitration Panel's October 21, 2013 Interim Order; the results of which are contained in Section 6 of LADWP, 2013 (pages 218-229). LADWP's analysis of the significance of vegetation changes in Blackrock 94 concluded (page xiv) "*the measureable changes in vegetation cover and composition in Blackrock 94 are not significant because:*

- *Measurable changes in vegetation cover are not attributable to groundwater pumping or to changes in LADWP's past surface water management practices since 1970.*

- *Measurable changes in vegetation cover are attributable to periods of drought and fluctuations in wet/dry climatic cycles. During periods of drought or low runoff and precipitation, total perennial vegetation cover tends to decrease; during wet periods and associated high runoff and precipitation, vegetation cover rebounds.*

[7] See LADWP, 2013, Figure b.ii.28, page 104 and Table b.v.1, page 143.
[8] See LADWP, 2013, Figure b.i.11, page 35 and Table b.i.5, page 36.
[9] See LADWP, 2013, Figure b.ii.28, page 104 and Table b.v.1, page 143.

- *Similar trends in vegetation cover and composition observed at Blackrock 94 are also observed in control parcels in other areas of the Owens Valley.*

- *The size of the measurably different vegetation cover within the Blackrock 94 parcel is only about 2% of the Blackrock Vegetation and Wellfield Management Area.*

- *Because measurable changes in vegetation fluctuate widely, corresponding to changes in runoff and precipitation, the degree of change is not significant (an example of this is vegetation cover increased over 400%, from 12% to 50%, between 1994 and 1998, during a period of 140% of average runoff).*

- *Measurable changes in vegetation are not permanent and clearly fluctuate with available runoff and precipitation.*

- *There is no indication of an effect on air quality associated with Blackrock 94.*

- *The cumulative effect of adverse vegetation change since the Water Agreement was signed is zero. There has never been a determination pursuant to the provisions of the Water Agreement that a significant change in vegetation that is attributable to groundwater pumping or to changes in LADWP's surface water management practices.*

- *Existing enhancement/mitigation projects provide significant environmental benefits through the creation and/or conversion of more than 2,400 acres to meadow area.*

- *Changes in rare plants within Blackrock 94 are driven by changes in precipitation and are not significant.*

- *There is no indication of an effect on human health associated with Blackrock 94."*

The ICWD (2011) concluded that groundwater pumping and reduced surface water diversions[10] resulted in changes to vegetation in Blackrock 94 prior to the 1991 (which was prior to the signing of the Water Agreement) and coincident with the 1987-1992 drought. ICWD did not find that a significant change had occurred in Blackrock 94 in its February 2, 2011 report, rather it inexplicably concluded that the pre-1991 changes to vegetation *"indicate"* a significant change to be *"occurring"* in 2007 (over 20 years later). This conclusion ignores the fact that ICWD's own vegetation transects measured vegetation cover in 1998 to be 20% higher than that measured prior to 1991:

> *"Available factual and scientific data indicate a measurable vegetation change since baseline has occurred in Blackrock 94...These changes occurred between*

[10] Reduced surface water diversions for water spreading during low runoff years has been a standard surface water management practice of LADWP's since prior to 1970 (LADWP, 2013, Section 5.7). Since reduced surface water diversions during low runoff years or periods of drought are not a "*change in surface water management practices*", reduced surface water diversions during low runoff years or periods of drought do not met the criteria necessary to be determined "attributable" or "significant" pursuant to Water Agreement Section IV.B, page 18, paragraph 4 and page 19, paragraph 2.

baseline and 1991 and have persisted in time... and indicate that a significant change is occurring in Blackrock 94." (ICWD, 2011, page 66)[11].

ICWD arrived at the conclusion that vegetation change in Blackrock 94 was the result of groundwater pumping without considering the effects of drought and wet/dry climatic cycles. LADWP makes this assertion because the ICWD February 2, 2011 report did not evaluate the effects of drought, wet/dry cycles, or other factors as required by Green Book Section I.C.1.b.v. In its report, ICWD incorrectly claimed that the necessary data on precipitation, snowpack, and runoff did not exist: "*unfortunately, quantitative data do not exist to permit evaluation of most of these factors*" (ICWD, 2011, *Role of Other Factors,* page 53). Moreover, ICWD ignored the data from its own line-point vegetation transects when that data contradicted ICWD's claim that decreases in vegetation "*...occurred between baseline and 1991 and have persisted in time...*" As presented by ICWD (2011, Figure 3a, page 11), ICWD's own line-point vegetation measurements demonstrate that vegetation responded to the 1994-1998 wet cycle (~140% of normal). ICWD's own line-point measurements show that Blackrock 94 vegetation cover was equal to the 1986 baseline cover values by 1997, and by 1998, ICWD line-point vegetation measurements confirm that vegetation cover in Blackrock 94 was substantially higher (~20%) than the 1986 baseline values[12].

3.2.3 LADWP Disagrees with the ICWD Unsubstantiated Allegation that LADWP May Have Changed its Surface Water Management Practices Since 1970

Despite offering no evidence to support its claim in either its 2011 or 2014 reports, the ICWD attempted to change its question to the arbitration panel from:

> *"The County requests a determination by the mediators/temporary arbitrators that LADWP's groundwater pumping and **reductions in surface water diversions in the Blackrock 94 area** have caused a measurable and significant change in the vegetation conditions in violation of the provisions of the LTWA"* (Arbitrators Interim Order, October 21, 2013, page 1, paragraph 1, emphasis added).

to:

> *"Determine that a measureable and significant change and decrease in vegetation has occurred or is occurring at Blackrock 94 that is attributable to LADWP's groundwater pumping and to its **changes in surface water management practices**"* (ICWD, 2014, page 85).

LADWP rejects ICWD's attempt to change the disputed question from that initially presented to the arbitration panel. LADWP has not changed surface water management practices as concluded by LADWP (2013). Moreover, no evidence has been provided by ICWD to support its allegation.

Water Agreement Section IV.B (page 18, paragraph 4) provides that "*decreases and changes in vegetation and other environmental effects shall be considered "attributable to groundwater*

[11] LADWP's baseline vegetation surveys were completed between 1984 and 1987. The baseline vegetation survey of vegetation parcel Blackrock 94 was completed in 1986.

[12] Green Book Box I.C.1.a.ii (2) requires the parties to evaluate suspected vegetation changes allegedly due to groundwater pumping using data obtained by physically measuring vegetation cover using the line-point transect method: "*vegetation transects shall also be used in cases of suspected vegetation changes due to groundwater pumping...plant cover shall be measured by the line-point technique...*"

*pumping or to **a change in surface water management practices**", if the decrease, change, or effect would not have occurred but for groundwater pumping and/or **a change in past surface water management practices**"* (emphasis added).

Green Book Section I.C provides *"a determination of whether the impact is attributable to groundwater pumping or **changes in surface water management practices** will be based on evaluation and consideration of relevant factors..."* (Green Book, page 23, paragraph 3, emphasis added).

The Vegetation Management goals of the Water Agreement are stated in Green Book Section I (page 1, paragraph 1),

> *"This Green Book section describes methods for achieving the goals and principles for vegetation management of the Agreement. Unless otherwise specified, determinations, decisions, or actions called for in this section will be made by the Technical Group. **When reference is made to changes in surface water management practices, changes will be determined in comparison with past practices since 1970.**"*

LADWP (2013) provided considerable evidence in Section 5.7 (pages 182 – 207) that LADWP's surface water management practices, which include diversions for water spreading, agriculture, and to the Los Angeles Aqueduct for export to Los Angeles, have not changed in the area of vegetation parcel Blackrock 94 since at least 1970. LADWP conclusively demonstrated that while the amount of water diverted for agriculture has been relatively consistent over time, the amount of water diverted for both water spreading and into the Los Angeles Aqueduct is dependent on the amount of runoff in any given year and is directly related to wet/dry cycles. Specifically, LADWP's past surface water management practice has been to spread water during high runoff years, when runoff exceeded the capacity of the Los Angeles Aqueduct, and to not spread water during most low runoff years[13] (LADWP, 2013, Section 5.7.2.3, page 194).

ICWD provided no evidence that LADWP has changed its surface water management practices. While ICWD's February 2, 2011 report observed that Sawmill Creek "uses and losses", defined as "*irrigation, water spreading, or (percolation) into the subsurface through stream channels and conveyances*", had varied between high runoff years and low runoff years, ICWD did not contend that LADWP had changed its surface water management practices in the area of Blackrock 94. Instead ICWD concluded "*vegetation degradation is primarily attributable to changes in water availability resulting from groundwater pumping and reduced water diversions in the vicinity of Blackrock 94*" (ICWD, 2011, page 66). Reduced surface water diversions during periods of low runoff are not a change in LADWP's past surface water management practices and are permitted under the Water Agreement.

The ICWD (2014) neither provided evidence pertaining to LADWP's surface water management practices, nor did it refute LADWP's 2013 statement that LADWP has not changed surface water management practices in the area of Blackrock 94.

[13] While infrequent, water may occasionally be spread during lower runoff years coincident with maintenance activities, other factors that limit the Los Angeles Aqueduct's ability to receive additional water, or for other reasons (see LADWP, 2013, Section 5.7.1.4, page 184).

To summarize, LADWP:

- Disagrees with ICWD's unsubstantiated claim that LADWP may have changed its surface water management practices;
- Calls attention to the fact that the ICWD (2011) claims that "*reductions in surface water diversions in the Blackrock 94 area*" are the reason for vegetation change in Blackrock 94[14] and despite offering no evidence, ICWD (2014, page 85) requested the Arbitration Panel to find certain measurable changes in vegetation in Blackrock 94 to be attributable to "*...changes in surface water management practices...*";
- Rejects ICWD's last minute attempt to change the disputed question pertaining to surface water from that originally posed to the Arbitration Panel; and
- Stands by the analysis presented in Section 5.7 (LADWP, 2013) that concluded "*LADWP has not changed its surface water management practices in the Blackrock 94 area since 1970*" (Section 5.7.3.1, page 207).

3.2.4 LADWP and the ICWD Disagree as to the Most Applicable Method for Determining Depth to Water or Changes in Groundwater Elevation beneath Blackrock 94

Since the early 1970s, LADWP has frequently measured the water table in the area of Blackrock 94, and this physical data is presented in LADWP, 2013 (Figure b.i.6, page 29). LADWP is confident that the most applicable method for determining changes in depth to water beneath Blackrock 94 is to analyze the substantial amount of existing groundwater level data obtained by physically measuring the water table at monitoring wells in the Blackrock 94 area and, when necessary, augmenting this actual physical data by interpretive methods such as kriging or groundwater modeling. ICWD believes computer simulations to be the most applicable method for determining groundwater level changes: "*groundwater modeling is the most applicable tool available to determine how groundwater pumping has affected the water table*" (ICWD, 2014, page 83, paragraph 2).

The analysis in LADWP's, 2013 report is first and foremost based upon actual real world physical data[15]. To supplement existing physical data, LADWP (2013) also included conceptual techniques in its analysis to estimate changes in the water table, such as kriging or groundwater modeling and clearly indicated this data as being kriged or simulated (Figures b.i.9 and b.i.12).

With regard to the currently-available groundwater models, LADWP believes that the USGS Owens valley-wide model used by ICWD and LADWP's Taboose-Thibaut Wellfields

[14] Reductions in surface water spreading diversions during low-runoff years are in keeping with LADWP's past practices since 1970 and are not "*a change in surface water management practices*" and therefore cannot be the reason for a determination of "attributable" or "significant" pursuant to Water Agreement Section IV.B. Reductions in spreading water diversions during low runoff years and periods of drought are permitted by the Water Agreement (LADWP, 2013, Section 5.7).

[15] For example, the hydrographs of the Blackrock 94 area (Figures b.i.6, b.i.7, and b.i.8) and the water balance for the Blackrock Hatchery (Table b.i.4) reflect the physically-measured depth to water or water flow. When necessary, to estimate the water table elevations outside the period of record, LADWP extrapolated the existing physical data using statistical correlation with nearby monitoring wells and clearly marked the extrapolated data as "estimated" (Table b.i.5). It must be noted the Pearson's r values for the Blackrock 94 monitoring well correlations ranged between r = .91 and r = .97 indicating a very high statistical correlation between the wells (LADWP, 2013, Section 5.1.8, page 34).

groundwater model (which is a refined version of the USGS model) can be useful tools for estimating the influences of recharge and groundwater pumping on the water table, provided the models are used within their design parameters and for the objectives for which they were intended. However, both models were designed for more regional-scale analysis, and are not intended to evaluate the potential effects of pumping individual wells in a complex hydrogeologic environment. The results of either of these models should not be considered to be more credible than actual physical data. LADWP stated,

> *"It should also be noted that that none of the currently-available computer models, including the regional USGS model of Owens Valley, were developed for the specific purpose of simulating the groundwater beneath Blackrock 94 or at the Hatchery. Current models have either very large cell size, long stress periods, or the time period that was used for steady-state and transient conditions calibration that does not allow simulation of Blackrock Spring flow under the no Hatchery pumping condition, thereby precluding more detailed analysis of the effect of pumping on the Blackrock 94*" (LADWP, 2013, page 41, paragraph 2).

This is substantiated by the USGS in their documentation of the groundwater model used by ICWD, where they state:

> *"Because of the way it was calibrated, the model is most useful for evaluating valleywide conditions, not for predicting small-scale effects covering a few model cells. Site-specific ground-water flow models or multivariate regression models, such as developed by P.B. Williams (1978) and Hutchison (1991), can give more accurate predictions at selected sites." (Danskin, 1998, page 79, right hand column, paragraph 2). "Future analysis of these smaller-scale features or issues... might best be done by the use of smaller-scale models or field studies..."* (Danskin, 1998, page 194. Right hand column, second paragraph).

ICWD agreed with LADWP: "*we agree with LADWP's comments regarding the limitations of either groundwater model to accurately simulate drawdown at Blackrock 94 (LADWP, 2013, p. 41)...*" (ICWD, 2014, page 14, paragraph 2).

In order to compensate for the limitations of the existing groundwater models, LADWP conducted a field study of the Blackrock Hatchery hydrology and prepared a water balance, based on actual physical measurements to account for hatchery water inflows and outflows (LADWP, 2013, Section 5.1.5). The data from the updated water balance was then incorporated into the LADWP Taboose-Thibaut groundwater model. Next, LADWP used this real-world data for selecting the inputs used in its groundwater modeling of Blackrock Hatchery pumping. Groundwater modeling results were reported together with LADWP's analysis of the actual physical data, statistical correlations, and results of other analytical techniques. LADWP believes the multifaceted analytical approach based upon actual physical data, which is the basis for its conclusions presented its 2013 report, to be the most applicable method for evaluating the area's hydrology.

ICWD based the conclusions of its February 2, 2011 and February 14, 2014 reports on the simulated changes in the water table derived from its USGS groundwater model. However, each of the ICWD reports presents contradictory views regarding the value of groundwater modeling. Page 19 of ICWD, 2014 states *"groundwater modeling is the most applicable tool available to determine how groundwater pumping has affected the water table".* While elsewhere in the same report, the ICWD agrees with LADWP that limitations of the currently-available groundwater models preclude them from being used for a detailed analysis of the effects of pumping on Blackrock 94: "We *agree with LADWP's comments regarding the limitation of either groundwater model to accurately simulate drawdown at Blackrock 94*" (ICWD, 2014, page 14). Moreover, ICWD (2011) states "*uncertainty exists as to the accuracy of the various sources of vegetation information, groundwater model results, and the degree to which baseline conditions were a result of water spreading within the parcel*" (ICWD, 2011, page 3).

LADWP further notes that ICWD claims to have modeled the effects of water spreading (ICWD, 2014, Hypothetical scenario 4, page 12), while admitting in its February 2, 2011 report that the USGS groundwater model used by ICWD cannot simulate the effects of water spreading: "*It should be noted that the groundwater model is not equipped to reproduce localized short-lived spreading events*" (ICWD, 2011, page 51, scenario 4).

While LADWP believes that groundwater modeling is a useful tool, provided the model is used within the parameters for which it was designed, it does not agree with ICWD position (2014, page 19) that "*groundwater modeling is the most applicable tool available to determine how groundwater pumping has affected the water table* [at Blackrock 94]." LADWP believes that a multifaceted analytical approach as required by the Green Book and recommended by the USGS, based primarily upon analysis of the actual physical data and augmented by analytical techniques such as groundwater modeling and kriging, is the most applicable method for determining water tables changes. Actual real-world field data (when available) should always take precedent over computer-based simulations using generalized groundwater models.

3.2.5 LADWP and ICWD Disagree about How to Properly Represent Blackrock Fish Hatchery Pumping in the Groundwater Model Simulations Pertaining to Blackrock 94

Both parties agree that no currently-available groundwater model is capable of accurately simulating the effects of groundwater pumping to supply the Blackrock Fish Hatchery on the water table at Blackrock 94. ICWD states that *"We agree with LADWP's comments regarding the limitation of either groundwater model to accurately simulate drawdown at Blackrock 94 (LADWP report, p. 41)..."* (ICWD, 2014, page 14).

The evaluation presented in LADWP, 2013 gave preference to actual real world physical data whenever possible. However, despite the limitations of the available groundwater models, both LADWP and ICWD attempted to simulate the effects of Blackrock Fish Hatchery pumping on vegetation parcel Blackrock 94. LADWP and ICWD models treat Blackrock Fish Hatchery pumping differently, and both parties disagree on how it should be represented in the models.

As described in Section 5.1.5 of LADWP, 2013 (beginning on page 25), LADWP's modeling of Blackrock Hatchery groundwater pumping accounted for Big Blackrock Spring flow, which undoubtedly would have continued flowing at an average of approximately 7,000 AFY in the absence of Hatchery pumping. Because an average of 7,000 AFY would be removed from the groundwater system at Blackrock Hatchery either in the form of spring flow or pumping, LADWP accounted for that groundwater discharge in its modeling simulations. Additionally, a water balance of the Blackrock Hatchery found that approximately 3,000 AFY on average infiltrates into the groundwater table from the Hatchery rearing ponds (LADWP, 2013, Table b.i.4, page 27). This infiltration into the groundwater was also accounted for in the simulations of Hatchery pumping. Although ICWD did not account for any of these important factors in its groundwater modeling schemes, it agreed that LADWP's handling of infiltration at the hatchery rearing ponds made sense: "*LADWP's…method of calculating losses does not seem unreasonable and the Technical Group should consider this factor in any further work concerning groundwater use by the Hatchery*" (ICWD, 2014, page 17, paragraph 2). LADWP is confident that a reasonable method of simulating Hatchery pumping is to account for the net groundwater extraction, which takes into account all inflows and discharges that are occurring or would otherwise take place at the hatchery.

In its modeling effort, ICWD ignored Big Blackrock Spring flow and infiltration from the Hatchery rearing ponds into the groundwater table and simply used the full amount of groundwater pumped at the hatchery. By ignoring these and other influences on the water table, the modeling results depicted by ICWD overstate drawdown due to pumping (notwithstanding other limitations of the modeling).

3.2.6 LADWP and ICWD Disagree about the Magnitude of Changes in the Water Table beneath Blackrock 94

LADWP used numerous hydrologic analytical techniques, including the comparison of physical measurements of the water table in the area of Blackrock 94 (LADWP, 2013, Section 5.1.7, page 30) and statistical correlation to monitoring wells within Blackrock 94 (LADWP, 2013, Figures b.i.10 and b.i.11, page 35; Table b.i.5, page 36), to quantify changes in the water table beneath Blackrock 94. LADWP found groundwater levels since 1998 have remained between 9 and 12 feet higher than they were following the 1970-1977 dry cycle, and between 7 and 11 feet lower than those following the 1978 – 1986 wet cycle (LADWP, 2013, Figure b.i.10, page 35).

ICWD presents inconsistent and conflicting estimates of water table changes beneath vegetation parcel Blackrock 94. For example, ICWD reported Blackrock 94 area water table changes between the mid-1980's and 2007 to be either 2 feet (ICWD, 2011, page 52) or 11 feet (ICWD, 2011, Figure 13, page 38) or 10 to 15 feet (ICWD, 2014, page 83), all depending on which report (2011 or 2014) is read and which section of the report is referenced.

ICWD also presents disparities within the same figures presenting its modeled groundwater estimates. Figures 18 and 19 (pages 52 and 53) in ICWD, 2011 indicate that in 1992, the water table beneath Blackrock 94 under its "Actual pumping" scenario to be about 17 feet lower than its modeled "no pumping" scenario. However, calculating the actual pumping presented in Figures 18 and 19, as the sum of the "Hatchery pumping only" and "No hatchery pumping"[16] results in about a 10 foot difference between ICWD "no pumping" scenario and its estimate of drawdown due to actual pumping. ICWD does not explain this seven-foot disparity in discussions of its modeling results.

[16] Because the ICWD defined "no hatchery pumping" to be all pumping other than Hatchery pumping, the sum of the estimates of drawdown induced by "hatchery pumping only" and "no hatchery pumping" should equal "actual pumping".

3.2.7 LADWP Disagrees with the ICWD that the 1991 Environmental Impact Report or Water Agreement Requires LADWP To Maintain Baseline Water Levels

The Water Agreement does not make any reference to a ***baseline water table***. Furthermore, the Water Agreement has no provisions for baseline water tables or direct management of the water table.

Without regard to the provisions of the Water Agreement, ICWD makes multiple references to baseline water levels "*...raising the water levels to baseline levels or above could be accomplished by a reduction in pumping...*" (ICWD, 2011, page 53, paragraph 1) and "*...the results estimate the relative contribution of runoff and pumping to changes in water levels with respect to the plant root zone or baseline water levels*" (ICWD, 2014, page 18, paragraph 1).

LADWP disagrees with the ICWD that the Water Agreement or the 1991 Environmental Impact Report (EIR) requires LADWP to maintain baseline water levels. There are ***no*** provisions for baseline water levels in these documents.

3.2.8 LADWP and ICWD Disagree Regarding the Selection of Control Sites

Scientific controls are a part of the scientific method. A scientific control is designed to minimize the effects of variables other than the single independent variable. The use of a control increases the reliability of the results, often through a comparison between control measurements and the other measurements.

In the case of determining the attributability of vegetation change in Blackrock 94, Green Book Section I.C.1.b requires the Technical Group to designate a control site that would control for (or minimize) the effects of groundwater pumping or surface water practices on the control site's vegetation when attempting to determine if a measurable "*...decrease, change, or effect would not have occurred but for groundwater pumping and/or a change in past surface water management practices*" (Water Agreement Section IV.B, page 18, paragraph 4). The Green Book Section I.C.1.b.ii, page 23, requires the Technical Group to conduct a *"comparison of soil water, depth to water and degree of vegetation decrease or change at the affected area and at a control site(s) determined to have similar soil type and vegetation composition and cover."*

LADWP selected control sites PLC106, LNP018, and UNW029 for a comparison to Blackrock 94 to evaluate the influences of groundwater pumping and surface water influences on vegetation, whereas the ICWD selected vegetation parcel Blackrock 99.

The ICWD rationale for selecting Blackrock 99 was that "*the permanent monitoring site TS3 and an adjacent meadow parcel Blackrock 99 were chosen for comparison with conditions in Blackrock 94, TS1 and TS2. These locations were chosen over control sites located east of the Los Angeles Aqueduct because of similar baseline vegetation, soil/landscape position, and proximity to Blackrock 94*" (ICWD, 2011, page 27, paragraph 1).

LADWP rejects the use of Blackrock 99 as a control site because of the significant hydrologic differences between the two parcels. Blackrock 99 has two pumping wells, one on it and one adjacent to it, that should immediately rule it out as a control site for groundwater pumping. In addition, the following significant differences in the hydrologic regime of the two sites make Blackrock 99 unsuitable for use as a control site:

- Blackrock 99 is irrigated, Blackrock 94 is not;
- Blackrock 99 has two flowing wells that contribute to soil moisture, Blackrock 94 has none;
- Blackrock 99 receives recharge from the unlined LAA and unlined diversion channels, Blackrock 94 does not; and
- Blackrock 99 has a shallower water table and is less sensitive to changes in runoff-driven recharge because it is topographically lower and relatively flat.

For these reasons, using Blackrock 99 as a control site or the comparison of vegetation change between the two parcels to determine attributability due to pumping or changes in surface water management practices is not appropriate.

In comparison, LADWP selected control parcels PLC106, LNP018, and UNW029. The protocol for the selection of these parcels is outlined in Section 5.2.5 of LADWP, 2013 report (pages 86-96) and incorporates an ICWD-developed protocol to determine areas that were not affected by groundwater pumping (LADWP, 2013, Section 5.2.5.3, page 88). Each control parcel selected by LADWP meets requirements prescribed in the Green Book.

Green Book section 1.C.1.b.ii ***does not require identical*** soil types or vegetation communities for comparison with the affected area but rather states, *"Comparison of... control sites determined to **have similar** soil type and vegetation composition and cover."* LADWP (2013, pages 86-96 and pages 136-138) clearly demonstrated that the three control parcels selected by LADWP for comparison with Blackrock 94 were more than adequate with regard to similarities in initial vegetation composition and cover, changes in vegetation over time, soil type, and precipitation. Furthermore, all three parcels selected by the LADWP are unaffected by groundwater pumping, and therefore meet the basic requirements of a control parcel which is, they ***control*** for the effects of groundwater pumping. In addition, of the 198 parcels monitored since 1991 by either the ICWD or the LADWP, only four (IND163, LNP018, PLC106, and UNW029) have the following attributes necessary for a control site as required by the Green Book:

- Control classification,
- Type C classification,
- Not dominated by saltbush,
- Not located on a river floodplain, and
- Contains a complete data set.

Of these four control sites, IND163 was most dissimilar with regard to its initial vegetation cover compared to Blackrock 94. Therefore, it was dismissed from further consideration. Of the available parcels, PLC106, UNW029, and LNP018 were the most similar control parcels to Blackrock 94. In conclusion, it is clear that the LADWP conducted a Green Book-compliant comprehensive analysis to select adequate control parcels that not only control for groundwater pumping, but also adequately control for initial vegetative conditions, soil characteristics, water table, and vegetative cover over time to permit meaningful conclusions pertaining to the effect of groundwater pumping on vegetation at Blackrock 94.

3.2.9 LADWP Disagrees with ICWD's Use of Spectral Mixture Analysis (SMA) to Determine Attributability

ICWD's 2014 report alleges that "*LADWP has omitted consideration of relevant data, including vegetation cover derived from satellite imagery, and data from a parcel neighboring Blackrock 94*" (page 10). LADWP disagrees with this statement and asserts there is no requirement under the Water Agreement that satellite imagery be used to determine attributability or significance (Green Book Section I.C.1.a.iv requires the use of remote sensing only when determining measurability) or that Blackrock 94 should be compared to its neighboring vegetation parcels. What the Green Book does require is that "*vegetation transects shall also be used in cases of suspected vegetation changes due to groundwater pumping...*" and "*...plant cover shall be measured by the line-point technique...*" (Green Book Box I.C.1.a.ii (2), page 22).

The spectral mixture analysis (SMA) model used by ICWD was designed to measure 33 specific monitoring sites and is not applicable for extrapolation to Blackrock 94 or for the analysis of other Owens Valley vegetation parcels. The SMA model was found to yield poor estimates of vegetation cover when compared to physical measurements of vegetation cover obtained using the line-point method. Discrepancies between the actual physically measured peak growing season vegetation cover and modeled SMA-estimated cover values were large, highly variable, and unpredictable. The SMA analytical method employed by ICWD provided inconsistent estimates of actual cover including cover values less than zero percent and cover values greater than 100% (both are impossible). In addition, SMA-estimated cover for Blackrock 94 failed to detect the actual measured recovery of vegetation cover that was observed in the parcel in the late 1990s (and physically measured by ICWD to be 20% greater than 1986 baseline cover). The SMA model should not be given more credibility than actual physical measurements of vegetation cover.

For these reasons, LADWP concludes that the SMA model as applied by ICWD in the ICWD, 2014 was inappropriate for use in comparing vegetation change in Blackrock 94 that ICWD suspects to be caused by groundwater pumping. Therefore all conclusions, results, and inferences based on the SMA data are flawed and should be discounted. Modeled SMA estimated cover cannot be used as a substitute for physical line-point measurements of vegetation cover.

3.2.10 LADWP and the ICWD Disagree that Changes in Soil Water Due to LADWP Pumping Caused Vegetation To Decline at Monitoring Sites TS1 and TS2

The ICWD (2014, page 38) concluded "*that lack of available groundwater in the grass root zone due to LADWP pumping caused the decline in vegetation cover and in particular the decline in grass cover measured at the permanent monitoring sites TS1 and TS2 in Blackrock 94.*"

LADWP disagrees with this ICWD finding, which focused on groundwater pumping as the reason for soil moisture change in Blackrock 94, especially because the ICWD provided no evaluation of wet/dry climatic cycles, the effects of drought, or essentially no other non-pumping factors in either its 2011 or 2014 reports. As is shown in LADWP, 2013 (Figure b.i.8, page 31), the water table in the area of Blackrock 94 was much higher in the mid-1980's than it is currently, although the amount of groundwater pumping during the two periods is nearly the same. The reason for the change in the groundwater table between the mid-1980's and present becomes evident when taking into account the differences in runoff between the two periods. As shown on Figure b.i.7 (LADWP, 2013, page 31), the water table in the area of Blackrock 94 fluctuates with variations in runoff. During periods of high runoff, both increased infiltration and water spreading directly recharge the groundwater table beneath Blackrock 94[17].

Unlike ICWD's 2014 analysis, which suggests that local groundwater levels are the primary mechanism that drive soil moisture, LADWP found that surface water spreading exerts a much stronger influence on soil-water content at Blackrock 94, as spread water infiltrates into the soil. In years of high runoff, water is spread unevenly across the parcel leading to variations in local soil moisture levels and hence variations in vegetation cover. During years with high runoff, cover increases and during periods of drought or low runoff, cover declines.

The differences in cover values between monitoring sites TS1 and TS2 can be explained simply because TS1 is in a location that receives spread water during most high runoff years[18], while monitoring site TS2 is at a greater distance from the Sawmill Creek water spreading points of diversion and receives spread water only in exceptionally high runoff years. This spatial variability combined with annual variations in runoff provides a clear and straightforward explanation for the trends in soil moisture content and vegetation cover at Blackrock 94. Moreover, there is even a greater influence of precipitation on soil moisture in the uppermost soil layers (LADWP, 2013, page 180).

Lastly, ICWD postulates that had groundwater pumping never occurred, then soil moisture and vegetation cover conditions at TS1 and TS2 would resemble those at the TS3 site. This notion is thoroughly flawed as it fails to account for the natural variability in groundwater and soil moisture recharge stemming from wet and dry periods and does not consider the influences of irrigation, flowing wells, unlined water conveyance ditches, an unlined section of the Los Angeles Aqueduct, topography, soil type, and other factors in the area affecting soil moisture differences between the three sites.

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[17] LADWP's past surface water management practices in the area of Blackrock 94 include spreading surface water during high runoff periods and not spreading surface water during periods of low runoff/drought (LADWP, 2013, Section 5.7).

[18] The ICWD (2011, Figure 2, page 8) demonstrates that monitoring site TS1 vegetation cover has been higher than the 1986 baseline cover values during three of the four years coinciding with the wet period between 1995 and 1998. ICWD attributed this increase in cover to water spreading activities during high runoff years: *"Cover has been less than the initial measurement at both transects every year except for three years at TS1 when a section of the transect was affected by water spreading"* (ICWD, 2011, page 7, paragraph 4).

4 HYDROLOGY: VARIATION IN GROUNDWATER LEVELS AT BLACKROCK 94

Variations in vegetation cover and composition within Blackrock 94 since the 1986 vegetation inventory are due primarily to fluctuations in wet/dry climatic cycles, (including runoff, water spreading, and precipitation) and not due to groundwater pumping since the 1986 vegetation survey. Although a detailed presentation of these analyses and conclusions is presented in LADWP's 2013 report, the summary provided in this section makes it clear that wet/dry cycles are the primary factor influencing vegetation cover. This section addresses the hydrology of the Blackrock 94 area, including a review of LADWP's key points complemented by specific responses to the ICWD's Hydrology section presented in ICWD (2014).

4.1 It Is Clear that Owens Valley Hydrology Is Characterized by Wet/Dry Cycles that Affect Groundwater Levels

Owens Valley runoff is characterized by a cyclic nature and subject to wide variations in wet/dry climate cycles. In turn, runoff-driven recharge is the primary driver influencing depth to groundwater, referred to as "depth to water" or "DTW." By definition, DTW is the distance from the ground surface to the groundwater table. The Owens Valley hydrology from the late 1960s to present included[19]:

- The ***late 1960s*** were characterized as "wet", with average runoff between 1965 - 1969 at 123% of the long-term average (defined as a 50-year average), giving rise to elevated groundwater levels throughout the Owens Valley.

- In contrast, ***1970 - 1977*** average runoff was 84% of the long-term average, negatively impacting DTW. After completion of the second LAA in 1970, LADWP increased groundwater pumping to meet the increased capacity of its aqueduct system. Also, groundwater pumping for Blackrock Hatchery was initiated in 1972.

- ***1978 - 1986*** average runoff was 137% of the long-term average, and included more water spreading to deal with the increased high runoff, both of which contributed to dramatic increases in groundwater levels. This wet period provided excellent conditions for vegetation.

- The ***1986 vegetation inventory*** at Blackrock 94 followed 9 years of above-average runoff and precipitation.

- ***1987*** was the start of an ***8-year drought[20] (1987 - 1994)***, with average runoff at 68% of the long-term average. LADWP also increased pumping considerably during the first three years of the drought (1987 - 1989). Multiple years of low runoff and increased pumping caused groundwater levels to decline. ***It is important to note that pumping from the Hatchery wells has been nearly constant since 1972.***

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[19] See Section 4.0 of LADWP, 2013 for a complete overview of Owens Valley hydrologic conditions.

[20] Because 1993 was a 106% of normal runoff year and 1994 was a 66% of normal runoff year, this drought is alternately referred to as a six-year drought (1987-1992). The 1987-1992 period averaged 62% of normal runoff and the 1987 – 1994 period averaged 68% of normal runoff.

- The Water Agreement was in place in ***1991***, and LADWP dramatically reduced pumping valley-wide.

- ***1994 - 1998*** was once again a wet period, characterized by average runoff of 141% of the long-term average, giving rise to increased groundwater levels and record high vegetation cover at Blackrock 94.

- By ***1998***, Blackrock 94 vegetation cover was ~20% higher than the 1986 vegetation inventory (total perennial cover was 21% higher and grass cover was 7% higher), clearly demonstrating a full recovery from any decreases in cover that occurred during the preceding 8-year drought. "*Again, since 1986, pumping from the Hatchery wells was relatively constant since the 1986 inventory. Furthermore, since 1998, Blackrock Hatchery pumping has accounted for 95% of all of the groundwater pumping in the Thibaut-Sawmill Wellfield; and out of the other 5% pumping in the wellfield, 78% of it is derived from wells screened in a deeper aquifer without direct effect on the shallow water table beneath Blackrock 94" (LADWP, 2013, p. 230, paragraph 4).*

- ***1999 - 2004*** was characterized by drought with a 6-year average runoff that was 81% of the long-term average.

- ***2005 - 2006*** provided two years of higher than normal runoff, averaging 142% of the long-term average.

- ***2007-2013*** represented a 7-year drought (that is still ongoing) with 81% of normal runoff.

- ***2008 - 2009*** was declared as a state emergency by former California Governor Schwarzenegger that ended in 2011.

- The current drought that began in ***2012*** has also resulted in a state emergency declared by current California Governor Brown.

Figure 2 shows hydrographs for monitoring wells near Blackrock 94 plotted with Owens Valley runoff through time. Wet and Dry periods from 1972 through 2013 are highlighted to illustrate the cyclic nature of these climatic cycles. Knowing that pumping from the Hatchery wells was relatively constant from 1986 to present, it is clear that wet and dry periods are the most significant factors affecting depth to water. This is further borne out by statistical correlation presented in LADWP's 2013 report (Section 5.1.8).

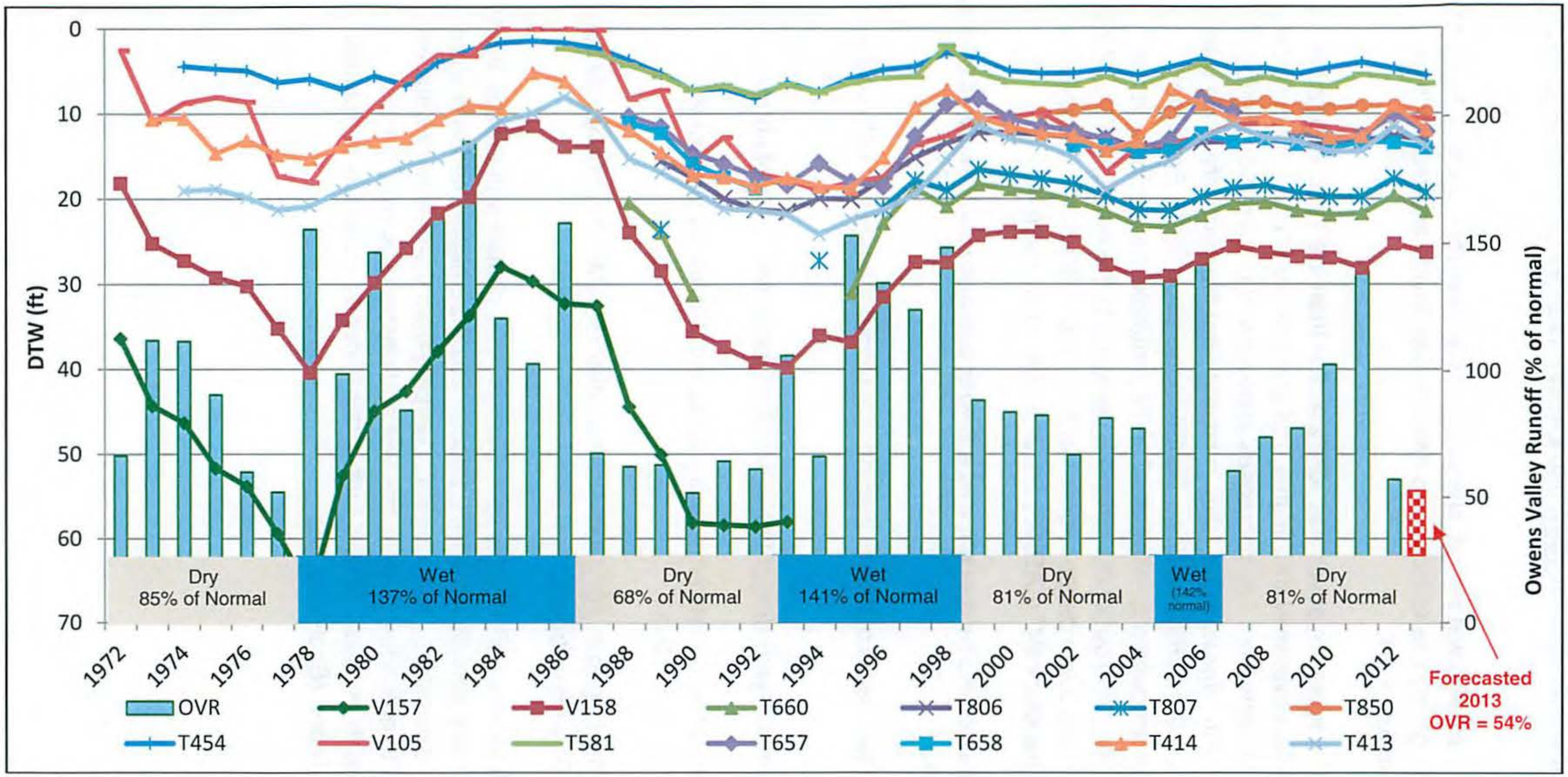


Figure 2
Demonstration of the Relationship Between Wet/Dry Cycles and Groundwater Levels

4.2 It Is Clear that Hatchery Pumping Affects Water Levels, but the Effects Stabilized Long Before the 1986 Vegetation Inventory

The ICWD (2014, p. 11) makes the assertion that "*...over the period 1970 to present, groundwater pumping has been the primary cause of changes in groundwater levels observed in Blackrock 94. This finding is supported by groundwater modeling performed by both LADWP and the County, as well as the USGS is a previous study (Danskin, 1998)".* LADWP agrees that pumping from the Blackrock Hatchery wells affected groundwater levels after pumping began in 1972, but this is not the point. The question is if pumping has caused a measurable and significant change in vegetation since the 1986 vegetation inventory in violation of the provisions of the Water Agreement.

The purpose of groundwater production wells W351 and W356 (**Figure 1**) is to supply Blackrock Hatchery. The wells began pumping in 1972, pumping a relatively constant amount of approximately 12,000 AFY.

Groundwater pumping to supply Blackrock Hatchery has been the bulk of pumping in the study area. Table b.i.3 (LADWP, 2013) summarizes the relationship between Hatchery supply pumping and the total pumping from the Thibaut-Sawmill wells and south and central Taboose-Aberdeen Wellfields. As shown in this table, Hatchery supply pumping has been 89% of pumping from Thibaut-Sawmill Wellfield since 1973. Since 1998, pumping for Hatchery supply has been 95% of all pumping in Thibaut-Sawmill Wellfield. Therefore, the effects of pumping other wells on the Thibaut-Sawmill Wellfield are very minor.

Because Hatchery groundwater pumping had been relatively constant at ~12,000 AFY for 14 years prior to the 1986 vegetation inventory, its effects on DTW were in place and established well before 1986. Hatchery pumping affects DTW, but those effects were established early on after pumping was initiated. Given the constant nature of Hatchery pumping, those effects are stable and relatively unchanging. Therefore, Hatchery pumping could not have caused water table fluctuations in the late 1980s when vegetation declined (or since).

This conclusion is further supported by the fact that the groundwater table was exceptionally high during the 1986 vegetation inventory due to spreading and repeated years of high runoff. An 8-year drought followed, but by 1998 (with constant Hatchery pumping still in place), vegetation levels were even higher (~20%) than the 1986 vegetation inventory due to a 4-year wet period with average runoff at 141% of the long-term average, and its response to runoff-driven recharge. Since 1998, both groundwater pumping in the Thibaut-Sawmill Wellfield and groundwater levels in Blackrock 94 have remained stable (**Figure 3**), while vegetation cover has fluctuated between 37% and 15% (LADWP, 2013, Figure b.ii.28, page 104). Therefore, in fact, Hatchery pumping could not have caused any post-1986 vegetation change.

By the late 1990s, there was substantial recovery from the effects of higher pumping on DTW by wells in Thibaut-Sawmill and south and central Taboose-Aberdeen wellfields during the drought of 1987-1992 as evidenced by both recovery of water levels and vegetation cover. **Figure 3** clearly illustrates this point. While pumping from 1993 to 2012 is relatively constant, water levels varied in response to wet/dry cycles. In 2004, for example, pumping was reduced, but water levels continued to decline. While more rigorous analysis is presented by LADWP, 2013, the graphics make it clear that wet/dry cycles, and not pumping are the dominant influence on water levels.

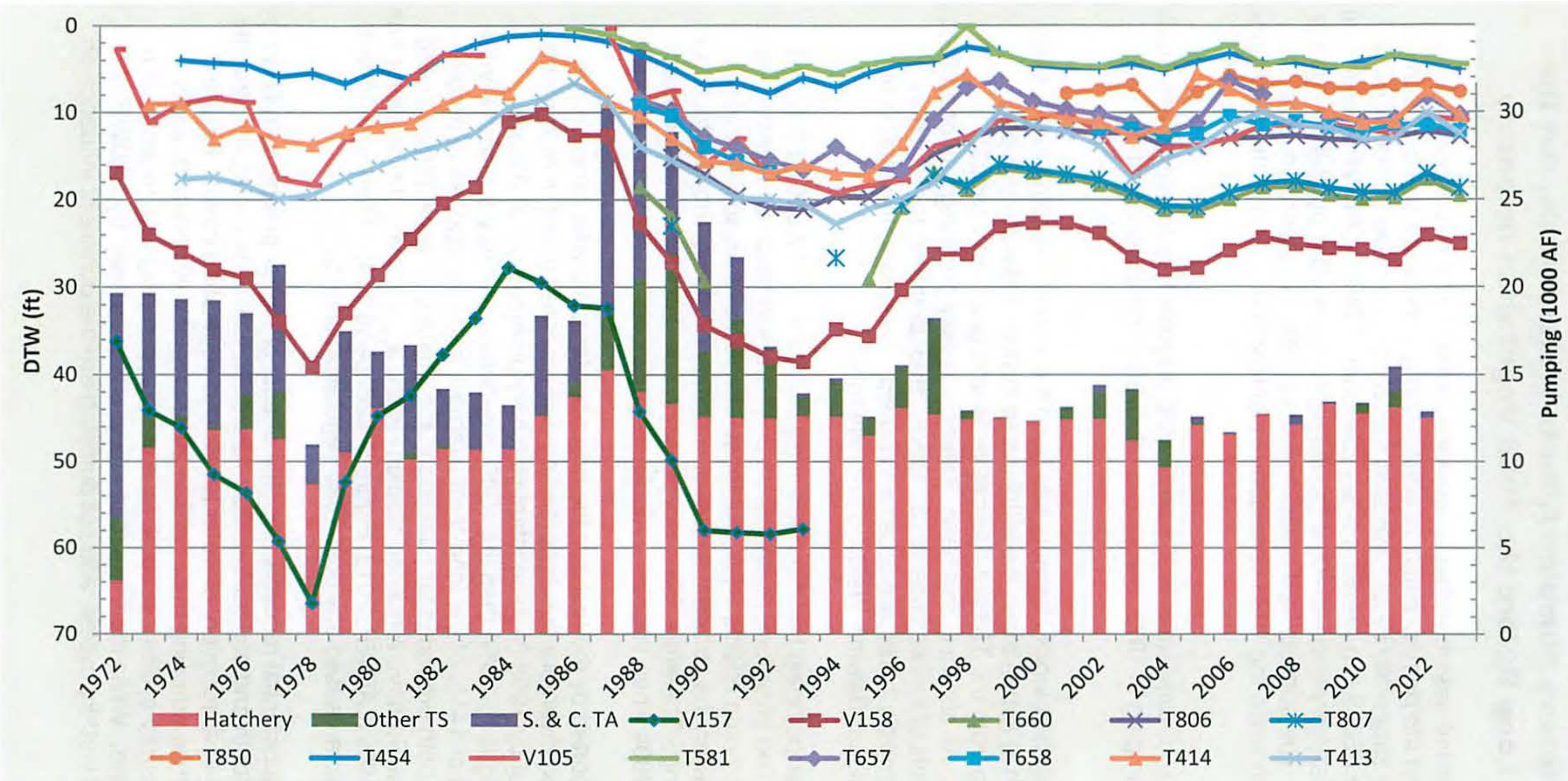


Figure 3
Hydrograph of Monitoring Wells near Blackrock 94 Plotted against Hatchery Pumping

4.3 LADWP Has Not Changed Surface Water Management Practices Since 1970

There is a strong correlation between percent of normal runoff and spreading that indicates LADWP's practice of spreading pre-Water Agreement and post-Water Agreement has not changed[21] as shown on **Figure 4**. LADWP has not changed its surface water management practices since 1970 in the area of Blackrock 94 and Sawmill Creek. Water from Sawmill Creek is spread during high runoff and not spread during drought or low runoff. Reductions in surface water spreading in dry years and periods of drought are in keeping with LADWP's surface water management practices. Since the practice of not spreading water in dry years is not a change in LADWP's past surface water management practices, reduced water spreading in Blackrock 94 during dry years is permitted under the Water Agreement. Because surface water spreading occurs during wet cycles, the effect of wet/dry cycles on groundwater levels is amplified at Blackrock 94.

4.4 Visual Graphic Relationships Are Supported by Correlation Analysis

Another useful analytical tool to establish causal relationships is statistics. LADWP conducted a correlation analysis (LADWP, 2013, p. 37-38), and the purpose of this exercise was to utilize statistics to determine the statistical relationships between runoff, pumping, and DTW at monitoring wells T806 and T807, located at monitoring sites TS2 and TS1 (**Figure 1**).

Not surprisingly, the results demonstrate with confidence that DTW is correlated with Owens Valley runoff, specifically because pumping for Hatchery supply was constant while pumping from non-Hatchery wells was minimal after 1992. A statistically significant correlation between Hatchery pumping and DTW was not found and would not be expected because this pumping had been stable and in place since 1972; therefore, its effect could not be identified through statistics as it represents a constant stress on the system. Correlation analysis is valid, makes sense, and its results are aligned with the actual measured data from hydrographs. Non-Hatchery pumping affected groundwater levels prior to 1991, but groundwater levels recovered by 1998 and have been stable since that time.

Hatchery pumping has not been the primary cause of fluctuations in the water table since soon after hatchery pumping began in 1972. The relatively steady-state pumping of the Hatchery cannot cause fluctuation in the water table. Fluctuations in the water are due to fluctuations in runoff. This finding was confirmed by the correlation analysis.

[21] See 5.7 of LADWP, 2013 for a detailed review of surface water management practices, including surface water spreading.

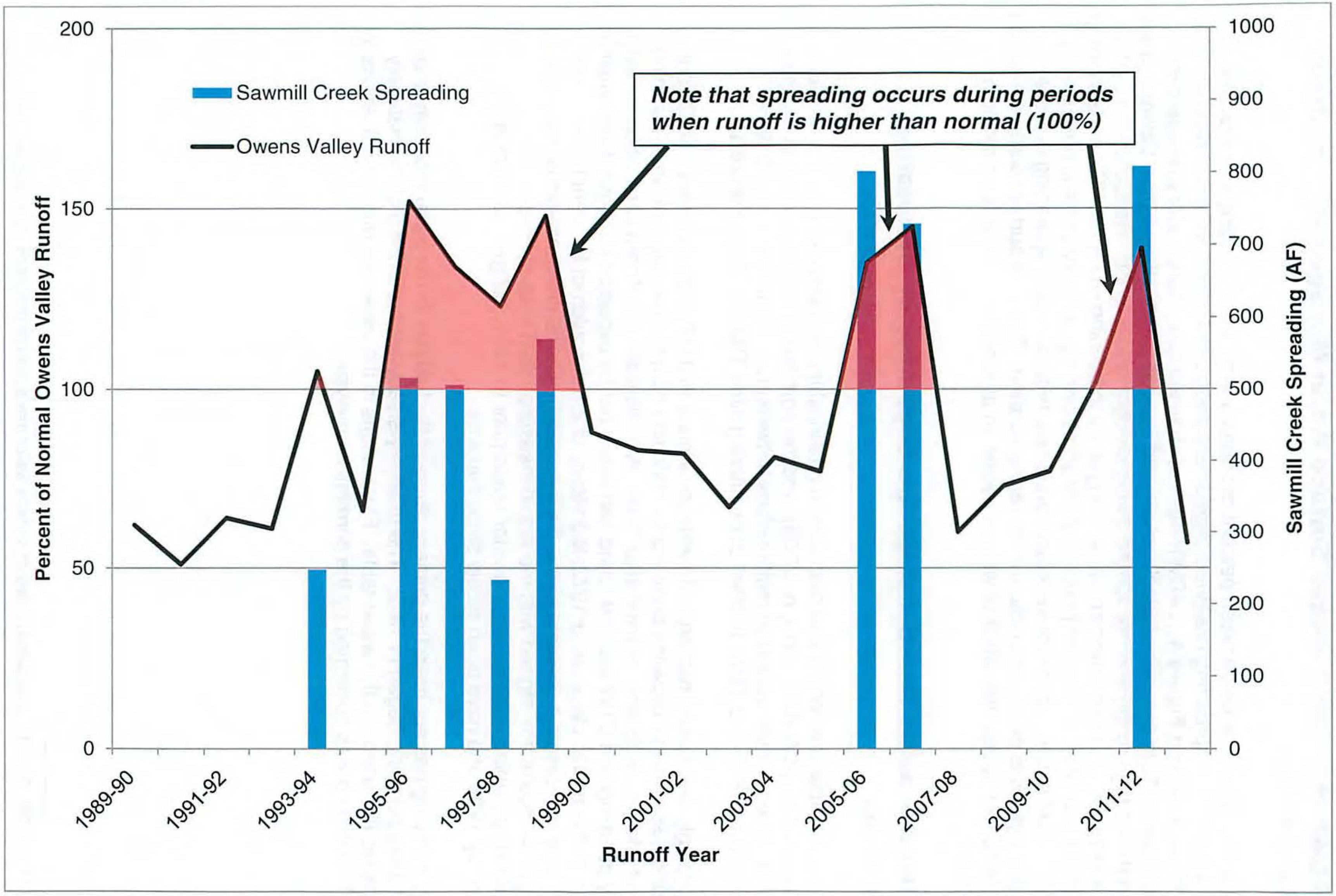


Figure 4
Relationship Between Sawmill Creek Spreading and Owens Valley Runoff

4.5 The ICWD Reference to U.S. Geological Survey Modeling Is Taken Out of Context

On page 16 (paragraph 3) of ICWD, (2014), ICWD noted that the modeling results were consistent with the conclusion of the USGS concerning the relative effects of pumping and recharge in Owens Valley, where the USGS concluded "*...the ground-water model showed that pumpage is the dominant stress in the aquifer system both near well fields and in recharge areas.*" (Danskin, 1998, p. 138). As a point of clarification, this quotation from the ICWD response is taken out of context. In reality, this statement is in reference to the sensitivity analysis of the USGS model, where the actual pumping for the period of 1963 to 1988 is compared with pumping at the 1963 level. The sensitivity analysis in the USGS report did not consider recharge or pumping in the Thibaut-Sawmill Wellfield. The quote is summarizing a numerical model sensitivity analysis, an evaluation of a numerical model, and its performance simulating observed conditions.

The actual USGS quote from Danskin (1998) in its entirety states:

> *"Sensitivity analysis of the ground-water model showed that pumpage is the dominant stress in the aquifer system both near well fields and in recharge areas. Away from recharge areas and well fields, such as in the area between Bishop and Big Pine, neither recharge nor pumpage has a significant effect on simulated heads. Surprisingly, the model was not sensitive to the vertical distribution of pumped water. The match with measured ground-water-level data when all the pumpage was from the lower model layer was similar to the match when pumpage was divided between the layers. During short-term aquifer tests, the vertical distribution of pumpage has been shown to be important; however, this lack of sensitivity shown by the model indicates that over a longer period of time the quantity of pumpage is more important than the design or location of wells."*

One could come to an opposite conclusion based on reference to the USGS report. On p.88, Danskin (1998) states, "*effects in recharge areas are most dependent on recharge, and the effects near well fields are most dependent on pumpage. Away from either area, heads are relatively unaffected by changes in either recharge or pumping...*" Blackrock 94 is a recharge area with Sawmill Creek running on its northern boundary. Water is spread from both Sawmill and Black Canyon Creeks. While there are two wells either in or adjacent to Blackrock 94 (W155 and W159), the combined production from these wells since the Water Agreement was signed was only 456 AF; since 1995, it was only 18 AF; and these wells have not been pumped since 2000.

In any case, citations from the USGS report are not appropriate, given that this modeling evaluated effects of pumping since 1963 (not the mid-1980s baseline period), and the model did not address the site-specific issues at Blackrock 94. In fact, the USGS did ***not*** recommend that the model be used for this purpose:

> *"Because of the way it was calibrated, the model is most useful for evaluating valleywide conditions, not for predicting small-scale effects covering a few model cells. Site-specific ground-water flow models or multivariate regression models, such as developed by P.B. Williams (1978) and Hutchison (1991), can give more accurate predictions at selected sites"* (Danskin, 1998, page 79, right hand column, paragraph 2).

4.6 Groundwater Modeling Was Applied Inappropriately by ICWD

A groundwater model is a numerical representation of the groundwater system developed for a specific objective and can be a useful tool for evaluating a variety of groundwater scenarios. Both LADWP and ICWD agree that neither previously-developed model was developed for an evaluation of this type and both models suffer from limitations, which means that they should not be relied upon as the sole basis for evaluating the effects of pumping on the Blackrock 94 parcel. The Owens Valley model, originally developed by the USGS and adopted/modified by ICWD, was developed to evaluate management decisions on a valley-wide scale. LADWP's model for the Taboose-Aberdeen and Thibaut-Sawmill wellfields area was developed to evaluate groundwater management decisions at a wellfield-wide scale. Neither model was developed to evaluate groundwater management decisions for an area as small as Blackrock 94 (approximately 333 acres).

Both models are similar, with differences in grid cell size and stress periods (time increments). The USGS cell size is 2,000 feet by 2,000 feet, affording a much coarser and large model cell size. In fact, the entire Blackrock Hatchery would easily fit within one USGS model cell. Stress periods in the USGS model are 1 year in duration, compared to stress periods in the LADWP model that are 6 months.

The USGS notes that use of the basin-wide model is inappropriate for evaluation of small scale features such as Hatchery pumping or estimations of DTW at Blackrock 94:

> *"Future analysis of these smaller-scale features or issues-such as a volcanic deposit , a facies change, or a question of local water use – might best be done by use of smaller-scale models or field studies, in combination with simulations from the valleywide model"* (Danskin, 1998, page 94, right column, top paragraph).

and;

> *"The most appropriate use of the valleywide model is best illustrated by the results presented in this report. The goal in designing both water-management alternatives and figures was to maintain the "regional" character of the model, focusing on larger issues, over longer periods of time... The specific value of drawdown at a well (pl.1) or for an area of the basin (fig. 23 is far less important than the relative value (more drawdown or less drawdown) in comparison with other areas of the basin"* (Danskin, 1998, page 94, right column, second paragraph).

4.6.1 The Main Difference between the Two Models Is How the Models Account for Pumping

The main difference between ICWD and LADWP model evaluation is how the models were used to account for groundwater pumping and the method in which pumping is applied. LADWP used a "net discharge" concept, which took into account previously-measured spring flow discharge and infiltration from the Hatchery rearing ponds, while ICWD ignored the reduction of discharge from Blackrock Spring prior to 1972, and the amount of water returning to the aquifer and considered only the "gross discharge" from the Hatchery wells in its evaluation.

Prior to 1972, groundwater discharge was in the form of spring flow, with an average discharge rate of 7,000 acre-feet per year (1991 EIR, Table 9-4). Groundwater pumping to supply the Hatchery started in October 1972 at a relatively constant rate of approximately 12,100 AFY. Approximately 3,000 AFY returns/recharges to groundwater within the Hatchery ponds (LADWP, 2013, Section 5.1.5, pages 25 - 28). Additional seepage occurs from the surface diversion feeding into Blackrock Hatchery, so the water balance underestimates infiltration, but because this seepage has not been measured, it was conservatively not added to the budget for groundwater return. Therefore, there is currently an average groundwater withdrawal of approximately 9,100 AFY. Prior to 1972, the average discharge was 7,000 AFY. So, the net difference comparing pre-1972 to current conditions is 2,100 AFY. This concept is summarized in **Table 1**. While LADWP simulated the net change in discharge, ICWD ignored the reduction in spring flow and water returning to the aquifer due to leakage at the Hatchery ponds. By ignoring the reduction in spring flow and water returning to the aquifer, ICWD overestimated the effect of hatchery pumping on the water table.

Table 1
Annual Blackrock Fish Hatchery Water Balance

Time Period	Groundwater Discharge (AFY)	Groundwater Return at the Hatchery Site Due to Recharge (AFY)	Net Discharge (AFY)
Pre-1972	(7,000) (Spring Flow	0	(7,000)
Post-1972	(12,100) Pumping	3,000	(9,100)
Difference in Groundwater Discharge since 1972:			**2,100**

4.6.2 ICWD Used Two Wells To Represent the Entire Parcel

Based on the information presented in ICWD, 2014 (page 50 and ICWD's "MLR model"), LADWP understands that differences in DTW between actual and no-pumping were based on the average from two points, T807 and T806/T582, and the average value was then subtracted from ***the ICWD's kriging DTW estimates*** under Blackrock 94. Therefore, DTW estimates under the "no pumping" scenario are based on two points taken from the 333 acre-wide parcel with topographic relief of more than 40 feet, and they are also based on ICWD's kriging DTW estimates that are off by at least 3 m (10 feet) (see 4.9.1). Moreover, ICWD's kriging methodology does not account for variations in topography, introducing error commensurate with changes in elevation. ICWD's DTW estimates cannot be considered reliable.

Error or uncertainty is cumulative each time an additional source of error is introduced. Therefore, DTW estimates of the "no pumping" scenario estimated by ICWD could be off by as much as 18 feet (10 feet from kriging and as much as 8 feet from the groundwater model). Any attempt to utilize the estimated DTW from the "no pumping" scenario with the estimated SMA cover values (discussed in Section 5) should be viewed with a tremendous amount of skepticism because of the cumulative errors inherent in both models.

4.7 Blackrock 99 Is Not an Appropriate Control Site

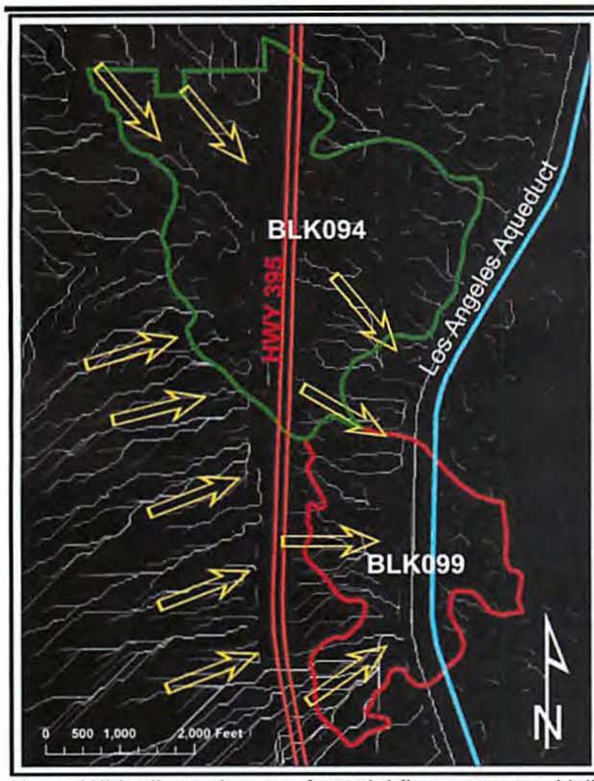
Relative to the Owens Valley and determining the attributability of vegetation change in Blackrock 94, Green Book Section I.C.1.b requires the Technical Group to designate a control site. The site would control for (or minimize) the effects of groundwater pumping on its vegetation when attempting to determine if a measurable *"...decrease, change, or effect would not have occurred but for groundwater pumping and/or a change in past surface water management practices"* (Water Agreement Section IV.B, page 18, paragraph 4). Green Book Section I.C.1.b.ii, also requires the Technical Group to conduct a *"comparison of soil water, DTW, and degree of vegetation decrease or change at the affected area and at a control site(s) determined to have similar soil type and vegetation composition and cover."* ICWD selected Blackrock 99 as a control site.

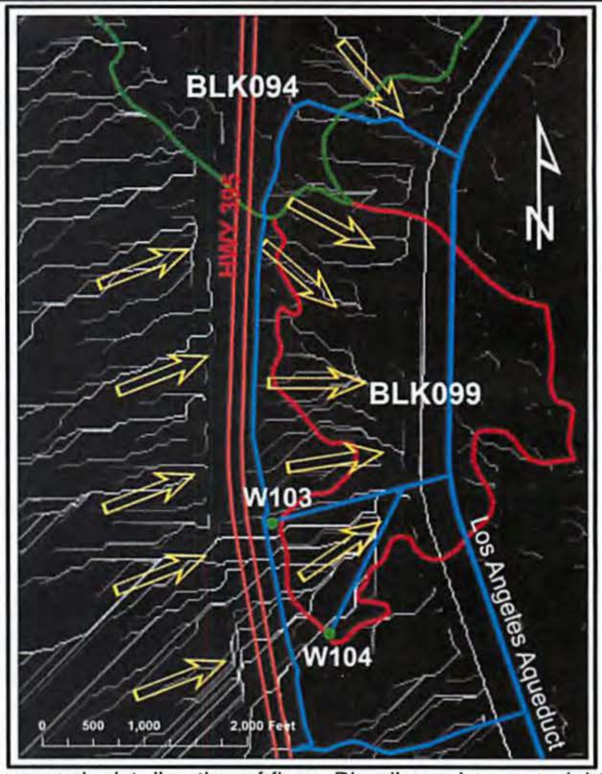
LADWP and ICWD agree that scientific controls are a part of the scientific method. A control is designed to isolate the effects of pumping, with all other variables that could affect groundwater levels (and vegetation) being equal, or at least similar. The ICWD's selection of Blackrock 99 as a control parcel or use for any comparative purposes is not reasonable as it does not meet this definition.

The geographic location of Blackrock 99 in comparison to Blackrock 94 is not comparable. Blackrock 94 is located along the terminus of an eastern-facing alluvial fan, and therefore is higher on the western side as compared to its eastern side. Surface water infiltration (from runoff, precipitation, spreading) raises the water table. Groundwater then mounds and dissipates to the southeast. In comparison, Blackrock 99 is southeast and downslope of Blackrock 94, located on the valley floor, and relatively flat. Therefore, as a result of the parcel's hydraulic grade, groundwater mounding at Blackrock 99 dissipates more slowly than it does at Blackrock 94. In addition, water that is shed off Blackrock 94, whether it is subsurface, surface, or channelized surface water, will eventually end up on Blackrock 99 (**Figure 5**).

Furthermore, Blackrock 99 has two groundwater production wells (one located on it and one adjacent to it, as shown on **Figure 1**) that automatically exclude it from being a control site. There are fundamental hydrologic differences between the two parcels, and these critical differences are summarized in **Table 2**.

The parcel Blackrock 99 does not meet the definition as a control site because the water availability to Blackrock 99 is fundamentally different (for reasons other than pumping) than Blackrock 94. These differences are described in more detail in the following sections.





Note - White lines show preferential flow patterns. Yellow arrows depict direction of flow. Blue lines shown on right map depict unlined water conveyances that contribute to groundwater through leakage. Blue line on left side of right map is an irrigation ditch that spreads water across the surface of the parcel from the west to east. Blue line on the right is the LA Aqueduct. Blue lines connecting wells W103 and W104 to the aqueduct are unlined ditches.

Figure 5
Flow Accumulation Rendering Using Arc Map Spatial Analyst

Table 2
Critical Hydrologic Differences between Blackrock 94 and 99

Difference Between Vegetation Parcel	Vegetation Parcel	
	Blackrock 94	Blackrock 99
Surface Water Irrigation		Routinely irrigated with surface water
Flowing Well Discharge	No flowing wells	Influenced by flowing well discharge with water conveyed to the LAA via unlined ditches that add water to the groundwater system
Los Angeles Aqueduct	Parcel does not come in contact with the LAA	Bifurcated by the unlined LAA with water seepage influencing the groundwater system
Elevation Differences and Sensitivity to Runoff-Driven Recharge	At a higher elevation, and therefore further from the groundwater surface. More sensitive to changes in runoff.	At a lower elevation, and therefore closer to the groundwater surface. Less sensitive to changes in runoff.

4.7.1 Blackrock 99 Receives Surface Water Irrigation

Blackrock 99 is primarily managed for cattle grazing and receives a great deal of surface water to maximize grass production. Principal irrigation ditches are shown on **Figure 6**. The majority of irrigation water at Blackrock 99 comes from Black Canyon Creek.

Both Blackrock 94 and Blackrock 99 have water courses that enter and leave the parcels, Sawmill Creek and Black Canyon Creek, respectively. Sawmill Creek is contained in a pipe as it traverses Blackrock 94, meaning that water from this creek does not infiltrate naturally into the groundwater system. Black Canyon Creek, upgradient of Blackrock 99, is approximately 36 percent of the drainage area of Sawmill Creek, and is used for irrigation on Blackrock 99 when water is available (**Figure 7**). LADWP lessee (Mr. Rod Ayers) has stated (statement dated July 11, 2011) that he used the water of Black Canyon Creek for irrigation whenever available.

The amount of irrigation at Blackrock 99 was evaluated based on a review of available hydrologic records. Many creeks in the Owens Valley are monitored at the base of the mountains (where they exit from the Sierra Nevada) as the creek enters onto alluvial fans, and then again as the creek reaches LADWP infrastructure (diversion, LAA, etc.). Monitored creeks near Black Canyon Creek include Sawmill Creek, Taboose Creek, and Goodale Creek. To estimate the amount of water available for irrigation for Blackrock 99 from Blackrock Canyon Creek the following steps were completed (data is included in **Appendix A**):

1. To calculate the drainage area, each drainage was digitized from a digital elevation model. A uniform grid was applied to the drainage area, and the elevation at each cell center was extracted using digital elevation model data. This technique was conducted for the Black Canyon, Sawmill, Taboose, and Goodale Creek base of mountain drainages.

2. The annual precipitation at each grid cell center was calculated using the USGS (Danskin, 1998) formula for long-term average precipitation (precipitation regression as a function of elevation).

3. The precipitation values and their respective cell areas were multiplied and aggregated for each area to determine the average calculated base of mountain flow.

4. The ratio between the average calculated base of mountain flow and the annual recorded base of mountain flow for Sawmill, Taboose, and Goodale Creeks were calculated, averaged, and applied each year to the average calculated base of mountain flow for Black Canyon Creek to determine the annual time series base of mountain flow for Black Canyon Creek. This difference is to account for losses to evapotranspiration and base flow that occur prior to the base of mountain flow measurement and to account for the percent of normal Owens Valley runoff for each year.

5. To determine the annual flow at a theoretical Highway 395 gage, a constant loss rate (15 cubic feet per day per foot [Danskin, written communication, 2002]) was applied to the total length of Black Canyon Creek to account for infiltration along the creek from the Black Canyon base of mountain gage to Highway 395. Since 2005, calculated values can be corroborated with field measurements.

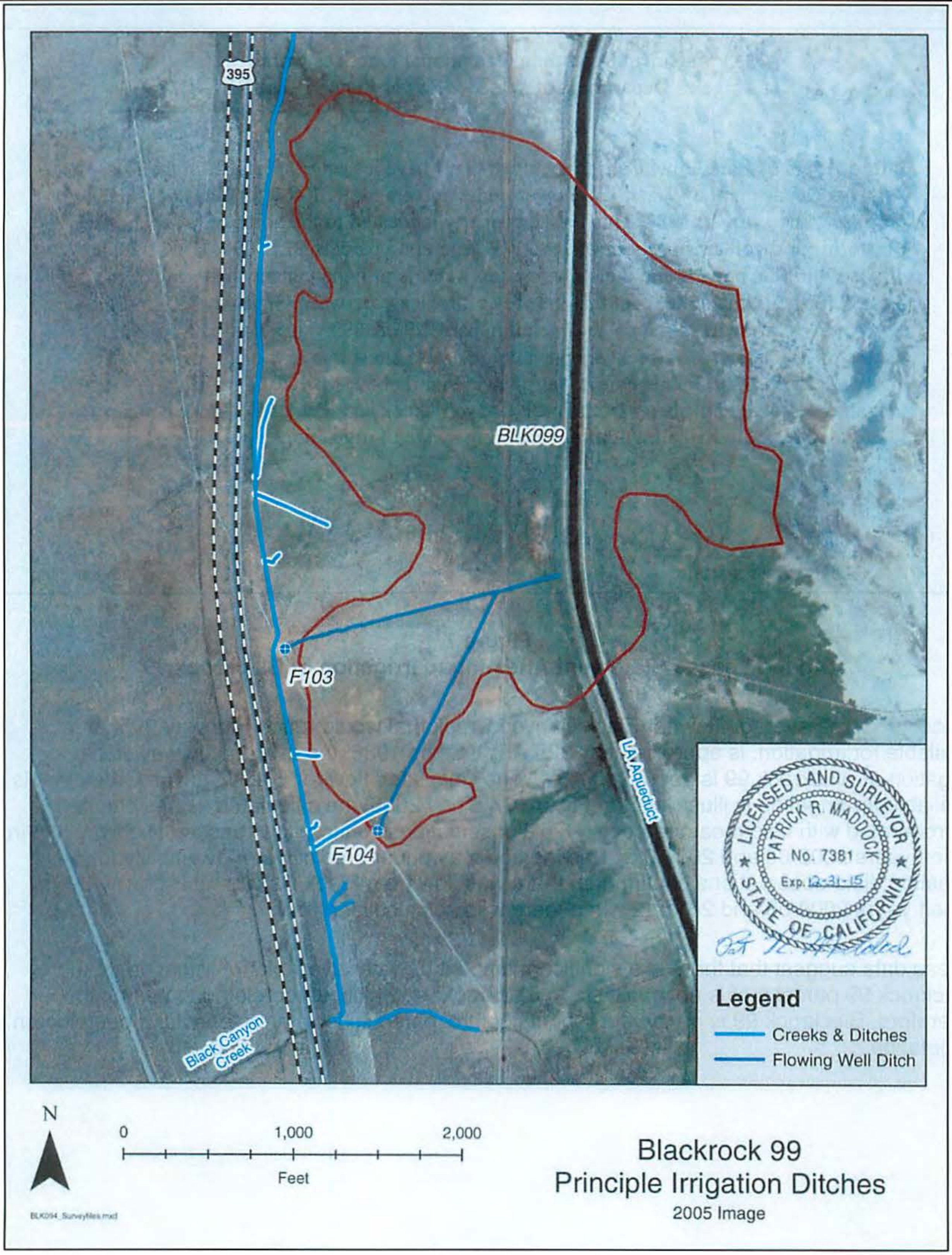


Figure 6
Blackrock 99 Principal Irrigation Ditches

Statement Regarding Operational Practices within
Los Angeles Department of Water & Power Ranch Lease RL1-407

I, Rod Ayers of Lone Pine, California, attest that I have leased property from the Los Angeles Department of Water and Power under agreement RLI-407 for livestock grazing purposes since July 2, 1981. This leased property is located to the north of Independence, California and contains portions of LADWP vegetation parcels BLK 094, BLK 099, and others within its bounds and that no irrigation water is provided under the terms of the lease. I further attest to the fact that the area of my lease between Highway 395 and the Los Angeles Aqueduct, known as vegetation parcel BLK 099 was irrigated from the waters of Black Canyon Creek when available. I also attest that to the best of my knowledge, LADWP management was unaware until about May 2011 that I was irrigating my leased property from Black Canyon Creek and that LADWP took measures to prevent me from irrigating it after becoming aware of my actions.

Rod Ayers July 11 2011

Rod Ayers / date

Figure 7
Signed Lessee Statement Attesting to Irrigation of Blackrock 99

Since 1963, the average flow for Black Canyon Creek that would reach Highway 395, or is available for irrigation, is approximately 225 AFY. Since 1986, the average flow available for irrigation at Blackrock 99 is about 290 AFY. The calculated flow for Black Canyon Creek that is available for irrigation is illustrated on **Figure 8**. Since 2005, the calculated values can be corroborated with field measurements. Field observations confirm flow reached Highway 395 in runoff years 2005/06 and 2006/07. This method may under predict water availability for irrigation; field observations confirm that there was flow from Black Canyon at Highway 395 in runoff years 2008/09 and 2011/12 when there was no calculated flow.

These data suggest that there is a significant amount of water available for irrigation on the Blackrock 99 parcel that is not available to Blackrock 94, which is not related to pumping. Therefore, Blackrock 99 is not an appropriate control parcel to isolate the effects of pumping on vegetation.

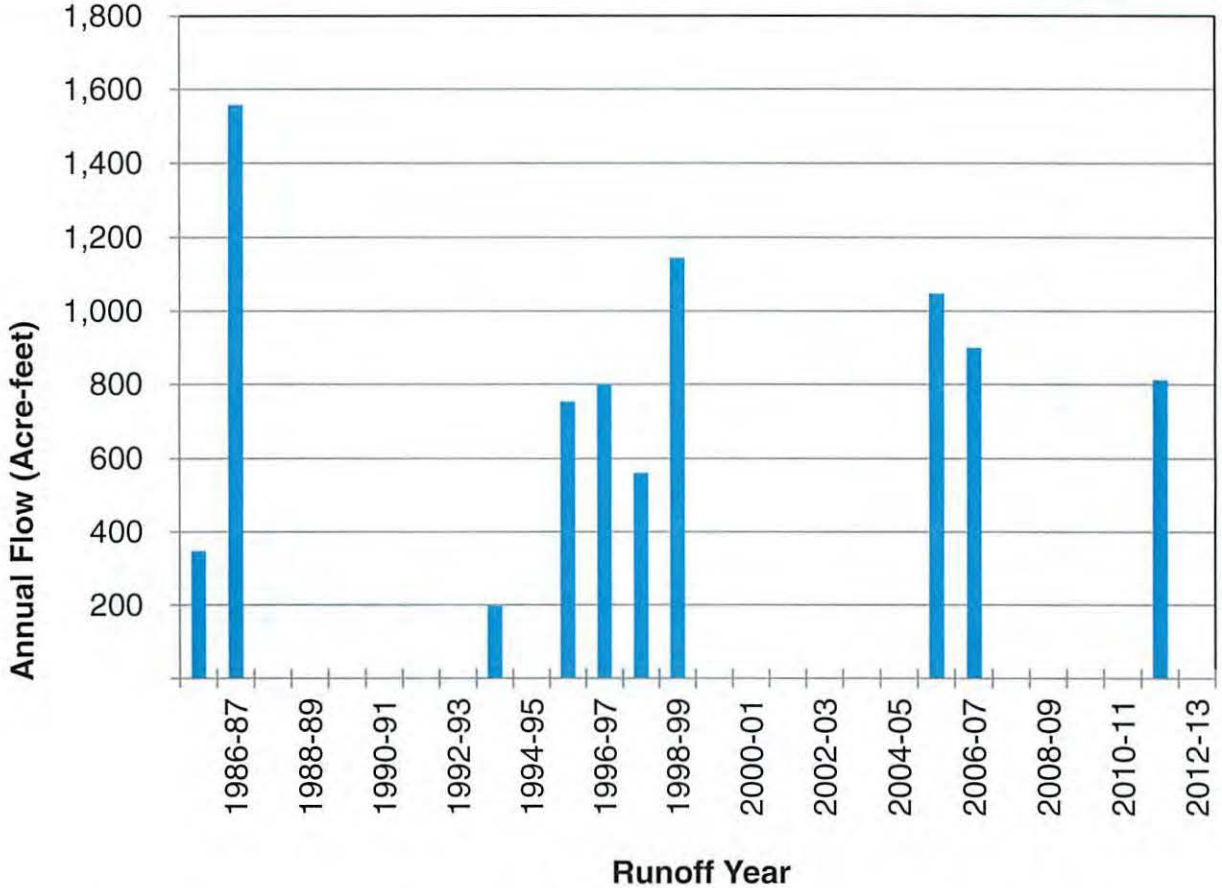


Figure 8
Annual Black Canyon Creek Flow Available for Irrigation on Blackrock 99

4.7.2 Flowing Wells Discharge Groundwater to Blackrock 99

There are no flowing wells located within Blackrock 94, but there are two that discharge groundwater to the surface in Blackrock 99 (F103 and F104) (note that these wells are also referred to as W103 and W104, respectively) (see **Figure 1**). These wells flow under artesian pressure and/or are pumped and consistently discharge water into two unlined channels that connect to the LAA. When these wells are pumping, they are designated as "W" wells, and when they are not being pumped, they are designated as "F" wells and flow to the ground surface. The cumulative average discharge from the Blackrock 99 flowing wells since 1986 is 107 AFY (**Figure 9**) (data provided in **Appendix B**).

Flowing wells supply water to Blackrock 99 that is not available to Blackrock 94. This is further evidence that Blackrock 99 is not an appropriate parcel to isolate the effects of pumping on vegetation.

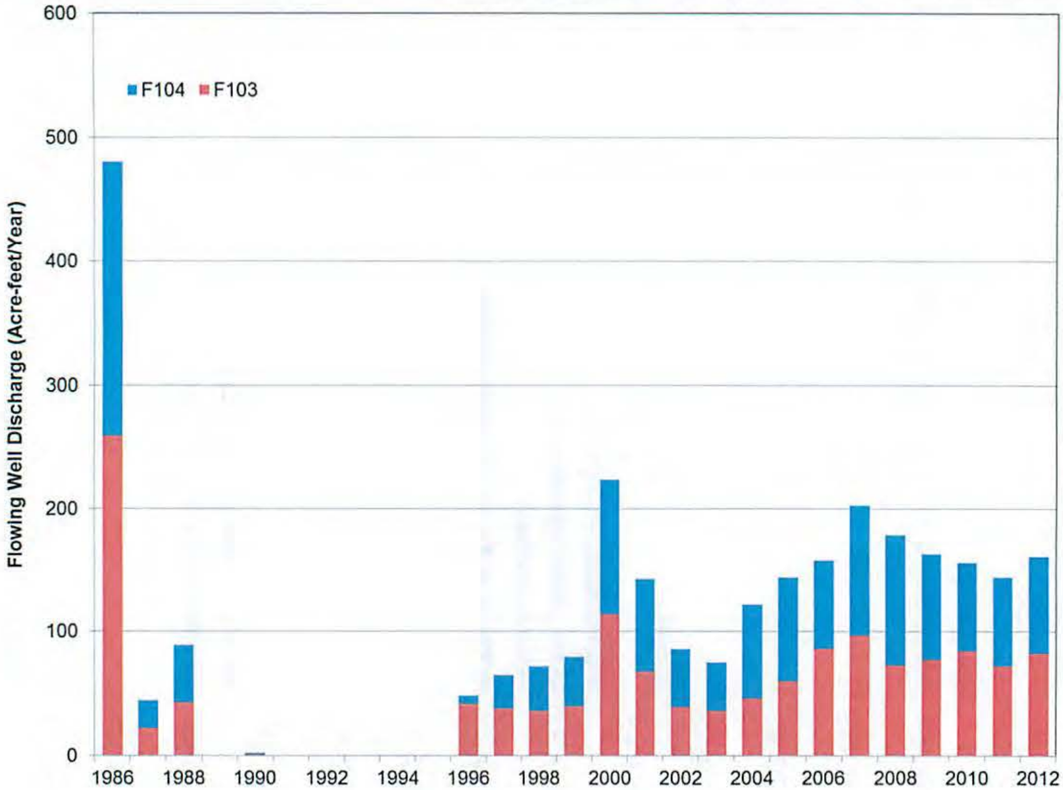


Figure 9
Annual Flowing Well Discharge on Blackrock 99

4.7.3 Blackrock 99 Receives Recharge from the Unlined Los Angeles Aqueduct and Other Channels

Blackrock 99 is bisected by an unlined section of the Los Angeles Aqueduct, as well as an unlined F/W103 channel and F/W104 channel (**Figure 6**). These unlined channels and the unlined LAA flow through Blackrock 99 and can add a great deal of water to the local aquifer through infiltration. The LAA, in particular, is approximately 38 feet across 8 feet in depth, and provides a constant source of water that infiltrates and bolsters groundwater levels east of the LAA. **Figure 1** illustrates the location of the LAA relative to parcels Blackrock 94 and Blackrock 99, and **Figure 10** is a schematic showing the variation between high- and low-DTW conditions. Due to the lower elevation and the proximity of the parcel to the unlined LAA, Blackrock 99 has a lower range in DTW than Blackrock 94. For example, well T581, located in Blackrock 99, has the lowest DTW recorded (0.72 feet from ground surface to the water table), primarily because this well is located adjacent to the LAA and receives a constant source of water.

The unlined LAA and unlined well channels provide water to Blackrock 99 that is not available to Blackrock 94. This also means that Blackrock 99 is not an appropriate parcel isolate the effects of pumping on vegetation.

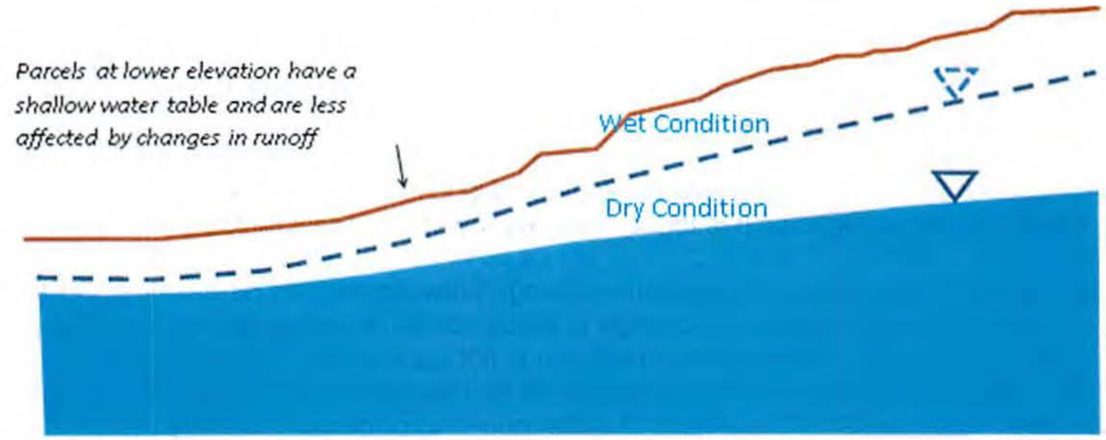


Figure 10
Schematic Showing How A Lower Elevation Parcel has a Shallower Water Table and is Less Affected by Changes in Runoff

4.7.4 Blackrock 99 Is at Lower Elevation than Blackrock 94, Meaning It Is Less Sensitive to Variations in Runoff-Driven Recharge

Blackrock 99 is at a lower elevation and closer to the discharge area than Blackrock 94. This means that the depth to water is less, and the variability of groundwater elevations less sensitive to changes in recharge at Blackrock 99 than at Blackrock 94. This concept is illustrated in **Figure 10** showing the difference between parcels at higher and lower elevations on a typical alluvial fan in the Owens Valley.

This concept is also illustrated by comparison of hydrographs of monitoring wells located on the two parcels. A comparison of V158 (higher elevation) and T581 (lower elevation) hydrographs (**Figure 2**) illustrates this concept (see locations shown on **Figure 1**).

The fact that Blackrock 99 has a shallower water table and is less sensitive to changes in runoff-driven recharge also makes it unsuitable as a control site. It is also notable that Blackrock 99 is contiguous with Blackrock 94, so that the water table and drawdown conditions would be identical at their boundaries with each other.

4.7.5 The Differences between the Two Parcels Unrelated to Pumping Render Blackrock 99 an Unsuitable Control Site

In the context of the Water Agreement, the concept of a control site is one that has similar vegetation and hydrologic conditions, but is unaffected by pumping. Blackrock 99 has two wells, one on it and one adjacent to it, that should immediately rule it out as a control site for groundwater pumping. In addition, the following significant differences in the hydrologic regime of the two sites make Blackrock 99 unsuitable for use as a control site:

- Blackrock 99 is irrigated, Blackrock 94 is not;

- Blackrock 99 has two flowing wells that contribute to soil moisture, Blackrock 94 has none;
- Blackrock 99 receives recharge from the unlined LAA and unlined well channels, Blackrock 94 does not; and
- Blackrock 99 has a shallower water table and is less sensitive to changes in runoff-driven recharge because it is topographically lower that Blackrock 94 and relatively flat.

For these reasons, comparison of vegetation change between the two parcels in order to determine if measureable vegetation change in Blackrock 94 is attributable to pumping (or to changes in surface water management practices) is not appropriate. It is clear that Blackrock 99 is not a reasonable comparison to Blackrock 94 for determining the cause of vegetation change within Blackrock 94. The effects of either pumping or climate (wet/dry cycles) cannot be differentiated from the other hydrological influences affecting the availability of water for vegetation within Blackrock 99. Blackrock 99 cannot control for (or minimize) the effects of groundwater pumping on its vegetation, is not appropriate for comparison with Blackrock 94 when attempting to determine if a measurable decrease, change, or effect would not have occurred but for groundwater pumping, and must be excluded from being used as a *"control site"* pursuant to Green Book Section I.C.

4.8 ICWD's Critique of LADWP's Vegetation Regression Model Is Misapplied

In its 2014 report, ICWD misapplied LADWP's vegetation regression model of Blackrock 94 presented in the LADWP 2013 report (Section 5.2.2.3). ICWD erroneously asserted that (page 41-45):

1. LADWP's vegetation regression model of Blackrock 94 is ineffective because it cannot explain vegetation cover changes in Blackrock 99;
2. LADWP's vegetation regression model did not consider DTW; and
3. Runoff is an indirect variable such that it does not directly affect vegetation cover.

LADWP disagrees with each of three points raised by ICWD. First, LADWP's vegetation regression model was developed specifically for Blackrock 94 and was not designed to be extrapolated to other parcels. Second, runoff sufficiently explains the effect of DTW on vegetation cover. Lastly, runoff as an indirect variable inserts significant influence on vegetation cover and cannot be discarded.

4.8.1 ICWD Misuses LADWP's Vegetation Regression Model

ICWD agrees that LADWP's vegetation regression model was sufficient to explain historical vegetation cover changes in Blackrock 94, but could not be applied to Blackrock 99 because of large discrepancies between model estimates and measured cover for Blackrock 99 (ICWD, 2014, page 44, paragraph 1). This attempt to discredit LADWP's vegetation regression model is a gross misuse of the LADWP's model. LADWP's vegetation regression model was developed to examine what environmental factors had contributed to changes in vegetation cover in parcel Blackrock 94. Any attempt to utilize LADWP's Blackrock 94 model for Blackrock 99 is not appropriate because of distinct hydrologic factors described previously that mask vegetation changes due to wet/dry cycles (see Section 4.7). ICWD's claim the variables used in LADWP's model are related to each other (called multicollinearity in a statistical term) is invalid because LADWP evaluated the potential for this relationship early in the analysis and determined that there was no multicollinearity (VIF[22] score of 4.12), and therefore the analysis was valid.

4.8.2 The Influence of Depth to Water on Vegetation Is Explained by Runoff

ICWD states that two variables have the same influence on cover when two variables are related closely. There is a strong correlation between runoff and DTW ($r = -0.85$), but only one variable (runoff) remains significant or ecologically meaningful after removing the influence of the other variable (**Table 3**). When the influence of DTW was removed, the relationship between runoff and cover remained almost unchanged. This is not the case for DTW as the relationship between vegetation cover and DTW disappears or becomes positive after removing the influence of runoff, indicating that the apparent negative relationship between vegetation cover and DTW is spurious, and the observed decline in vegetation cover after the baseline year is mainly driven by decreased runoff of Sawmill Creek, not by water table decline. The influence of DTW on vegetation is explained by runoff, but the influence of runoff on vegetation cannot be explained by DTW.

Table 3
Relationship Between Perennial Cover and Runoff after taking Account of Three Direct Variables (Precipitation, Spreading, and DTW)

First	Second	Third	r	p
Cover	Runoff		0.63	0.0009
	Runoff	Precip	0.77	0.0001
	Runoff	Spread	0.62	0.0015
	Runoff	DTW	0.62	0.0009
Cover	DTW		-0.39	0.06194
	DTW	Precip	-0.53	0.0043
	DTW	Spread	-0.39	0.0291
	DTW	**Runoff**	**0.37**	**na**

Note - This table illustrates the partial correlation coefficients of the variables that affect vegetation cover in Blackrock 94. The effect of runoff and DTW (second) on vegetation are examined by controlling for the effects of other variables (third). The partial correlation coefficient (r) indicates the strength of the effect of runoff and DTW on vegetation cover (the closer r is to "1" or "-1", the stronger the relationship). The probability value (p) indicates how likely the observed relationship is due to chance alone (the closer p is to zero, the less likely the observed relationship is due to chance alone).

[22] VIF or Variance Inflation Factor is a measure of how variables are related in a multiple regression model or multicollinearity. A value of VIF greater than 10 strongly suggests multicollinearity. VIF was calculated using Function "VIF" from Package "fsmb" of R Project.

4.8.3 Sawmill Creek Runoff Is the Ideal Variable to Explain Vegetation Changes

While seemingly agreeing with the LADWP's 2013 report finding that changes in vegetation are due to fluctuations in runoff, surface water spreading, and precipitation associated with wet/dry cycles, ICWD has argued runoff should not be used as a dependent variable in any analyses because runoff is an indirect variable, and concluded;

> *"Runoff influences soil water through recharge of the aquifer or direct infiltration, and is thus highly correlated to depth to water (r=-0.85). Runoff is also positively correlated with surface water spreading...runoff and precipitation are also highly correlated. It is not surprising that runoff is correlated to vegetation cover because the information contained in* ***the runoff variable combines information contained in depth to water, surface water spreading, and precipitation variables which actually drive water availability and vegetation cover****"* (ICWD, 2014, page 43, emphasis added).

LADWP agrees with the ICWD that the runoff variable combines information contained in depth to water, surface water spreading, and precipitation variables, which actually drive water availability and vegetation cover.

However, to respond to the contention that runoff should not be used as a dependent variable, LADWP performed additional statistical analyses known as partial correlation analysis to precisely address the above mentioned point (Sec.5.2 Table b.ii.1). Results for each analysis indicated that regardless of the effect of other variables, runoff remains significant even after taking account of the influence of other variables in terms of describing vegetation cover (**Table 3**). This indicates runoff measured at Sawmill Creek is a significant factor influencing cover in Blackrock 94 because runoff can not only recharge the water table, but also directly replenish soil moisture through surface water spreading[23]. Therefore, ICWD's conclusion that Sawmill Creek runoff should not be used as a dependent variable is invalid and should be disregarded. In other words, the influence of runoff on vegetation cover cannot be explained by three variables (runoff, water spreading, and precipitation) individually because the influence of runoff on vegetation is caused by the combined effects of each of these variables. On this point the ICWD and LADWP agree. High runoff triggers a cascade of events[24], which eventually lead to increases in perennial cover, but individual variables cannot effectively explain the end result. Therefore, runoff is the ideal variable to explain vegetation cover changes in Blackrock 94.

[23] Surface water spreading replenishes soil moisture from the bottom by raising water table and from the top by directly supplying water on the ground surface.
[24] High runoff years usually mean a fuller Los Angeles Aqueduct, which in turn necessitates surface water spreading from creeks. Increase surface water spreading, then, leads to increased recharge and soil moisture.

In an effort to evaluate the effects of direct and indirect variables on vegetation as suggested by ICWD, LADWP developed a simple path model in which precipitation, DTW, and spreading are direct variables influencing perennial cover, while pumping and runoff are indirect variables that can only influence perennial cover by influencing the two direct variables, DTW and spreading (**Figure 11**). This model also tests the relationship between pumping, runoff, and DTW. Partial correlation coefficients[25] were used to determine if each relationship, represented by an arrow, would remain significant through a series of three-way partial correlations. For the relationship between DTW, runoff, and pumping, a five-year running average between 1977 and 2013 was used to reflect the delayed response of the water table at nearby monitoring wells to runoff and temporal and extended suppression of the water table in the zone of influence, while annual values are used to test the relationship between runoff and spreading.

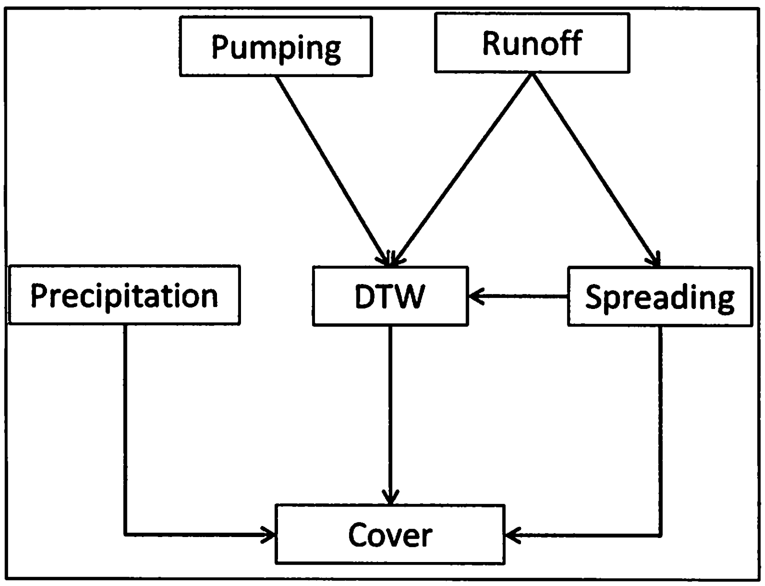


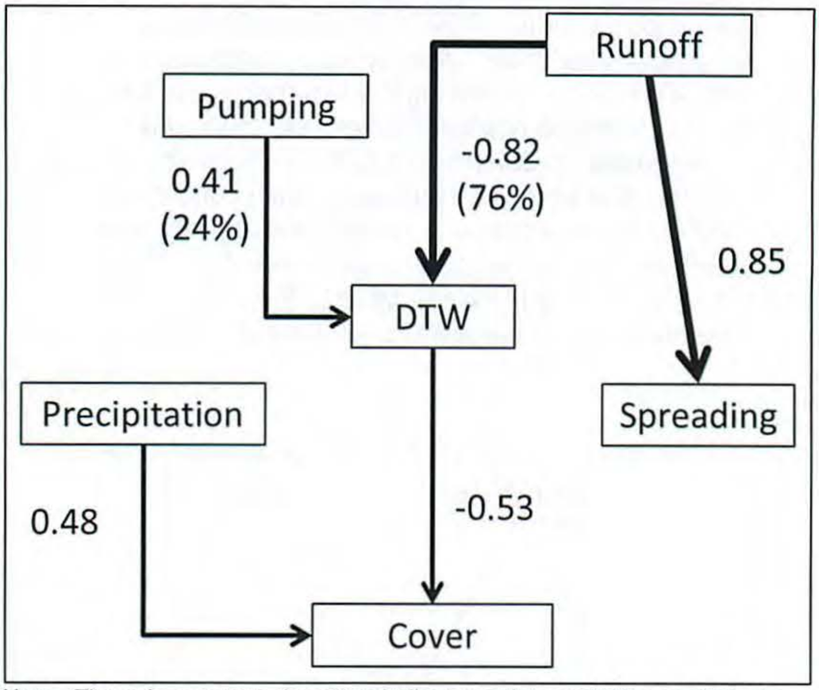
Figure 11
The Path Model Describing Direct and Indirect Relationships Between Environmental Variables and Vegetation Cover

The results show precipitation and DTW were the only variables that directly influence perennial cover, while runoff and pumping indirectly influence perennial cover through DTW (**Figure 12**). Between runoff and pumping the influence of runoff (76%) is much stronger than the influence by pumping (24%). This indicates that runoff is a much more important factor influencing DTW underneath Blackrock 94. Therefore, runoff is the most important "indirect" variable influencing vegetation cover, and cannot be discarded from any type of analysis to examine or model a relationship between vegetation cover and environmental variable.

[25] Partial correlation coefficients are based on Pearson's product moment (r) and related to r by

(r(1,2)-r(1,3)*r(2,3))/sqrt((1-r(1,3)^2)*(1-r(2,3)^2))

where numbers (1 through 3) indicate variables. For instance, r(1,2) indicates correlation coefficient between variable 1 and variable 2.



Note - The values next to the arrow indicate partial correlation coefficients, and thickness of each arrow is adjusted to the value of partial correlation (stronger the correlation, thicker the line). The number in the parentheses under correlation coefficient indicates relative importance of runoff and pumping on DTW.

Figure 12
The Final Path Model Describing Significant Direct and Indirect Relationships Between Environmental Variables and Vegetation Cover at Blackrock 94

4.8.4 Summary

ICWD misapplied LADWP's Blackrock 94 vegetation regression model by attempting to use it to model Blackrock 99. The Blackrock 94 vegetation regression model was not designed to be applied to Blackrock 99, which experiences totally different hydrologic and ecological processes and had a distinctly different initial environmental condition. ICWD's attempt at implementing a model developed under one set of criteria to a completely different application with a different set of criteria is scientifically invalid. ICWD agreed with LADWP that a strong correlation exists between runoff and vegetation cover and was due to the fact that runoff contains information of all three variables (precipitation, DTW, and spreading). Moreover, runoff remained as the significant factor even after removing the influence of all other variables. The effect of wet years cannot be effectively represented by any one direct variable. High runoff normally means wetter conditions within the valley through winter and spring months, increased stream flows, which in turn results in increased recharge, and a fuller Los Angeles Aqueduct, which results in water spreading from Sawmill Creek. This cascade of events during wet years is precisely the reason that runoff is more suitable than other reasons to explain vegetation changes over time.

4.9 ICWD's New Multiple Regression Model Is Fundamentally Flawed

ICWD (2014) introduced a new multiple regression model and devoted several pages (Pages 45 to 50) to discuss this model. Two of the model inputs, modeled DTW and modeled vegetation cover (SMA), are fundamentally flawed[26]. Therefore, predictions resulting from this model are too unreliable to use for reaching any meaningful conclusions. Furthermore, ICWD completely ignored the important role of surface water spreading in the new model[27].

4.9.1 ICWD Used Unreliable Depth to Water Estimates as Model Inputs

In order for its new model to function, ICWD had to combine Blackrock 94 and Blackrock 99 DTW data because Blackrock 94 alone does not provide enough data points for the shallow water table conditions. Combining two vegetation parcels, Blackrock 94 and Blackrock 99 to estimate DTW, is wrong because two of the most important assumptions are violated. The first assumption that the similar vegetation condition observed in two parcels was solely due to similarity in the water table condition is not satisfied as DTW conditions of two parcels would have been completely different. The second assumption, that the mechanism or process of groundwater recharge must be similar is not satisfied either because these two parcels do not share the same recharge mechanism.

4.9.1.1 Deeper Water Table under Blackrock 94 in 1986

As previously described, ICWD's estimated DTW under Blackrock 94 was obtained by interpolating actual data collected from test wells only. ICWD reported these DTW estimates under Blackrock 94 for April 1986 as being 0.96 m (3.1 feet). A major flaw in the development of their estimate, however, is that ICWD excluded four observation wells located within or near Blackrock 94 (V156, V157, V158, and V339). The approach of ICWD[28] does not work for estimating DTW for Blackrock 94 because it leaves important relevant actual data out of the model development. When LADWP utilized all of the relevant available data to determine DTW, the average April DTW value under the parcel is 4.0 m (13.2 feet), which is 10 feet deeper than ICWD's estimate (Figure b.i.9 in LADWP, 2013). Therefore, the average DTW under Blackrock 94 would have been greater than the estimated maximum grass root zone of 2.5 m contrary to ICWD's assumption.

The ICWD's estimated average DTW under Blackrock 99 is reported as being 0.56 m (1.8 feet), which is 11 feet shallower than the water table under Blackrock 94. In their attempt at justifying the use of Blackrock 99 as a comparison for Blackrock 94, ICWD argued a comparison parcel must have similar DTW conditions (ICWD, 2014, page 56). LADWP agrees some portions of Blackrock 94 would have had DTW similar to 0.56 m in 1986, but LADWP disagrees that the water table under Blackrock 94 would have been uniformly shallow. The water table would have closely followed the topography and much deeper especially in the western portion of the parcel. LADWP's analysis, which shows that there was at least a 3 m (10 feet) difference, is further evidence that comparisons between Blackrock 99 and Blackrock 94 are inappropriate.

4.9.1.2 Mechanism of Groundwater Recharge

The water table condition under Blackrock 94 is much more complicated than what ICWD presented in Appendix A of ICWD, 2011. Groundwater mounding at T807 has been noted by

[26] A detailed discussion of ICWD's SMA analysis is presented in Section 5.

[27] The ICWD agrees that *"...runoff is correlated to vegetation cover because the information contained in the runoff variable combines information contained in depth to water, surface water spreading, and precipitation variables which actually drive water availability and vegetation cover"* (ICWD, 2014, page 43, paragraph 2).

[28] ICWD's kriging methodology does not account for variations in topography, which results in incorrect estimations of DTW if the ground surface elevation between the test well and area being interpolated differ.

ICWD and LADWP (**Figure 13**). The water table here has been shown to respond very rapidly to the presence of surface water spreading from Black Canyon Creek. The sharp spike observed at T807 in 1993, 1995, and again 1996 indicate highly-localized groundwater recharge due to surface water spreading. This is verified by examination of an aerial photo taken in 1996 that clearly shows Black Canyon Creek water was being spread in Blackrock 94.

In contrast, the recharge mechanism of Blackrock 99 is driven by high groundwater under the parcel that is maintained at high levels by the presence of the LAA, two flowing wells, and unlined ditches within the parcel. Additionally, Blackrock 99 is regularly irrigated from Black Canyon Creek (see Section 4.7).

The USGS notes the importance of runoff (and spreading which is correlated to high runoff:

> *"Antecedent conditions affect the saturated ground-water system. As much as a 3- to 12-month delay occurs in the effect of an above average runoff year on ground-water levels and discharge rates (well 1T, pl. 1; spring discharge, fig. 21). This means that above-average runoff will mitigate some of the adverse effects of a drought that occurs the following year. Groundwater levels beneath the valley floor will tend to rise at the same time there is a need for additional ground water by native vegetation. The adverse effects of an extended dry period, however, will not be counteracted immediately by an above-average runoff year; the delay in recharge essentially extends the drought for an additional 3 to 12 months"* (Danskin, 1998, page 103, right column, paragraph 2).

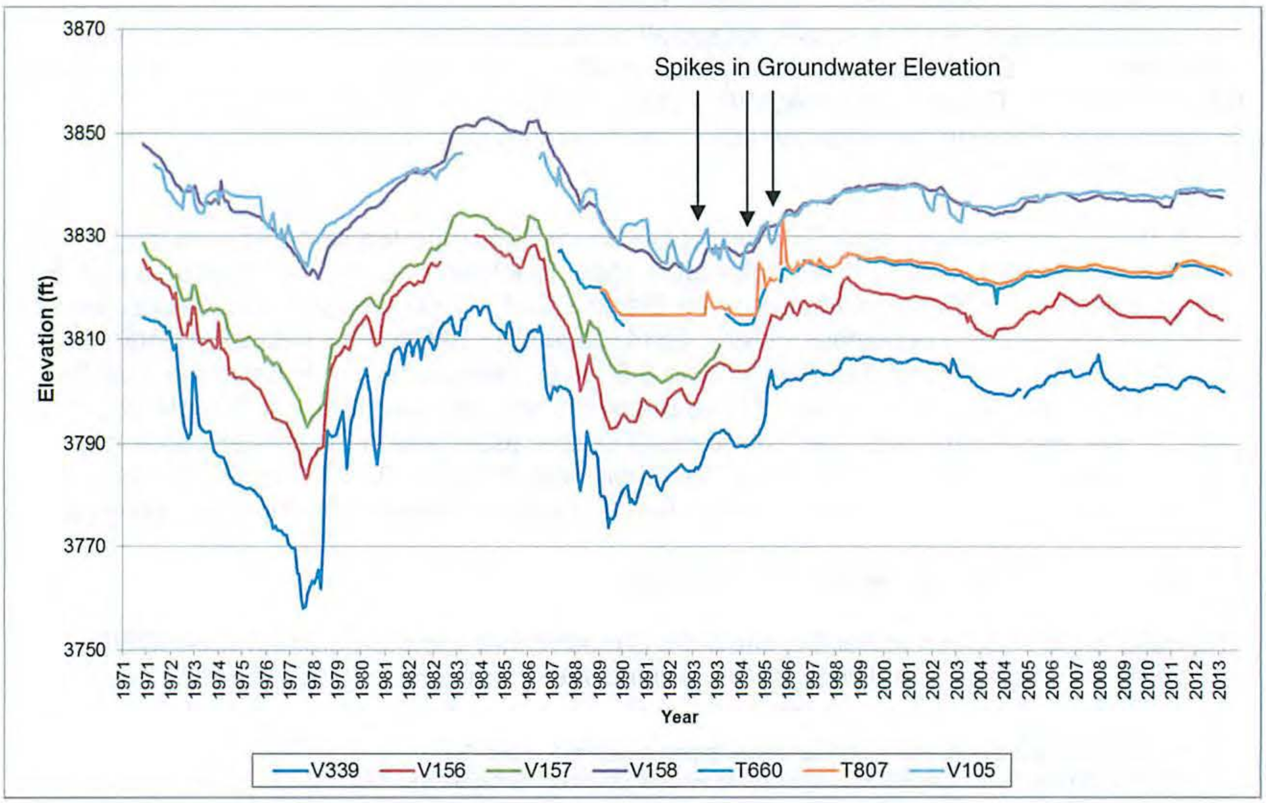


Figure 13
Groundwater Elevation at Observation and Test Wells along the Western Edge of Vegetation Parcel Blackrock 94 Based on Actual DTW Measurements

4.9.2 There Are Unreliable Depth to Water Estimates in the ICWD No-Pumping Scenario

As previously described, ICWD omitted data from test wells located in Blackrock 94 when it attempted to estimate DTW for the parcel. Because of these omissions, DTW estimates that were developed by the ICWD are purely conjecture regarding what DTW would have been in the absence of pumping, are unreliable, and should not be accepted because 1) the USGS model was not designed for small scale effects[29], and the outputs of these simulations contain a large degree of uncertainty, which may be systematically introduced or too large to be ignored, and 2) the wells used (T807 and T806/T582) do not adequately represent the entire parcel, especially when additional data from within the parcel was available for use.

4.9.3 ICWD Ignores the Role of Surface Water Spreading

Despite acknowledging that *"...episodic surface water spreading affect the water table at Blackrock 94*" (ICWD, 2011, page 2) and *"...surface water spreading, and precipitation variables which actually drive water availability and vegetation cover"* (ICWD, 2014, page 43), ICWD completely ignores the role of surface water spreading in its new regression model introduced in ICWD, 2014. As previously discussed, surface water spreading has a highly-localized effect on vegetation cover. When there is ample evidence of surface water spreading occurring in the parcel, ICWD's complete omission of the fact challenges its own preconceived notion that fluctuations in vegetation cover are mainly driven by water table fluctuations, not surface water spreading. Surface water spreading is an important mechanism not only directly influencing vegetation cover, but also directly recharging groundwater and increasing soil moisture.

4.9.4 Review of Unreliable ICWD Depth to Water Estimates

The new model introduced by ICWD is based on flawed data sets (ICWD's kriging, using the USGS model in an effort to simulate small scale effects, and SMA data). The hypothetical circumstances of no pumping is also based on a flawed data set (USGS model being applied to small-scale effects, ICWD's kriging data) and inadequate number of modeled DTW points (TS1 and TS2) with unknown quantity of uncertainty or error. Real-world analysis or management decisions cannot be based on flawed DTW estimates and simulated vegetation cover in this hypothetical world constructed by ICWD.

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[29] The USGS made the following statements regarding the USGS model: "*Because of the way it was calibrated, the model is most useful for evaluating valleywide conditions, not for predicting small-scale effects covering a few model cells. Site-specific ground-water flow models or multivariate regression models, such as developed by P.B. Williams (1978) and Hutchison (1991), can give more accurate predictions at selected sites*" (Danskin, 1998, page 79). "*Future analysis of these smaller-scale features or issues-such as a volcanic deposit, a facies change, or a question of local water use – might best be done by use of smaller-scale models or field studies...*" (Danskin, 1998, page 94).

4.10 Summary: Hydrology Data Demonstrate that Hatchery Pumping Could Not Have Caused Vegetation Changes Since the 1986 Vegetation Inventory

ICWD states that over the period of 1970 to present, groundwater pumping has been the primary cause of changes in groundwater levels in Blackrock 94. However, this is not relevant. What is relevant is changes in vegetation since 1986, and whether those changes are caused by groundwater pumping from the Blackrock Fish Hatchery, which since 1998, amounts to 95 percent of the pumping from the Thibaut-Sawmill Wellfield.

Pumping for the Blackrock Hatchery began in 1972 and has been maintained at a nearly constant rate. Hydrologic effects of this pumping would have reached a steady-state condition long before the 1986 vegetation inventory. Since 1986, water levels and vegetation have varied, and have surpassed 1986 levels during wet periods – all the while pumping has been relatively constant. For example, in 1998, vegetation was 20% higher than that in 1986. These facts indicate that factors, other than pumping, are responsible for changes in vegetation at Blackrock 94. Data presented by LADWP (2013) conclusively demonstrate that changes in runoff-driven recharge are largely responsible for changes in groundwater elevation beneath the Blackrock 94 parcel since 1986, not pumping.

Furthermore, the use of Blackrock 99 as a control site for comparative purposes is inappropriate because of key differences in the hydrologic regime of the two sites that is not related to pumping.

Relative to regression modeling, ICWD misused LADWP's vegetation regression model. As stated by the USGS, the use of the USGS valley-wide model to simulate small-scale effects is inappropriate (Danskin, 1998, page 7). Furthermore, ICWD's new multiple regression model is fundamentally flawed. The ICWD regression model used 1) USGS valley-wide groundwater model-simulated DTW values instead of physically-measured DTW values, and 2) modeled vegetation cover values instead of physically-measured vegetation cover values[30].

[30] A detailed discussion of ICWD's vegetation modeling simulations is presented in Section 5.

5 VEGETATION: THE ICWD RELIES ON FLAWED VEGETATION DATA - MODELED VEGETATION COVER DATA IS NO SUBSTITUTE FOR PHYSICALLY-MEASURED VEGETATION COVER DATA

Green Book Box I.C.1.a.ii (2) states that "*vegetation transects shall also be used in cases of suspected vegetation changes due to groundwater pumping. However, rather than using the intensive sampling technique of Section III.D for calculating evapotranspiration, plant cover shall be measured by the line-point technique described below.*" Instead of using plant cover based on the line-point technique (line-point monitoring), the ICWD February 14, 2014 report substitutes Spectral Mixture Analysis (SMA) for this requirement in its most recent attempts to estimate or model vegetation cover in Blackrock 94. The reason cited by ICWD for deviating from the Green Book requirement is "*that it is difficult to make comparisons to baseline data because of certain characteristics of the baseline data*" (ICWD, 2014, page 8). Moreover, the ICWD also poses yet another new question: "*Would vegetation cover have changed in Blackrock 94 if pumping had been different?*" In its attempt to answer this question, ICWD combined a mixture of SMA-estimated vegetation cover values from two parcels, Blackrock 94 and Blackrock 99, and developed another new model that ICWD had not presented before. In order for their new model to function, ICWD had to combine the two parcels because Blackrock 94 alone does not provide enough data points for the shallow water table conditions.

5.1 ICWD Relies on Spectral Mixture Analysis (SMA) as Vegetation Data

ICWD makes use of SMA in their estimation of cover at Blackrock 94 (BLK094). SMA is a method of matching color spectral bands from satellite photographs to spectral "signatures" characteristic of various surface conditions. ICWD's reference for the methodology used is Elmore et al. (2000). SMA is a commonly-used method for mapping using satellite imagery. The basics of the method are straightforward. Examples of specific types of ground cover are selected that are considered to be good representations of homogeneous conditions of the specific types. Examples might be such things as dark-colored bare soil, light-colored bare soil, dense vegetation, and water. The spectral colors characteristic *of* each of these types (termed "endmembers") are determined and those characteristic colors are considered as "signatures" indicating that particular type or endmember. Computer software is then used to scan the satellite photographs in discrete spatial units (pixels), and the software produces a numeric combination of these signatures for each pixel.

5.1.1 There Is an Inherited Limitation and Uncertainty with SMA Model Output

The ICWD SMA model was developed by Elmore et al. (2000) and calibrated using 33 permanent line-point transects that were annually sampled by ICWD and LADWP between 1991 and 1996. Transects were 100 meters in length and were located on the valley floor between the towns of Laws and Lone Pine. Remotely-sensed data was then aligned and georeferenced to equate known permanent transect vegetation cover values to intercepted imagery pixels. SMA absolute percent live cover estimates were reported to be accurate within ±4.0%. Estimates of change in live cover were reported to have a precision of ±3.8%. Lastly, the SMA model was also reported to correctly determine the sense of change (positive or negative) in 87% of the samples.

First, it is important to note that the SMA model developed by Elmore et al. (2000) was not designed to estimate vegetation cover for the entire Owens Valley, but rather, it was developed to merely quantify the accuracy and precision of SMA to estimate vegetation abundance and change over time at certain specific permanent monitoring sites. This is clearly stated in the opening paragraphs of the Elmore et al. (2000) paper and is also reflected in the small sample size (33 transects) used to validate and test the SMA model. If the SMA model was designed to estimate vegetation cover as was attempted in the ICWD February 14, 2014 report, then a much larger sample size of transects would be necessary to assure reliable results. According to Elmore et al. (2000), the SMA model was ±4.0% accurate in predicting live cover at the permanent monitoring transects. The area associated with the 33 transects represents an extremely limited area as compared to the area of the valley floor, which is monitored using line-point methods by both the ICWD and LADWP. Therefore, an attempt to estimate vegetation cover outside of the design parameters of the SMA model, the 33 permanent monitoring locations, is not appropriate.

The error estimates reported by Elmore et al. (2000) increased as the SMA model was scaled up by the ICWD to estimate vegetation cover throughout the Owens Valley, primarily due to the coarseness (30m x 30m pixels) of the Landsat satellite imagery used in the Elmore study. Other authors, using similar techniques, report a wide range of accuracy and demonstrate the limitations of 30-meter resolution.

- Everitt et al. (2006), used QuickBird satellite imagery that has substantially finer resolution than Landsat (3-m resolution compared to 30-m for Landsat) and achieved average classification accuracies of **66-96%, for vegetation cover values above 50%**[31] for the major vegetation type on the Welder Wildlife Refuge (mixed brush). These accuracies were classifying areas into respective vegetation types, not estimating cover values. It is reasonable to believe that if 30m x 30m Landsat imagery had been used in the same analysis, classification accuracies would have been much lower than those reported by Everitt et al (2006).

- In another remote sensing study, Weber (2006) presented accuracy values for classifying leafy spurge sites in Idaho using various satellite platforms. Landsat was found to be only **40%** accurate. Weber (2006) stated that heterogeneity in rangeland communities likely resulted in low accuracies using Landsat.

- Mehner et al. (2004) used satellite imagery from Ikonos, which has a 4-m resolution compared to 30-m resolution in Landsat. They reported accuracies of **47-75%** for classifying upland vegetation in the UK. They made the statement "Previous applications of satellite imagery for this task (e.g., Landsat TM and SPOT HRV) have been unsuccessful, as such imagery proved to have insufficient spatial resolution for mapping vegetation."

These studies clearly show the limitations of 30-meter resolution Landsat imagery and suggest that the Elmore et al. (2000) SMA model is inappropriate to be used to estimate vegetation cover beyond the 33 permanent monitoring locations that is was designed for.

[31] 1986 Baseline cover in Blackrock 94 was measured to be about 43%. Vegetation cover in Blackrock 94 has not been measured to be above 50%.

5.1.2 Persistent Inaccuracies of SMA-Estimated Cover Exists

Elmore et al. (2000) reports, *"...pure pixels at the scale of the TM data are rare and some contamination is likely. As a result, some SMA-calculated percent live cover measurements are below 0% and above 100%* (page 95). Elmore et al. (2000) does not state how many or what percent were below 0% and above 100%; however, Figure 5 from Elmore et al. (2000) shows at least six estimates below zero. Because the scale on the y-axis within Figure 5 of Elmore et al. (2000) ends at 80%, it cannot be determined how many cover estimates were above 100%. From the text, it can, however, be safely inferred that at least one value was over 100%.

5.1.2.1 Endmembers

The SMA software recognizes only combinations of the endmembers, and therefore precision is limited by that number. In the case of the Elmore et al. (2000) and ICWD work, that number is four. In effect, that means that the entire landscape is defined in terms of four, and only four, "things": dark soil, light soil, water (the authors use the term "shadow"), and plants. The signature for "plants" was taken from a *"riparian area near the Owens River"* (Elmore et al. 2000, page 93). Therefore, the software was "trained" such that any plant cover has the same spectral signature of dense riparian vegetation. Many of the perennial plant species in Blackrock 94, as well as most other areas in the Owens Valley, have leaves that are not that same color of green, and therefore are likely to have different spectral signatures than riparian vegetation. Leaves of the chenopod shrubs for example, have either a tan (e.g., fourwing saltbush) or a gray-green (Nevada saltbush). Leaves of big sagebrush are gray. Given these differences in leaf color, it is probable that some live cover of these species was designated as something other than "riparian green" in the ICWD SMA analysis. If so, the live cover values being reported by ICWD SMA analysis would be lower than the actual values, and this difference would be most pronounced in shrub communities similar to Blackrock 94. In addition, the normal color of alkali sacaton is a lighter green than "dense riparian vegetation", and would therefore be underestimated by the ICWD's application of SMA.

This disconnect between SMA "green" and actual leaf cover is alluded to in Figure 7 of Elmore et al. (2000). The authors state *"(monitoring) Site SS3 illustrates an offset between SMA results and the field data. This offset ... can be attributed to characteristics of the vegetation at the site."* In other words, because the leaf color at monitoring site SS3 was not the same *as "dense riparian vegetation"*, the SMA analysis provided results that differed from physical field measurements.

The authors also refer to this problem of matching vegetation signatures in their text. Page 95 of Elmore et al. (2000) states: *"... however, pure pixels at the scale of the TM data are rare and some contamination is likely."* And, *"These points must be accepted as inaccurate measurements due to impure endmembers."*

5.1.2.2 Phenology

The 1986 inventory of Blackrock 94 measured "*live plant cover*" (Green Book Box I.C.1.a.ii, page 22, paragraph 4), which the Green Book defines to be "*...the crown cover of all live plants in relation to the ground surface*" (Green Book Section II.A.2.e, page 38). The Green Book requires the Technical Group to evaluate "*decreases in live vegetation cover*" pursuant to the *Impact Determination and Mitigation* procedures (Green Book Section I.C, page 19). ICWD uses the terms "*live vegetation cover*" in ICWD, 2011 or just "*vegetation cover*" when referring to its SMA analysis introduced in ICWD, 2014. However, what the ICWD is actually referring to is "leaf cover". The amount of leaf cover for a given amount of perennial plant structure is not constant. Perennial plant structure includes crowns (basal cover) of herbaceous species, such as grasses and live trunks, branches, and stems of woody species such as shrubs. In both cases (herbaceous and woody), amount of leaf material varies throughout the growing season and among years, even with the same amount of perennial structure. Moisture availability has a major influence on amount of leaf tissue. Perennial plants produce more leaves during moist periods and shed leaves during dry periods. Herbivory (including grazing by livestock, browsing by wildlife, and defoliation by insects) can have a major impact on amount of leaf tissue at any particular point in time. Seasonality also affects the relative amount of leaf tissue. Sampling at one particular time of the year, as indicated by ICWD, does not necessarily correlate with the same phenological stage of plants. They may have senesced (lost leaves) earlier or later in a particular year, and this would influence how much leaf tissue (i.e., live plant cover) was present when the satellite photographs were taken. As will be demonstrated later, seasonality does affect the estimated cover for the parcel because SMA uses images taken after the peak growing season, while physical measurements on the ground are conducted throughout the peak growing season.

5.1.3 There Is Variability in SMA Estimates of Cover

Elmore et al. (2000) stated that their SMA estimates of absolute live cover were accurate to within ±4% live cover. That estimate was illustrated in Figure 8a of their article; this shows that most of the means fall within a 8%-width band, i.e., the SMA mean might be as much as 8 percentage points different than the field reference mean. Therefore, their statement of ± 4% live cover is statistically correct, but should not be interpreted as 96% accuracy (100 – 4 = 96). It should be interpreted as an 8 percentage-point range in live cover. If the actual mean cover was 20% for example, their SMA estimate could be anywhere between 16 and 24% cover (± 4), or a range of 8 percentage points or accurate to only within +/- 20%[32].

This high variability is illustrated in Figure 8a (Elmore et al., 2000) by the wide error bars along the y-axis (= SMA cover estimate). For example, the uppermost value in the upper right-hand portion of the band has a mean of 73% cover, but an error bar from 62 to 84%, indicating that the SMA-estimated cover for that location could be as low as 62% or as high as 84%. Most of the locations have low cover values. Also, their means and error bars are difficult to distinguish in the cluster in the lower left-hand portion of the graph. Some however, can be distinguished. One is located on the upper side of the bands at about 30% SMA cover and 22% field cover (the SMA estimated cover was 31%, compared to the field cover value of 22%, or a difference of 9 percentage points). That mean (31% SMA-estimated cover) had an error bar of ± 9 (upper value of 40, mean value of 31). Therefore, the range in possible values for this location was 22 to 40% cover. In other words, the SMA method could not detect differences within these two values. A similar value occurs on the outer edge of the band below and to the right of the location just discussed. This mean was 24% SMA cover compared to 34% field cover, i.e., SMA under-estimated cover by 10 percentage points. The error bars indicate that the SMA mean could have been as low as 14% or as high as 34%, a range of 20 percentage points. At that location, SMA could not distinguish differences between 14-34% leaf cover.

In addition to these wide error bars, the authors reported that the confidence intervals used were 70% (page 95). Common practice in ecological studies is to report confidence intervals at

[32] The accuracy claims by Elmore et. Al. (2000) apply only to the 33 permanent monitoring sites the SMA model was designed to estimate. Extrapolating Elmore's SMA model to Blackrock 94 is beyond the models design parameters and is expected to result in significantly less accurate estimates of vegetation cover.

the 95% probability level. A 70% probability level indicates that there is only approximately a 2:1 (70/30) probability of a correct answer (Type I error). The more accepted level of 95% indicates a 19:1 (95/5) probability of a correct answer.

It is also interesting to note that the difference between SMA-estimated cover and field-determined cover shifted dramatically over time at permanent monitoring site SS3 (Figure 7b, Elmore et al., 2000). From 1987 through 1991, the graph indicates that the difference each year was 2-12 percentage points. From 1992 through 1997, it was 10-16 percentage points. And in all cases, the SMA value was the lower value, i.e., it consistently under-estimated cover.

As discussed previously, since the SMA model was not designed to be used for other than estimating vegetation cover in areas other than 33 specific monitoring sites, it is expected that the accuracy of the model outside of its design parameters makes the model inadequate to estimate vegetation cover in Blackrock 94. This is confirmed by great disparity between the SMA results and the cover values in Blackrock 94 that were physically measured by both the ICWD and LADWP using the line-point method (see Figure 25, page 81).

5.1.4 Comparison of SMA Estimates of Cover to LADWP Line-Point Transect Data Reveals Persistent Inaccuracies

Data for 17 transects established by LADWP in Blackrock 94 was compared to SMA estimates of cover for the blocks containing each of the 17 transects. For the SMA data, the SMA value was reduced by 75 to convert to % cover, as per the ICWD methodology (read me file included with ICWD SMA data transfer to LADWP). Averaged over 6 years (2004-09), SMA estimates differed from transect values by at least 10 percentage points at a minimum of 11 of the 17 locations each year (**Table 4**). In each of the 6 years, the difference was at least 30 percentage points at one or more of the locations. In 2004, there was a maximum difference of 37 percentage points, a maximum difference of 47 percentage points in 2005, 44 percentage points in 2006, 72 percentage points in 2007, 30 percentage points in 2008, and 46 percentage points in 2009.

Canopy cover fluctuates from year to year in response to a variety of environmental factors. Measured at the 17 transects in Blackrock 94, canopy cover varied by an average of 32 percentage points over the 6 years from 2004 through 2009 (**Table 5; Figure 14**). SMA-estimated cover varied by an average of 20 percentage points, or about 62% of the transect value, over the same period. This lower variability suggests that the SMA estimation of canopy cover is not accounting for a substantial portion of the natural variability in these plant communities. This is likely to be, at least in part, the result of failure to account for phenological changes in the vegetation (See Phenology section 5.1.2.2).

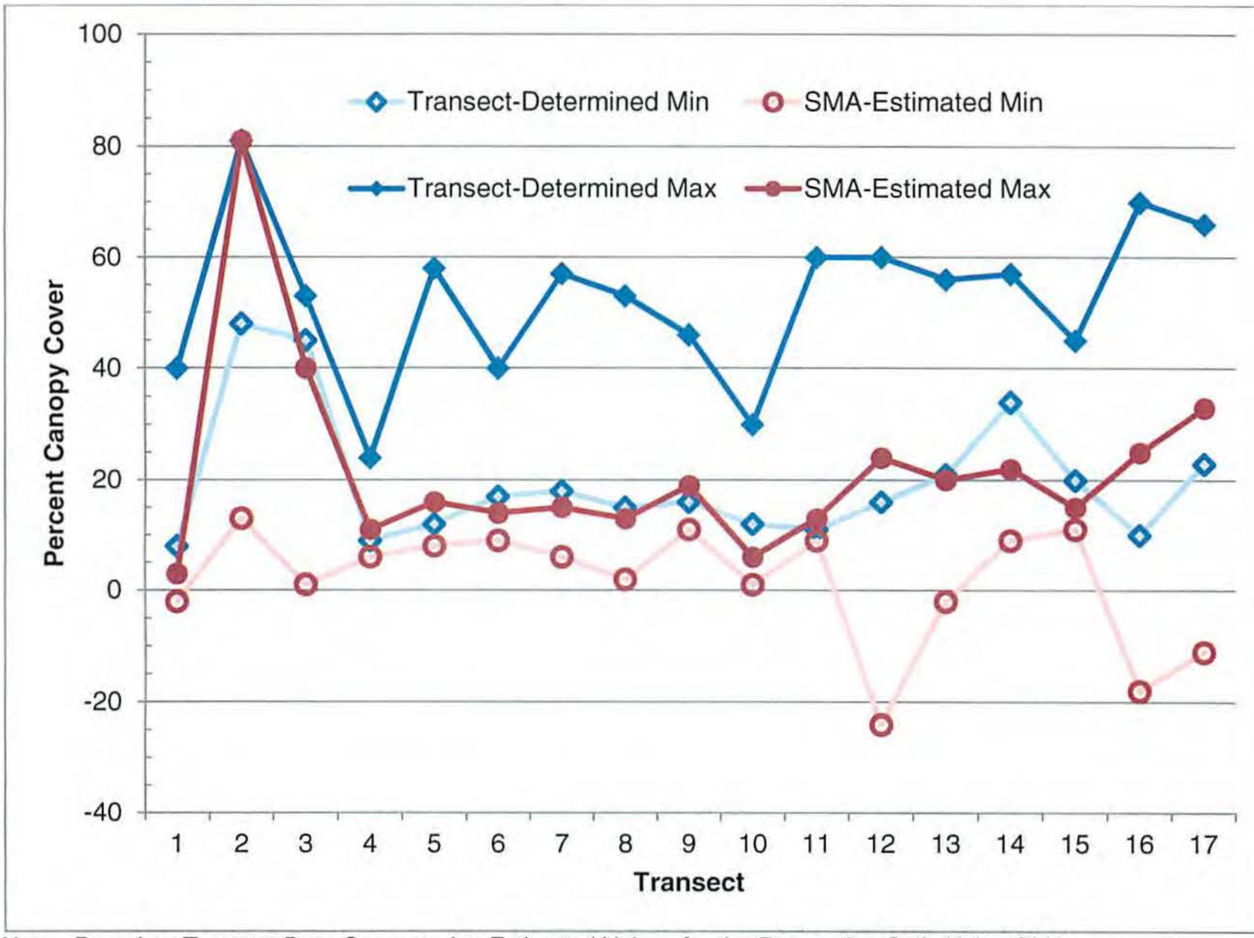
Table 4
Examples of Substantial Differences Between SMA-Estimated and Transect-Determined Canopy Cover at BLK094

	2004		2005		2006		2007		2008		2009	
Transect	SMA	TRN	SMA	TRN	SMA	TRN	SMA	TRN	SMA	TRN	SMA	TRN
1	4	8	3	34	2	40	-2	11	3	11	3	20
2	59	78	81	81	93	52	39	48	36	53	83	69
3	20	47	41	51	15	45	-6	45	22	45	25	53
4	8	19	12	21	11	9	9	24	8	20	7	18
5	11	18	12	30	14	58	7	12	10	38	9	28
6	8	28	11	29	10	17	10	18	7	26	10	40
7	9	18	13	57	19	19	18	26	12	18	11	22
8	8	41	14	15	10	31	7	18	17	36	12	53
9	11	46	19	36	20	25	16	16	18	46	19	27
10	6	19	4	18	1	13	6	12	5	21	4	30
11	12	45	13	31	12	41	10	26	13	11	14	60
12	21	28	18	60	24	58	-24	48	-1	16	10	21
13	16	53	15	36	19	56	3	21	8	38	12	54
14	15	42	18	38	20	52	10	34	16	42	15	57
15	14	39	15	36	16	35	12	20	11	37	14	45
16	21	31	23	70	25	56	-15	44	-4	10	16	20
17	21	57	27	66	27	51	-11	23	-4	26	13	56

SMA = SMA-Estimated
TRN - Transect-Determined

Table 5
Range in Canopy Cover Values (%) Over 6 Years (2004-09) at 17 transects in BLK094 Based on Transect Data Compared to Estimated Values for the Respective Cells Using SMA

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	Mean
Transect																		
Maximum	40	81	53	24	58	40	57	53	46	30	60	60	56	57	45	70	66	
Minimum	8	48	45	9	12	17	18	15	16	12	11	16	21	34	20	10	23	
Range	32	33	8	15	46	23	39	38	30	18	49	34	35	23	25	60	43	32.4
SMA Estimate																		
Maximum	3	81	40	11	16	14	15	13	19	6	13	24	20	22	15	25	33	
Minimum	-2	13	1	6	8	9	6	2	11	1	9	-24	- 2	9	11	-18	-11	
Range	5	68	39	5	8	5	9	11	8	5	4	48	22	13	4	43	44	20.1

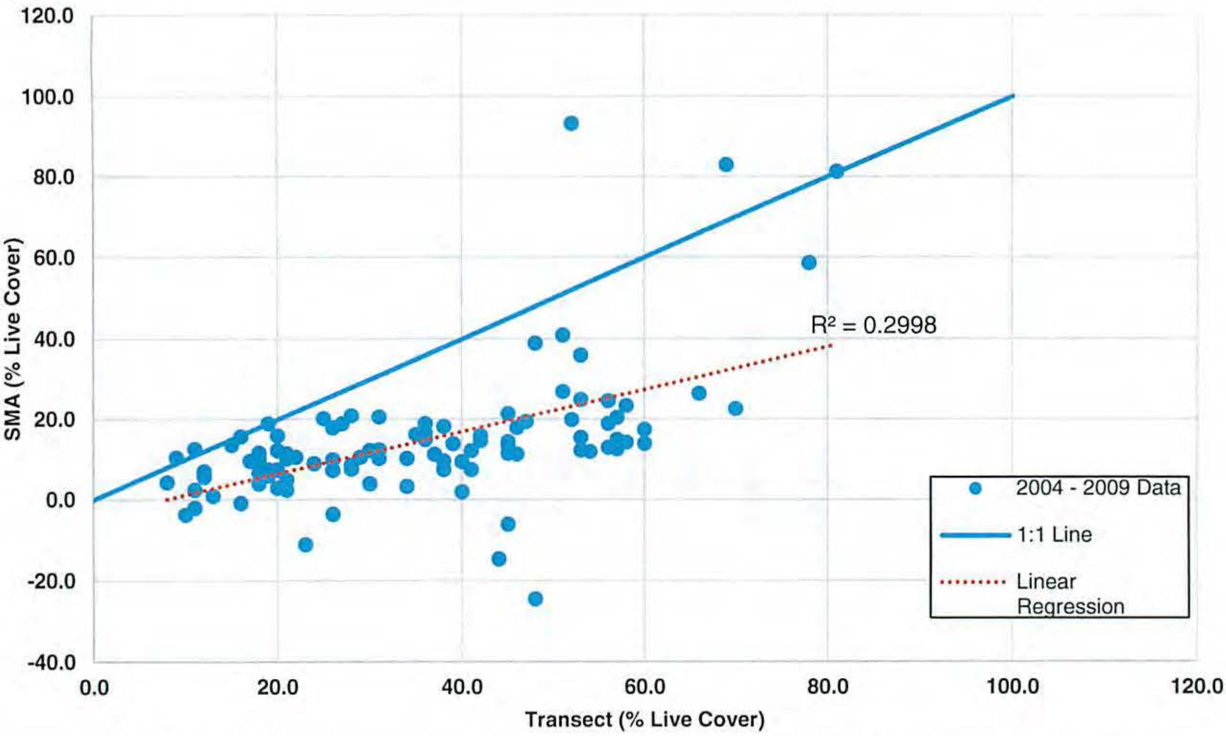


Note - Based on Transect Data Compared to Estimated Values for the Respective Cells Using SMA

Figure 14
Range in Canopy Cover Values Over 6 Years (2004 - 2009) at 17 Transects in BLK094

The statistical relationship between transect-determined canopy cover and SMA-estimated canopy cover can be tested by use of regression analysis. The R^2 values between transect and SMA values in individual years varied between 0.09 and 0.54, and averaged 0.34 over the 6 years. An R^2 value of 0.35 indicates that only about one-third of the variability in SMA values can be explained by variability in the transect data. When all 17 values from all 6 years are combined, the resulting R^2 is 0.30 (**Figure 15**).

Elmore et al. (2000) stated that their use of SMA analysis for determining canopy cover had an accuracy of $\pm$ 4 percentage points. Only 8 of the 102 observations (17 transects x 6 years) in Blackrock 94 fall within this range ($\pm$ 4% percentage points of the transect-determined canopy cover). This is a 7.8% success rate. If the acceptable band is increased to $\pm$ 10 percentage points, then the success rate increases to only 23.5% (24 out of 102; Elmore et al., 2000, Table 2).



Note - The comparison of the transect data (% live cover actually measured in the field) with SMA data indicates that in the majority of cases SMA under estimates % live cover. In regression analysis, the strength of the relationship between two variables, in this case % live cover measured along transects compared with SMA data, is determined by the deviation of the paired points from a 1:1 line. A perfect relationship between two variables would have all paired points occurring on and along the 1:1 line. However, in this comparison, the majority of points deviate from the 1:1 line, i.e., they fall below the 1:1 line indicating that SMA values under estimate measured transect values; the slope of the linear regression line is shallower than the 1:1 line indicating that as transect measured cover increases under estimation by SMA tends to increase; and the paired points exhibit noticeable scatter producing a low R^2.

Figure 15
Transect Data Compared to SMA Data (2004 - 2009)

The average difference (absolute value) between the 96 observations of canopy cover (Elmore et al., 2000, Table 2) based on transect data and the values based on SMA estimates is 18.9 percentage points. This provides for a more realistic level of accuracy (± 9.5 percentage points) at the permanent monitoring sites than the level (± 4 percentage points) stated by Elmore et al. (2000).

The ICWD (2011) stated that SMA-estimated total vegetation cover in Blackrock 94 from 1995 to 2009 (excluding the fire-year of 2007) ranged from about 10% (2008) to about 30% (1998) (Figure 8, ICWD, 2011). At a SMA accuracy of ± 11 percentage points, that would be a range of 0% to 41%. The SMA-estimated mean cover in most years (11 out of 12) from 1995 through 2006 (pre-fire years) was 18% or more. Accounting for the ± 11 percentage point accuracy means that the annual SMA-estimated means in these years could have been at least 29% in 11 of the 12 years.

5.1.5 Comparison of SMA Estimates of Cover to ICWD Line-Point Transect Data Reveals Consistent Inaccuracies and SMA Estimates of Cover Should Be Discounted

Any result and conclusion based on SMA should not be considered reliable because there are a number of questions regarding the accuracy of SMA-estimated cover and its applicability for this type of use. Further, it is dubious that SMA estimates truly capture vegetation cover during peak growing season because of late-summer/early-fall images used in the SMA model. LADWP has repeatedly questioned these attempts and will do so again here in more detail. LADWP also disagrees with the ICWD's assumption that Blackrock 94 and Blackrock 99 were similar in vegetation condition during the initial inventory because of the supposed shallow water table in 1986.

ICWD has provided its SMA-estimated cover values for 169 vegetation parcels located throughout the Owens Valley between 1985 and 2011. The total number of SMA estimates within this data set is 4,530. Of 169 parcels, 29 parcels have at least one negative SMA estimate, and this amounts to a total of 130 negative cover estimates[33]. ICWD is asserting that there is less than zero percent vegetation cover on 17 percent of the parcels they attempted to model using SMA. Further, three parcels have SMA-estimated cover greater than 100% or 6 cover estimates in total. Overall, ICWD's modeled SMA estimated cover range from -8.0% to 113%. Real vegetation cover collected on the ground is bounded between 0 and 100 percent. Therefore, SMA-estimated cover should be constrained between 0% if there is no vegetation cover and 100% if the parcel is completely covered by vegetation. Based on these results, any conclusion that relies on SMA for its foundation should be discounted completely because ***vegetation cover below 0% or over 100% is simply impossible.***

5.1.6 SMA Is Unable to Predict Actual Cover

In the Owens Valley, the peak growing season has been found to occur "*at approximately the mid-point of the calendar year under non-drought conditions and without excessive summer rains*" (Green Book III.C). For this reason, wellfield permanent transect monitoring has been conducted within two weeks of the summer solstice (June 21st) each year. Line-point monitoring conducted by ICWD and LADWP has also been conducted during a similar time period (June to early August). In its analysis of SMA, ICWD has documented that images it evaluated for vegetation cover were taken in late summer/early fall. This is justified as an attempt to reduce contribution by annual plant species in the estimates of vegetation cover for perennial plant species. This rationale is not reasonable because many perennial species have been documented to exhibit a decrease in cover in the late summer; therefore, a comparison of late spring/early summer cover to late summer/early fall cover is an unsuitable comparison.

Elmore et al. (2000) presents dates of Landsat TM acquisition between 1984 and 1997 (**Table 6**). During this period, most of images were captured sometime in September, which is almost 80 days after the summer solstice and the peak of the vegetation growing season. By this time much of available soil moisture has been utilized and much of the perennial cover has reduced. During the development of the Green Book, the reduction in perennial cover from the summer solstice to late summer was evaluated along the permanent vegetation monitoring transects between 1991 and 1996, including TS1 and TS2, which are located in vegetation

[33] Negative SMA cover values are presented in Appendix A along with parcel, year, and corresponding ICWD's and LADWP's actual cover values.

parcel Blackrock 94 (**Table 7**). For both monitoring sites the late summer values of perennial cover were lower than summer solstice readings. The one exception was the result of water spreading near monitoring site TS1 in 1995. Therefore, it is readily apparent from these actual measured data that SMA-estimated cover based on the late summer images could easily be as much as 10% lower than what the true vegetation cover would have been during the peak growing season.

A similar comparison was made between modeled SMA-estimated cover and cover based on line-point monitoring in order to demonstrate SMA's inability to capture actual vegetation cover. Line-point monitoring, as previously mentioned, is conducted at the peak of the growing season, rather than after the growing season. Field crews actually visit each parcel and physically measure ***actual*** vegetation cover on the ground using a widely-accepted and Green Book-required[34] line-point vegetation monitoring method. Therefore, vegetation cover based on line-point monitoring is not only real and required by the Green Book, but is also more representative of vegetation cover of the parcel during the peak growing season.

Table 6
Dates of Landsat TM Acquisition between 1984 and 1997

Landsat TM Acquisition			
Year	Month	Day	# of Days from Summer Solstice
1984	August	1	41
1985	October	7	108
1986	August	23	63
1987	September	29	100
1988	September	13	84
1989	August	31	71
1990	September	3	74
1991	September	22	93
1992	September	8	79
1993	August	26	66
1994	September	14	85
1995	September	17	88
1996	September	3	74
1997	September	6	77
Average	September	7	79

Notes - Dates of Landsat TM acquisition as presented in Table 2 of Elmore et al. (2000).
A Number of Days from the Summer Solstice were added by LADWP.

[34] Green Book Box I.C.1.a.ii (2), page 22.

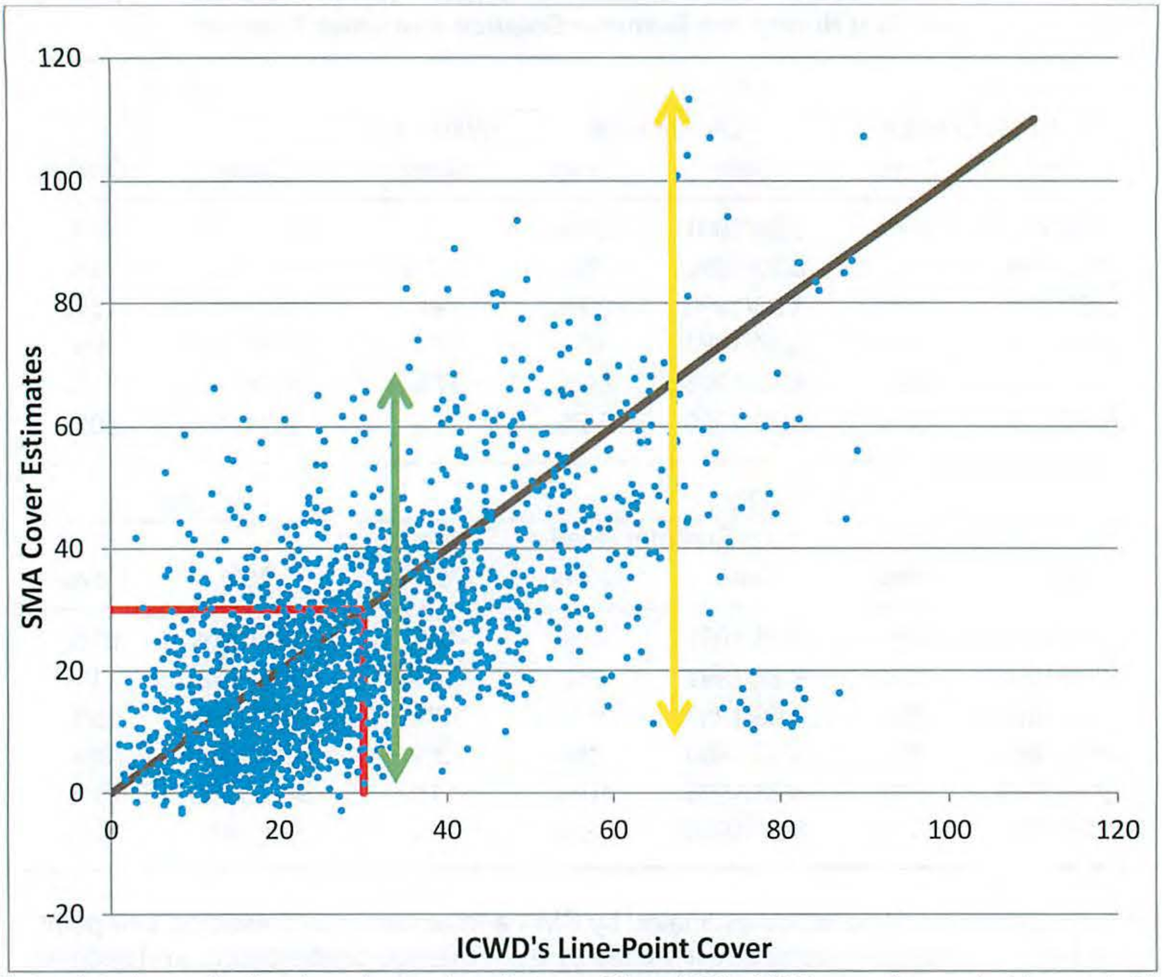
Table 7

Perennial Cover Recorded at Two Wellfield Permanent Transect Monitoring Sites (TS1 and TS2) during the Summer Solstice and Later Summer

TS1					SMA	
Summer Solstice		Late Summer		Difference		
Date	Cover	Date	Cover	Cover	Date	Cover
6/26/1991	29%	8/26/1991	20%	-10%	9/22/1991	21%
6/16/1992	17%	8/20/1992	5%	-12%	9/8/1992	11%
6/21/1993	30%	8/23/1993	20%	-9%	8/26/1993	15%
6/17/1994	8%	8/24/1994	6%	-1%	9/14/1994	8%
6/21/1995	32%	8/22/1995	50%	17%	9/17/1995	21%
6/20/1996	60%	8/20/1996	55%	-4%	9/3/1996	20%

TS2					SMA	
PTM		Late Summer Read		Difference		
Date	Cover	Date	Cover	Cover	Date	Cover
6/26/1991	19%	9/18/1991	10%	-10%	9/22/1991	21%
6/22/1992	12%	9/22/1992	2%	-10%	9/8/1992	11%
6/24/1993	20%	8/25/1993	11%	-9%	8/26/1993	15%
6/23/1994	5%	8/17/1994	2%	-3%	9/14/1994	8%
6/16/1995	21%	8/23/1995	10%	-11%	9/17/1995	21%
6/20/1996	22%	8/20/1996	12%	-11%	9/3/1996	20%

LADWP compared modeled cover estimated by SMA and actual cover based on line-point transects by first simply projecting cover values by each method on the graph, and second using simple linear regression. Differences between two methods are quite large and highly variable (**Figure 16**). For instance, 30% actual cover (redlines) can be anywhere between 5% and 66% of SMA cover (green double arrow). The range increases dramatically with increase in actual cover (yellow double arrow). The large variability is translated into a poor fit of the model when SMA is used as an independent variable to predict actual cover. The overall predictive accuracy of the SMA model was 40% (determined using linear regression). This means that 60% of the time the SMA model incorrectly estimated vegetative cover. Year-to-year accuracy of the SMA model ranged from 17% to 75% (**Table 6**). The highest predictive accuracy occurred during 2010 and 2011 with values of 68% and 75% respectively. All other years however averaged 34%. The SMA model is a poor predictor of vegetation cover when used outside of its design objective of estimating vegetation change at 33 permanent monitoring sites. Of the 27 years of SMA data provided by the ICWD 17 years were less than 41% accurate and 25 years were less than 51% accurate (**Table 8; Figure 17**).



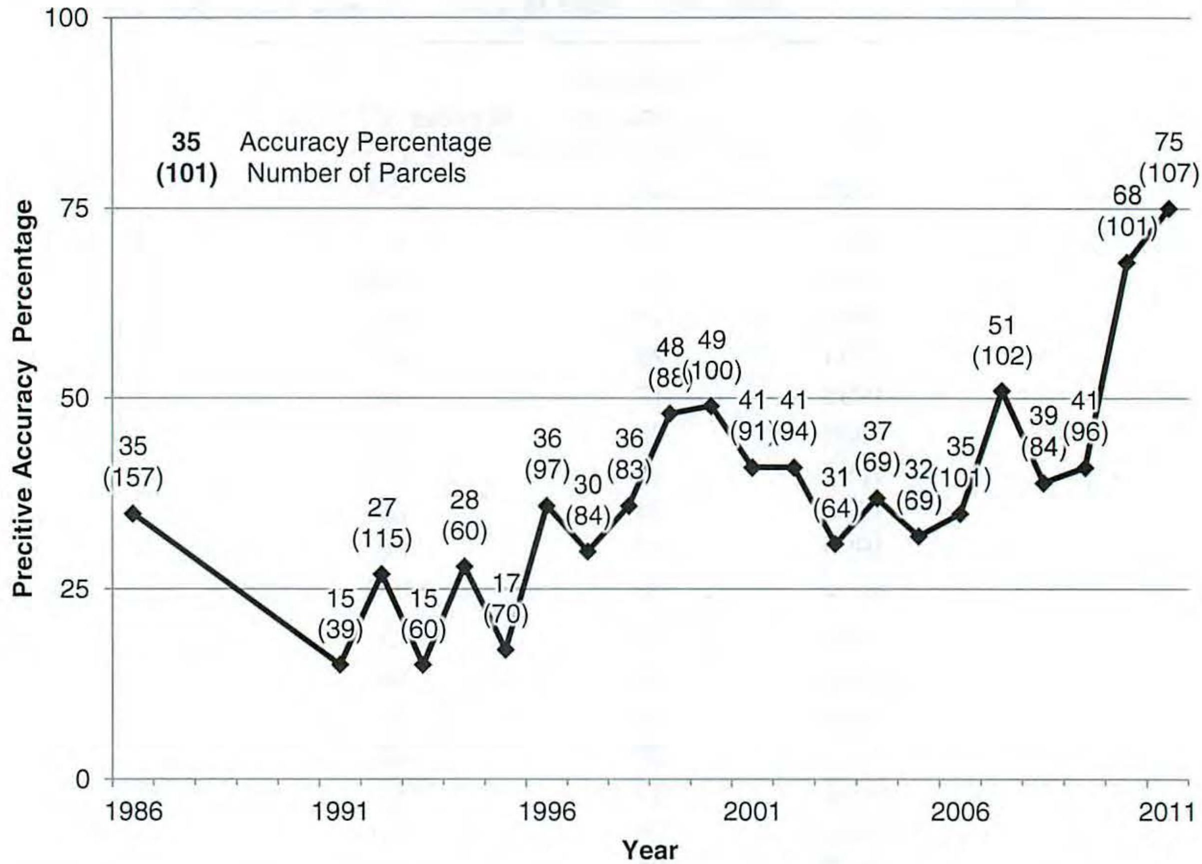
Note - Actual cover (redlines) can be anywhere between 5% and 66% of SMA cover (green double arrow). The range increases dramatically with increase in actual cover (yellow double arrow).

Figure 16
Graph Showing Differences in Cover Estimated by the ICWD SMA Model versus Actual Measured Cover

Table 8
Predictive Accuracy of the ICWD SMA Model for Owens Valley Parcels

Year	Predictive Accuracy %	Number of Parcels
1986	35	157
1991	15	39
1992	27	115
1993	15	60
1994	28	60
1995	17	70
1996	36	97
1997	30	84
1998	36	83
1999	48	88
2000	49	100
2001	41	91
2002	41	94
2003	31	64
2004	37	69
2005	32	69
2006	35	101
2007	51	102
2008	39	84
2009	41	96
2010	68	101
2011	75	107

Note - Accuracy values were calculated using regression analysis. The predictive accuracy of the SMA model is less than 50% based upon ICWD field measurements.



Note - Graph shows predictive accuracy of the ICWD SMA model at Owens Valley parcels through time. Accuracy values were calculated using regression analysis. The predictive accuracy of the SMA model is less than 50% based upon ICWD field measurements.

Figure 17
Graphical Display Showing Predictive Accuracy of the SMA Model

The SMA model also fails to accurately describe vegetation cover changes over time. LADWP examined whether a simple linear correlation relationship existed between the actual cover and SMA-estimated cover between 1986 and 2011 throughout the Owens Valley. Supposedly, both methods are tracking vegetation changes over time, so that values based on the two methods should change correspondingly even if the magnitude of changes may differ; thus, cover based on two methods should be ***highly-positively*** correlated. **Table 9** shows only eight parcels out of the 122 parcels examined (7%) show correlation coefficients greater than 0.8. A majority of parcels failed to show correlation coefficients greater than 0.6 and also failed to show predictive power of SMA greater than 40%. These results indicate that SMA-estimated cover poorly corresponds with actual peak growing season cover over time.

Table 9
Parcels with High Positive Correlation between Line-Point Measurements and SMA Estimates

r	# of Parcel	%	R^2	# of Parcel	%
> 0.8	8	7%	> 0.6	8	7%
> 0.7	21	17%	> 0.5	18	15%
> 0.6	38	31%	> 0.4	30	25%
Total	122			122	

Further evidence that SMA is not an appropriate tool for use outside of its intended design parameter of measuring change at 33 monitoring sites is provided by an examination of a parcel that is not one of the 33 sites used to develop the SMA model. A close examination of this parcel, Blackrock 99, reveals that SMA consistently underestimates vegetation cover at Blackrock 99 between 1991 and 2010, with a difference was as large as 34% (80% peak growing season line-point measured cover value compared to 46% SMA estimates) in 1999 (**Figure 18**). However, even the degree or magnitude of underestimation of the SMA analysis is not uniform throughout different monitoring years, illustrating another confounding influence of estimates made using the SMA model as compared to actual line-point measurement of cover.

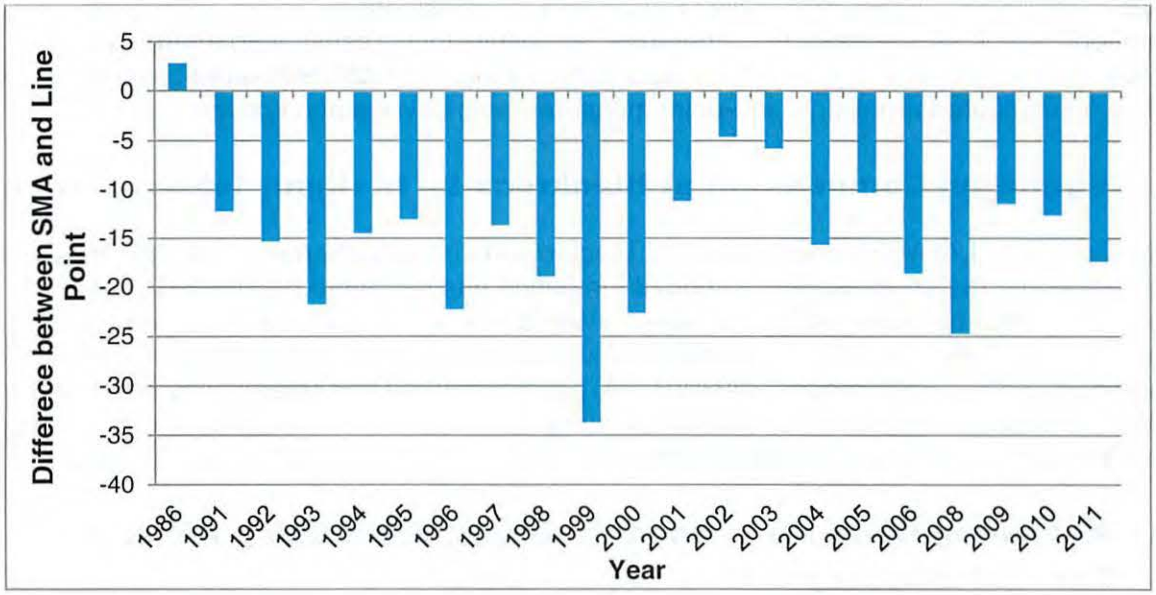


Figure 18
Differences in Vegetation Cover Obtained by SMA Estimates and ICWD's Line-Point Measurements at Blackrock 99

5.1.7 Summary: ICWD's Use of SMA to Estimate Vegetation Cover Is Inappropriate

While SMA analysis can be a useful tool when used within its design parameters, its general accuracy at best is 45% to 75%. The SMA model used by the ICWD was designed to measure 33 specific monitoring sites and is not applicable for extrapolation to Blackrock 94 or for the analysis of other Owens Valley vegetation parcels. The SMA model yields poor estimates of vegetation cover when compared to physical measurements of vegetation cover obtained using the line-point method. For this reason, Green Book Box I.C.1.a.ii (2) requires line-point transects to be conducted in cases of suspected vegetation change due to groundwater pumping. Discrepancies between the actual measured peak growing season vegetation cover and modeled SMA-estimated cover values are not only large, but also highly variable and unpredictable because the SMA analytical method employed by the ICWD provides inconsistent estimates of actual cover. The SMA model should not be given more credibility than physical measurements of vegetation.

It is also worth noting that SMA estimated cover for Blackrock 94 failed to detect the actual measured recovery of vegetation cover observed in the parcel in the late 1990s. The SMA estimated cover in 1998 was 20% lower than the actual cover values measured by the ICWD using the line-point method (28.8% estimate using SMA compared to 49.6% measured by ICWD using the line-point method).

For the reasons discussed above, it is concluded that the Elmore et al. (2000) SMA model as applied by the ICWD in the 2014 ICWD Report was inappropriate for use in comparing vegetation change in Blackrock 94. Therefore, all conclusions, results, and inferences based on the SMA data are flawed and should be discounted. Modeled SMA-estimated cover cannot be used as a substitute for physical line-point measurements of vegetation cover.

5.2 Vegetation Composition at Blackrock 94 Is Highly Heterogeneous

ICWD disregards LADWP's conclusion that Blackrock 94 is highly heterogeneous in its species composition and the southeastern portion of the parcel has remained relatively similar to the baseline condition because LADWP's analysis was based on the data set collected after the change has occurred. The ICWD attempts to support its position through the use of estimations it made based on its SMA model. LADWP will respond to ICWD's contention by first stating LADWP's conclusion again, second demonstrating heterogeneity of the parcel has existed prior to and during the baseline years, and third re-interpreting the 1986 SMA vegetation map.

5.2.1 Measuring Changes in Species Composition Using Absolute Cover Is Inappropriate

LADWP has stated that species composition in the southeastern portion of the parcel has remained relatively similar (***not SAME***), but species composition of the ***entire parcel*** has not, due to the distinct plant communities in the northwestern portion of the parcel. In the southeastern portion of the parcel, species composition has remained at least similar enough to the baseline condition such that statistical difference was not detected for all monitoring years but two. ICWD has stated that alkali sacaton (SPAI or *Sporobolis airoides*) is "*most strongly correlated with axis 2 and is driving a large portion of the difference observed in community composition between baseline and subsequent re-inventory years*" (ICWD, 2011, page 20).

When alkali sacaton cover is followed over time in the southeastern portion of the parcel, it has not shown great deviation from the baseline relative cover even though slightly lower in recent years (Table b.ii.8 of LADWP, 2013). On the other hand, relative cover of saltbush is higher while that of saltgrass is lower compared to the baseline condition. Combining these findings should lead to a conclusion that relative grass cover and relative shrub cover are different than in 1986, but the species composition remains similar because statistical analysis found no statistically significant trend in species composition changes in the southeastern portion of the parcel (LADWP, 2013, Section 5.2).

LADWP has followed the description of species composition in the Green Book (Section II.A.2.e, page 38), which is based on relative cover of species along each transect. Thus, relative cover is less prone to changes in absolute cover, and this is precisely why relative cover is commonly used to detect a long-term change of plant communities. Species composition is based on cover of all observed species not one species or in this case just two species (grass cover based on alkali sacaton and saltgrass). LADWP does agree that absolute cover of grass is different compared to the baseline even in the southeastern portion, but at the same time grass cover fluctuations closely follow the runoff patterns of Sawmill Creek. When there is high runoff, a cascade of events[35] take place that lead to increases in soil moisture and ultimately leads to increases in vegetation cover, including grass cover.

5.2.2 ICWD Concludes Spatial Heterogeneity at Blackrock 94 Exists

LADWP has argued that a distinctive plant community (or communities) exists in the northwestern portion of the parcel. This is based on not only ordination results but also on Ecological Site associated with Cartago Series Soil and vegetation classification of surrounding parcels. The northwestern portion of the parcel exhibits characteristics of a sagebrush-dominated plant community. ICWD has stated the northwestern portion of the parcel shows *"...the least change with respect to 1986..."* (ICWD's, 2014, page 55, paragraph 3). ICWD also states that *"the 18% of the parcel is Cartago soil which should naturally support some sagebrush"* (ICWD's, 2014, page 52, paragraph 2). The obvious conclusion is the northwestern portion of the parcel has been dominated by sagebrush since prior to 1986 and exhibits a very distinct vegetation community from alkaline meadow. Two or more distinct vegetation communities within a single ecological boundary, such as the parcel boundary of Blackrock 94, are defined as a heterogenic community.

5.2.3 ICWD SMA Analysis Shows that 1986 Vegetation Conditions Were a Result of Water Spreading

Figure 19 from ICWD, 2014 was presented by the ICWD to demonstrate that the southeastern portion of the parcel had experienced the largest decline in vegetation cover. This is in contrast to LADWP's conclusion (LADWP, 2013) that the southeastern portion of the parcel was relatively stable. First of all, SMA-estimated cover is not accurate or reliable, and cannot detect any change in species composition. Second, Figure 19 is based on the modeled SMA-estimated cover from 1986, which shows that the pattern of high vegetation cover closely follow the pattern of surface water spreading. As a result, the alleged decline in vegetation cover is mainly due to the presence or absence or quantity of surface water spreading. This second point is further discussed here.

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[35] High runoff years usually mean fuller LAA, which in turn necessitates surface water spreading off creeks. Increase surface water spreading, then, leads to increased recharge and soil moisture.

Although the overall predictive capabilities of ICWD's SMA model are unreliable, the 1986 SMA map presented in Appendix A of ICWD, 2011 and raster files provided by ICWD was re-examined by LADWP. The 1986 SMA map provides an incredibly clear picture of the processes affecting vegetation in the parcel in 1986 because it shows which parts of the parcel were wet or dry even though absolute values of SMA-estimated cover are unreliable (**Figure 19**). ICWD's DTW map in 1986 alleges that most of the parcel had a DTW of less than 5 feet (ICWD, 2011, Figure 5a); thus, the vegetation cover under the parcel should be uniformly high if ICWD's DTW map is correct. In Blackrock 94, high-cover areas form irregularly-shaped patches (indicated by orange and brown areas) instead of showing high cover uniformly throughout the parcel, while SMA cover is more uniformly high in Blackrock 99 (**Figure 19**).

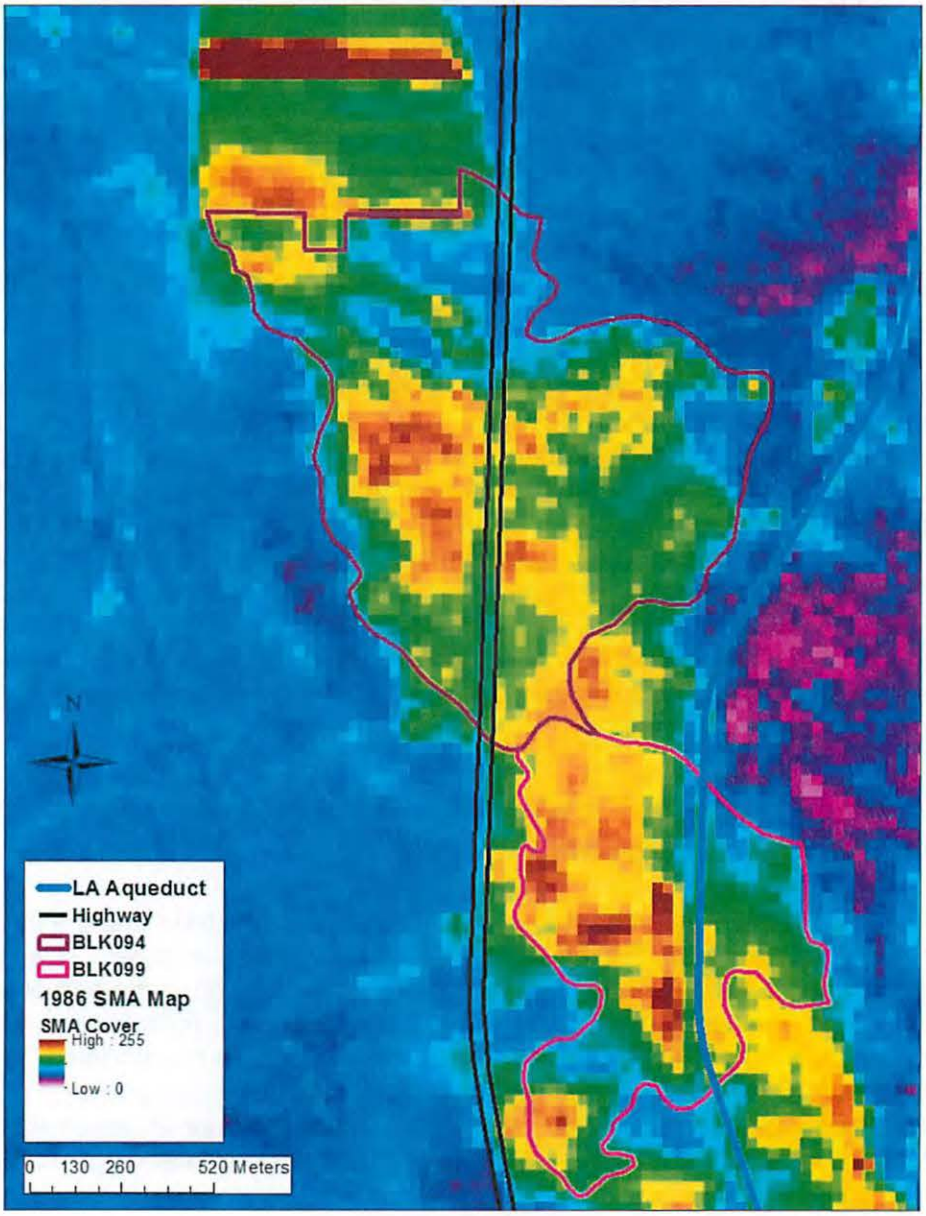


Figure 19
1986 SMA Vegetation Cover Map Based on Raw SMA Raster Files Provided by ICWD

Blackrock 94 shows a mix of patches of high-cover areas, with the most robust patch of high cover found in the mid-western portion of the parcel, not the southeastern portion of the parcel where water table is much shallower (**Figure 20**). This patch coincides with the location of the spreading diversion gate on the Sawmill conveyance pipe and near where the irrigation tailwater/stockwater ditches terminate. High-cover patches in the eastside of the parcel on the other hand, are very irregular in shape and fragmented. If water table was the primary driver of vegetation conditions, a uniformly-high grass cover should be found. Instead, the high-cover areas are narrowly shaped. These patterns of high-cover patches highly coincide with the pattern of water spreading that utilized current and old ditches (**Figure 20**).

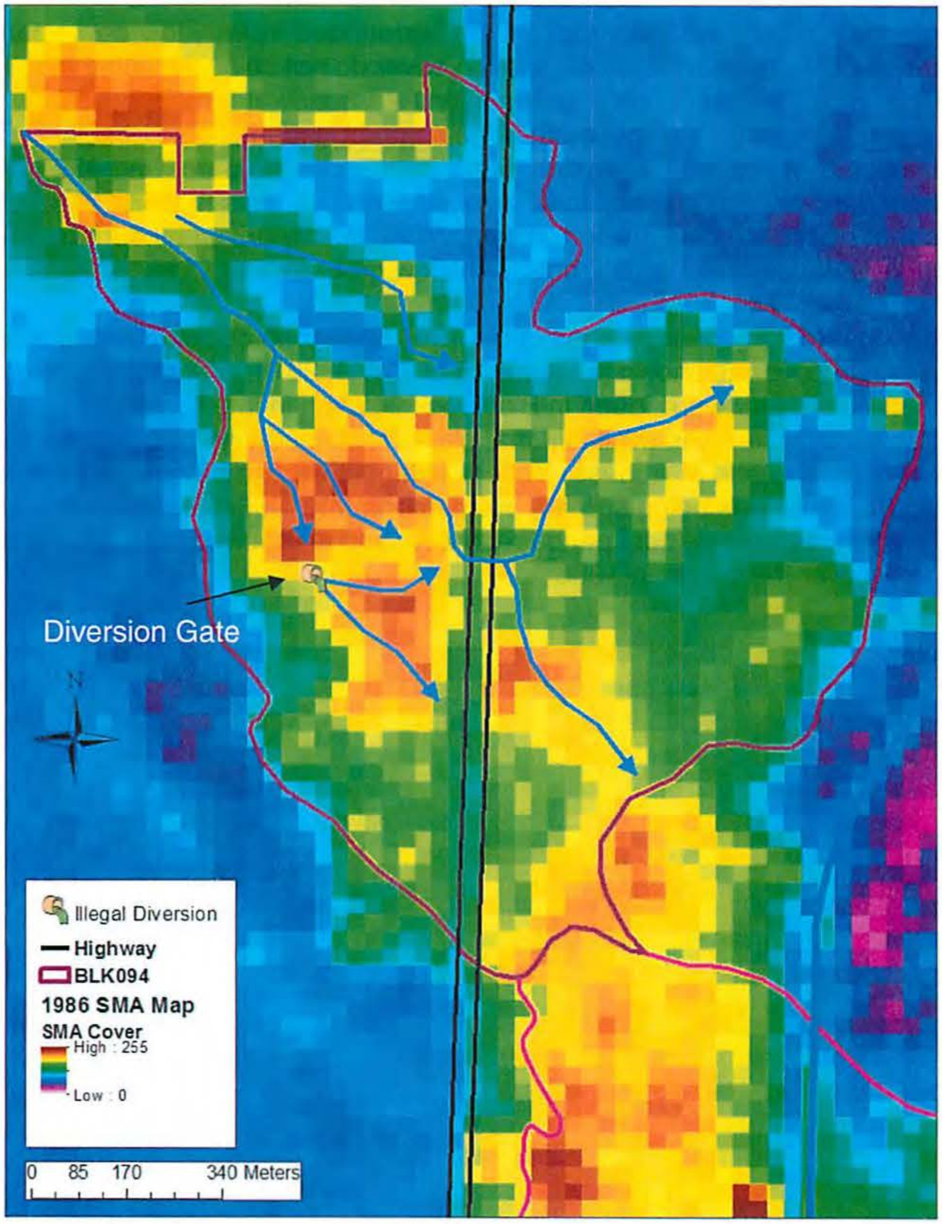


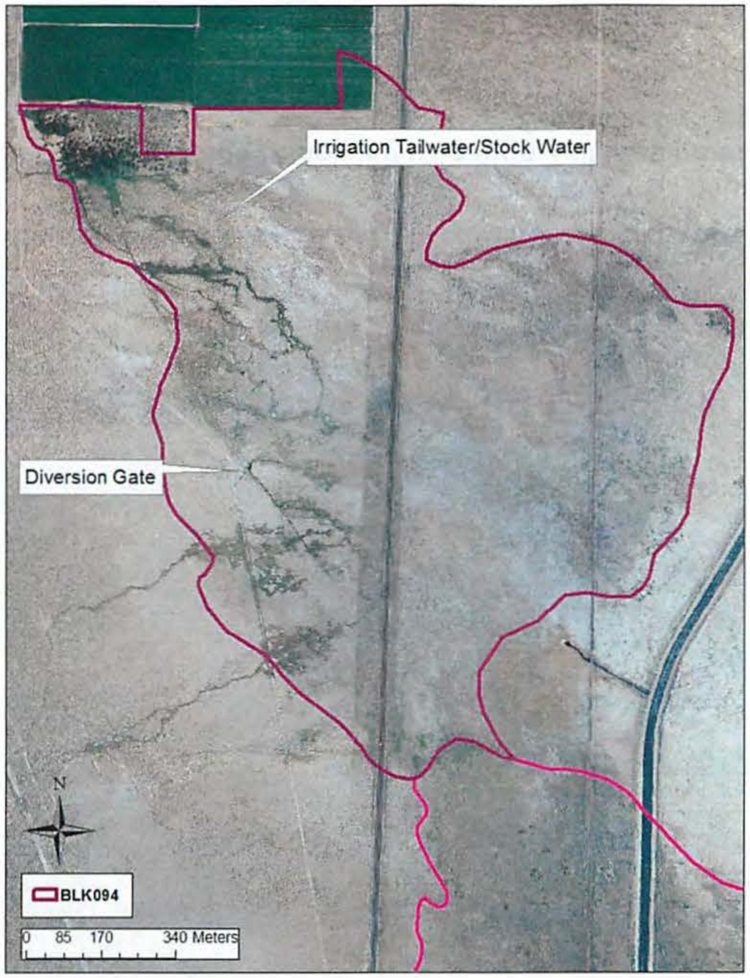
Figure 20
1986 SMA Vegetation Cover Map with Surface Water Movement over Blackrock 94

The mechanics of how water is spread over the west side of the parcel can be clearly seen in the 1993 aerial photo (**Figure 21**). The aerial photo from 1981 shows how water was spread across the highway into the eastside (**Figure 22**). The Division Creek flood, which occurred in July 2013, provided an opportunity to actually observe how surface water moves over Blackrock 94, particularly in the eastern half of the parcel (**Figure 23**). During this event, most of water was moving toward southeast and crossed the highway through the culvert into the eastside. Once water reached the eastside, the old eastside ditch acted to spread water, especially in the northeasterly direction. The spreading pattern of Division Creek flood water closely resembles the narrowly-shaped high-cover areas in the eastside of the 1986 SMA map (**Figure 23**).

Moreover, high-cover patches in Blackrock 94 are surrounded by very low-cover patches. These boundaries of sharp changes in vegetation cover do not coincide with the soil boundaries, Ecological Site boundaries, or the ICWD's groundwater map, but follow the pattern of water spreading in the parcel (**Figure 20**). The sharp boundaries also directly contradict ICWD's assumption that water table was uniformly high under the parcel in 1986. Water spreading during periods of high runoff is why vegetation cover was high in 1986. LADWP can only conclude that high SMA cover reported by ICWD is mainly driven by surface water spreading during periods of high runoff, not by shallow groundwater.

Not surprisingly, these high-cover patches in the 1986 SMA map coincide with the largest decline in vegetation cover as shown in Figure 19 of ICWD, 2014. Vegetation cover patches with greater than 70% cover were found in Blackrock 94 even in late summer. This clearly indicates that so much water was available that plants remained vigorous and were potentially still growing even into the end of August. Not coincidentally, these patches of high SMA occur in the areas where water was being spread. Remember, the 1986 baseline year was the last of nine years of the longest and wettest period recorded, and an enormous amount of water must have been spread over the parcel in 1986[36].

[36] See LADWP, 2013, Section 5.7.



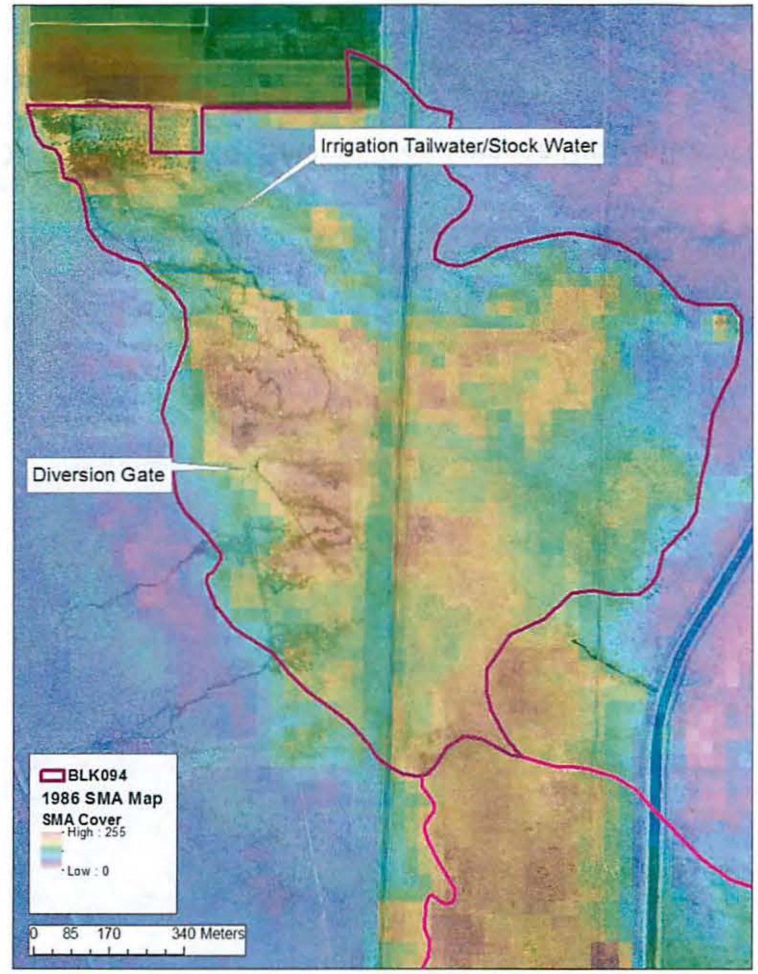


Figure 21
1993 Aerial Photography with the Diversion Gate Open

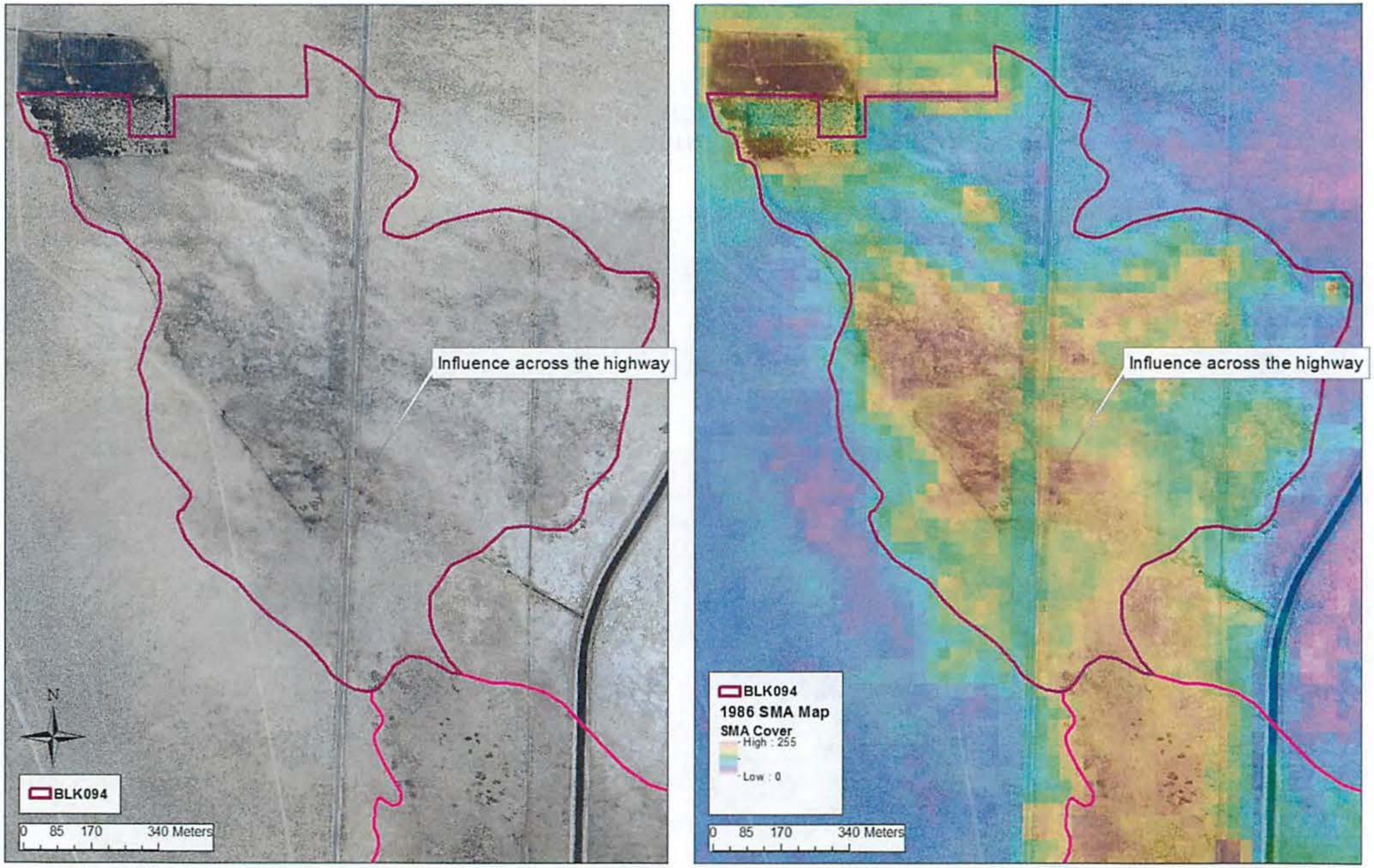
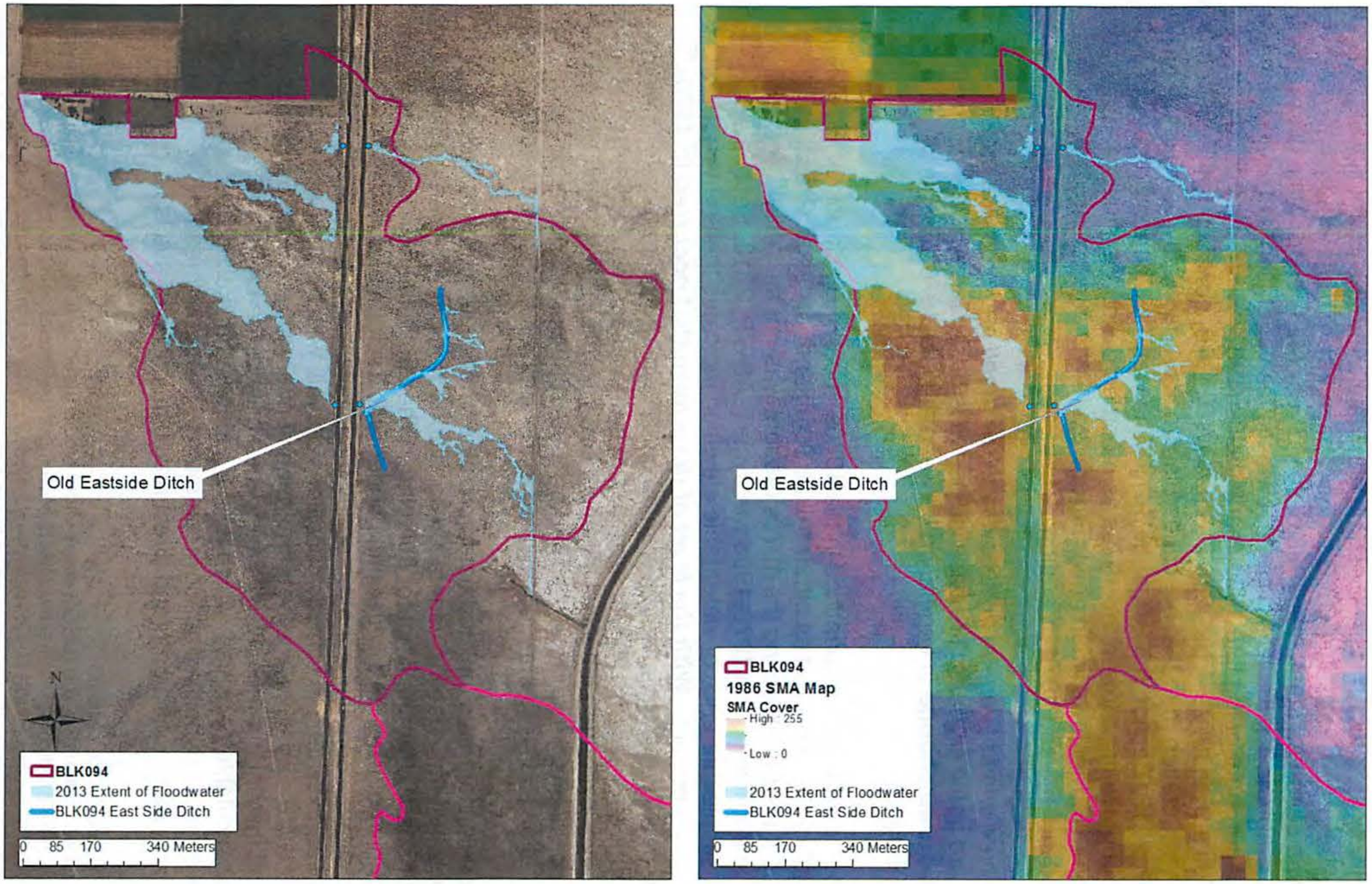


Figure 22
1981 Aerial Photography Showing Irrigation Tail Water and Diverted Water Off Sawmill Conveyance Pipe Influencing the Southeastern Portion of the Parcel



Note - See the movement of water into the eastside through a culvert and spread over the eastside.

Figure 23
Division Creek Flooding at Blackrock 94 in July 2013

5.2.4 There Is Evidence of Vegetation Recovery During Wet Cycles

ICWD argues that once decoupling between the groundwater table and the grass rooting zone occurs, the trajectory of succession is set for shrub dominance and the possibility of the system reverting to its original state is unlikely (ICWD's, 2014, page 72). This is simply not true. Very high grass cover was observed during the 1986 baseline year (42%), and again during the wet period in late 1990s (50% in 1998). ICWD somehow believes vegetation has only *"decoupled"* during the multi-year drought of the late 1980s/early 1990s (1987-1992), but not during the drought of the 1970s (1970-1977). The 1976 EIR (LADWP, 1976) contradicts that hypothesis. The EIR contains a vegetation map that describes Blackrock 94 as mostly being an alkali scrubland (LADWP, 2013, Section 5.5.2.3, page 147). The water table recorded by observation wells during this drought was as low in the 1970s as recorded during the multi-year drought of late 1980s (and about 10 feet lower than now) (**Figure 2**). ICWD attempts to discount the mapping conducted in 1973 and 1974 by stating;

> *"LADWP's prediction of vegetation recovery when runoff and precipitation conditions are again similar to the baseline period is based largely on a **general and unmeasured change** in vegetation between the late 1970's EIR and baseline.*" (Emphasis added).

Although vegetation cover was not quantified in the 1970s, most of Blackrock 94 was mapped as "Alkali Scrubland" or not classified as either "Alkali Scrubland" or "Alkali Grassland", indicating that most of the parcel during the 1970s drought was not the "Alkali Meadow" described in 1986 and following the 1978-1986 wet cycle (LADWP, 2013, Section 5.5.2.3, page 147). Moreover, a simple inference of water table elevation indicates that the vegetation classification in 1970s is correct. ***With the level of drawdown that occurred in 1970s[37], decoupling happened***. Yet, vegetation cover reached 42% in 1986 in response to nine years of above average runoff. Again in 1998, in response to four consecutive above normal runoff years, vegetation cover exceeded the initial inventory cover levels. Should the Owens Valley experience runoff conditions similar to 1978-1986 or 1995-1998 periods, a response in Blackrock 94 vegetation similar to that documented in the 1986 or 1998 inventories is expected.

Based upon its models that use simulated data from other models as input variables[38], ICWD inexplicably believes that the baseline vegetation conditions would have been maintained during dry periods and periods of drought, if not for pumping. When actual field data are examined, however, this is simply not true. The water table under Blackrock 94 was not as high as ICWD estimates, and the climatic conditions that preceded the initial inventory resulted in the high cover observed in 1986. When dry climatic conditions prevail, water is not spread in accordance with LADWP's past surface water management practices. Furthermore, during periods of low runoff throughout the Owens Valley, the ability of the LAA to receive runoff remains high (it has available capacity), which further reduces the likelihood of spreading[39]. As a result, the parcel cannot support a "meadow community" because "meadow" has been maintained by surface water spreading (and direct precipitation when available), and not

[37] See LADWP, 2013, Figure b.i.10, page 35.
[38] "Because of the way it was calibrated, the (USGS valley-wide) model (used by ICWD) is most useful for evaluating valley-wide conditions, not for predicting small-scale effects covering a few model cells, (such as Blackrock 94)" (Danskin, 1998, page 79). *"The goal (of the USGS valley-wide model)... was to maintain the "regional character of the model, focusing on larger issues..."Future analysis of these smaller-scale features or issues-such as a volcanic deposit, a facies change, or a question of local water use – might best be done by use of smaller-scale models or field studies..."* (Danskin, 1998, page 94).
[39] See LADWP, 2013, Section 5.7 regarding surface water management practices.

because of a high water table. As was demonstrated by the wet period between 1995 and 1998, when repeated years of high runoff reoccur, water is spread, soil moisture increases, and the meadow community is again supported.

ICWD's statement that:

> *"Should climatic conditions improve, the vegetation in Blackrock 94 probably will not resemble the baseline conditions because the starting point for recovery does not resemble vegetation conditions in the late 1970's."*

However, ICWD does not state what the *"starting point"* was. This completely contradicts an earlier ICWD statement that the 1976 EIR vegetation mapping is too general and no quantitative data are available and ignores the fact that the 1976 EIR classified the majority of Blackrock 94 as being "Alkali Scrubland" and most of the remainder as neither "Alkali Scrubland" nor "Alkali Grassland". There is no field data to support the supposition of the ICWD that the starting point is different than documented by the 1976 EIR. ICWD's conclusion completely ignores the 1976 EIR vegetation mapping and water table conditions in 1970s. Moreover, this statement by ICWD also ignores the changes in vegetation conditions from the period following the 1987-1992 drought (perennial cover in 1992 was 12% and grass cover was 6%) to those following the 1995-1998 wet period (perennial cover in 1998 was 50% and grass cover was 31%)[40].

5.2.5 Summary

1. ICWD's most recent attempts in ICWD, 2014 to corroborate its theory that vegetation conditions in Blackrock 94 were due to high groundwater levels in 1986 and have permanently and irreversibly changed from those described during the initial inventory fail for many reasons. In these attempts, ICWD ignored the effects of water spreading during the 1978-1986 and 1995-1998 wet periods and discarded analysis based upon actual field data in favor of simulated outputs from models that utilize the simulated outputs from other models as the basis of their conclusions.

2. ICWD, 2014, alleges that vegetation change in Blackrock 94 is due to decoupling with the groundwater table (ICWD's, 2014, page 72), basing its conclusions on small-scale simulations of Blackrock 94 using the USGS valley-wide model: "*Groundwater modeling is the most applicable tool available to determine how groundwater pumping has affected the water table"* (ICWD, 2014, page 84). However, the USGS stated that its model is not appropriate for *"predicting small-scale effects"* of the size of Blackrock 94 "*Because of the way it was calibrated, the* (USGS) *model is most useful for evaluating valleywide conditions, not for predicting small-scale effects covering a few model cells* (such as Blackrock 94). *Site-specific ground-water flow models or multivariate regression models, such as developed by P.B. Williams (1978) and Hutchison (1991), can give more accurate predictions at selected sites*" (Danskin, 1998, page 79), and "*Future analysis of these smaller-scale features or issues-such as a volcanic deposit, a facies change, or a question of local water use – might best be done by use of smaller-scale models or field studies...*" (Danskin, 1998, page 94).

3. LADWP refutes these "findings" by pointing out that the water table under Blackrock 94 was much deeper in 1986 than what ICWD estimates and the high grass cover

[40] 1986 baseline perennial cover was 41% and grass cover was 29% (LADWP, 2013, Table b.v.1, page 143)

documented in the 1986 baseline condition is not due to high water table, but due to surface water spreading during periods of high runoff[41].

4. Blackrock 94 vegetation conditions prior to 1978 were shown in the 1976 EIR to be predominantly "Alkali Scrubland" or more similar to the current vegetation conditions than those following the nine year high runoff period between 1978 and 1986. Current vegetation conditions in Blackrock 94 are a result of multi-year dry periods since 1986 and not a result of groundwater pumping.

5. The baseline vegetation conditions were the result of water spreading and more available precipitation during repeated years of high runoff between 1978 and 1986.

6. Vegetation cover in 1998 was 20% higher than 1986 cover as a result of a period of above normal runoff between 1995 and 1998.

7. Fluctuations in the vegetation conditions are largely driven by water spreading (and precipitation) that occur during high-runoff years and generally do not occur during low-runoff years (LADWP, 2013, Section 5.7).

8. Based upon the vegetation conditions documented following the high runoff periods between 1978-1986 and 1995-1998, the vegetation conditions of the parcel are expected to return to the baseline condition when similar climatic conditions reoccur[42].

5.3 Comparison with Control Parcels Removes Confounding Variables

Scientific controls are a part of the scientific method. A scientific control is designed to minimize the effects of variables other than the single independent variable. The use of a control increases the reliability of the results, often through a comparison between control measurements and the other measurements.

For instance, if one is trying to determine the effectiveness of plant fertilizer, the control group would not be provided with fertilizer. This would allow the experimenter to determine if the plants treated with the fertilizer grew better or produced more than if left untreated.

When attempting to determine if groundwater pumping is affecting vegetation in an area, a control site should be selected that is not itself affected by groundwater pumping. By selecting a control site that is not affected by groundwater pumping, the evaluator may determine the extent to which groundwater pumping is affecting the parcel being evaluated by comparing it's vegetation to the vegetation in the control site. By selecting a control site directly adjacent to the site being examined, as ICWD did with Blackrock 99, both sites are affected by the same groundwater pumping to some degree, therefore compromising the usefulness of the control site in controlling for groundwater pumping.

In the case of determining the attributability of vegetation change in Blackrock 94, Green Book Section I.C.1.b requires the Technical Group to designate a control site that would control for (or minimize) the effects of groundwater pumping or surface water spreading on the control site's

[41] Surface water management practices have not changed. LADWP's surface water management practice has been always been to spread water during high-runoff years and not to spread water during low-runoff years (LADWP, 2013, Section 5.7).

[42] Between 1995 and 1998 high-runoff conditions averaging ~140% of normal for Owens Valley resulted in vegetation cover in Blackrock 094 being 20% higher than baseline.

vegetation when attempting to determine if a measurable *"...decrease, change, or effect would not have occurred but for groundwater pumping and/or a change in past surface water management practices"* (Water Agreement Section IV.B, page 18, paragraph 4). Green Book Section I.C.1.b.ii, page 23, requires the Technical Group to conduct a *"comparison of soil water, depth to water and degree of vegetation decrease or change at the affected area and at a control site(s) determined to have similar soil type and vegetation composition and cover."*

ICWD claims that vegetation parcel Blackrock 99 is an appropriate control parcel for comparison with Blackrock 94 *"because soils, precipitation, baseline vegetation cover and composition, and initial depth to water are known to be similar"* (ICWD, 2014, page 84). Besides being mistaken regarding a number of these claims, ICWD left out the most important criteria for selecting a control parcel when attempting to control for the effects of pumping: ***the control parcel should not be affected by pumping!*** As described in Section 4.7, Blackrock 99 has one well within its boundaries and one well within 100 feet of its boundaries that have operated periodically since the 1986 baseline period, just that simple fact alone should eliminate Blackrock 99 as a control parcel. However, Blackrock 99 is also adjacent to Blackrock 94 and affected by the same pumping the ICWD claims is affecting Blackrock 94. Moreover, as summarized in Section 4.7, Blackrock 99 has a unique set of hydrologic features that Blackrock 94 does not, rendering them incomparable.

To bolster its supposition regarding Blackrock 99, ICWD presented a multitude of modeled vegetative cover data using SMA for control parcels LNP018 and UNW029, wellfield parcel Blackrock 94, and the single "control" parcel chosen by the ICWD, wellfield parcel Blackrock 99.

In this section LADWP will show that the modeled SMA vegetation data presented by the ICWD did not accurately represent actual vegetative cover measurements taken on the ground. Within this discussion it will also become apparent that the SMA model contains serious flaws that the ICWD overlooked. Lastly, LADWP will revisit control parcels PLC106, UNW029, and LNP018 that were originally presented in LADWP, 2013. During this final discussion, it will be shown that the three control parcels chosen by LADWP are appropriate choices to permit meaningful analysis and conclusions on the effect of groundwater pumping on vegetation at Blackrock 94.

5.3.1 The Use of Vegetation Parcel Blackrock 99 as a Control Parcel Is Not Appropriate

Due to confounding variables, wellfield parcel Blackrock 99 is not an appropriate control parcel for comparison with wellfield parcel Blackrock 94. In statistics there are three main variables of interest, dependent, independent, and confounding. The dependent variable is referred to as the response variable or measured variable. The independent variable is referred to as the predictor variable or manipulated variable. A confounding variable, or variables, are hidden variables that correlate with both the dependent variable and the independent variable. In simpler terms the confounding variable is an unseen or ignored variable that influences the results of the study creating a confusing or confounding effect. How does this relate to the Blackrock 94 dispute?

ICWD claimed that changes in DTW (independent variable) caused by steady-state groundwater pumping at the Blackrock Fish Hatchery were causing changes in vegetation cover (dependent variable) at Blackrock 94. After extensive analysis of all possibilities, including pumping, wet/dry cycles, and other factors, LADWP concluded that climate (drought and wet/dry cycles) of the Owens Valley were causing changes in vegetation cover (dependent variable) at

Blackrock 94. As demonstrated by LADWP, 2013, wet/dry cycles are best represented by annual runoff (independent variable). ***Both claims bear the same premise; what is the primary path for water to reach vegetation through the soil at Blackrock 94?*** The independent variables are runoff and DTW. The dependent variable is vegetation cover. In the ICWD scenario, as DTW increases (becomes deeper) vegetation cover decreases, and as DTW decreases (becomes shallower) vegetation cover increases. In the LADWP scenario, as runoff decreases (reduced soil moisture) vegetation cover decreases, and as runoff increases (increased soil moisture) vegetation cover increases. It is important to note, periods of high runoff often coincide with increased precipitation and water spreading, both of which result in increased soil moisture, rise in water table, and increased vegetation cover.

To determine which path was the driving factor in vegetation cover at Blackrock 94, both the ICWD and LADWP examined vegetation cover at other places in the Owens Valley. Choosing appropriate comparisons is the most critical step in this type of investigation. Areas to be compared to Blackrock 94 should have similar initial vegetation composition and cover, similar soils, and similar precipitation. Lastly and more importantly, areas to be compared to Blackrock 94 need to be unaffected by groundwater pumping. These areas are referred to as "control" as they control for the effects of groundwater pumping while all other variables remain the same. In the next section we will discuss the roll of confounding variables and how they affect the control parcels chosen by both the ICWD and the LADWP.

ICWD chose Blackrock 99 as their area of comparison or "control" for groundwater pumping. LADWP chose three areas of comparison, PLC106, UNW029, and LNP018. ICWD chose Blackrock 99 because it had similar in soil type, vegetation cover/composition, and precipitation (ICWD, 2014). However, this choice came at a great expense. Because Blackrock 99 is in such close proximity to Blackrock 94, it is also affected by groundwater pumping. In fact, this parcel has been classified by the ICWD as a "wellfield" parcel in their annual Owens Valley "Vegetative Conditions" reports (1991 to present). This concern is referred to as a confounding variable. How can the effects of groundwater pumping on vegetation cover in Blackrock 94 be determined by comparing vegetation change at another area affected by groundwater pumping? It is imperative that the control area be free of pumping affects so differences in vegetation cover between the two areas (Blackrock 94 vs. Control) can be attributed to pumping.

The LADWP chose PLC106, UNW029, and LNP018 for areas of comparison or "controls". These three parcels are free from the effects of groundwater pumping, and therefore are more appropriate to determine the effects of groundwater pumping on vegetation at Blackrock 94. In fact, all three parcels have been classified under methods developed by the ICWD to be control parcels and are referenced as control parcels in the ICWD's annual "Vegetative Conditions" reports from 1991 to present. Only by comparing changes in vegetation cover at Blackrock 94, where groundwater pumping occurs, with changes in vegetation at control parcels not affected by groundwater pumping, can other factors accounted for and the effects of groundwater pumping on vegetation be determined. When performing the same comparison using Blackrock 99 the effects of pumping cannot be ascertained because pumping occurs at both locations.

The control parcels chosen by LADWP are also more appropriate than Blackrock 99 to differentiate the effects of climate (wet/dry cycles) from the effects of pumping in regard to changes in vegetation cover at Blackrock 94. This is because the soils at each of the three control parcels are not irrigated like those at Blackrock 99 (see section 4.7). By comparing changes in vegetation cover at Blackrock 94 with vegetation changes at areas with similar soil moisture regimes to that of Blackrock 94, and are unaffected by groundwater pumping, the effects of pumping can be differentiated from the effects of climate. Therefore, due to the confounding effects of groundwater pumping and artificially elevated soil moisture levels caused by unlined water conveyances and irrigation practices at Blackrock 99 any conclusions derived as a result of comparisons with Blackrock 94 will be erroneous.

Blackrock 99 is ***not an appropriate control*** because:

1. It is classified as a wellfield parcel (affected by pumping)
2. It has different hydrologic conditions/buffered from effect of climate (See Section 4.7) (artificially wet soils):
    a. Lower in elevation (closer to groundwater table) and less sensitive to changes in runoff-driven recharge
    b. Receives irrigation water
    c. Receives direct infiltration from flowing well ditches and LAA

LADWP controls ***are appropriate controls*** because:

1. They are classified as control parcels (unaffected by pumping)
2. They are not buffered from effect of climate (more natural soil moisture regime)
    a. No water spreading at UNW029 and PLC106, minimal surface water is received by LNP018 from irrigated pasture to the west during high runoff years.
3. They contain similar soils[43]
4. They contain similar vegetation cover/communities[43]

5.3.2 Model Prediction SMA Vegetation Cover Is Inaccurate when Compared to Actual Measured Vegetation Cover

Throughout the ICWD, 2014 report, ICWD uses SMA of satellite imagery to predict annual vegetation cover at Blackrock 94, Blackrock 99, UNW029, and LNP018 from 1985 to 2010. On page 40, the ICWD stated that it chose to present the SMA data to fill in missing data between baseline (1986) and the onset of the line-point vegetation monitoring program that began in 1991. To recapitulate, the ICWD line-point monitoring program monitored vegetation cover throughout the Owens Valley from 1991 to present using on the ground measurements. Vegetation measurements of this kind are not modeled, estimated or even predicted, they are actually, physically measured in the field. When measuring vegetation cover in the field, the decision-making process is very straight forward; the vegetation is either present or absent, and when present, it is either alive or dead. Predicting vegetation cover using satellite imagery requires many assumptions and is fraught with technical issues that may result in large errors. Additional information pertaining to technical issues with SMA were previously described in section 5.1.

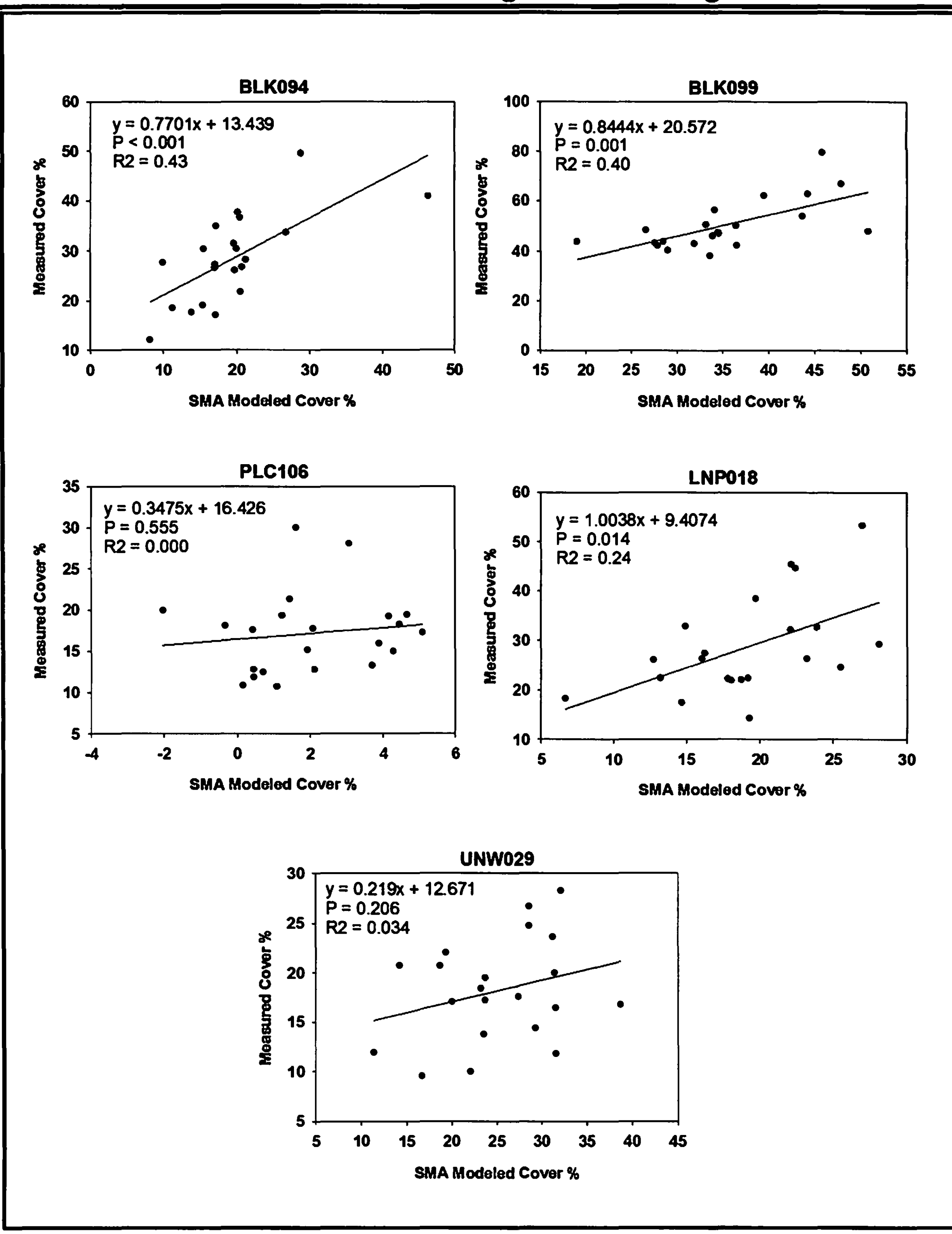
[43]Green Book section 1.C.1.b.ii ***does not require identical*** soil types or vegetation communities for comparison with the affected area but rather states, *"Comparison of... control sites determined to* ***have similar*** *soil type and vegetation composition and cover."*

In this section, vegetation cover using SMA values will be compared to actual measured vegetation cover values for Blackrock 94, Blackrock 99, UNW029, LNP018, and PLC106, which the ICWD failed to analyze. Using regression analysis it can be demonstrated that the SMA model does not predict actual cover, and when compared to actual measured cover, differences are abundant and pronounced. Lastly, after reviewing differences in cover values between SMA cover and actual measured cover at PLC106 it will become apparent that the ICWD's omission of analysis of this parcel masks the severe limitations of the SMA model.

Because the Green Book requires the use of line-point transects in suspected cases of vegetation changes due to groundwater pumping (Green Book section 1.C.1.a.ii(2)) it is not clear why the ICWD used SMA to estimate cover in their 2014 report and in previous reports. Secondly, the SMA model was designed to measure vegetation change at 33 specific permanent monitoring sites, not Blackrock 94 (section 5.1). Thirdly, even if the SMA model was improvised to measure vegetation change in Blackrock 94, the improvised model would require line-point transects to calibrate. Therefore, the additional step of calibrating the SMA model to produce estimates only introduces error to an already existing data set. This error will be shown below.

Regression analysis was used to measure the accuracy of SMA in predicting actual measured cover (**Figure 24**). To do this, SMA-estimated cover was plotted against actual measured vegetation cover for Blackrock 94, Blackrock 99, PLC106, UNW029, and LNP018 and a coefficient of determination, or R^2 value, was calculated for each assessment. The R^2 value measures the predictive accuracy of the SMA model and ranges from 0 to 1. Values closer to zero represent poor accuracy whereas values closer to 1 represent high accuracy. For this type of analysis, a R^2 value below 0.6 represents a poor association between the two variables.

The R^2 values reported in **Figure 24** ranged from 0.0 to 0.43. This means that the predictive accuracy of the SMA model ranged from 0% to 43% depending on the parcel. Of the five parcels analyzed, the SMA model was not accurate at estimating vegetation at any of the five parcels, but came the closest to estimating measured cover values for Blackrock 94 and Blackrock 99 with R^2 values of 0.43 and 0.40 respectively (57% and 60% error rates, respectively). It is important to note that the 2007 cover values were removed from the Blackrock 94 and Blackrock 99 regressions due to the Inyo Complex Fire. This was done because vegetation was measured on the ground before the fire, and the satellite imagery was taken after the fire. Even with this adjustment, SMA predictive accuracy was only 43% for Blackrock 94. The predictive accuracy for Blackrock 99 was 40%. The predictive accuracy for the other three parcels ranged between 0% and 24%. Based on regression analysis it is clear that the SMA model is not an accurate predictor of actual measured cover.

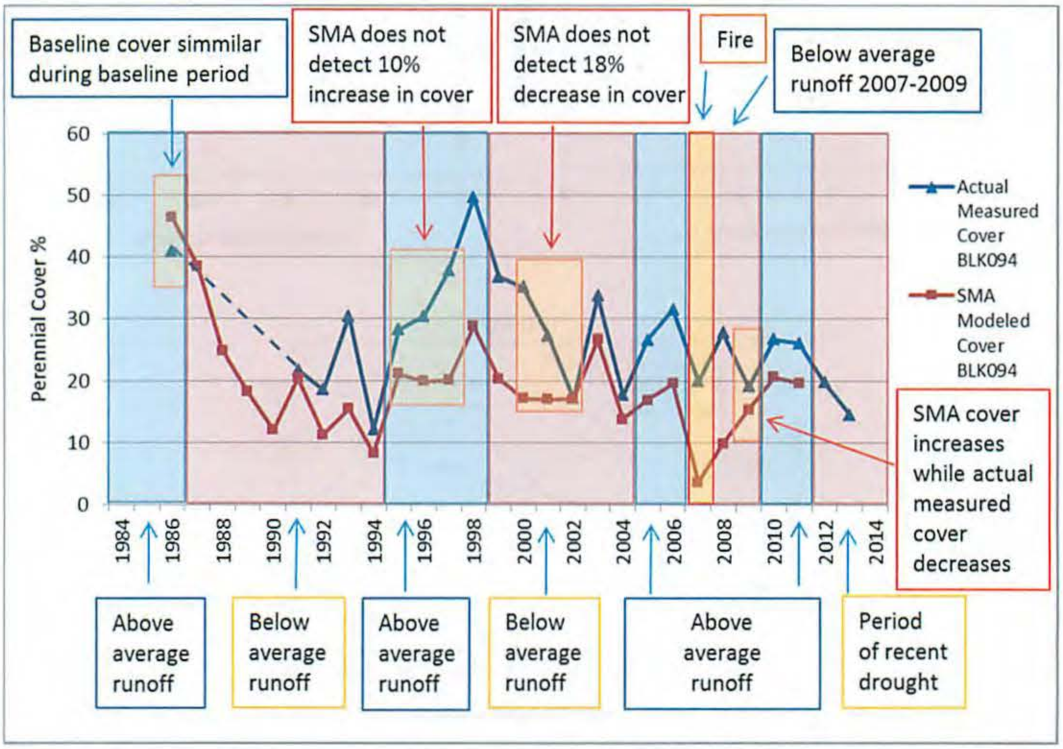


Note - Predictive accuracy of the ICWD SMA model ranged from zero percent for control site PLC106 to 43% for Blackrock 94.

Figure 24
Regression Analysis of Wellfield Parcels BLK094, and BLK099, and Control Parcels PLC106, UNW029, and LNP018

5.3.3 Blackrock 94 - ICWD's SMA Estimates Failed To Accurately Reflect Physical Line-Point Measurements

In another attempt to assess the accuracy of the modeled SMA data presented by the ICWD, SMA cover values were graphed alongside actual measured cover values. Although slightly higher, baseline SMA-estimated cover in Blackrock 94 was similar to actual measured cover (**Figure 25**). After baseline, however, SMA-estimated cover was consistently lower than actual measured cover. From 1995 to1997 actual measured cover increased from 28% to 38%, whereas SMA estimated cover decreased from 21% to 20%. From 2000 to 2001, actual measured cover decreased from 35% to 17% whereas SMA-estimated cover remained at 17%. In 1998, the SMA model underestimated actual field measurements of cover by 21%. From 2008 to 2009, actual measured cover decreased from 28% to 19%, whereas SMA estimated cover increased from 10% to 15%. Lastly, on average, both SMA-estimated cover and actual measured cover increased during periods of above average runoff and decreased during periods of below average runoff. However, the SMA model failed to track the trend of vegetation change during the 2007-2009 period of below average runoff. In 2008 and 2009, SMA-estimated cover increased whereas actual vegetation cover measured in the field, as expected, followed the climate pattern and decreased (**Figure 25**).

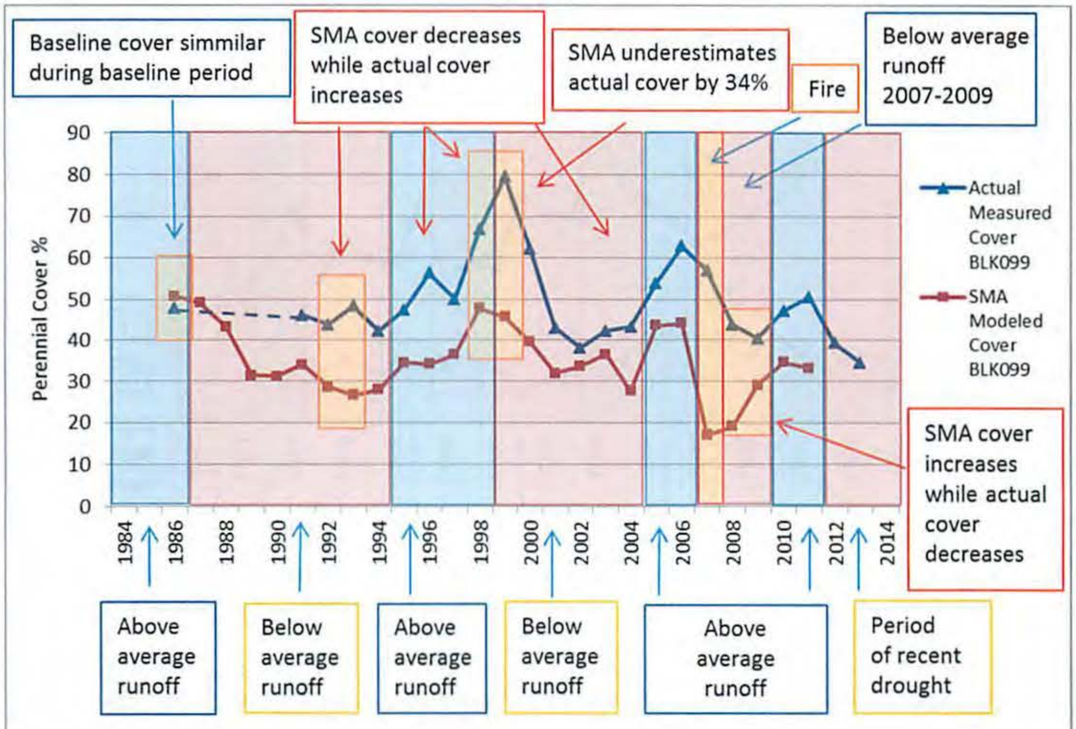


Note - Red blocks represent periods of below average runoff whereas blue blocks represent periods of above average runoff. Dashed blue line represents years where actual measured data was not available. Yellow rectangles were used to call out areas of special interest.

Figure 25
Modeled SMA Vegetation Cover vs. Actual Measured Vegetation Cover for Wellfield Parcel Blackrock 94

5.3.4 Blackrock 99 - ICWD's SMA Results Consistently Underestimated Actual Measured Cover

Although slightly higher, baseline SMA-estimated cover in Blackrock 99 was similar to actual measured cover (**Figure 26**). After baseline, however, SMA-estimated cover was consistently lower than actual measured cover. From 1992 to 1993, actual measured cover increased from 44% to 48% whereas SMA-estimated cover decreased from 29% to 27%. From 1995 to 1996, actual measured cover increased from 48% to 56%, whereas SMA-estimated cover decreased from 35% to 34%. From 1998 to 1999, actual measured cover increased from 67% to 80%, whereas SMA-estimated cover decreased from 48% to 46%. In 1999, the SMA model underestimated actual cover by 34%. From 2008 to 2009, actual measured cover decreased from 44% to 40%, whereas SMA-estimated cover increased from 19% to 29%. Lastly, on average, both SMA-estimated cover and actual measured cover increased during periods of above average runoff and decreased during periods of below average runoff. However, the SMA model failed to track the trend of vegetation change that occurred during the 2007-2009 period of below average runoff. In 2008 and 2009, SMA-estimated cover increased whereas actual vegetation cover measured in the field, as expected, followed the climate pattern and decreased (**Figure 26**).

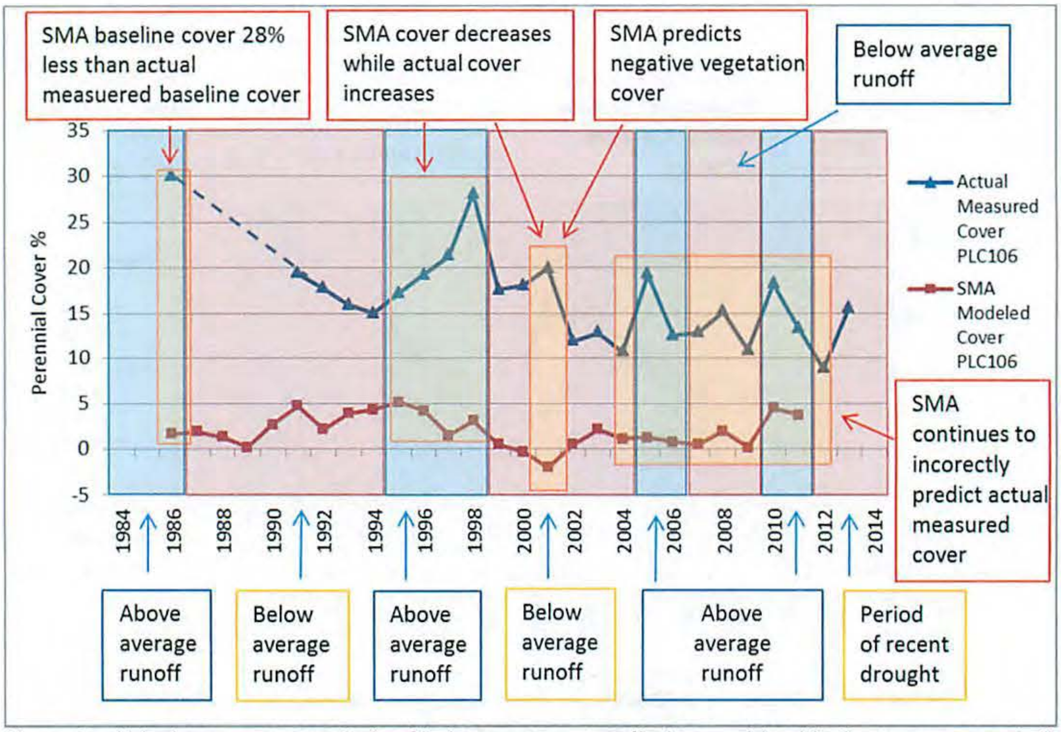


Note - Red blocks represent periods of below average runoff whereas blue blocks represent periods of above average runoff. Dashed blue line represents years where actual measured data was not available. Yellow rectangles were used to call out areas of special interest.

Figure 26
Modeled SMA Vegetation Cover vs. Actual Measured Vegetation Cover for Wellfield Parcel Blackrock 99

5.3.5 PLC106 - ICWD's SMA Model Produced Vegetation Cover Values Less than Zero Percent

The SMA model underestimated actual measured baseline cover by 28% (**Figure 27**). After baseline, SMA-estimated cover remained near zero or was negative, whereas actual measured cover ranged anywhere from 8% to 28% depending on year. From 1995, actual measured cover increased from 17% to 28%, whereas SMA-estimated cover decreased from 5% to 3%. In 1998, the SMA model underestimated actual measured cover by 25%. From 1999 to 2001, actual measured cover increased from 18% to 20%, whereas SMA-estimated cover decreased from 0% to -2%. From 2004 to 2011, the SMA model continued to incorrectly predict actual measured cover. During this time period, actual measured cover averaged 14%, whereas SMA-estimated cover averaged 2%. Lastly, on average, actual measured cover increased during periods of above average runoff and decreased during periods of below average runoff, whereas SMA-estimated cover decreased during periods of above average runoff and increased during periods of below average runoff.

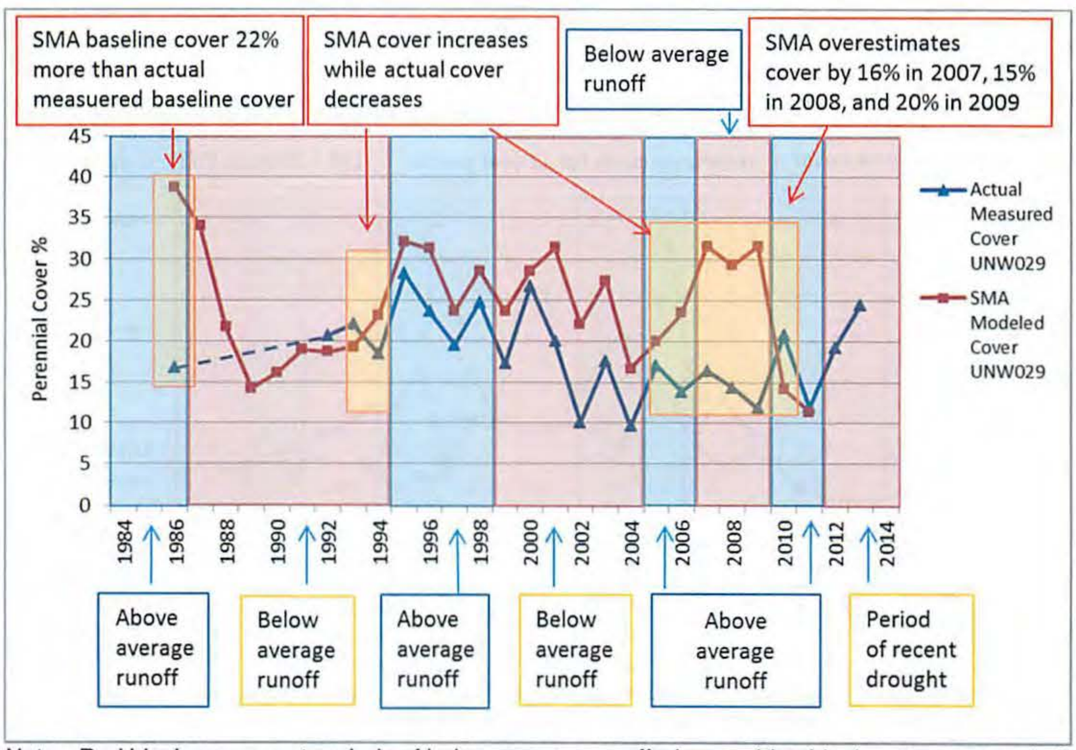


Note - Red blocks represent periods of below average runoff whereas blue blocks represent periods of above average runoff. Dashed blue line represents years where actual measured data was not available. Yellow rectangles were used to call out areas of special interest.

Figure 27
Modeled SMA Vegetation Cover vs. Actual Measured Vegetation Cover for Control Parcel PLC106

5.3.6 UNW029 - ICWD's SMA Results Consistently Overestimated Actual Measured Cover

The SMA model overestimated actual measured baseline cover by 22% (**Figure 28**). After baseline, SMA-estimated cover was consistently higher than actual measured cover, with the exception of the years 1993 and 2010. From 1993 to 1994, actual measured cover decreased from 22% to 18%, whereas SMA-estimated cover increased from 19% to 23%. From 2005 to 2009, actual measured cover decreased from 17% to 12%, whereas SMA-estimated cover increased from 20% to 32%. In 2007, 2008, and 2009, the SMA model overestimated cover by 16%, 15%, and 20%, respectively. From 2009 to 2010, actual measured cover increased from 12% to 21%, whereas SMA-estimated cover decreased from 32% to 14%. Lastly, on average, both SMA-estimated cover and actual measured cover increased during periods of above average runoff and decreased during periods of below average runoff. One exception, however, occurred during the transition from the 2007-2009 period of below average runoff to the 2010-2011 period of above average runoff. During this transition period and through 2011 SMA-estimated cover decreased from 32% to 11%, whereas actual measured cover more closely followed the climate pattern.

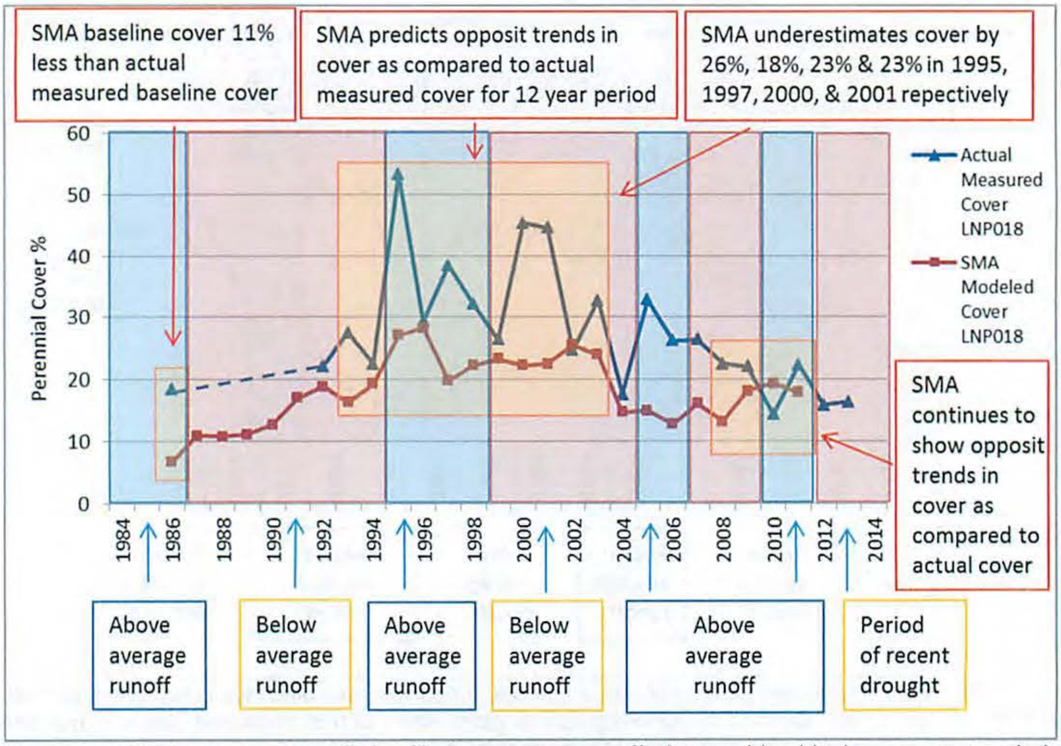


Note - Red blocks represent periods of below average runoff whereas blue blocks represent periods of above average runoff. Dashed blue line represents years where actual measured data was not available. Yellow rectangles were used to call out areas of special interest.

Figure 28
Modeled SMA Vegetation Cover vs. Actual Measured Vegetation Cover for Control Parcel UNW029

5.3.7 LNP018 - ICWD's SMA Model Predicted Opposite Trends In Vegetation Cover as Compared to Actual Measured Cover

The SMA model underestimated actual measured baseline cover by 11% (**Figure 29**). After baseline, SMA-estimated cover was consistently lower than actual measured cover with the exception of 2010. From 1992 to 2003, the SMA model predicted opposite trends in vegetation cover as compared to actual measured cover. This means that when actual measured cover increased SMA predicted a decrease in cover or when actual measured cover decreased SMA predicted an increase in cover. This occurred during the following periods: 1992-1993, 1993-1994, 1995-1996, 1996-1997, 1997-1998, 1998-1999, 1999-2000, 2000-2001, 2001-2002, 2002-2003, 2008-2009, 2009-2010, and 2010-2011. Of all the years where the SMA model underestimated actual measured cover 1995, 1997, 2000, 2001, and 2005 contained the greatest error with respective differences of 26%, 18%, 23%, 23%, and 18%. Lastly, on average, actual measured cover increased during periods of above average runoff and decreased during periods of below average runoff. During the below average runoff period between 1987 and 1994, actual measured cover seemed to increase; however, due to the lack of available data during this period any inference in trend would be a guess at best. However, during the same below average runoff period (1987-1994), SMA-estimated cover increased from 7% to 19%. SMA cover increased again during the 2007-2009 below average runoff period from 16% to 18%.



Note - Red blocks represent periods of below average runoff whereas blue blocks represent periods of above average runoff. Dashed blue line represents years where actual measured data was not available. Yellow rectangles were used to call out areas of special interest.

Figure 29
Modeled SMA Vegetation Cover vs. Actual Measured Vegetation Cover for Control Parcel LNP018

5.3.8 Modeled SMA Vegetation Cover vs. Actual Measured Vegetation Cover Summary

In summary, the SMA model utilized by ICWD did not accurately predict actual vegetative cover and produced errors in excess of 42% when compared to real world data obtained by physical line-point field measurements[44]. This is seen in both the regression analysis (**Figure 16**) and the direct comparisons provided previously. In every comparison, the SMA model either substantially over or underestimated actual measured vegetation cover. The SMA model also incorrectly predicted magnitude and direction of change when compared to actual measured cover. In some years, cover values differed wildly between SMA-estimated cover and actual measured cover. In other years, SMA cover estimates would decrease during wet periods and increase during dry periods, which is in stark contrast to the actual measured field cover data and is contradictive to the basic plant/water relationship. Lastly, ICWD stated (2014, page 66) that it omitted control parcel PLC106 from their SMA evaluation *"Because of the suspect origin of baseline for Poleta Canyon 106, and significant differences in community composition and soil properties compared to Blackrock 94...."* (ICWD, 2014, page 66). However, on page 40 (ICWD, 2014) ICWD stated *"Using SMA also addresses the problematic comparison between baseline data in which the transect locations are unknown..."* If SMA addresses the issues associated with baseline data, then why would *"the suspect origin for baseline for Poleta Canyon 106"* be a problem? Next, PLC106 has been shown in LADWP's, 2013 to be an adequate control parcel for comparison with Blackrock 94. In light of the discrepancies in the ICWD argument and the nonsensical SMA model data provided in **Figure 27**, it becomes clear that the ICWD did not omit PLC106 from its evaluation due to the *"suspect nature of baseline data"* and *"differences in community composition and soil properties"*, but rather ICWD omitted PLC106 from its evaluation because the SMA model, it relied so heavily on for its ICWD, 2014 response, produced such nonsensical cover values for PLC106 that its evaluation of other parcels would become more suspect.

5.3.9 The Control Parcels Selected by LADWP Meet the Prescribed Requirements

Vegetation parcel Blackrock 94 is one of 198 parcels monitored by either the ICWD or the LADWP since 1991. Vegetation monitoring is performed using the same methods across all 198 parcels. These parcels are located at various locations throughout the Owens Valley from Bishop to Lone Pine. Of the 198 parcels, 113 parcels are classified as wellfield parcels, the same designation as Blackrock 94. The remaining 85 parcels are classified as control, which are unaffected by groundwater pumping. Because Blackrock 94 was classified as Type C during the baseline inventory, the choice of any parcel other than a Type C control parcel would be inappropriate. Since 1991, only 42 Type C control parcels have been monitored by either the ICWD or LADWP. This pool of potential parcels is further narrowed to 27 parcels by removing those dominated by Nevada saltbush and those located on river floodplains, both of which are characteristics not comparable to Blackrock 94. Of the remaining 27 parcels, only four contained complete data sets from 1992 to present, and of those only two were monitored in 1991.

In summary, the four remaining parcels contained the following characteristics: control classification, Type C classification, are not dominated by saltbush, are not located on a river

[44] Section 1.C.1.a.ii(2) of the Green Book requires line-point transects in cases of suspected vegetation changes due to groundwater pumping. The ICWD's SMA model is not an approved method.

floodplain, and contain a complete data set. These four potential control parcels are IND163, LNP018, PLC106, and UNW029. Of these four control sites, IND163 was most dissimilar in initial vegetation cover. Total perennial cover, shrub cover, and grass cover for this parcel in 1986 was 10%, 3%, and 7% respectively. Initial total perennial cover, shrub cover, and grass cover at Blackrock 94 was 40%, 10%, and 30% respectively.

In the LADWP, 2013 report, LADWP followed a similar path to arrive at the decision to use the same three control parcels, further strengthening the argument that of the available data PLC106, UNW029, and LNP018 are the most similar control parcels to Blackrock 94. ICWD, 2014, page 56) incorrectly stated that "*...LADWP did not adequately control for initial vegetative conditions, soil characteristics, water table, and vegetative cover over time to permit meaningful conclusions on the effect of DTW on vegetation at Blackrock 94"*. Again, within this statement the information actually being conveyed is *"... meaningful conclusions on the effect of* ***groundwater pumping*** *on vegetation at Blackrock 94"*. LADWP agrees that initial vegetative conditions, precipitation, soil characteristics, and vegetation cover over time are important characteristics and made its selection of control sites based upon these characteristics. ICWD overlooked the most glaring aspect in determining meaningful conclusions on the effect of groundwater pumping on vegetation at Blackrock 94, which is ***controlling for the effects of groundwater pumping***. This premise is the fundamental basis on which all credible research is built, controlling for confounding variables.

All three parcels selected by the LADWP ***control*** for the effects of groundwater pumping, and therefore meet the basic requirements of a control parcel. Second to this most basic requirement, is the need for the selected control parcels to be comparable to Blackrock 94 in regard to initial vegetative conditions, precipitation, and soil characteristics. LADWP's selected control sites: LNP018, PLC106, and UNW029 not only control for the effects of groundwater pumping, but also have similar initial vegetative conditions, soil characteristics, and precipitation conditions. The ICWD selection of Blackrock 99 meets the secondary requirements of vegetation, soil type, and precipitation, but fails to meet the primary requirement of a control site; control for the effects of groundwater pumping. Blackrock 99 is not only affected by groundwater pumping, but is also influenced by confounding factors such as irrigation and infiltration from unlined conveyances that increase soil moisture and mask other factors affecting vegetation change (such as wet/dry climactic cycles).

5.3.10 Comparison with Control Parcels Summary

Due to the confounding effects of groundwater pumping and the unnatural elevated soil moisture conditions caused by irrigation practices and infiltration from the Los Angeles Aqueduct and associated ditches at wellfield parcel Blackrock 99, it was determined that the ICWD should have chosen a more appropriate parcel to control for the effect of groundwater pumping in comparison with Blackrock 94. However, this was not the case.

In order to fill in missing data years between 1986 and 1991 and to deal with *the "...problematic comparison between baseline data in which the transect locations are unknown..."* ICWD chose to use modeled vegetative cover data using SMA of satellite imagery. Regression analysis and direct side-by-side comparison with actual measured vegetation cover revealed serious flaws with the SMA model. The predictive accuracy of ICWD's SMA model ranged from 0% to 43% and modeled SMA cover was found to differ wildly from actual field measurements of vegetation cover (ICWD line-point data) in the majority of year to year comparisons. SMA modeled estimates of cover were also found to increase when actual field measurements of cover decreased and decrease when actual cover increased. When viewed in comparison to wet and dry cycle's, actual measured cover reacted as expected increasing during above average runoff periods and decreasing during below average runoff periods. The SMA model, however, consistently produced cover values that were in stark contrast to the same climatic patterns with cover often decreasing during above average runoff periods and increasing during periods of below average runoff periods. Clearly, the SMA-estimated cover data is in error. Lastly, due to the nonsensical SMA model data provided in **Figure 27** it is clear that ICWD did not omit PLC106 from their evaluation due to the *"suspect nature of baseline data" and "differences in community composition and soil properties"* as stated, but rather because the SMA model produced such nonsensical cover values for PLC106 that the ICWD SMA evaluation of other parcels would become glaringly suspect.

It has been clearly demonstrated that the control parcels chosen by LADWP not only controlled for the effects of groundwater pumping, but also were more comparable to Blackrock 94 than any other of the 198 parcels monitored throughout the Owens Valley since 1991. Unfortunately, ICWD chose to compare a wellfield parcel to another irrigated wellfield parcel that is affected by groundwater pumping to determine the effects of groundwater pumping on vegetation. On page 20 of the Green Book it is clearly states, "*Comparison of vegetation cover and composition at the affected area with vegetation data from **one or more control sites** located in areas which have similar vegetation, soil, and precipitation conditions"* is to be made when making a determination of significant impacts. It is unclear why the ICWD chose wellfield parcel Blackrock 99 for comparison with wellfield parcel Blackrock 94. In accordance with the Green Book, LADWP chose three control parcels of similar vegetation, and precipitation for comparison with Blackrock 94[45]. Furthermore, LADWP chose the three control parcels based on methods developed by ICWD to classify parcels as either "wellfield" or "control". Lastly, just to be thorough, LADWP referenced Annual Vegetative Condition Reports produced by the ICWD from 1991 to present to ensure that the parcels were also classified and referenced as "control" by ICWD. In conclusion, it is clear that LADWP exhausted all resources in selecting adequate control parcels that not only control for groundwater pumping, but also adequately control for initial vegetative conditions, soil characteristics, water table, and vegetative cover over time to permit meaningful conclusions on the effect of groundwater pumping on vegetation at Blackrock 94.

[45] A complete summary of the methodology used by LADWP in its selection of control sites is included in Sections 5.2.5.4 – 5.2.5.7, page 89-96 of LADWP, 2013.

6 SOIL MOISTURE: SURFACE WATER SPREADING, RUNOFF-DRIVEN RECHARGE, AND PRECIPITATION GOVERN SOIL-WATER CONTENT IN BLACKROCK 94

ICWD (2014) incorrectly claims LADWP's (2013) soil water analysis is inaccurate and incomplete. In particular, ICWD claims that groundwater pumping is the primary factor for the reduction of soil moisture and the subsequent decline in vegetation cover at Blackrock 94. Analysis of the data, however, show that surface water spreading, runoff-driven recharge, and precipitation are the primary factors governing soil moisture at Blackrock 94. Annual changes in vegetation cover at the parcel are clearly explained by the variations in soil moisture levels that are directly associated with surface-water spreading practices, groundwater recharge patterns and rainfall. The ICWD, 2014 did not adequately consider these variables and their relation to vegetation cover. By solely subscribing that groundwater pumping is the primary reason for the decline in vegetation considerably oversimplifies the issue at Blackrock 94.

Following six years of drought accompanied by three years of elevated groundwater pumping in the late-1980's, vegetation cover declined in both monitoring sites TS1 and TS2. ICWD, ignoring the effects of reduced runoff, water spreading, and precipitation during the 1987-1992 drought[46], states that elevated pumping resulted in the loss of groundwater in the rooting zone and therefore a loss in soil moisture, particularly below 2 meters. However, soil moisture profiles demonstrate that near or completely saturated conditions have occurred since 1992, but both the spatial extent and frequency varies between and within years. For instance, in June of 1996, TS1 supported saturated soils below 2 meters; however, this same observation did not hold for TS2 (**Figure 30 a & b**). A similar trend, although more variable, occurred in June 1998 across both TS1 and TS2 (**Figure 30 c & d**). Below 2 meters at TS1, only one soil moisture measuring tube supported high soil-water content, while two other tubes were nearly dry; while at TS2, tubes 1 and 2 were near saturation and tube 3 was essentially dry. Additionally, both sites demonstrate elevated moisture levels near the surface. Soil moisture is highly variable both across the sites and throughout time.

[46] The ICWD agrees that it is the "*runoff...surface water spreading, and precipitation variables which actually drive water availability and vegetation cover*" (ICWD, 2014, page 43, paragraph 2).

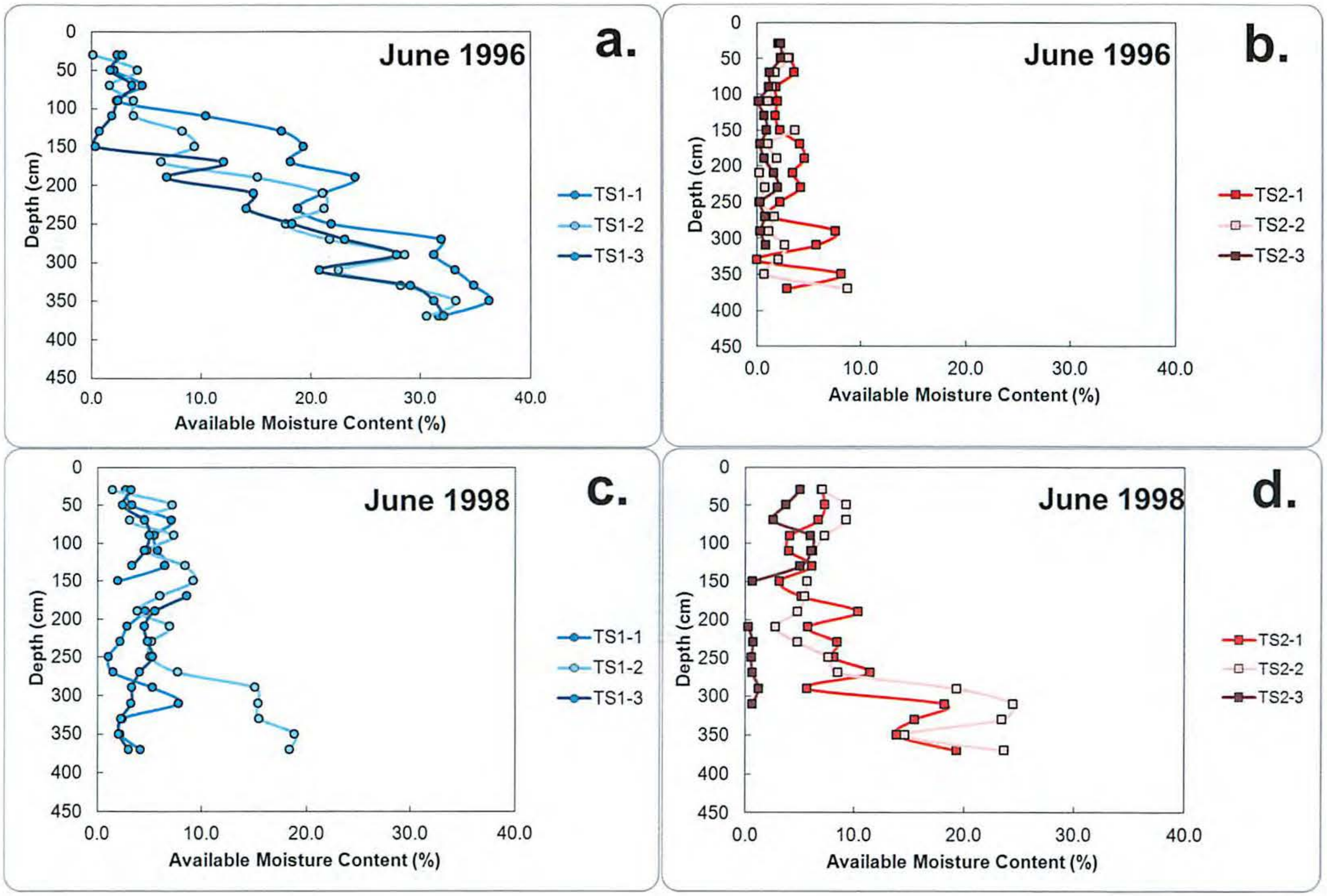


Figure 30
Soil Moisture Content for Sites TS1 and TS2

If, as ICWD maintains, local groundwater is the primary driver of soil-water content, one would expect to see similar trends at both TS1 and TS2. This is not the case. Instead, the variability in soil moisture within and between TS1 and TS2 is because of surface water spreading and precipitation. In 1996, runoff from Sawmill Canyon was 140% of normal and was 171% in 1998. Spreading that occurred because the high runoff for these years was responsible for locally recharging soil moisture. The elevated soil moisture conditions that resulted from water spread resulted in vegetation cover nearly doubling at TS1 in 1996 and at TS2 in 1998 (**Figure 31 a & b**). In fact, vegetation cover at TS1 moves in tandem with runoff – during high runoff years cover increases and during periods of drought or low runoff cover declines. TS2 does not show as strong of response to runoff simply because it is a greater distance from where spreading occurs, thus only in exceptional wet years does it receive surface water. Lastly, the increase in soil moisture near the surface in 1998 is directly related to precipitation. Precipitation for 1998 was nearly 10 inches, (which is twice the long-term average) with the majority of this falling before the June soil-moisture sampling.

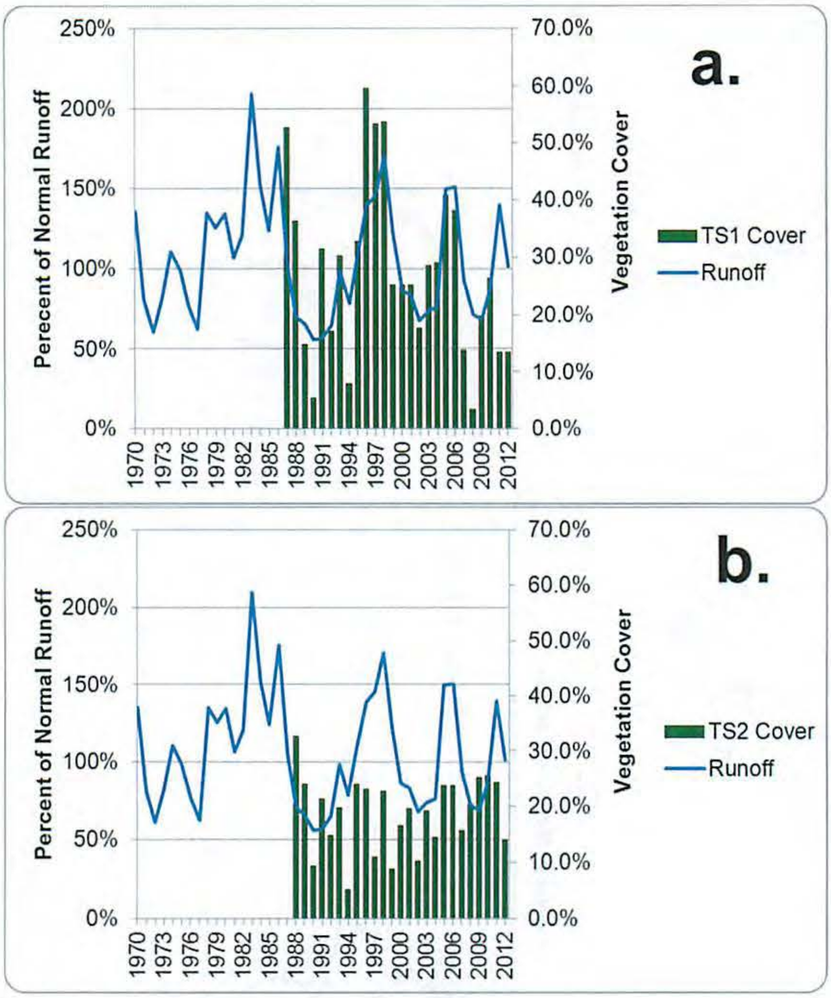


Figure 31
Total Vegetation Cover for Sites TS1 and TS2 and Runoff from Sawmill Creek as a Percentage of Normal

ICWD incorrectly states that the reason both TS1 and TS2 readily respond to surface water spreading is because of the absence of a stable groundwater levels. ICWD inappropriately offers TS3 as a site that is buffered from these cyclic wet/dry periods because of a high and stable water table and thus allege it represents what both soil-moisture levels and vegetation conditions would be at TS1 and TS2 had groundwater pumping not occurred. The problems with this comparison are that the TS3 area is irrigated by Black Canyon Creek (see Section 4.7) and shallow groundwater levels in the vicinity of TS3 are held high because of constant discharge from well F104 (**Figure 9**), which draw from a separate and deeper aquifer into an unlined ditch that allows water to infiltrate in the vicinity of the monitoring site. Additional details on the hydrologic differences between Blackrock 94 and Blackrock 99 are provided in Section 4.7. These artificially static conditions fail to account for the variability in recharge associated with naturally occurring wet/dry periods and therefore it is not an appropriate comparison site.

Unlike ICWD's 2014 analysis, which contends that local groundwater levels are the primary mechanism that drive soil moisture, LADWP counters that surface water spreading, runoff-driven recharge, and precipitation exerts a stronger influence on soil-water content (LADWP, 2013). In years of high runoff, water is spread unevenly across Blackrock 94 leading to variations in local soil moisture levels. Additional change is related to fluctuations in annual precipitation. The annual variation in both runoff and precipitation, combined with spatial variability related to spreading, provides a clear and straightforward explanation for the trends in vegetation cover at Blackrock 94. Lastly, the conditions at the TS3 site, which ICWD offers as what the soil moisture and vegetation cover would be at TS1 andTS2 had groundwater pumping never occurred, is erroneous as it fails to account for the natural variability in groundwater and soil moisture replenishment stemming from wet and dry periods.

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Annual Black Canyon Creek Flow Available for Irrigation on Blackrock 99

Runoff Year	Long-Term Average Danskin Calculated Flow[1] (AF)	Correction Factor[2]	Estimated Base-of-Mountain Flow[3] (AF)	Estimated Loss to Infiltration[4] (AF)	Estimated Flow Available for Irrigation[5] (AF)
1985-86	2,834	0.79	2,239	1,890	349
1986-87	2,834	1.22	3,448	1,890	1,559
1987-88	2,834	0.49	1,399	1,399	0
1988-89	2,834	0.45	1,270	1,270	0
1989-90	2,834	0.45	1,276	1,276	0
1990-91	2,834	0.36	1,016	1,016	0
1991-92	2,834	0.45	1,265	1,265	0
1992-93	2,834	0.47	1,323	1,323	0
1993-94	2,834	0.74	2,088	1,890	198
1994-95	2,834	0.44	1,256	1,256	0
1995-96	2,834	0.93	2,644	1,890	754
1996-97	2,834	0.95	2,689	1,890	800
1997-98	2,834	0.86	2,451	1,890	561
1998-99	2,834	1.07	3,036	1,890	1,146
1999-00	2,834	0.60	1,704	1,704	0
2000-01	2,834	0.54	1,541	1,541	0
2001-02	2,834	0.55	1,561	1,561	0
2002-03	2,834	0.46	1,294	1,294	0
2003-04	2,834	0.56	1,578	1,578	0
2004-05	2,834	0.57	1,605	1,605	0
2005-06	2,834	1.04	2,938	1,890	1,048
2006-07	2,834	0.98	2,789	1,890	899
2007-08	2,834	0.38	1,085	1,085	0
2008-09	2,834	0.46	1,291	1,291	0
2009-10	2,834	0.48	1,357	1,357	0
2010-11	2,834	0.63	1,777	1,777	0
2011-12	2,834	0.95	2,702	1,890	813
2012-13	2,834	0.37	1,051	1,051	0

[1] A uniform grid (500 by 500 meters) was applied to Sawmill, Taboose, Goodale, and Black Canyon Creek drainage areas. Using a digital elevation model, elevations were extracted at each grid cell center and used in the equation from Danskin (1998) to calculate long-term average annual precipitation. The precipitation values at each cell center were multiplied by their respective cell area and aggregated to estimate annual volume of water generated in each drainage area. The resulting values in this column represent the estimated long-term average annual volume of water generated in Black Canyon Creek.
[2] The correction factor is the average ratio between the measured and estimated annual flows at Taboose, Goodale, and Sawmill Creek base of mountain gages for each year.
[3] Estimated Black Canyon Creek base-of-mountain flow is calculated by multiplying the long-term average Danskin calculated flow by the correction factor for that year.
[4] Estimated loss to infiltration is the water lost to infiltration from Black Canyon Creek base of mountain to Highway 395 for a specific year. This is calculated by assuming a constant 15 cubic feet per day per foot of channel length, at a channel length of approximately15,030 feet. This value is the base-of-mountain flow if the base-of-mountain flow is less than 1,890 acre-feet.
[5] Estimated flow available for irrigation is the difference between the estimated base-of-mountain flow and the estimated loss to infiltration.

Black Canyon Creek 2005 Flow Spot Estimate At Hwy 395

DATE	TIME	READ	REMARKS
3/14/2005	10:00	0.25X	Read at Highway by BEB
3/16/2005	13:30	0.25X	Read at Highway by BEB
3/17/2005	14:02	0.20X	Read at Highway by BEB
3/21/2005	12:10	0.20X	Read at Highway by MLC
3/23/2005	12:08	0.50X	Read at Highway by MLC
3/28/2005	12:45	0.30X	Read at Highway by MLC
3/29/2005	7:00	0.25X	Read at Highway by BEB
4/1/2005	7:00	0.25X	Read at Highway by BEB
4/4/2005	7:00	0.30X	Read at Highway by BEB
4/6/2005	7:00	0.30X	Read at Highway by BEB
4/11/2005	15:47	0.25X	Read at Highway by BEB
4/13/2004	16:58	0.30X	Read at Highway by BEB
4/15/2005	9:45	0.25X	Read at Highway by BEB
4/18/2005	7:00	0.25X	Read at Highway by BEB
4/20/2005	7:00	0.30X	Read at Highway by BEB
4/25/2005	7:00	0.25X	Read at Highway by BEB
4/27/2005	7:00	0.50X	Read at Highway by BEB
4/29/2005	7:00	0.50X	Read at Highway by BEB
5/2/2005	7:00	0.50X	Read at Highway by BEB
5/4/2005	14:35	1.00X	Read at Highway by BEB
5/9/2005	7:30	1.00X	Read at Highway by MLC
5/10/2005	16:50	1.00X	Read at Highway by MLC
5/11/2005	15:45	1.25X	Read at Highway by MLC
5/16/2005	7:00	1.25X	Read at Highway by BEB
5/18/2005	7:00	1.50X	Read at Highway by BEB
5/19/2005	15:50	1.50X	Read at Highway by MLC
5/23/2005	7:00	1.25X	Read at Highway by BEB
5/25/2005	7:00	1.25X	Read at Highway by BEB
5/26/2005	7:00	1.25X	Read at Highway by BEB
5/30/2005	6:00	2.00X	Read at Highway by BEB
5/31/2005	15:15	2.25X	Read at Highway by MLC
6/2/2005	17:40	2.00X	Read at Highway by REM
6/3/2005	8:35	2.25X	Read at Highway by MLC
6/8/2005	17:56	1.75X	Read at Highway by BEB
6/13/2005	13:50	2.25X	Read at Highway by BEB
6/14/2005	14:03	2.50X	Read at Highway by BEB
6/21/2005	9:40	2.50X	Read at Highway by BEB
6/22/2005	12:40	2.50X	Read at Highway by MLC
6/23/2005	11:20	2.75X	Read at Highway by BEB
6/24/2005	12:00	2.50X	Read at Highway by MLC
6/27/2005	12:35	2.50X	Read at Highway by MLC
6/29/2005	12:35	3.00X	Read at Highway by MLC
7/5/2005	7:00	2.75X	Read at Highway by BEB
7/6/2005	15:45	3.00X	Read at Highway by MLC
7/7/2005	15:30	3.00X	Read at Highway by MLC
7/11/2005	7:00	3.00X	Read at Highway by BEB
7/21/2005	7:16	3.25X	Read at Highway by BEB
7/22/2005	14:01	2.50X	Read at Highway by BEB
7/25/2005	7:00	2.75X	Read at Highway by BEB
7/26/2005	9:15	2.25X	Read at Highway by BEB
7/28/2005	12:40	2.25X	Read at Highway by MLC

Black Canyon Creek 2005 Flow Spot Estimate At Hwy 395

DATE	TIME	READ	REMARKS
8/1/2005	6:48	1.50X	Read at Highway by BEB
8/5/2005	11:09	2.00X	Read at Highway by BEB
8/8/2005	11:40	1.25X	Read at Highway by MLC
8/10/2005	11:54	1.00X	Read at Highway by MLC
8/15/2005	12:25	1.00X	Read at Highway by MLC ; est for rain effect
8/16/2005	12:25	2.00X	Read at Highway by MLC
8/19/2005	18:30	1.25X	Read at Highway by MLC
8/23/2005	14:20	1.00X	Read at Highway by MLC
8/24/2005	12:55	0.80X	Read at Highway by MLC
8/29/2005	15:51	0.50X	Read at Highway by MLC
9/6/2005	16:16	0.50X	Read at Highway by REM
9/8/2005	16:52	0.40X	Read at Highway by REM
9/12/2005	7:32	0.40X	Read at Highway by REM
9/13/2005	14:20	0.30X	Read at Highway by MLC
9/14/2005	6:30	0.25X	Read at Highway by BEB
9/15/2005	12:40	0.20X	Read at Highway by MLC
9/26/2005	11:57	0.25X	Read at Highway by MLC
9/28/2005	12:52	0.20X	Read at Highway by MLC
9/30/2005	12:35	0.15X	Read at Highway by MLC
10/4/2005	6:46	0.10X	Read at Highway by BEB
10/11/2005	12:53	0.10X	Read at Highway by BEB
10/13/2005	6:45	0.10X	Read at Highway by BEB
10/18/2005	12:20	0.10X	Read at Highway by MLC
10/26/2005	6:55	0.10X	Read at Highway by BEB
10/27/2005	12:50	0.10X	Read at Highway by BEB
11/3/2005	15:41	0.15X	Read at Highway by MLC
12/5/2005	14:16	0.25X	Read at Highway by MLC
12/6/2005	13:40	0.25X	Read at Highway by MLC
12/23/2005	7:30	0	Read at Highway by MLC

Black Canyon Creek 2006 Flow Spot Estimate At Hwy 395

DATE	TIME	READ	REMARKS
5/1/2006	11:00	0.30X	Found Flowing REM
5/2/2006	9:30	0.70X	REM
5/3/2006	14:18	0.50X	MLC
5/4/2006	8:45	0.30X	REM
5/8/2006	14:38	0.70X	MLC
5/9/2006	15:34	0.90X	MLC
5/10/2006	15:07	1.20X	MLC
5/14/2006	11:52	1.30X	MLC
5/15/2006	10:57	1.50X	MLC
5/16/2006	11:57	1.50X	MLC
5/17/2006	12:43	1.50X	MLC
5/22/2006	11:43	1.50X	MLC
5/23/2006	11:33	1.50X	REM
5/24/2006	12:54	1.75X	MLC
5/25/2006	13:18	2.00X	MLC
5/26/2006	12:29	2.00x	MLC
5/30/2006	16:38	2.00X	MLC
5/31/2006	14:45	1.80X	REM
6/1/2006	15:05	1.30X	MLC
6/6/2006	15:48	1.80X	MLC
6/7/2006	12:12	2.00X	MLC
6/8/2006	12:48	2.00X	MLC
6/9/2006	13:33	2.00X	MLC
6/12/2006	17:45	2.00X	MLC
6/14/2006	16:10	1.80X	DLB
6/15/2006	14:00	1.80X	REM
6/16/2006	11:00	1.75X	DLB
6/19/2006	11:10	1.75X	DLB
6/20/2006	16:45	1.75X	DLB
6/21/2006	16:57	1.80X	MLC
6/22/2006	16:48	1.80X	MLC
6/23/2006	12:36	1.50X	MLC
6/26/2006	11:46	2.00X	MLC
6/27/2006	13:40	1.80X	MLC
6/28/2006	12:58	2.00X	MLC
6/29/2006	15:58	2.00X	MLC
6/30/2006	12:47	2.00X	REM
7/3/2006	10:54	2.00X	MLC
7/5/2006	10:10	1.80X	MLC
7/6/2006	13:48	1.80X	MLC
7/7/2006	9:48	1.80X	MLC
7/10/2006	14:32	1.70X	MLC
7/11/2006	14:40	1.30X	MLC
7/13/2006	11:04	1.20X	MLC
7/14/2006	10:21	1.20X	MLC

Black Canyon Creek 2006 Flow Spot Estimate At Hwy 395

DATE	TIME	READ	REMARKS
7/18/2006	15:25	1.30X	MLC
7/20/2006	9:15	1.25x	MLC
7/21/2006	10:40	1.30X	MLC
7/22/2006	11:10	1.20X	MLC
7/24/2006	11:20	1.20X	BEB
7/25/2006	11:10	1.00X	MLC
7/26/2006	13:40	0.80X	MLC
7/27/2006	13:33	0.80X	MLC
7/28/2006	12:00	0.80X	MLC
7/29/2006	7:54	0.80X	MLC
7/31/2006	13:05	0.60X	MLC
8/1/2006	12:40	0.50X	MLC
8/2/2006	8:30	0.60X	MLC
8/3/2006	7:55	0.60X	MLC
8/4/2006	11:24	0.60X	MLC
8/5/2006	12:46	0.60X	MLC
8/6/2006	10:19	0.50X	MLC
8/7/2006	9:59	0.40X	REM
8/8/2006	11:49	0.20X	MLC
8/9/2006	12:20	0.20X	MLC
8/14/2006	12:17	0.10X	MLC
8/16/2006	13:05	0	MLC, TRACE
8/17/2006	12:40	0	MLC, TRACE
8/23/2006	9:44	0	MLC, TRACE ; discontinued reads, signed off for season

Black Canyon Creek 2008 Flow Spot Estimate At Hwy 395

DATE	TIME	READ	REMARKS
4/26/2008	8:00	No Flow	MLC - Found NO Flowing
4/27/2008	9:00	0.10X	MLC - Found Flowing
5/8/2008	10:56	0.15X	REM
5/9/2008	12:05	0.25X	REM
5/12/2008	9:30	0.35X	REM
5/13/2008	8:00	0.50X	REM
5/15/2008	14:20	0.20X	REM
5/19/2008	7:43	0.30X	DJT
5/20/2008	8:39	0.50X	REM
5/21/2008	9:33	1.0X	REM
5/22/2008	9:13	0.50X	REM
5/23/2008	10:16	0.50X	DJT
5/28/2008	13:30	0.20X	MLC
5/29/2008	8:30	0.10X	DJT
6/2/2008	7:20	0.15X	REM
6/3/2008	11:15	0.20X	REM
6/4/2008	7:20	0.25X	MLC
6/5/2008	7:43	0.10X	DJT
6/9/2008	13:00	0.10X	DJT
6/10/2008	6:05	0.15X	MLC
6/11/2008	11:33	0.25X	REM
6/12/2008	5:48	0.20X	MLC
6/16/2008	8:25	0.20X	REM
6/17/2008	9:00	0.15X	REM
6/17/2008	12:56	0.10X	DJT
6/18/2008	5:38	0.20X	MLC
6/18/2008	14:05	0.10X	DJT
6/20/2008	12:10	0.10X	REM
6/23/2008	12:35	0.15X	MLC
6/30/2008	16:38	0	MLC - No Flow
7/1/2008	14:08	0	MLC - No Flow
7/3/2008	12:17	0	REM- Not Flowing
7/9/2008	13:33	0	MLC- No Flow

Black Canyon Creek 2011 Flow Spot Estimate at Hwy 395

Date	Time	Flow	BY	Remark
3/31/2011	12:00 PM	0.00	DLB	No Flow
4/4/2011	9:04 AM	0.3X	MLC	
4/5/2011	5:33 PM	0.5X	BRP	
4/7/2011	9:05 AM	0.5X	MLC	
4/12/2011	1:23 PM	0.5X	MLC	
4/13/2011	11:25 AM	0.5X	BRP	
4/14/2011	7:16 AM	0.3X	BRP	Ice/ Partially Frozen
4/15/2011	8:20 AM	0.5X	BRP	
4/18/2011	7:08 AM	0.7X	BRP	
4/19/2011	12:50 PM	0.8X	BRP	
4/20/2011	1:25 PM	0.7X	BRP	
4/21/2011	12:20 PM	0.7X	BRP	
4/25/2011	1:47 PM	0.7X	MLC	
4/27/2011	1:38 PM	0.8X	MLC	
5/2/2011	2:30 PM	1.0X	MLC	
5/9/2011	7:18 AM	0.9X	BRP	
5/10/2011	1:05 PM	1.0X	BRP	
5/11/2011	7:18 AM	0.9X	BRP	
5/12/2011	8:00 AM	1.0X	MLC	
5/16/2011	8:09 AM	1.0x	BRP	
5/18/2011	2:52 PM	.25X	BRP	Spreading Diversion Work
5/23/2011	7:28 AM	.25X	BRP	Spreading Diversion Work
5/24/2011	7:05 AM	.25X	BRP	Spreading Diversion Work
5/31/2011	10:15 AM	.50X	BRP	Spreading Diversion work completed
6/1/2011	9:30 AM	1.2X	MLC	
6/6/2011	6:50 AM	0.5X	BRP	
6/8/2011	6:51 AM	1.0X	BRP	
6/9/2011	11:45 AM	1.5X	MLC	
6/13/2001	9:45 AM	1.5X	RGO	
6/15/2011	9:45 AM	1.75X	BRP	
6/16/2011	7:15 AM	2.0X	BRP	
6/20/2011	7:20 AM	1.75X	RGO	
6/21/2011	3:45 PM	2.75X	MLC	
6/22/2011	7:30 AM	3.0X	BRP	
6/23/2011	9:45 AM	3.0X	BRP	
6/24/2011	8:15 AM	3.0X	BRP	
6/24/2011	1:00 PM	0.00	RLB	creek flow diverted out spreading diversion
6/29/2011	7:45 AM	0.00	MLC	creek flow diverted out spreading diversion
7/5/2011	4:00 PM	0.00	MLC	creek flow diverted out spreading diversion
7/18/2011	8:00 AM	0.00	BRP	creek flow diverted out spreading diversion
7/19/2011	12:30 PM	1.00X	BRP	creek flow put back into bed at 08:00

Black Canyon Creek 2011 Flow Spot Estimate at Hwy 395

Date	Time	Flow	BY	Remark
7/21/2011	7:20	2.50X	RGO	
7/25/2011	2:05 PM	2.00X	BRP	
7/26/2011	8:15 AM	2.00X	BRP	
7/27/2011	7:45 AM	2.00X	BRP	
8/1/2011	9:57 AM	2.00X	MLC	
8/2/2011	7:15 AM	2.00X	RGO	
8/4/2011	2:45 PM	1.75X	BRP	
8/8/2011	11:00 AM	1.25X	BRP	
8/10/2011	1:00 PM	1.00X	BRP	
8/15/2011	11:00 AM	1.00X	BRP	
8/17/2011	12:48 PM	0.75X	BRP	
8/23/2011	3:01 PM	0.50X	BRP	
8/29/2011	2:30 PM	0.30X	MLC	
9/6/2011	9:30 AM	0.05X	MRH	
9/12/2011	7:02	0.1X	DJT	
9/13/2011	7:30 AM	0.00	BRP	No Flow/ Dry
10/5/2011	6:00	0.00	MLC	Start Rain Event
10/5/2011	10:58	2.00X	MLC	
10/11/2011	8:17	0.00	MLC	No Flow/Dry

Appendix B – Flowing Well F103 & F104 Discharge into Blackrock 99

Runoff Year	F103 Discharge (AF)	F104 Discharge (AF)	Total Discharge (AF)
1986-87	259	222	481
1987-88	22	23	45
1988-89	43	46	89
1989-90	0	0	0
1990-91	1	1	2
1991-92	0	0	0
1992-93	0	0	0
1993-94	0	0	0
1994-95	0	0	0
1995-96	0	0	0
1996-97	42	7	49
1997-98	38	27	65
1998-99	36	36	72
1999-00	40	40	80
2000-01	114	110	224
2001-02	68	75	143
2002-03	39	47	86
2003-04	36	39	75
2004-05	46	76	122
2005-06	60	84	144
2006-07	86	72	158
2007-08	97	106	203
2008-09	73	106	179
2009-10	77	86	163
2010-11	84	72	156
2011-12	72	72	144
2012-13	82	79	161