Chapter 2 Alternatives

Chapter 2 Alternatives

Introduction

Reclamation is directed in PL 109-103, Title II, Section 208(a) and PL 111-85 to provide funding to the University or NFWF for the Acquisition Program and associated research. As noted in Chapter 1, NFWF and the University have entered into an Assignment and Delegation Agreement (Appendix 1A). Under this agreement the University assigned to NFWF all of the University's rights, interests, and obligations for the Acquisition Program. This includes all the option and purchase agreements previously entered into by the University.

Under NFWF's direction, the Acquisition Program would provide water to Walker Lake by acquiring water and water rights (and related interests) from willing sellers in the Walker River Basin in Nevada. Alternatives that meet the Purpose and Need identified for the Acquisition Program are discussed in this chapter and are collectively referred to as the acquisition alternatives. Funding for acquisitions is assumed to be the same for each acquisition alternative; however, the alternatives differ in the method by which water and water rights (and related interests) would be acquired. Acquisition alternatives were developed with input from public comment, tribal consultation, and Cooperating Agencies. A No Action Alternative is also identified.

No Action Alternative

Under the No Action Alternative, no land, water appurtenant to the land, or related interests would be acquired. Surface water diversions, groundwater withdrawals, and overall water use would remain the same in the future as under current conditions, and NFWF would not use funds provided by Reclamation for an Acquisition Program to increase inflow of water to Walker Lake.

Acquisition Alternatives

Objective of All Acquisition Alternatives

The objective of all acquisition alternatives is to acquire sufficient water and water rights from willing sellers to increase average inflow to Walker Lake by 50,000 af/yr. This objective was selected based on several prior studies, which indicated that additional inflow of approximately this amount (over and above period-of-record inflows) would lead to significant reductions in Walker Lake TDS concentration. Please see Chapter 3, Water Resources, for additional information.

Assumptions Applicable to All Acquisition Alternatives

Acquisitions would be negotiated by NFWF based on offers from willing sellers. The location of specific acquisitions cannot be determined in advance. Although 10 water and water rights option and purchase agreements (options) were entered into by the University between 2007 and 2009 (see below), there is no assurance that any single agreement (or all agreements) will be exercised, either in whole or in part. In order to analyze potential impacts of the Acquisition Program, Reclamation developed the assumptions described below.

Geographic Distribution of Acquisitions

Most of the willing sellers who entered into options or expressed interest to the University through the end of 2009 were located in Mason Valley and, to a lesser extent, in the East Walker area and Smith Valley. Expressions of interest have come from agricultural and geothermal water users and a developer. Based on interest expressed to date, this analysis assumes that non-agricultural acquisitions would be minimal, although the option(s) involving geothermal groundwater represent a potentially sizeable amount of non-agricultural water.

The existing distribution of irrigated lands and the information noted above were used to determine an expected distribution by geographic area of water and water rights to be acquired. Using satellite imagery collected periodically between 1986 and 2002 (Yardas 2007, Appendix A), DRI estimated the acreage of irrigated lands in the East Walker, Smith Valley, and Mason Valley subareas of the Walker River Basin in Nevada. Average irrigated acreage totals and their percentage distribution by geographic subarea are shown in Table 2-1. Land, water appurtenant to land, and related interests in California would not be acquired because the enabling legislation for the Acquisition Program analyzed in this Revised DEIS only authorizes acquisitions of water rights appurtenant to land in Nevada. As noted in Chapter 1, under separate authority in PL 111-85, WRID will develop and administer a demonstration water leasing program that may or may not include leases of water derived from water rights appurtenant to lands in the California portions of the Walker River Basin. That demonstration program, while similar in many respects to Alternative 2, is not formally analyzed in this Revised DEIS.

Table 2-1. Distribution of Irrigated Lands and Water-Righted Acres

	Mason Valley	Smith Valley	East Walker	Total
Irrigated Acres	34,972	17,452	4,015	56,439
Percent	62%	31%	7%	100%
Decree Acres	33,174	8,905	3,722	45,801
Percent	72%	19%	8%	100%
New Land Acres	17,525	11,886	5,090	34,500
Percent	51%	34%	15%	100%

Note: Irrigated acreages represent 6-year averages for the years 1986, 1992, 1995, 1998, 2000, and 2002. (Yardas 2007, Appendix A). Decree and new land acreages are based on Myers 2001.

Using these data, and considering the location of lands with appurtenant surface water rights that have been the subject of discussions with and offers by potential willing sellers to date, the following approximate ranges of anticipated water acquisitions by subarea are assumed:

- Mason Valley: 60 to 85%
- Smith Valley: 10 to 30%
- East Walker: 5 to 10%

These percentages represent the approximate portions of the 50,000 af/yr average additional Walker Lake inflow that could be expected to be obtained from the respective geographic subareas. Although it is theoretically possible that acquisitions could be made in areas of the Walker River Basin in Nevada that lie outside of Mason Valley, Smith Valley, and the East Walker areas (such as underground water in basins near Walker Lake, and water from the Mt. Grant watershed), this is not currently expected and is not analyzed in this Revised DEIS.

Measurement and Monitoring

Under all acquisition alternatives, it is assumed that institutional arrangements would be put in place, in coordination with the federal water master, WRID, the Nevada State Engineer (NSE), and other jurisdictional entities, to measure and monitor increased flows derived from acquired water and water rights, as well as surface water diversions and groundwater withdrawals associated with acquisition transactions and agreements. Costs associated with implementing such arrangements would be covered as necessary by existing and/or future Acquisition Program funding.

Program Administration

As noted in Chapter 1, NFWF will administer the Acquisition Program going forward. Many other potential entities could also be involved in implementation efforts, such as NFWF grantees, agency partners, a local nonprofit established to hold and exercise acquired water rights, University/DRI for research and monitoring, and entities like WRID for the demonstration leasing program under future amended authorities. Administration of the Acquisition Program will involve all aspects of program implementation, including but not limited to negotiating and exercising acquisition agreements, seeking all necessary water rights change approvals and agreements, and making decisions about the utilization of acquired water rights. All water rights acquired by NFWF will be managed and administered for the benefit of Walker Lake.

Acquisition Considerations

NFWF will strive to maximize expected program benefits and minimize anticipated program costs by considering the following and other factors in the pursuit of offers from willing sellers, particularly if such offers exceed available funding:

- type, seniority, and constraints of the water rights involved in the acquisition;
- proximity of point of diversion to Walker Lake;

- amount of water offered;
- costs and potential difficulties involved in acquiring and making use of the land, water appurtenant to the land, and related interests;
- potential benefits to environmental restoration in the Walker River Basin;
- potential for conflict with other owners or users of property and water rights;
- potential for conversion from agricultural to urban land uses within 1 year of acquisition of appurtenant water rights , including lands previously converted from agricultural to urban uses; and
- other potential risks or liabilities associated with the offer.

Change in Point of Diversion, Place, or Purpose of Use

The process to formally change the point of diversion, place, or purpose of use of acquired water rights would depend on the type of water or water rights involved. For example, changes for decreed natural flow diversion rights would require approvals from the NSE and the U.S. District Court of Nevada, which has continuing jurisdiction under the Walker River Decree (Decree C-125). Changes for storage water would require WRID, NSE, and federal court approvals as well as California State Water Resources Control Board (SWRCB) approvals. Changes for state-permitted groundwater would require NSE approval. Changes for state-permitted water that is surface water would require NSE approval and WRID concurrence.

Once a change has been approved, the federal water master, the NSE, and/or WRID would be responsible for administering those rights. The water master has day-to-day responsibilities for apportioning and distributing natural flow and storage waters in coordination with WRID, ditch companies, and other water right holders; and the NSE has jurisdiction over the use of state-issued ground water rights.

Coordination or agreements with Bureau of Indian Affairs (BIA) and WRPT would also be needed to ensure that water acquired and administered upstream of the Walker River Indian Reservation (presumptively at the Wabuska gage) would benefit Walker Lake. NFWF would work with the water master, WRPT, and BIA to ensure that the water is delivered to Walker Lake. Additional information on this topic is discussed under Reservoir Operations below.

Reservoir Operations

Under all acquisition alternatives, Bridgeport Reservoir and Topaz Lake Reservoir operations are not projected to change significantly because acquired storage water rights would still be expected to be exercised during the irrigation season in accordance with past patterns of use. Operating criteria for these reservoirs are not anticipated to be changed by the Acquisition Program, and the reservoirs are expected to continue to be operated in accordance with the WRID Operations Manual, California water rights licenses (as amended for the new proposed place and purpose of use), and Decree C-125.

At some later date, it may be determined that changes in the timing of reservoir releases could be beneficial for the river ecosystem and/or for efficient passage of acquired water to Walker Lake. It this occurs, additional environmental analysis, permitting, and documentation would be necessary, most likely under or in conjunction with the California Environmental Quality Act (CEQA).

Effective implementation of the Acquisition Program would require development of an operating agreement for Weber Reservoir and related facilities to manage both acquired and other water (including water associated with WRPT's decreed water rights and any excess flows) from the expected point of delivery at the Wabuska gage to the lower Walker River and Walker Lake. The agreement would provide assurance that water rights associated with the Walker River Indian Irrigation Project are not impaired, proper water accounting, and protection of the safety of the downstream community.

It is anticipated that such an agreement would address a number of factors, including but not limited to the amount and timing of deliveries of acquired water to the Wabuska gage; reservoir operations criteria; physical losses between the Wabuska gage and Weber Reservoir; physical losses in Weber Reservoir as well as diversions into and releases from storage; physical losses and diversions between Weber Reservoir and Walker Lake; physical and safety constraints of hydraulic infrastructure and the downstream river channel; dam safety and flood control operating criteria; storage targets for irrigation season; and coordination, communication, and governance among affected parties for water measurement, delivery, storage, and release (Strekal pers. comm.).

Pending Litigation

Pending litigation in the U.S. District Court for the District of Nevada by the WRPT, United States, and Mineral County involving Decree C-125 will likely affect issues and impacts related to the Acquisition Program. However, attempting to predict the outcome of the litigation and any environmental impacts that may result is purely speculative and would not be meaningful. Timing of resolution of litigation is also unknown. Therefore no analysis related to the litigation outcome possibilities is included in the Revised DEIS.

Alternative 1 (Purchase Alternative)

Alternative 1 (Purchase Alternative) would fund NFWF to provide water to Walker Lake by acquiring land, water appurtenant to land, and related interests from willing sellers in the Walker River Basin in Nevada.

Potential Types of Acquisitions

Based on inquiries and offers made to date, expected acquisitions from willing sellers can be grouped into the following general categories: whole farms or ranches, provisional water cards, stand-alone water rights, and other types of offers.

Whole Farms or Ranches

These acquisitions would involve the sale of an entire farm or ranch; i.e., offers that include land, water appurtenant to the land, and related interests (including improvements).

Provisional Water Cards

Provisional water cards for individual water users are maintained by WRID for assessment purposes. Typically, provisional water cards describe the different types, amounts, and priority dates of the surface water rights associated with particular parcels of land, including decreed natural flow direct diversion rights and apportioned storage water rights. Provisional water cards also identify the major ditches through which surface waters are diverted to serve the associated water rights, as well as legal descriptions, claim numbers, user numbers, recorded document histories, and comments. While the information included on provisional water cards is no substitute for adequate chain-of-title analyses to confirm the ownership of offered water rights, the cards have been used by most sellers to date (see Option Agreements, below) to represent the surface water rights they believe they own, as well as which of those rights (if not all) they are willing to sell.

Stand-Alone Water Rights

Stand-alone water rights are rights that are not grouped together with other types of rights. They include primary groundwater rights, natural flow rights without supplemental rights, and new land storage rights. These rights could be offered with or without the land to which they are appurtenant.

Other Types of Offers

NFWF could consider other types of acquisition opportunities not yet encountered, such as long-term agreements to lease water appurtenant to the land, if and when such offers were made.

Any of the above types of acquisitions could include a variety of related interests such as wells, pumps, equipment, irrigation works, water conveyance or drainage infrastructure, buildings, or other improvements, as well as easements or rights-of-way.

Types of Water Rights That Could Be Acquired

Potentially, offers could include one or more of the following types of water rights or water derived from those rights:

- decreed natural flow diversion rights appurtenant to lands in Nevada, such as rights to divert water for irrigation purposes;
- storage rights held by WRID for supplemental use on lands with decreed natural flow diversion rights and for primary use on other New Lands in Nevada (New Lands are lands within WRID boundaries [Figure 2-1] without appurtenant decreed natural flow diversion rights);
- primary or supplemental groundwater rights appurtenant to lands in Nevada for which the NSE has issued permits and certificates to individual landowners;
- state-certificated surface water rights held by WRID and exercised when available for distribution to individual users within its boundaries to supplement other water supplies (the water associated with these rights is generally referred

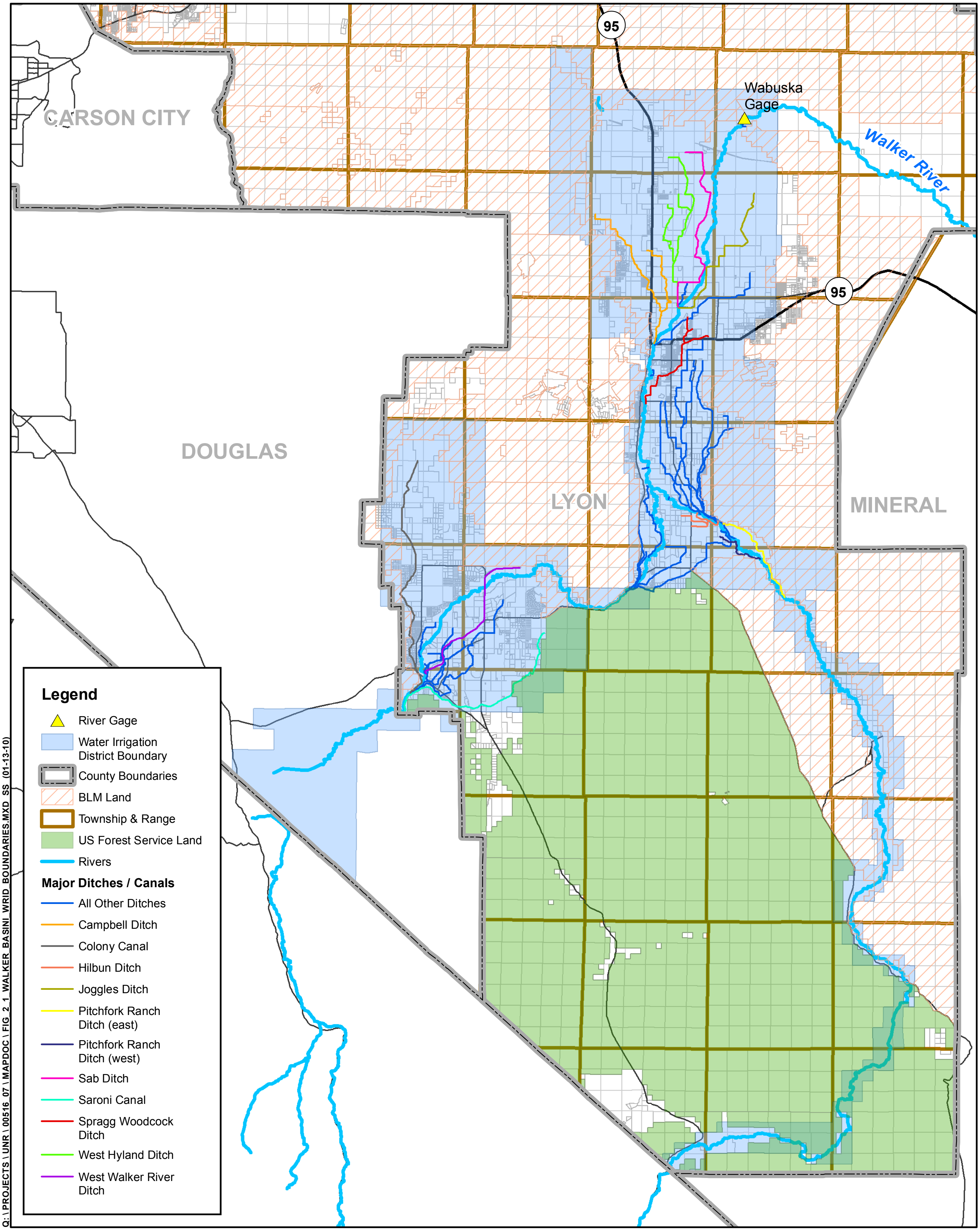

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Figure 2-1
Walker Basin Project
WRID Boundary

to as state permit water, but does not appear on WRID water cards; these supplies are also referred to as flood, surplus, or excess water);

- drainage or tailwater rights appurtenant to lands in Nevada that have been issued to individual land owners by the NSE, which could be acquired as a related interest in conjunction with primary water rights (although it is unlikely that such rights could be changed for use at Walker Lake); and
- geothermal groundwater rights documented by permits and certificates issued by the NSE.

While surface water and water rights would be the primary focus of the Acquisition Program, supplemental and/or primary groundwater rights could be acquired and used to provide water to Walker Lake both directly (e.g., through pumping and discharge of groundwater into drains or the river itself) and indirectly (e.g., through an exchange of groundwater rights for surface water rights, or in support of full credit for the consumptive use portion of an acquired surface water right that has previously been used in conjunction with a supplemental groundwater right). Groundwater rights could also be used (i.e., acquired and retired) to address or mitigate potential reductions in incidental groundwater recharge associated with the acquisition and transfer of surface water rights, or simply to take pressure off an over-allocated surface-groundwater system. Acquired groundwater rights could also provide a flexible source of water for the temporary irrigation of lands previously irrigated with surface water rights. Finally, acquired groundwater rights could be resold if necessary to provide funding for additional surface water acquisitions, for the payment of assessments, or for other program needs.

Option Agreements

As of December 2009, the University had entered into a total of 10 option and purchase agreements with willing sellers to acquire water and water rights (and related interests) appurtenant to lands in Nevada (Figure 2-2). These agreements —assigned to NFWF in December 2009 —include nine agreements to acquire, conditionally, the water and water rights represented in whole or in part by more than 40 individual provisional WRID water cards; and two separate but closely related agreements (listed below as a single agreement, Option 2A-B) to acquire, conditionally, geothermal groundwater effluent.

Table 2-2, below, summarizes the decreed natural flow, storage, and groundwater rights offered under each option agreement, including associated appurtenant lands, total negotiated purchase prices for each category of water right under option (subject to appraisal, title verification, and other contingencies), and expected average yield at existing points of diversion for each option agreement and for each category of water right under option. Totals for all agreements include the following:

- 65.98 cubic feet per second (cfs) (expected average yield of 15,099 af/yr) of decreed natural flow direct diversion water and water rights appurtenant to 5,352 acres of land;
- 1,986.6 af/yr (expected average yield of 1,389 af/yr) of supplemental storage water and water rights appurtenant to the same 5,352 acres of land;

- 2,065.5 af/yr (expected average yield of 1,446 af/yr) of New Land storage water and water rights appurtenant to 1,273 acres of land; and
- 7,000 af/yr of geothermal ground water and water rights (expected average yield dependent on limitations to be included in a future discharge permit).

Appendix 2A provides additional details on each option agreement, and Appendix 2B describes the derivation of expected average yield for each water card option.

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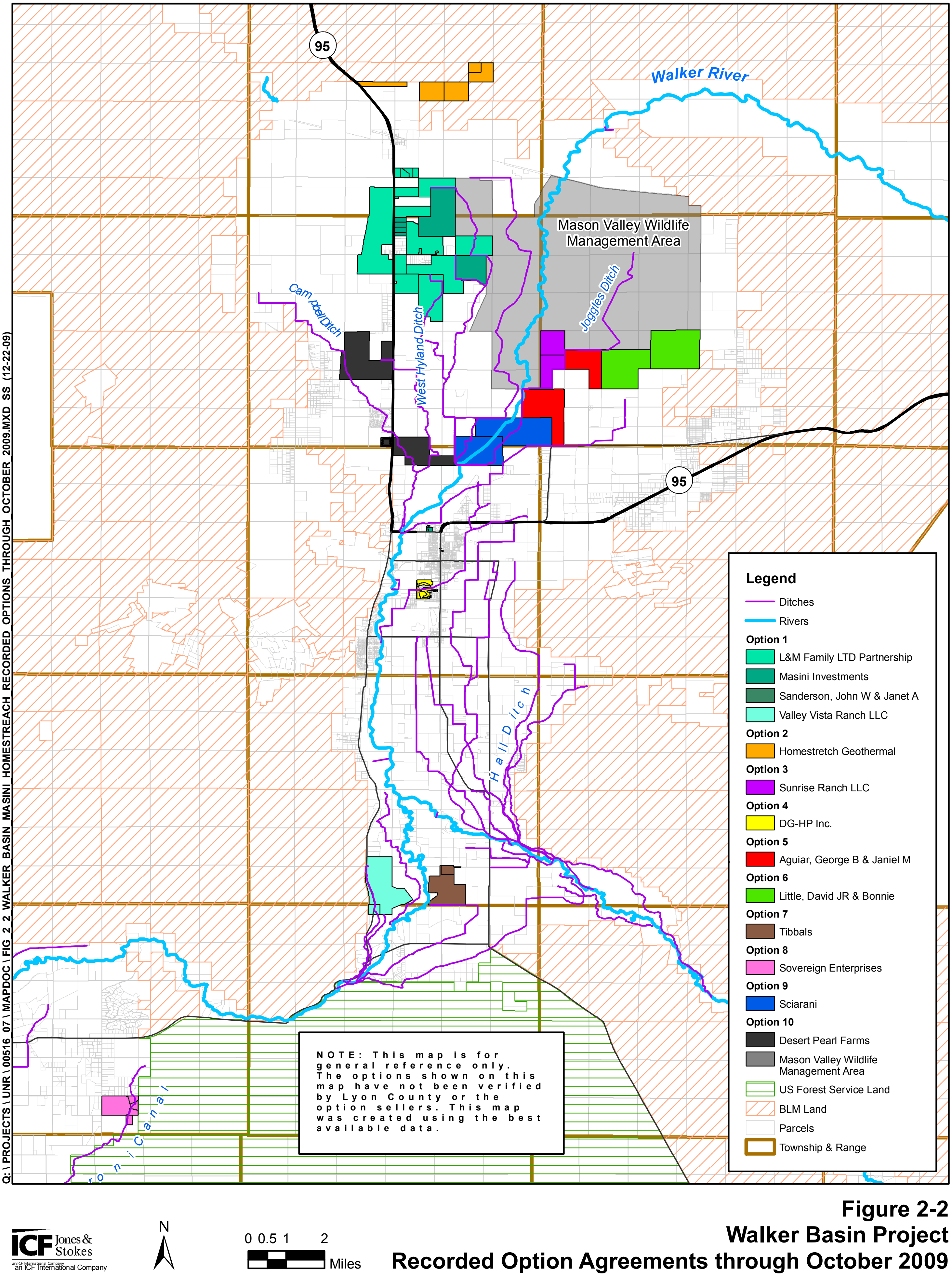

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Figure 2-2
Walker Basin Project
Recorded Option Agreements through October 2009

Table 2-2. Recorded Option and Purchase Agreements through December 2009

	Offered					Not Offered	
	Decree Natural Flow (cfs)	Supplemental Storage Face Value (af/yr)	New Land Storage Face Value (af/yr)	Geothermal Groundwater Effluent (af/yr)	Expected Average Yield (af/yr)[a,b]	Decree Acres	New Land Acres
Option 1 - Masini et. al.	19.751	474.3	484.1	–	5,431	1,561	263
Option 2A-B - Homestretch	–	–	–	7,000[b]	7,000	–	–
Option 3 - Sunrise Ranch	3.312	149.2	191.5	–	962	276	124
Option 4 - DG-HP	1.808	37.9	7.5	–	483	150	5
Option 5 - Aguiar	8.844	359.3	170.8	–	2,362	738	122
Option 6 - Little	9.888	345.6	–	–	2,404	824	–
Option 7 - Tibbals	1.840	7.0	173.2	–	654	115	105
Option 8 - Sovereign	–	–	329.5	–	231	–	160
Option 9 - Sciarani	9.251	376.8	516.5	–	2,648	771	369
Option 10 - Desert Pearl Farms	11.290	236.5	192.4	–	2,760	917	125
Total	65.984	1,986.6	2,065.5	7,000	24,933	5,352	1,273
Expected Average Yield (AF/year)	15,099	1,389	1,446	7,000	24,933	–	–
Purchase Price ($ millions)[c]	$59.3	$6.4	$6.3	$18.0	$90.0	–	–

[a] Expected average card yield at existing points of diversion per Revised DEIS analysis (Appendix 2B).

[b] Assumed face value of Option 2A-B. Actual value would be subject to groundwater and discharge permit restrictions.

[c] Purchase price subject to appraisal, title, and other contingencies. Derived values assume acquisition of all property interests under the terms of each agreement.

Walker Lake Inflow Associated with Acquisitions and Funding

As discussed in Chapter 3, Water Resources, the type of restrictions placed on water transfers would affect instream flow losses and, therefore, the amount of water that would need to be acquired to attain the Acquisition Program analysis objective of an average additional inflow to Walker Lake of 50,000 af/yr. Two types of transfers are evaluated in Chapter 3; a Full Transfer Scenario (which assumes that the full expected average yield of a water right could be transferred downstream) and Consumptive Use Scenarios (which assume that water transfers would be limited to the consumptive use portion of a water right). It should be noted that the Full Transfer and Consumptive Use scenarios differ in additional ways (see Chapter 3). Under the Full Transfer Scenario evaluated in Chapter 3, approximately 82,000 af/yr of surface water would need to be acquired from willing sellers in Mason Valley, Smith Valley, and the East Walker area in order to provide, on average, 50,000 af/yr of additional inflow to Walker Lake. The difference of 32,000 af/yr represents the combined effects of hydrologic losses (e.g., reduced contributions from groundwater, losses to riparian vegetation, and channel losses). Under the Consumptive Use Scenarios, approximately 57,000 af/yr of surface water would need to be acquired in order to provide, on average, 50,000 af/yr of additional inflow to Walker Lake. Less water is needed for the Consumptive Use Scenarios because infiltration from the river to groundwater is expected to be much lower for the Consumptive Use Scenarios.

Chapter 1, Purpose of and Need for Action, describes the legislative origins of the Acquisition Program and indicates that $70 million was provided for acquisitions and research in PL 109-103 with an additional $25 million for acquisitions provided in PL 111-85. PL 111-85 also includes $25 million under separate authority for a 3-year WRID demonstration leasing project to be funded through a grant agreement with NFWF, which has not yet been completed. The demonstration project is not specifically analyzed in this Revised DEIS; however, many of the impacts of Alternative 2 (Leasing Alternative) analyzed in this Revised DEIS are expected to be similar to those that would occur under the demonstration leasing project, although they would likely differ in several key respects.

Of the $70 million provided for acquisitions and research, the following expenditures occurred as of December 2009:

- $350,000 to develop a plan for the $70 million funding;
- $9.6 million, out of $11.1 million allocated, for research by the University and DRI;
- $2.5 million, out of $2.7 million allocated, for work related to investigating and implementing water rights acquisitions and for work on the DEIS.
- $2.725 million for water right options, out of $55.5 million allocated for acquisitions and related activities. It is anticipated that most of the remaining funding amount will be de-obligated from the University and provided to NFWF for the Acquisition Program.

The Revised DEIS analyzes adverse and beneficial impacts based on the following two scenarios:

- An average of approximately 7,300 af/yr of additional inflow would be provided to Walker Lake following expenditure of the $56 million originally authorized under PL 109-103 based on the purchase prices negotiated and property offered under existing option agreements as well as a host of related assumptions.
- An average of approximately 50,000 af/yr of additional inflow would be provided to Walker Lake under a fully funded Acquisition Program, which is expected to involve up to $385 million based on the purchase prices negotiated and property offered under existing option agreements as well as a host of related assumptions. (See Appendix 2B for additional information.)

While additional funding of $25 million has been provided beyond the $56 million originally allocated in PL 109-103 for acquisitions, the Revised DEIS does not specifically analyze the additional funding and amount of water it could acquire. However, the impacts that could occur with the addition of the new funding would be between those that would occur with $56 million, and those that would occur with full funding, the two funding levels that are analyzed in the Revised DEIS. This range depicts all impacts that could be expected to occur under the Acquisition Program.

The amount of water that could be acquired under any funding amount is subject to a variety of uncertainties. Average unit acquisition costs are based on the negotiated offer prices (all subject to appraisal, title confirmation, and other contingencies). For example, it is likely that appraised values will be less than the purchase prices negotiated for the option and purchase agreements entered into by the University because of the economic downturn since 2007 and possibly other factors. However, the negotiated values are used in this Revised DEIS in order to remain conservative, i.e., to ensure that the expected cost of the Acquisition Program is not understated, and/or that the expected increase in inflow to Walker Lake associated with a given amount of funding is not overstated.

With $56 million for acquisitions it is estimated that, on average, Alternative 1 (Purchase Alternative) would secure approximately 11,900 af/yr in perpetuity at existing points of diversion on the Walker River, which in turn would increase inflow to Walker Lake by at least 7,300 af/yr. This estimate is based on the assumptions listed below and is described more fully in Appendix 2B.

- Approximately 15% of acquisition funds would be set aside for transactional support activities and other related program costs.
- Acquired surface water rights would yield, on average, approximately 52% of their maximum face value across all types and priorities at existing points of diversion.
- Unit fee acquisition costs would equal, on average, the negotiated offer prices described in public summaries of recorded provisional water card option agreements (all subject to appraisal).
- The NSE and the U.S. District Court would allow the transfer of up to the average amount of water historically diverted per irrigated acre of water rights

acquired as described for the Full Transfer Scenario in Chapter 3, Water Resources.

- Various estimated physical losses would occur between the existing points of diversion and Walker Lake (see Chapter 3, Water Resources).

An alternate basis for estimating increased Walker Lake inflow under funding of $56 million would be to limit changes to acquired natural flow rights plus supplemental storage rights to a consumptive use component, as is described for the Consumptive Use Scenarios in Chapter 3. Under these scenarios, the amount of water available for transfer is somewhat uncertain. Less water may be available for transfer than would be available for the Full Transfer Scenario, but a greater percent of the transferred water would be expected to reach Walker Lake. As is described in Appendix 2B, the amount of water estimated to reach Walker Lake with funding of $56 million under the assumptions of the Consumptive Use Scenarios is expected to equal or exceed the amount reaching the Lake under the assumptions of the Full Transfer Scenario.

Finally, sufficient funding to purchase enough water to increase Walker Lake inflow by an average of 50,000 af/yr for Alternative 1 is referred to as full funding in this Revised DEIS. Applying the quantitative relationships between funding and increased inflow at Walker Lake described above, it is estimated that full funding of Alternative 1 would require up to $385 million in 2008 dollars. This estimate, described more fully in Appendix 2B, was developed to facilitate the analysis of environmental consequences in this Revised DEIS. Actual funding cost would depend on many variables.

Limit on Reduction in Irrigated Lands

Alternative 1 (Purchase Alternative) would likely cause significant and permanent reductions in the amount of irrigated land. To limit the potential impacts of this alternative on agricultural land use and the agricultural economy in Mason Valley, Smith Valley, and the East Walker area, it was the University's intention under the DEIS to limit reductions in irrigated land to no more than 33% of the assumed preacquisition baseline. The feasibility of this limitation is evaluated in Chapter 3 and, for impact assessment purposes in the Revised DEIS, the maximum permanent reduction in irrigated and/or water-righted land attributable to implementation of the Purchase Alternative is still assumed to be 33%. It is likely that the 33% limitation is feasible even if acquisitions are limited to agricultural water and alternate sources such as geothermal were not included (see Chapter 3), although imbalances in the distribution of acquisitions could cause localized exceedance of the 33% limit. However, retirement of irrigated land may not be as large as was evaluated because it is likely that a mix of acquisition alternatives would eventually be implemented, in which case the 50,000 af/yr increased inflow objective would be satisfied by a combination of fee purchases, water leases, and appropriate efficiency measures (and such a multifaceted program is already taking shape under PL 111-85).

Required Applications, Agreements, and Approvals

Under Alternative 1, the place of use for the acquired water rights would be transferred by NFWF or its designee to the lower Walker River and Walker Lake in order to best accommodate deliveries to the new expected point of diversion (i.e., delivery or administration) at the Wabuska gage. Depending on the type of water rights acquired, such transfers would involve:

- submitting change applications to the NSE, the Walker River Decree court, WRID, and/or the California SWRCB as appropriate with regard to the point of diversion and the place, manner, and purpose of use of the particular rights at issue;
- obtaining a National Pollutant Discharge and Elimination System (NPDES) permit for the discharge of cooled geothermal effluent to the Walker River;
- negotiating agreements with BIA, WRPT, and other parties as needed to ensure the delivery of water to satisfy the exercise of the water rights acquired for the benefit of Walker Lake (see Reservoir Operations, above); and
- entering into assessment agreements with the relevant ditch companies, the U.S. Board of Water Commissioners (USBWC), and/or WRID, and thus continuing to pay the apportioned share of ongoing operation and maintenance costs for all water rights acquired.

While Alternative 1 would only involve the acquisition of water rights that are already permitted for use in Nevada, any proposed use of stored water from Bridgeport or Topaz Lake Reservoirs that would occur outside of WRID boundaries, or for purposes other than irrigation (or recreation in the case of Bridgeport Reservoir, or domestic use in the case of Topaz Lake Reservoir), would require approval by SWRCB, WRID, and the U.S. District Court for the District of Nevada. Compliance with CEQA would also be required.

Any other required applications, agreements and approvals would be obtained prior to full implementation of the Acquisition Program.

Alternative 2 (Leasing Alternative)

Alternative 2 (Leasing Alternative) is adapted from a program described conceptually by WRID (Spooner pers. comm.) and may or may not be the same as the newly funded 3-year WRID demonstration leasing project. For this alternative, the WRID program would be modified to feature centrally administered surface water leases from individual willing sellers derived from water rights appurtenant to lands in Nevada. Although WRID's suggested program would lease water from willing participants throughout the Walker River Basin upstream of the Walker River Indian Reservation, Alternative 2 as presented in this Revised DEIS would be limited to water derived only from water rights appurtenant to lands in Nevada. In addition, WRID's proposal includes the concept of banking leased water (i.e., credit storing water acquired by lease for later release), but water banking is excluded from Alternative 2 in this Revised DEIS because of myriad uncertainties in how this concept would be implemented. (Among these uncertainties are potential impacts on reservoir operations and stream flows in California; the need for reservoir modeling tools that go well beyond the focus on average annual water budgets in the Revised DEIS; expected tradeoffs between the management of reservoirs to optimize the conveyance of water to Walker Lake versus the instream and riparian needs of the Walker River and/or use of the reservoirs themselves for recreation and other purposes; the associated need for a multiparty operating agreement and/or adaptive management plan; and the likelihood that it could take many years, if not decades, to develop and implement such a program. These and other factors suggest that water banking might best be considered as a possible management improvement under a future phase of Acquisition Program implementation, and/or as part of a more comprehensive CEQA analysis that focuses on potential impacts in the California portions of the Walker River Basin. Alternative 2, as evaluated in this Revised DEIS, would involve surface storage with operations similar to those of other acquisition alternatives.

Similar to WRID's water leasing proposal(s), Alternative 2 would focus on purchases of water, not water rights. Water rights would be retained by existing owners, but all or a specific portion of the water associated with the rights would be committed for the duration of the lease period according to the terms of binding voluntary agreements. The agreements would involve individual water rights holders, WRID, and the leasing program administrator (if different from WRID); and all water leased would revert to the original rights holder following the end of the agreed-upon lease period.

Funding for Alternative 2 is assumed to be similar to Alternative 1, and estimates have been prepared that indicate how long water could be leased under both $56 million and full funding in order to achieve the same increased inflow objective. Program funding will also be driven by federal appropriations, which are only available for expenditure as authorized, so the use of financial arrangements to perpetuate funding into the future, as has been suggested, has not been analyzed in this Revised DEIS. (DOI regulations and existing federal law generally do not allow nonfederal entities to earn interest on federal grant funds, particularly in the form of an interest-bearing endowment. While it is possible that such a mechanism could be established by a future act of Congress, the full funding analysis merely assumes that additional funds would be provided under existing federal authority, without speculation as to the myriad ways that such authority might change in the future.)

Types of Water Rights for Leased Water

Potentially, all types of surface water (e.g., water derived from the exercise of decreed natural flow diversion rights and storage water rights) would be eligible for enrollment under agreements for renewable or rotating terms of an estimated 1 to 3 years each. Leases of surplus or excess water associated with WRID's state permit water rights might also be possible; however, these rights would be leased directly from WRID (if offered) and would not be included in the annual participation agreements with individual willing sellers.

Walker Lake Inflow Associated with Acquisitions and Funding

As indicated above for Alternative 1, under the Full Transfer Scenario, an estimated 82,000 af/yr would need to be acquired at the point of diversion to increase Walker Lake inflow by an average of 50,000 af/yr, and under the Consumptive Use Scenarios, an estimated 57,000 af/yr would need to be acquired at the point of diversion to increase Walker Lake inflow by an average of 50,000 af/yr. These estimates also apply to Alternative 2.

As discussed more fully in Appendix 2B, with funding of $56 million, less an estimated 15% set-aside for indirect costs, approximately 240,000 af of surface water could be purchased, based on an average assumed lease cost of slightly over $200 per af in 2008 dollars at existing points of diversion. The unit price is estimated based on best currently available information to be 5% of the average water rights acquisition cost (Seeley pers. comm.). Five percent of the approximately $4,000 per af of expected average yield under existing water card options (see Appendix 2B) is $200 per af. This estimate may not represent actual costs that would be paid.

Based on these assumptions, and applying the average physical loss rates from above (i.e., 50,000 af/yr inflow at Walker Lake for every 82,000 af/yr acquired upstream), $56 million would be sufficient to implement Alternative 2 for about 3 years while continuing to achieve the objective of increasing average inflow by 50,000 af/yr. If average lease costs were closer to $100 per af, the leasing program could last for nearly 6 years while providing an average of 50,000 af/yr of increased inflow at Walker Lake. Conversely, if average lease costs were closer to $300 per af, the leasing program could only last for about 2 years while meeting the 50,000 af/yr objective.

If $56 million were used to purchase 7,300 af/yr at Walker Lake (11,900 af/yr at points of diversion for $200 per af), Alternative 2 would last for approximately 20 years. Alternative 2 with a funding level of $56 million is evaluated as providing 50,000 af/yr to Walker Lake for 3 years instead of 7,300 af/yr to Walker Lake for 20 years. The decision to use one approach instead of the other makes little difference over the long term because neither provides sustained benefits to Walker Lake. Relative to the No Action Alternative, 3 years of 50,000 af/yr inflow provides a slightly greater but shorter term increase in lake surface elevation than 20 years of 7,300 af/yr inflow. In this regard, water leasing may be most valuable as a “bridge strategy” that helps to restore Walker Lake in the near term while more permanent acquisitions take hold.

If the $385 million full funding amount described above for Alternative 1 (inclusive of the assumed 15% set-aside) were instead available to implement Alternative 2, the leasing program would be expected to last for approximately 20 years at an average lease cost of $200 af/yr.

Limit on Reduction in Irrigated Lands

The 33% limit on reductions in irrigated and/or water righted land, described above for Alternative 1, could also apply in the aggregate to Alternative 2. It should, however, be noted that individual leases would be based on temporary agreements, and thus participating lands would only be enrolled (i.e., not irrigated) for an estimated 1- to 3-year period at a time, at which point newly enrolled lands would replace those that return to irrigated production so long as sufficient funds and willing sellers remained to support such new enrollments. Accordingly, it would seem more appropriate to limit any permanent reductions in irrigated and/or water-righted land under Alternative 1 as described, but to exclude from that limit any reductions in irrigated land associated with temporary or short-term water leasing.

Program Administration

The amount of water produced by the leases on a year-to-year basis would depend on factors such as spring snowpack, storage conditions, and projected runoff. Annual lease payments would be based on the amount of water actually provided, rather than on the face value or average yield of the water rights. Annual payments would be structured to provide for an initial payment early in the year based on projected deliveries, and a final payment or adjustment at the end of the year would be based upon actual deliveries under the program.

The leasing program administrator would:

- develop and oversee enrollment in the program to achieve program objectives, including maintaining a waiting list of any willing sellers to replace those who may wish to opt out;
- be responsible for determining both the expected and actual amount of water leased by the program each year and for making lease payments to participants;
- coordinate with the federal water master and WRID to ensure upstream reservoirs are operated in a manner consistent with the purpose and objectives of the program within the constraints of existing operating requirements; and
- coordinate with BIA, WRPT, and other parties as needed to ensure the delivery of leased water to Walker Lake.

Required Applications, Agreements, and Approvals

It is anticipated that temporary changes in the point of diversion or the place, manner, and purpose of use of water rights involved in the leasing program would be sought based upon relevant provisions of Nevada water law (e.g., Nevada Revised Statutes [NRS] 533.345 and/or NRS 533.0243), along with annual approvals from WRID. Because there is no provision for temporary changes to water rights under USBWC's 1996 Administrative Rules and Regulations, modifications to Decree C-125(e.g., recurrent 1- to 3-year changes) would also likely be needed. The potential to enter into programmatic approvals based on conformance with Nevada water law and USBWC's 1996 Administrative Rules and Regulations likely would be explored to facilitate implementation of Alternative 2.

Any other required applications, agreements and approvals would be obtained prior to full implementation of the Acquisition Program.

Alternative 3 (Efficiency Alternative)

Alternative 3 (Efficiency Alternative) would involve program funding for conservation and water management improvements that could make water available for subsequent movement to Walker Lake. This alternative would feature a variety of potential water conservation and efficiency measures that would reduce the amount of surface water conveyed or applied to lands with appurtenant surface water rights in the Walker River Basin in Nevada.

Types of Efficiency Measures

There are two general categories of potential measures: system efficiency measures and on-farm efficiency measures.

System efficiency measures would reduce losses in the conveyance of surface water from the point of diversion to the land where the water is used (i.e., to the farm headgate). These measures could include:

- upgrading delivery systems to reduce water conveyance losses;
- lining canals with concrete;
- replacing surface conveyances with underground conveyances;
- consolidating canals, laterals, and ditches;
- automating head gates to maintain constant and reliable flows;
- improving and consolidating diversion works; and
- implementing phreatophyte control measures, including the removal of vegetation such as tall whitetop and tamarisk in or along ditches and canals.

On-farm efficiency measures would reduce the amount of water needed to serve crop evapotranspiration (ET) needs (and/or to reduce crop ET itself) from the farm headgate to the point of final demand. These measures could include:

- lining farm ditches with concrete;
- replacing farm ditches with underground pipelines;
- laser-leveling farm fields;
- changing from flood to sprinkler or drip irrigation;
- shifting to crops that use less water and/or reducing the number of irrigations applied to hay and pasture crops (e.g., split-season leasing);
- improving irrigation management and scheduling; and
- installing tailwater pump-back, recovery, and recycling systems.

Some of the above measures are already in effect in the Walker River Basin. For example, as of early 2010, Natural Resources Conservation Services (NRCS) had entered into more than 113 conservation program agreements with Lyon and Mineral County landowners to implement land, irrigation, and other farm system improvements under a variety of conservation programs authorized by the 1996, 2002, and 2008 Farm Bills (Yardas 2007; Biggs pers. comm.); however, it is unknown if these agreements resulted in reduced diversions, water use, or increased stream flows, and if they did it is unlikely that, absent accompanying water rights change approvals, such additional flows were protected from diversion by other users. Although the NRCS agreements do not account for conserved water, they do provide an example of how conservation measures might be implemented. While similar agreements with individual landowners could potentially play an important role going forward, the need for associated water rights change approvals would have to be addressed, and it may also be the case that improved system efficiencies would present the greatest opportunities for conserving significant quantities of water (because large system efficiencies would likely be easier to administer and manage than numerous small farm-by-farm measures).

Walker Lake Inflow Associated with Increased Efficiencies

The analysis presented in Chapter 3, Water Resources, indicates that an average of 50,000 af/yr of additional inflow to Walker Lake could only be achieved under Alternative 3 if Alternative 3 included conversion to crops that use less water (crop switching). The existing overall level of water efficiency in the three acquisition areas, defined as the ratio of crop ET to the amount of surface water diverted and groundwater pumped, is approximately 50%. Assuming an ambitious 75% level of water efficiency could be achieved, it is estimated that, on average, Alternative 3 could deliver 32,300 af/yr of additional inflow to Walker Lake, based on existing crop ET rates (i.e., no crop switching). It is estimated that this additional inflow would require water savings in Mason Valley, Smith Valley, and the East Walker area totaling slightly more than 100,000 af/yr. This large amount of water would be needed because much of the existing inefficiency is contributing to incidental groundwater recharge. Loss of this groundwater recharge is expected to greatly increase river infiltration.

As suggested above, and as supported by research conducted by Curtis et al. (2009), there may be considerable potential in the Walker River Basin for converting from existing conventional crops such as alfalfa to alternative crops that use less water, as a means to make water available for Walker Lake without taking the land out of production. For example, by reducing total crop ET by an estimated 15% in Mason Valley, Smith Valley, and the East Walker River area, it would be possible to build on the water efficiency improvements assumed above and increase the average annual flow augmentation from 32,300 af/yr to the 50,000 af/yr objective. Because it would be difficult to attain an overall efficiency of 75% in Mason Valley, Smith Valley, and the East Walker area, total crop ET would probably have to be reduced even further to attain the average 50,000 af/yr objective.

There are, however, concerns with the economic viability of most alternative crops for Walker Basin growers. Even the alternative crops that appear most promising raise questions about the availability of dependable markets and verifiable yields, required investments, time needed to fully develop the crop, and the risk profile of the grower (Curtis et al. 2009). In light of such uncertainties, the potential water savings associated with reduced crop ET resulting from the cultivation of low water use alternative crops has not been included in the Revised DEIS analysis of Alternative 3.

Using the 2004 water conservation investment program funded by Reclamation at NDOW's Mason Valley WMA as a proxy, it appears that the cost of conserved water for a variety of efficiency investments would range from $2,430 to $3,410 per af of water conserved in 2008 dollars (Appendix 2B). Applying the upper end of this range to the approximately 102,000 af of conserved water assumed to be acquired upstream (see Chapter 3, Water Resources), a total Alternative 3 investment cost of approximately $408 million can be inferred (based on the higher cost estimate of $3,410/af and 15% set-aside). Because Alternative 3 as analyzed would only provide about 32,300 af/year of increased inflow to Walker Lake (even if conserved water was fully transferrable), the full costs of Alternative 3 would be substantially greater than $408 million if lake inflow were increased by an additional average 17,700 af/yr by implementing crop switching or other measures needed to attain the Acquisition Program objective of an average additional inflow of 50,000 af/year at Walker Lake. Finally, using the higher unit cost estimated above, and assuming comparable rates of physical loss and transferability between existing points of diversion and Walker Lake, approximately 4,400 af/yr of additional inflow could be provided within the limits of existing funds.

Program Administration

Conservation agreements would be established by the program administrator with willing water rights holders. Potentially, surface water with all types of rights could be included. These agreements would identify the conservation or efficiency measures that would be implemented with program funding in exchange for conveyance or assignment of the associated water rights in amounts commensurate with the expected water savings. All or a portion of the applicable water rights would then be transferred to the lower Walker River and Walker Lake.

Participants would either:

- implement the identified measure(s) directly, with payments to landowners to implement specific on-farm improvements; or
- agree to have those measures implemented by others, such as ditch companies, with payments to those entities to implement specific conveyance system improvements within their respective service areas and jurisdictions.

Required Applications, Agreements, and Approvals

For this alternative to be feasible, it would be necessary to establish regulatory and administrative mechanisms to ensure that the conserved water could be transferred to Walker Lake. Water saving measures would be implemented in conjunction with the approval of water rights changes by the NSE and/or the Walker River Decree court, which would require involvement by WRID. Although Nevada water law has established mechanisms for transferring water rights in their entirety away from the lands to which they are appurtenant (and thus requiring the cessation of irrigation for the duration of the transfer), the NSE's office has indicated a willingness to consider a number of potential approaches to the transfer of conserved water derived from existing water rights within the Walker River Basin that would allow for continued irrigation of at least a portion of the lands to which those water rights are appurtenant (Gallagher pers. comm.). While rulings on applications to change water rights will always be based on specific facts and circumstances, in general the ability to account for the water savings and various types of water rights involved will be important for potential approval. Because USBWC's 1996 Administrative Rules and Regulations do not directly address many of the issues surrounding the potential transfer of rights to conserved water, it is not known how the U.S. District Court might address these kinds of water rights changes.

Any other required applications, agreements and approvals would be obtained prior to full implementation of the Acquisition Program.

Alternatives Proposed During Scoping

During the public scoping process held early in the development of this Revised DEIS, many suggestions were made regarding potential program alternatives. Some actions were eliminated from further analysis, while others were incorporated into each of the action alternatives (Bureau of Reclamation 2008).

Actions Eliminated from Further Analysis

The following suggested actions were eliminated from detailed analysis in this Revised DEIS because they did not meet the Purpose and Need for the Acquisition Program in conformance with authorizing legislation, and/or they were not considered to be reasonable for environmental, legal, financial, or technical reasons. Some of these actions could possibly be pursued in the future if authorizing legislation and funding from Congress or funding from another source becomes available.

- Install a dike across a portion of the lake to create a salinity barrier.
- Cement the riverbed.
- Declare emergency status for addressing elevation of Walker Lake.
- Oxygenate Walker Lake.
- Add pipeline to Las Vegas and reduce lake elevation.
- Create outlet to lake so lake can clean itself.
- Use desalination.
- Allow private purchase.
- Mandate that WRPT share water.
- Import groundwater from another basin (e.g., Whiskey Flats, Rawhide Flats).
- Import surface water from the Pacific Northwest.
- Define restoration as water for WMAs and wetlands.
- Mandate that farmers who will not share water live at Walker Lake for 4 years.
- Exclude bed and banks from going back to WRPT.
- Use cloud seeding (this has been occurring for numerous years and may continue. As such, any flow-related effects from cloud seeding are already included in the Revised DEIS baseline runoff assumptions).
- Develop reservoirs for capturing flood event flows for future use.
- Mandate two federal water masters rather than one and locate in an office other than WRID.
- Include willing sellers in all communities in the Walker River Basin (include California water).
- Acquire water rights in the Hawthorne area only.
- Use mining effluent and mine remediation effluent.
- Enforce and monitor all water diversions and wells and provide saved water to Walker Lake.
- Restore channel to increase river conveyance efficiency.

Actions Incorporated into Alternative 1

The following suggested actions were incorporated into Alternative 1 as sources of water from potential willing sellers. Whether the suggested water sources actually would provide water through implementation of Alternative 1 would depend on obtaining any necessary permits and the willingness of the owners of the land, water appurtenant to the land, and related interests.

- Use wastewater effluent.
- Use geothermal effluent.
- Include water from Hawthorne Army Depot.
- Consider buying water (such as water rights from marginal farmland) that would benefit a wide variety of resources in addition to the lake.

Actions Incorporated into Alternative 2

The following suggested actions were incorporated into Alternative 2. Some of the ideas were modified to better fit the program's defined Purpose and Need (e.g., limit the geographic scope to the Nevada portion of the Walker River Basin) or to enhance viability as a reasonable alternative.

- Lease upstream water.
- Use a lease/water bank alternative (WRID).
- Use a lease/bank alternative (including basin-wide program).
- Rotate fields and fallow every 7 years and provide conserved water to Walker Lake.
- Develop a water market using a local and state water contractor partnership to enhance management of water.

Actions Incorporated into Alternative 3

The following suggested actions were incorporated into Alternative 3.

- Conserve water.
- Upgrade delivery system to prevent loss to groundwater.

Chapter 3 Water Resources

Chapter 3 Water Resources

Summary

The following text provides a summary of the analysis approach for water resources and the main water resource impacts (impacts on irrigation, Walker Lake volume and water quality, groundwater, and erosion). This summary is provided for readers who would like to see more detail than is provided in the Executive Summary, but less than is provided in the rest of this long chapter.

Analysis Approach

For Alternatives 1 and 2, the restrictions placed on water transfers would affect instream flow losses and, therefore, the amount of water that would need to be acquired to attain the objective of an average additional inflow to Walker Lake of 50,000 af/yr. Two types of transfers are evaluated: a Full Transfer Scenario (which assumes that the full expected average yield of a water right could be transferred downstream) and Consumptive Use Scenarios (which assume that water transfers would be limited to the consumptive use portion of a water right). The Full Transfer and Consumptive Use Scenarios also differ in additional ways. Under the Full Transfer Scenario, approximately 82,000 af/yr of surface water would need to be acquired upstream to provide, on average, 50,000 af/yr of additional inflow to Walker Lake. Under the Consumptive Use Scenarios, approximately 57,000 af/yr of surface water would need to be acquired in order to provide, on average, 50,000 af/yr of additional inflow to Walker Lake. Less water would be needed for the Consumptive Use Scenarios because river infiltration to groundwater is expected to be much lower for the Consumptive Use Scenarios.

Because conventional uses of federal appropriations do not include endowments or interest earnings, Alternative 2 was assumed to require continual payments for water leases. Assuming that Alternative 2 had as much funding available as a fully funded version of Alternative 1 (i.e., sufficient funding to acquire enough water to increase Walker Lake inflow by an average 50,000 af/yr), it was estimated that Alternative 2 could be implemented for 20 years (Chapter 2). In contrast, water acquired under Alternatives 1 and 3 would last in perpetuity.

Alternative 3 was analyzed by assuming that the overall level of water use efficiency, defined as the ratio of crop ET to the amount of surface water diverted and groundwater pumped, would increase from 50%, the approximate value for existing conditions, to 75%. Assuming a 75% level of water efficiency could be achieved, it was estimated that, on average, Alternative 3 could save approximately 102,000 af/yr upstream and deliver 32,300 af/yr of additional inflow to Walker Lake, based on existing crop ET rates (i.e., no crop switching). Most of the saved water was estimated to be lost in transit because much of the *existing inefficiency is contributing to incidental groundwater recharge. Loss of this groundwater recharge is expected to greatly increase river infiltration.*

The assessment for Alternative 3 is somewhat theoretical because it is unlikely that all farmers would want to participate in this program and unlikely that an efficiency of 75% could be attained everywhere. Crop switching (shifting to crops that use less water) was not part of the quantitative analysis because it is unclear to what extent farmers would be willing to switch crops under the Acquisition Program. If crop switching were to occur, it could result in increased river flow with a smaller effect on groundwater than other efficiency measures and could result in water savings that could significantly increase the yield from Alternative 3.

Main Impacts

Irrigated Lands

Under the No Action Alternative, irrigated lands would not be affected.

Under Alternatives 1 and 2, acquisition of water rights or leasing of water would be expected to reduce the amount of water available for irrigation and could reduce the amount of irrigated land. The Full Transfer and Consumptive Use Scenarios were used to estimate that Alternatives 1 and 2 could result in a 26 to 33% reduction in irrigated lands assuming that all acquired water would come from agricultural sources. Alternative 3 would not result in a reduction in irrigated lands.

Walker Lake Storage and Water Quality

Under the No Action Alternative, Walker Lake storage, surface elevation, and surface area would decrease. Water quality would become degraded, and TDS concentration would increase to levels that would significantly alter the ecosystem of the lake.

Under Alternative 1, Walker Lake storage would increase to a level sufficient to reduce TDS concentration to an estimated low of 11,300 to 12,300 mg/L. Lake storage could increase under Alternatives 2 and 3, but the increase under Alternative 2 would only be temporary and, because Alternative 3 is not expected to provide a full additional average lake inflow of 50,000 af/yr, the increase in storage (and reduction in TDS) would not be as great as for Alternative 1.

Groundwater

Under the No Action Alternative, groundwater could decline in a manner similar to what appears to be occurring under existing conditions.

Walker Lake to:	River Miles
Schurz Gage	13.5
Three Gages	21.7
Weber Dam	24.3
Wabuska Gage	45.6
Confluence	67.5
Strosnider Gage	81.4
Hudson Gage	77.7
Hoye Bridge Gage	99.0
Bridgeport Gage	138.5

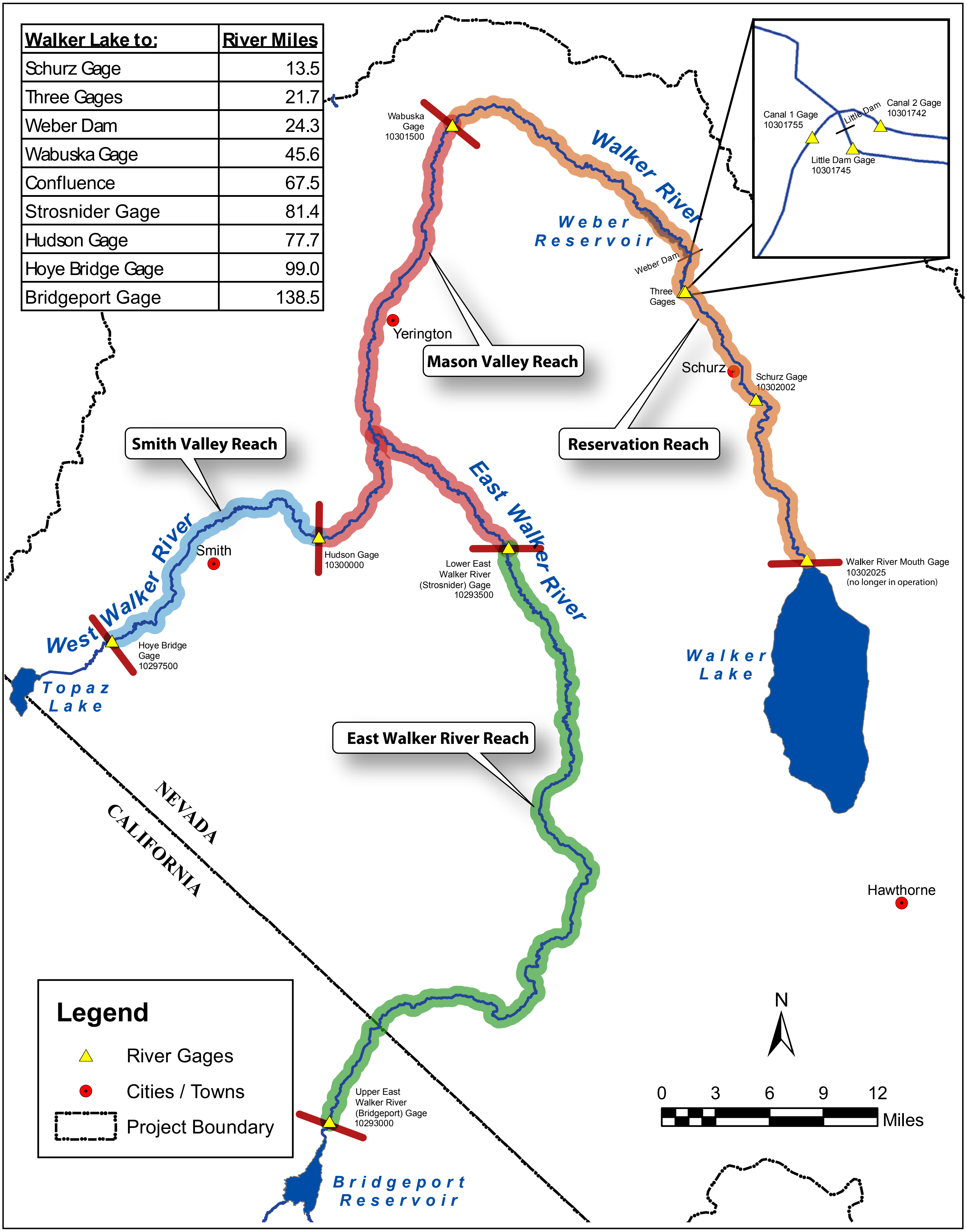

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Figure 3-1
Walker River Basin
River Gages and Reaches

All acquisition alternatives could result in a decrease in groundwater recharge (and, therefore, groundwater levels) in the Walker River Basin. The effect of Alternatives 1 and 2 on groundwater levels would depend on the restrictions placed on the transfer of water. If water were transferred in a manner similar to the Full Transfer Scenario, groundwater levels could decrease. However, if water were transferred in a manner similar to the Consumptive Use Scenarios, the groundwater levels could be unaffected by the Acquisition Program or could even increase relative to the No Action Alternative.

Erosion

Under the No Action Alternative, erosion problems associated with decreasing lake levels would continue.

Under the acquisition alternatives, the erosion associated with decreasing lake levels would be reduced, but erosion in the river could increase as a result of increases in river flow and increases in the amount of exposed earth.

Additional Information

The Chapter 3 text below provides information about the affected environment and environmental consequences. The methods and impacts sections contain more information about the analysis and impacts than is provided in the summary above. In addition, the impacts section describes minor impacts that are not included above.

Introduction

This chapter describes the affected environment for water resources in the study area and the potential impacts on water resources that would result from the acquisition alternatives and the No Action Alternative. This chapter includes evaluation of river flows, lake elevation, water quality, groundwater, and water use for agriculture.

Sources of Information

The key sources of data and information used in the preparation of this chapter are listed below by topic. Full references can be found in Chapter 17, References.

- **Surface water diversions:** 1931-1991 data from a Nevada Division of Water Planning (NDWP) summary of surface water irrigation diversions (Pahl 2000), and 1992-2007 data received from Jim Shaw, Walker River federal water master (pers. comm.).
- **Groundwater pumping:** Estimated annual groundwater pumping for 1994-2004 (Gallagher 2006).

- **Groundwater levels:** data collected by Nevada Division of Water Resources (NDWR) (2009).
- **Evapotranspiration rates**: Communication with Kip Allander and Tom Lopes of USGS regarding net ET in the Walker River Basin (Allander pers. comm. 2008a and Lopes pers. comm.), USGS report 2005-5288 (Maurer et al. 2006) on ET in the Carson Valley, communication with Rick Felling on consumptive use (Felling pers. comm.) and information on ET rates for a variety of crops (Food and Agricultural Organization of the United Nations 1986).
- **River flows:** USGS flow data from multiple gages (U.S. Geological Survey 2008).
- **Groundwater-surface water interaction:** hydrologic modeling of Smith and Mason Valleys (Myers 2001a and 2001b).
- **Irrigated acres:** Appendix A (Desert Research Institute 2006) of the Great Basin Land and Water Study (Yardas 2007). This appendix also includes estimates of combined riparian and wetland acres.
- **Water-righted acres:** Tables from Myers' report on water rights in Smith and Mason Valleys (Myers 2001c) and acres with center-pivot irrigation (associated with primary groundwater rights) from Lopes and Allander (2009a).
- **Walker Lake water balance and TDS:** USGS Walker Lake budget fact sheet (Thomas 1995), water balance spreadsheet from Randy Pahl (Pahl pers. comm.), USGS bathymetry data (Lopes and Smith 2007, Appendix A), historic Walker Lake elevation and TDS concentration data compiled by USGS (Allander pers. comm. 2008b), preliminary data from the USGS quarterly report to Reclamation (Lopes 2009), new USGS water balance assessment (Lopes and Allander 2009a), and total maximum daily load (TMDL) for Walker Lake TDS (Nevada Division of Environmental Protection 2005).

Affected Environment

This section describes the affected environment related to water resources in the study area. The federal, state, and local regulations relevant to water resources in the study area are described in Appendix 1B of this Revised DEIS**.**

The Walker River Basin is approximately 4,050 square miles and encompasses parts of California and Nevada; approximately 1,002 square miles of the basin are in California (Lopes and Smith 2007). The river and its watershed originate in the eastern Sierra Nevada and terminate at Walker Lake.

Most precipitation in the basin occurs as snow in the Sierra Nevada. Snowmelt from the Sierra Nevada and other ranges flows down the East Walker River and the West Walker River, which merge into the mainstem Walker River in Mason Valley, Nevada. The river continues flowing downstream into the northern end of Walker Lake. Walker Lake is bounded on the west by the Wassuk Range and on the east by the Gillis Range.

The study area for the water resources analysis incorporates five key hydrologic areas in the Walker River Basin: East Walker reach, Smith Valley reach, Mason Valley reach, Reservation reach and Walker Lake. For the purposes of this Revised DEIS water resources analysis, the boundaries of these areas are defined using the USGS gage locations shown in Figure 3-1. Water resources upstream of the study area are not expected to be affected by the acquisition alternatives and the No Action Alternative.

Other geographic terms used in this chapter are defined as follows:

- East Walker area—the East Walker reach and all flatlands along the East Walker River and Sweetwater Creek between the California border and Mason Valley.
- Upstream of Wabuska—the three most upstream reaches (East Walker reach, Smith Valley reach, and Mason Valley reach).
- Downstream of Wabuska—same as the Reservation reach.

The Affected Environment section describes the water resources in the study area that would be affected by the acquisition alternatives and the No Action Alternative. The discussion focuses on surface water, groundwater, the water balance for the Walker River system upstream of Wabuska, and water quality. Flows into and through the Reservation reach (including losses) are discussed in the surface water section that follows, and the water balance for Walker Lake is described under Walker Lake Analysis in the Environmental Consequences section of this chapter.

Surface Water

Key surface water topics discussed below include Walker Lake water surface elevations, Walker River flow both above and below Wabuska, and surface water diversions.

Walker Lake Water Surface Elevation

The volume of water in Walker Lake has a direct relation to water surface elevation (elevation) and surface area. This relation has been well defined by USGS (Lopes and Smith 2007, Appendix A). Surface area affects the volume of water that leaves the lake through evaporation, and changes in lake elevation expose or cover portions of the lake bed, which can affect resources addressed in other chapters of this Revised DEIS, such as recreation and air quality. In addition, lake volume has a strong influence on water quality.

Over millennia, Walker Lake has fluctuated well above and below the present lake elevation as a result of climate fluctuation and changes in the course of the Walker River. About 4,700 years ago, the lake filled quickly after having been dry or very low for at least 8,000 years (Bradbury et al. 1989). The lake level then probably remained high, peaking about 3,400 years ago (Adams 2007). During the past 3,400 years, lake level may have fluctuated between a shallow saline lake less than 3 feet deep (Benson et al. 1991) and a deep lake with a surface elevation of approximately and 4,120 feet [1](approximately 190 feet higher than the elevation during November 2009) (Adams 2007). At least some of the periods of lower lake levels were probably caused by the course of the river being diverted through the Adrian Valley to the Carson Basin (Benson et al 1991, Adams 2007).

Recent drops in lake level, however, have been caused by humans. Water surface elevation in Walker Lake has been declining since the late 1800s, when the diversion of water to irrigate agricultural crops began in the Walker River Basin. As described below, during recent years, approximately 67% of the combined inflow to East Walker reach and Smith Valley reach has been diverted for agriculture in the East Walker area, Smith Valley, and Mason Valley. In 1882, the lake elevation was estimated to be 4,083 feet (Russell 1885 as cited by Allander pers. comm. 2008b), but it has since dropped substantially and, as of November 2009, was at approximately 3,927 feet (U.S. Geological Survey 2009a). This represents an overall decline of 156 feet over 127 years, or an average decline of about 1.2 feet per year (Figure 3-2). With the drop in lake elevation, the concentration of TDS has increased (see Walker Lake Water Quality, Total Dissolved Solids, below).

[1] Note that many of the numbers presented in this chapter are rounded, which may cause some of the calculations to seem imprecise.

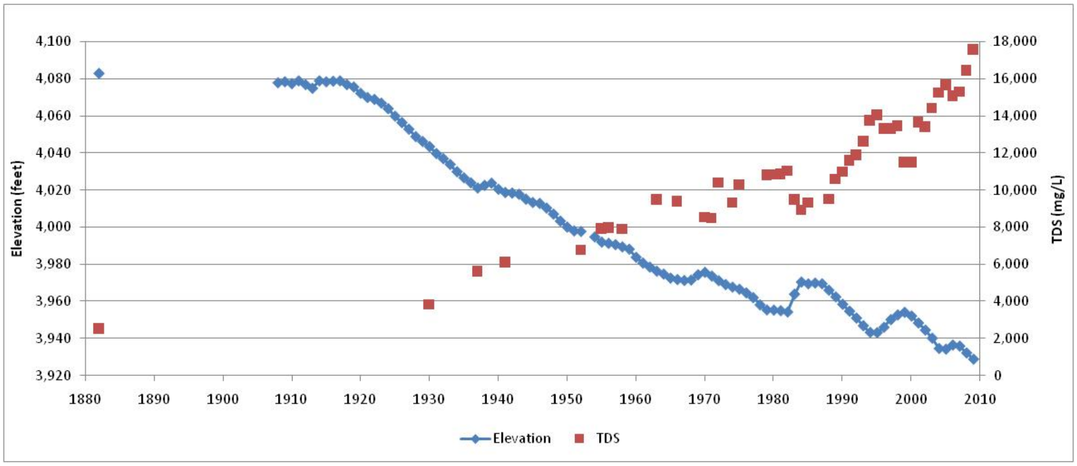

Figure 3-2. Walker Lake Water Surface Elevation and Concentration of Total Dissolved Solids since 1880

The volume of Walker Lake is dependent on inflow from Walker River, groundwater inflow, local surface water inflow, precipitation, and evaporation. The volume of water associated with evaporation and direct precipitation is largely dependent on the surface area. Groundwater inflow may also change in response to change in lake elevation; for example, as lake elevation drops, there is a steeper gradient from the groundwater aquifer to the lake. However, groundwater inflow is understood to be relatively small (less than 10%) compared to Walker River inflow and much of the groundwater inflow may be derived from the river (Lopes and Allander 2009a). The net change in groundwater inflow to the lake in response to river flow is uncertain because increased river flow would augment the aquifer, but higher lake elevation could reduce the gradient from the aquifer to the lake.

River Flow

USGS has measured flows at multiple locations in the Walker River Basin (Table 3-1). River flow is a major factor in the Walker Lake water budget (presented later in this chapter); it also influences other water supplies and habitat conditions. The change in river flow from the upstream to downstream ends of a reach (defined above) indicates the potential magnitude of accretions and depletions (i.e., inflow gains and losses).

Three types of flow are presented in this section: inflow to the study area, daily flow, and average flow. Inflow to the study area shows the total amount of surface water entering the system. The daily flow for wet and dry years shows the seasonal differences between these types of years. Finally, average monthly and annual flows provide a basis for understanding the system over the long term. In addition, average annual values are used in the water balance upstream of

Wabuska, and for the flow losses downstream of Wabuska (presented later in this section).

Table 3-1. USGS Flow and Storage Gage Locations in the Walker River Basin at or Downstream of Bridgeport and Topaz Lake Reservoirs

Gage Number	Full USGS Site Name (Short Site Name for EIS in Parenthesis)	Period of Record
West Walker		
10297000	Topaz Lake near Topaz, CA	1921-present
10297500	West Walker River at Hoye Bridge near Wellington, NV (Hoye Bridge Gage)	1910-present[a]
10298000	Saroni Canal near Wellington, NV	1920-1923
10298500	West Walker River near Wellington, NV	1918-1924
10299100	Desert Creek near Wellington, NV	1964-present
10300000	West Walker River near Hudson, NV (Hudson Gage)	1914-2008
East Walker		
10292500	Bridgeport Reservoir, CA	1971-present
10293000	East Walker River downstream of Bridgeport Reservoir, CA (Bridgeport Gage)	1921-present
10293048	Sweetwater Creek at Highway338 above Mouth near Bridgeport, CA	2005-present
10293050	East Walker River below Sweetwater Creek near Bridgeport, CA	1974-1982
10293500	East Walker River above Strosnider Ditch near Mason, NV (Strosnider Gage)	1947-present
10294000	East Walker River above Mason Valley near Mason, NV	1916-1924
10294500	East Walker River near Yerington, NV	1902-1908
10295000	East Walker River near Mason, NV	1910-1916
Mainstem Walker		
10300600	Walker River near Mason, NV	1974-1984
10301000	Walker River at Mason, NV	1910-1922
10301500	Walker River near Wabuska, NV (Wabuska Gage)	1902-present
10301600	Walker River above Weber Reservoir near Schurz, NV	1977-present[b]
10301700	Weber Reservoir near Schurz, NV	1995-present
10301742	Canal No. 2 above Little Dam near Schurz, NV (Canal 2 Gage)	1995-present
10301745	Walker River above[c] Little Dam near Schurz, NV	1995-present
10301755	Canal No. 1 below[c] Little Dam near Schurz, NV (Canal 1 Gage)	1995-present
10301900	Canal 2 at End of Lined Ditch below Schurz, NV	1998-2001
10302000	Walker River at Schurz, NV	1913-1933
10302002	Walker River at Lateral 2-A Siphon near Schurz, NV (Schurz	1994-present

Gage Number	Full USGS Site Name (Short Site Name for EIS in Parenthesis)	Period of Record
	Gage)	
10302010	Reese River Canyon near Schurz, NV	1966-1977
10302025	Walker River near Mouth at Walker Lake, NV	2004-2006
10288500	Walker Lake near Hawthorne, NV	2004 – present

[a] Some periods of records contain large gaps. *Present* indicates that data extend at least into 2008.

[b] Flow measurements at this gage can be inaccurate because flow sometimes bypasses the gage (Allander pers. comm. 2008b)

[c] Site names are based on the location of the gage houses, not the location of the flow being measured. Canal 1 diverts water above Little Dam and gage 10301745 measures flow in the river downstream of Little Dam (Allander pers. comm. 2008c).

Note: gage locations important to the Acquisition Program are highlighted.

Inflow to Study Area

Inflow at the upstream end of the East Walker reach is measured at the USGS gage downstream from Bridgeport Reservoir and inflow at the upstream end of the Smith Valley reach is measured at the USGS gage at Hoye Bridge. Because the acquisition alternatives and the No Action Alternative assume no major changes in reservoir operations upstream of these sites, the sum of the flows at these two gages provides a good estimate of the historic variability in flow entering the potentially affected valleys (Figure 3-3). Between water years 1960 and 2007, inflow to the two valleys ranged between about 100,000 and 800,000 af/yr.

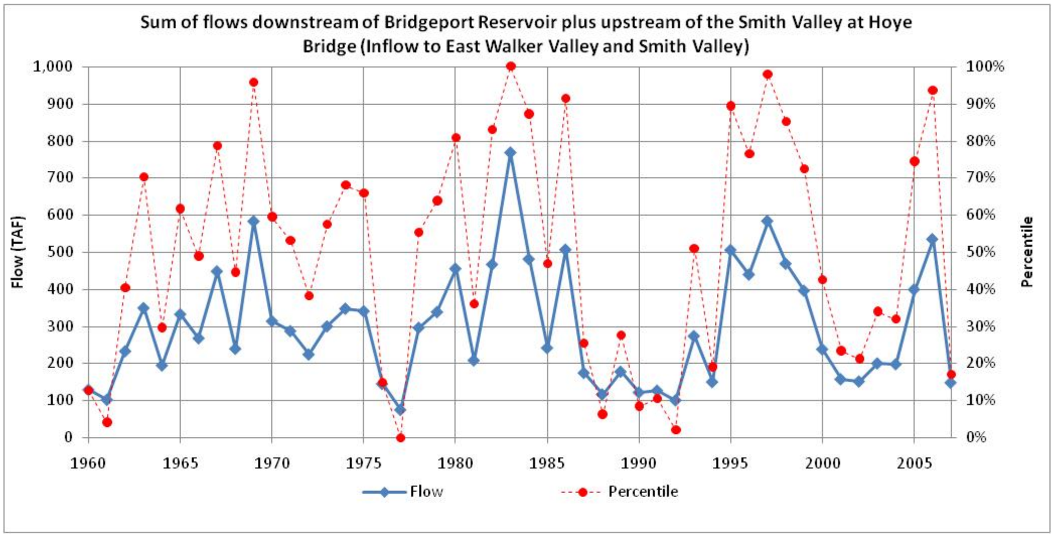

Figure 3-3. Flow Entering the Study Area for Water Years 1960–2007, with Percentiles Shown to Characterize the Extremity of Each Inflow Value

Daily Flows

To illustrate the flow patterns for a wet year and a dry year, daily flows for water year 1997 (98th percentile) and water year 2007 (17th percentile) are shown in Figures 3-4 through 3-7. These figures show flows at the upstream and downstream ends of the East Walker, Smith Valley, and Mason Valley reaches.

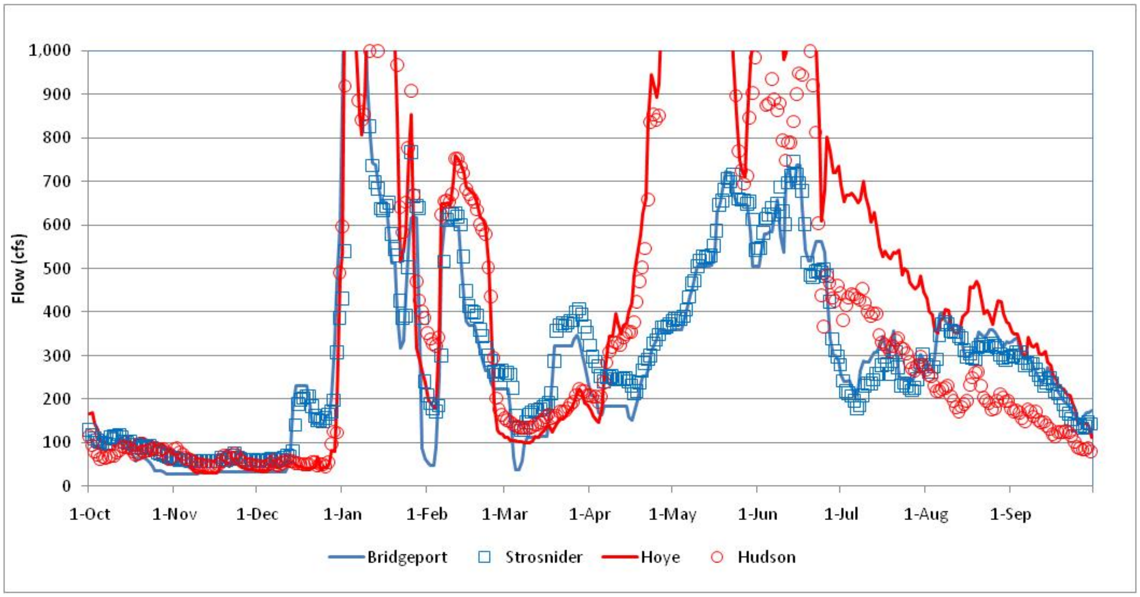

Figure 3-4. Daily Flow in the Smith Valley Reach and Along the East Walker Reach during a Wet Water Year, 1997

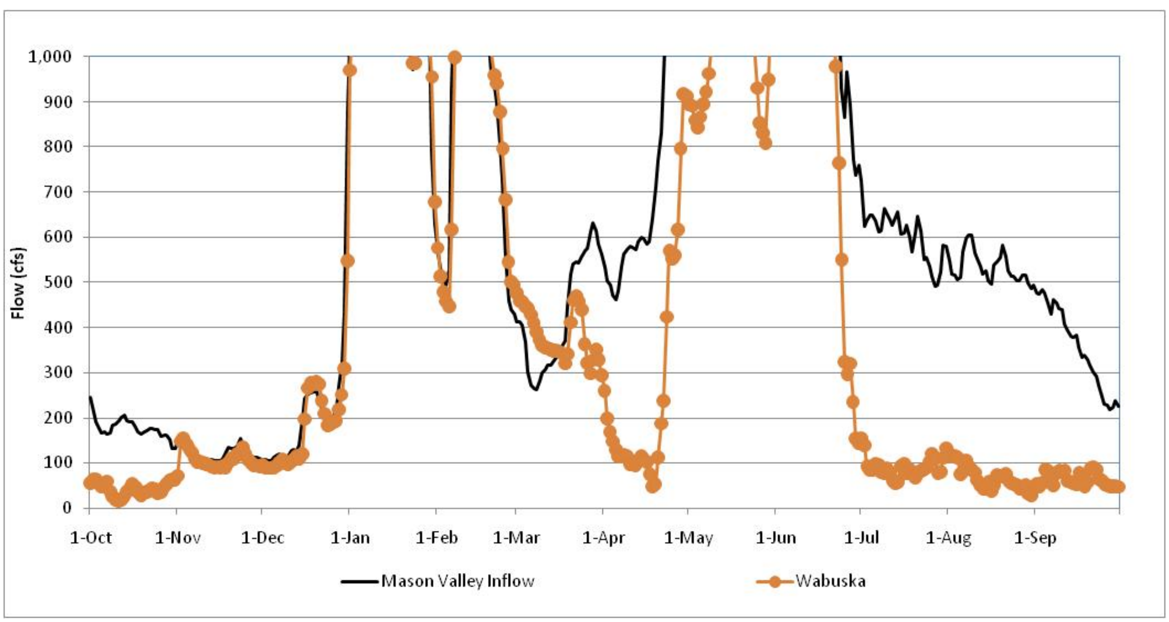

Figure 3-5. Daily Flow at the Upstream and Downstream Ends of the Mason Valley Reach during a Wet Water Year, 1997

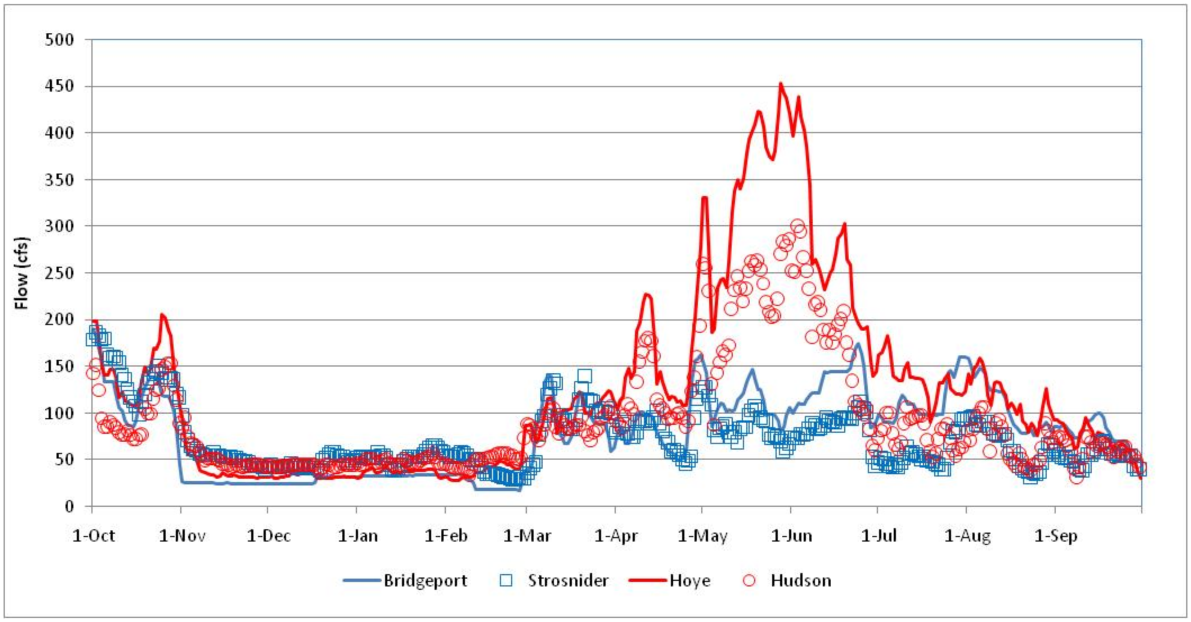

Figure 3-6. Daily Flow in the Smith Valley Reach and Along the East Walker Reach during a Dry Water Year, 2007

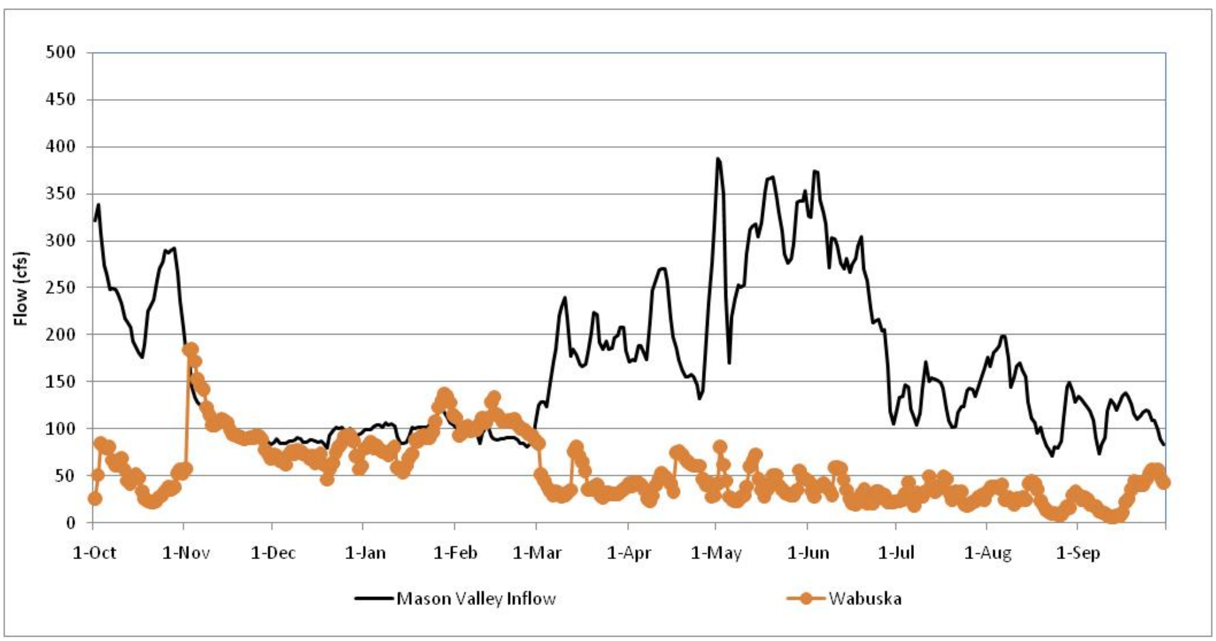

Figure 3-7. Daily Flow at the Upstream and Downstream Ends of the Mason Valley Reach during a Dry Water Year, 2007

During the wet year of 1997, winter flows at the downstream ends of the East Walker and Smith Valley reaches, measured at Strosnider and Hudson gages, respectively, were similar to but slightly greater than the flows entering these reaches at the Bridgeport and Hoye gages, respectively. The increases may be attributable to surface runoff, tributary inflow, or gains from groundwater accretions (Figure 3-4). Winter flows at the downstream end of Mason Valley were generally very similar to the flows at the upstream end of Mason Valley during 1997 (Figure 3-5). However, during January, peak flows entering Mason Valley were almost 6,000 cfs, but this flow was dissipated (either by leaving the river channel or by becoming more spread out along the length of the river) and peak flows leaving the valley only reached 2,500 cfs. Once the irrigation season began, flows at the downstream ends of Smith and Mason Valleys, at the Hudson and Wabuska gages, respectively, were noticeably lower than the flows at the upstream ends, but the decrease in flow along the East Walker River was not as noticeable.

During the dry year of 2007, there were no rainy-season peak runoff events (Figures 3-6 and 3-7) and peak flows (450 cfs entering Smith Valley) did not occur until the irrigation season. Despite the relatively dry hydrology, winter flows at the downstream ends of the East Walker reach and the Smith Valley reach were slightly greater than the upstream flows. Because this increase in flows occurred during this relatively dry year, there is an increased likelihood that the source of the local inflow is groundwater. Winter flows at the downstream end of Mason Valley were generally very similar or less than the flows at the upstream end of Mason Valley during 1997 (Figure 3-5). Once the irrigation season began, flows at the downstream ends of all valleys were noticeably lower than the flows at the upstream ends of the valleys.

Average Flows Upstream of Wabuska

To evaluate flows through the valleys, monthly average flows measured at the upstream and downstream ends of the East Walker, Smith Valley, and Mason Valley reaches were compared. The evaluation focused on 1981 through 2007 when supplemental groundwater pumping was more likely to be greater than past periods (Myers 2001b). At two locations (downstream ends of the East Walker and Smith Valley reaches), flow was not measured from October through March during water years 1979 through 1994. As a result, the average values for these months are based on a smaller number of years.

Peak flows generally occur during June in response to spring snow melt (Figure 3-8). Average June flow downstream of Bridgeport Reservoir was about 350 cfs, half of the approximately 700 cfs at the upstream end of the Smith Valley reach (Hoye gage). Flow at Wabuska, averaged 500 cfs for June, or half of the flow (1,050 cfs) entering the East Walker and Smith Valley reaches.

The pattern of flow losses and gains during the rainy season (approximately November through April) and irrigation season is similar to those described above for the 1997 and 2007 daily flows. There were slight increases in flow during the wet season along the East Walker and Smith Valley reaches and slight decreases in flow during the wet season in the Mason Valley reach. During the irrigation season, flow decreased noticeably in the Smith and Mason Valleys, but not substantially along the East Walker reach.

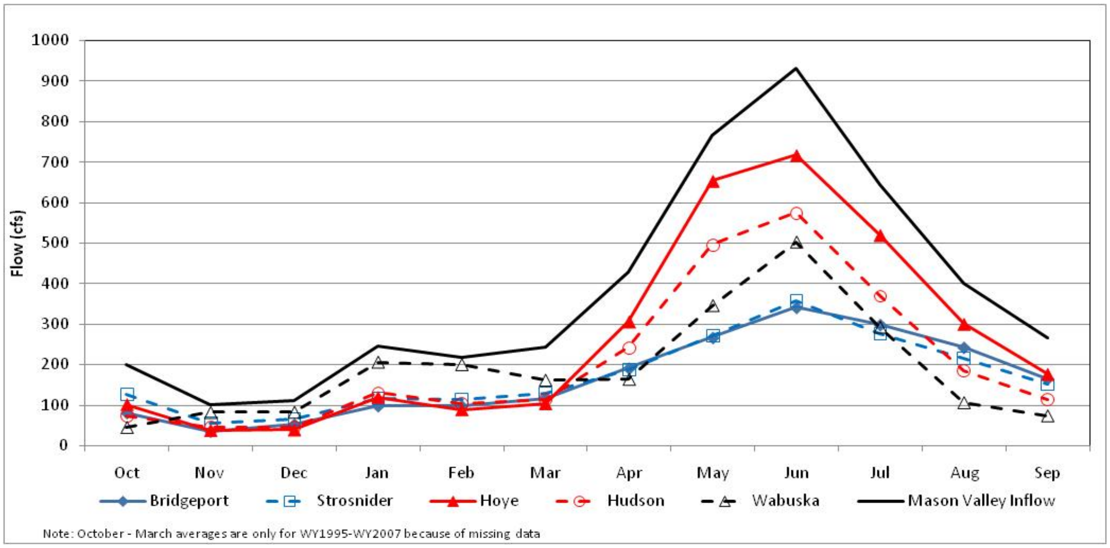

Figure 3-8. Average Monthly Flows in the Walker River Basin, 1981-2007

Average annual flow volumes at each of these locations are as follows:

- East Walker River downstream from Bridgeport Reservoir: 118,000 af
- East Walker River upstream of Strosnider Ditch: 125,000 af
- West Walker River at Hoye Bridge (upstream Smith Valley): 191,000 af
- West Walker River near Hudson (downstream Smith Valley): 151,000 af
- Walker River near Wabuska (downstream Mason Valley): 139,000 af

The averages are based on data from water years 1981 through 2007 (except for the Strosnider and Hudson gages). The sum of these average annual inflows to the East and West Walker Rivers is 309,000 af. Note that the total average annual flow volume at Wabuska (139,000 af) is 45% of the total inflow to the system (309,000 af).

Average Flows in Reservation Reach

Downstream from Wabuska (USGS gage 10301500), the Walker River flows through Weber Reservoir, then downstream to Canals 1 and 2, located just upstream of Little Dam on the Walker River Indian Reservation, approximately 22 miles upstream of Walker Lake. Upstream of Weber Reservoir and downstream from Schurz, the river is braided. Flow measurements just upstream of Weber Reservoir are unreliable because the channel is unstable, beaver structures can affect the channel depth, and some of the flow can bypass the gaged channel, sometimes as subsurface flow (Allander pers. comm. 2008b).

USGS has measured flow at the Wabuska gage since 1902. Flow has been measured at Canal 1, Canal 2 and in the Walker River at the lateral 2-A siphon near Schurz (Schurz gage) since 1995. The Schurz gage, located approximately 13.5 miles upstream of the present-day lake, has provided the best relatively long-term measurement of river flow entering Walker Lake. Flow has been measured closer to the lake, but for shorter periods. Figure 3-9 shows the monthly flows measured at the Schurz gage. Between 1995 and 2008, the average annual flow was 109,000 af. Flows at this location have been highly variable, ranging from 0 cfs to more than 1,000 cfs, with the highest occurring in June. Figure 3-10 shows the flow volumes measured annually and for the irrigation season from 1995 through 2007. This figure further illustrates the wide range of lake inflow values. Total flow at Schurz was more than 300,000 af in 1997, but less than 10,000 af/yr from 2001 through 2004. During 2007, flow at the Schurz gage was also low at 20,000 af, but not as low as it would have been without the WRPT fallowing program (described in more detail below). The pattern of flow volumes for the irrigation season is similar to the annual pattern.

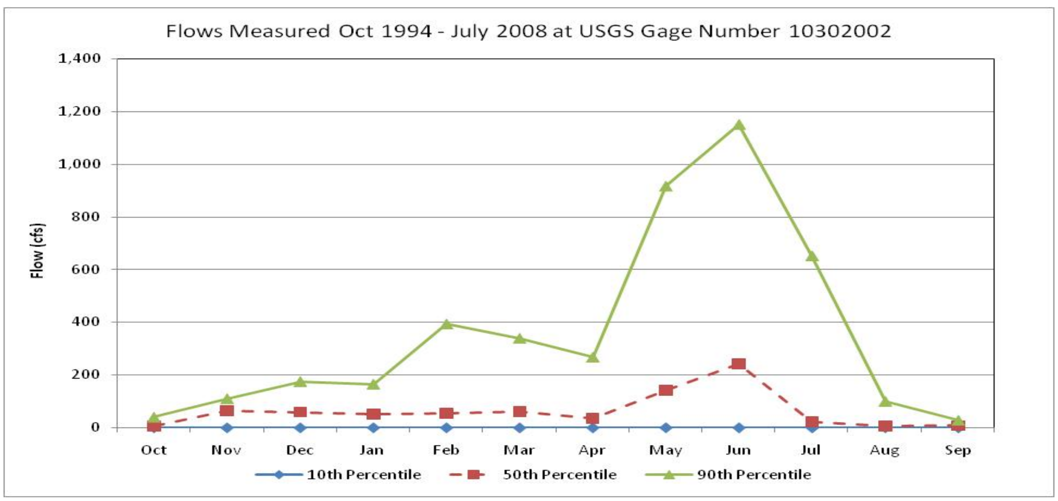

Figure 3-9. Distribution of Monthly Average Flow in the Walker River near Schurz

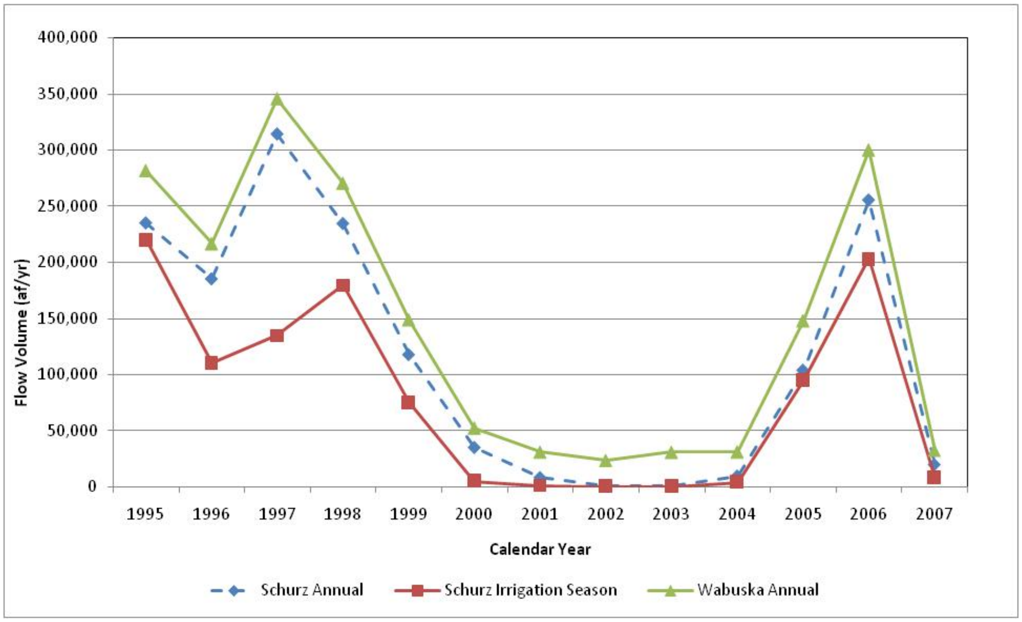

Figure 3-10. Annual and Irrigation-Season Flow in the Walker River near Schurz Compared to Annual Flow at Wabuska

Flow Loss in the Reservation Reach

The riverine losses in the Reservation reach are of interest for the purposes of assessing the loss of any acquired flows. As described in Chapter 2, Alternatives, it is assumed that WRPT, BIA, The University, and NFWF would develop an agreement for managing the passage of acquired water through the Reservation reach for delivery to Walker Lake. Therefore, the only reduction in volume of the acquired flow would be caused by loss to groundwater or evapotranspiration. These losses are influenced by travel time, the width of the channel, and local groundwater pumping. Increases in flow caused by the acquisition of water would increase width, but decrease travel time. The presence of acquired water is not expected to change groundwater pumping on lands in the Walker River Indian Reservation.

Walker River flow losses between Wabuska and Walker Lake were evaluated for two subreaches of the Reservation reach: Wabuska to Schurz, and Schurz to Walker Lake.

Flow Loss between Wabuska and Schurz

To evaluate river losses between Wabuska and Schurz, inflows at the upstream end of this reach were compared to the flows at the downstream end. Flows at the upstream end include the flow at Wabuska plus the drawdown in Weber Reservoir storage (an increase in storage would reduce the inflow) as measured by USGS. Flows at the downstream end include flows measured in Canals 1 and 2 plus flow at Schurz as measured by USGS. The analysis was performed using data for water years to avoid unrealistic fluctuations caused by time lags between upstream and downstream flows and to avoid comparisons between the summer and winter. When a small number of years are evaluated, Weber Reservoir drawdown can have an effect on the results, although the effect of Weber Reservoir drawdown is relatively small compared to the annual inflow at Wabuska. Complete datasets were only available for water years 1998 through 2007.

The amount of water lost does not correspond greatly to the amount of flow. Rather, river water losses are dependent on ET of riverine vegetation and infiltration to groundwater, where infiltration to groundwater depends largely on the effect of hydrologic conditions of prior years or the status of the aquifer. These losses can increase with increases in flow because greater channel width may allow for greater ET and infiltration. However, these losses do not increase in direct proportion to river flows because there is a fixed amount of vegetation for ET and because the river width does not increase in direct proportion to river flows. As a result, the river loss volume is not highly variable from year to year (Figure 3-11), indicating that an increase in flow may not incur a large increase in loss.

However, the percent of flow lost does vary greatly; higher percent losses occur during the drier years (Figure 3-12). Because these years contribute less to the filling of Walker Lake, these higher percents have less effect on lake volume than the lower percent losses that occur during the high flow years. For water years 1998 through 2007, 24% of the Wabuska flow disappeared before Schurz. The percentage of loss varied widely, from 4% in 1999 to 55% in 2002 (Figure 3-12). The data suggest that in years of greater water availability, when annual river inflow is greater than 50,000 af, the loss is typically less than 10%.

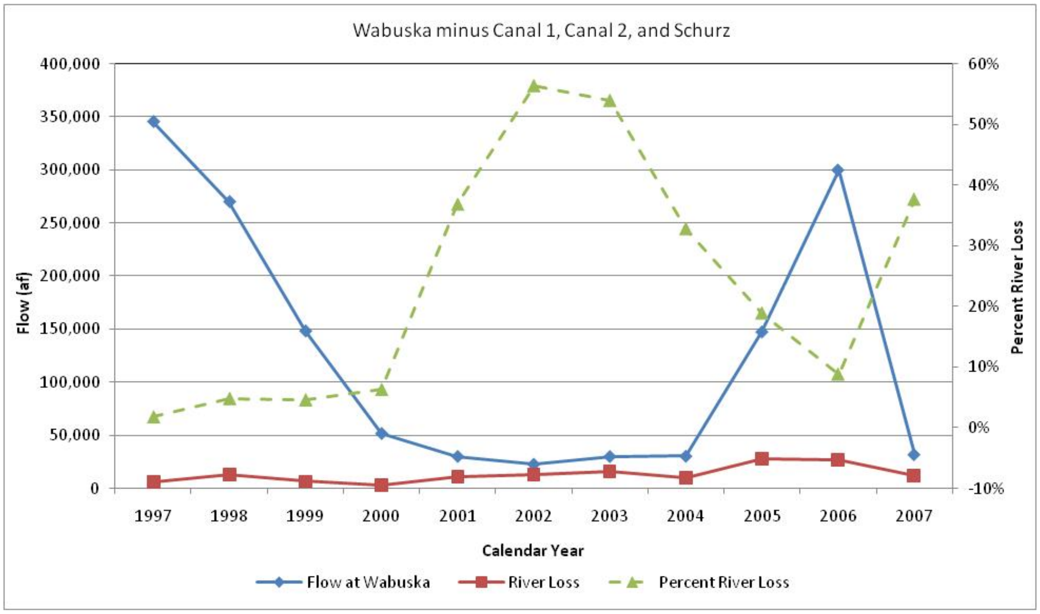

Figure 3-11. Annual River Flow and Losses Measured between Wabuska and Schurz

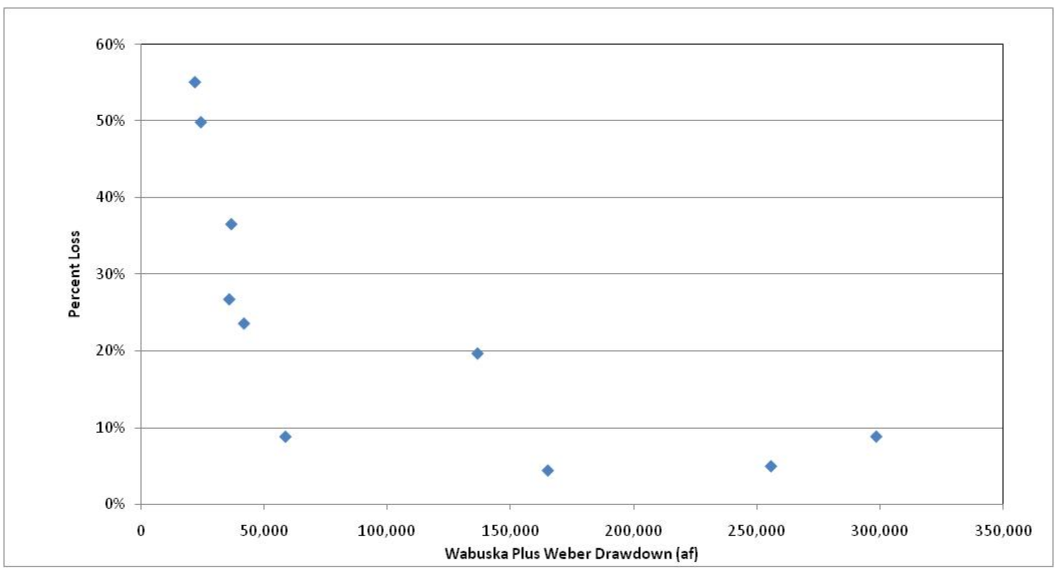

Figure 3-12. Percent Flow Loss between Wabuska and Schurz in Relation to Reach Inflow for Water Years 1998 through 2007

The relationship between reach inflow and river loss from Wabuska to Schurz was also analyzed (Figure 3-13). Average water year inflow to the Reservation reach (Wabuska plus Weber drawdown) was compared to the average riverine flow losses between Wabuska and Schurz for water years 1998 through 2007. The data indicate that as inflow increases, the volume lost may increase at a rate of approximately 4% of the reach inflow.

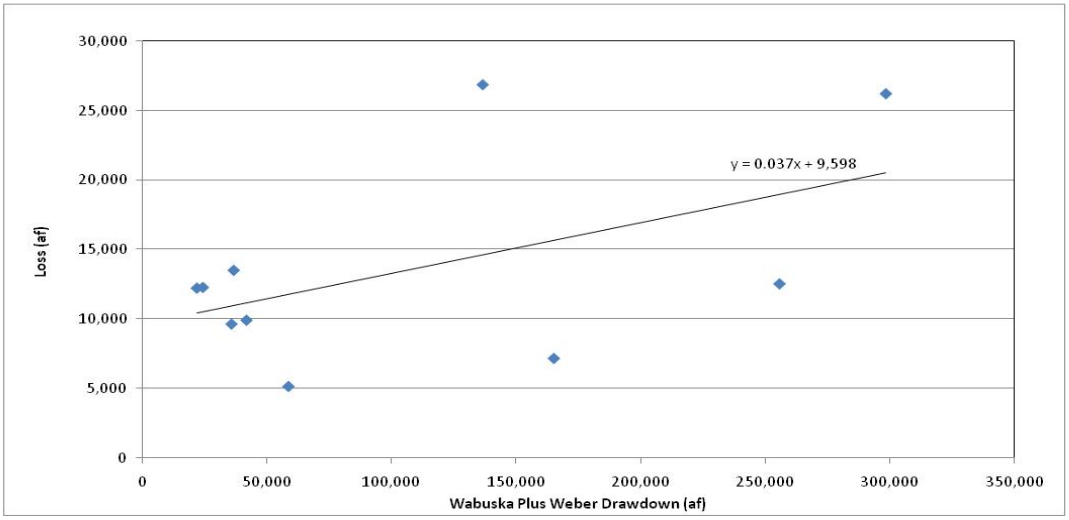

Figure 3-13. Correlation between Annual Flow and Flow Loss between Wabuska and Schurz (Water Years 1998 through 2007)

Flow Loss between Schurz and Walker Lake

Flow losses in this reach are uncertain because of limited data and periods of no flow reaching Walker Lake. Losses may increase with increased flow as a result of increased ET or increased infiltration to groundwater. In this reach, some of the water infiltrating to groundwater likely flows subsurface into the lake, so some of the riverine losses may not be lost to Walker Lake.

From March 14, 2007 through September 27, 2007, Huffman and Carpenter (2007) measured flow intermittently near the Schurz gage and at Pelican Point, approximately 0.75 mile upstream of Walker Lake. The Pelican Point location was the most downstream location found for suitable flow measurements. Toward the end of the study, the Pelican Point site was dry. From March through June, when flow was present at Pelican Point, approximately 900 af (average of 4 cfs) out of 12,500 that flowed past the Schurz gage was lost. This represented approximately 7% of the inflow from Wabuska plus Weber Reservoir drawdown.

USGS measured flow intermittently between 1994 and 2007, and made a preliminary finding that little flow was lost between Schurz and the lake

(Lopes 2007). More intensive flow measurements in this reach have occurred for relatively short periods. USGS operated flow gage 10302025 at the mouth of the Walker River between October 2004 and May 2006. The USGS flow measurements at the mouth of the Walker River are useful because they cover more than 1 year. Figure 3-14 shows the monthly flows and losses that were measured by the USGS between Schurz and the lake.

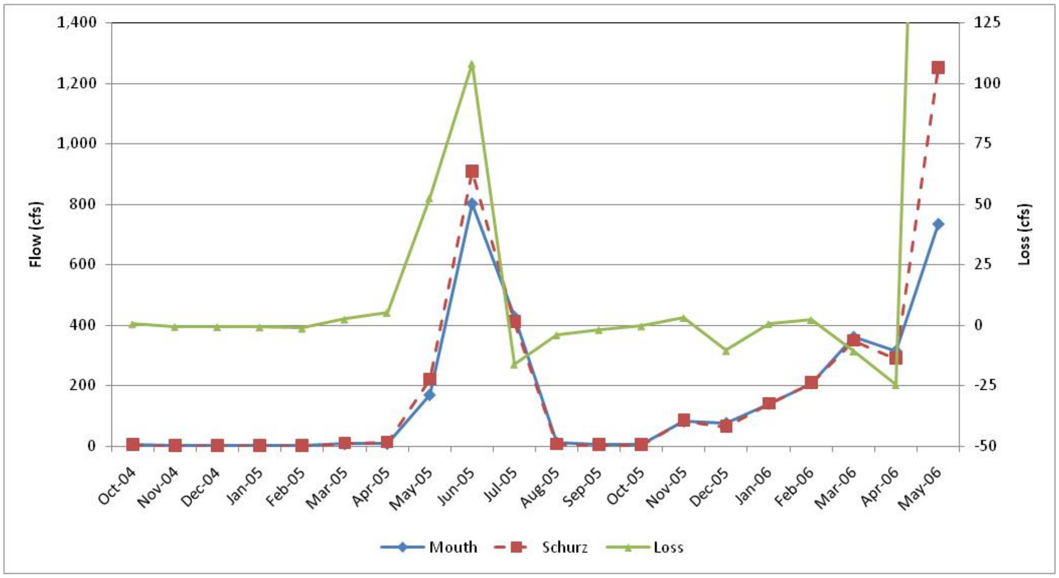

Figure 3-14. Monthly Difference between Flows Measured at Schurz and at the Mouth of the Walker River

Water year 2005 provides a useful example of potential flow losses, particularly because most of the flow occurred during the irrigation season when losses would be expected to be most similar to losses experienced by flow augmentation. During water year 2005, total flow loss between Schurz and the lake was measured as 8,600 af, 6% of the flow at Wabuska (plus Weber Reservoir drawdown). In contrast, for the first part of water year 2006, the loss was almost zero. The data indicate that the greatest losses from the river may occur as flow is increasing. When flows drop, however, the river may gain flow (e.g., July 2005, December 2005, and April 2006).

During water year 2005, most of the 8,600 af of lost water left the river through infiltration. Direct evaporation from the surface of the river is relatively small (probably less that 1,000 af) because of the relatively small surface area of the river (probably less than 150 acres for this reach). Once water infiltrates the substrate, it can then either be used by riparian and wetland vegetation or be pumped for irrigation. Water that remains in the aquifer may move through the substrate to the lake or head east out of the Walker River Basin toward Double Springs (Lopes 2008a).

Surface Water Diversions for Irrigation

Mason Valley and Smith Valley have a large network of irrigation ditches and canals. Figure 3-15 shows a schematic of major canals in the Walker River Basin in Nevada. This figure is similar to Figure 2-1 except that it is a schematic (not a map), it shows only the larger canals, and it shows some of the return drains.

Surface water diversions provide an indication of how much water may be available for purchase. Surface water diversion data for the Walker River are collected by USGS, WRID, and the federal water master. Data for 1931 through 1995 were compiled by NDWP (Pahl 2000). More recent data have been collected by the federal water master and WRID. This analysis uses data from both sources.

The compiled diversions are summarized in Table 3-2 for the period 1931 through 2007. A subset reflects more recent groundwater usage (1981 through 2007). These data exclude Walker River diversions in California, Antelope Valley, and on the Walker River Indian Reservation.

The data indicate that total surface water diversions for the East Walker, Smith Valley, and Mason Valley reaches averaged about 225,000 af/yr for 1931 through 2007, with considerable annual variation. Minimum annual surface water diversion was about 57,000 af and the maximum was close to 366,000 af. Average diversions for the full period of record were a little larger than those for the more recent record. The biggest differences in diversions between the two time periods occurred in Smith Valley (10,000 af less) and Mason Valley (12,000 af less).

The more recent diversion data for 1981 through 2007 indicate an average diversion of about 207,000 af/yr. This represents about 67% of the average inflow to the East Walker reach and Smith Valley (average of 309,000 af/yr for the same period).

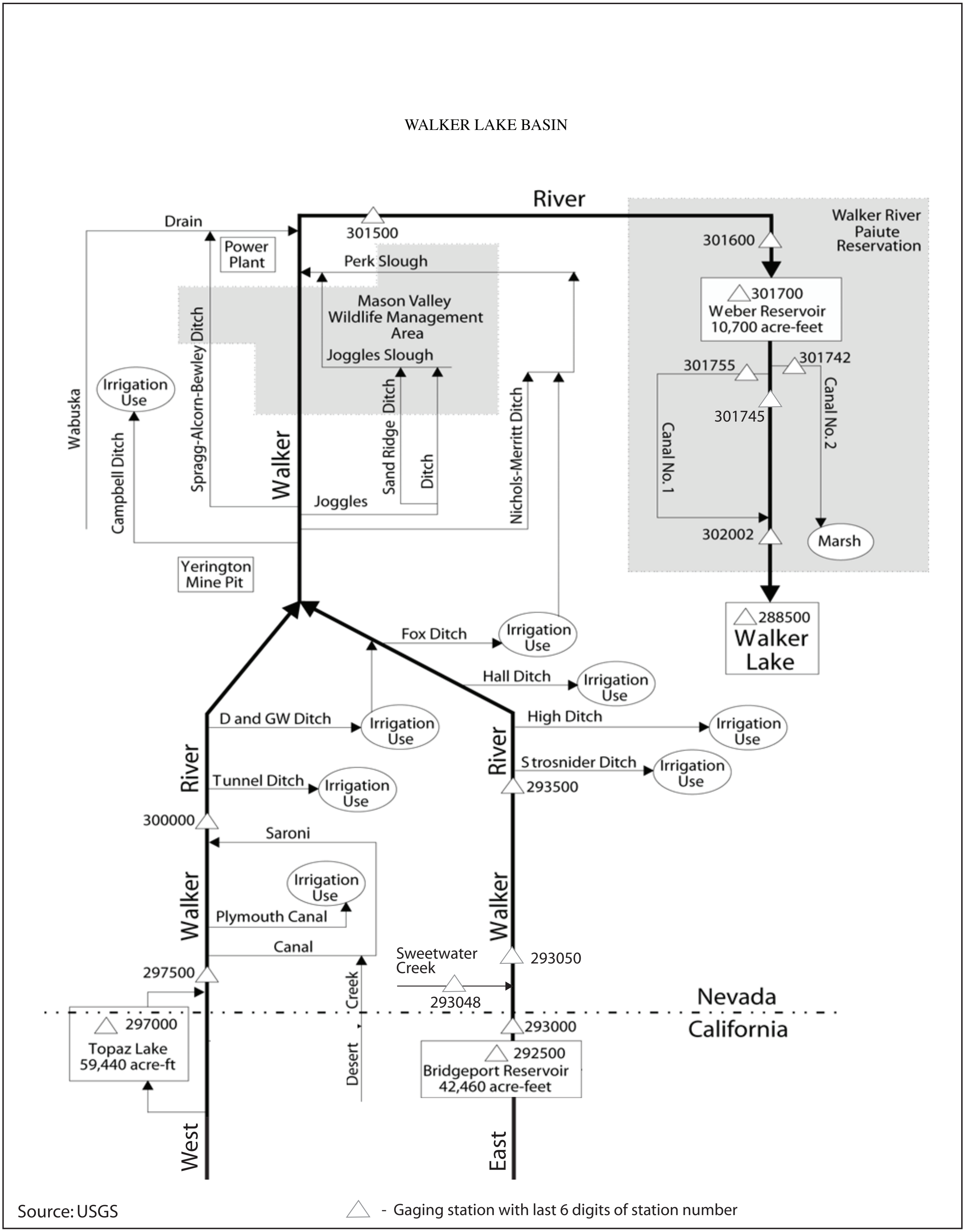

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Figure 3-15
Schematic Diagram of Flow System and Gaging Stations in the Walker Lake Basin

Table 3-2. Summary of Walker River Surface Water Diversions between 1931 and 2007

Year	Smith Valley Reach (acre-feet)	East Walker Reach (acre-feet)	Mason Valley Reach (acre-feet)	Total [a] (acre-feet)
1931-2007				
Minimum	14,400	6,800	35,035	57,245
Average	69,110	21,588	137,598	224,781
Maximum	119,142	37,394	219,412	365,560
1981-2007				
Minimum	14,400	7,125	35,719	57,245
Average	59,095	21,913	125,707	206,715
Maximum	117,147	37,394	202,924	344,992

This summary excludes diversions from streams tributary to the Walker River reaches.

[a] Only years with a full complement of data for each reach were included in the calculation. The calculation of minimum, average, and maximum values was based on totals for each year, not the reach components.

Surface water rights are divided into three major types:

- Decree water rights are rights to divert natural river flow (i.e., flow without support from upstream storage).
- Storage water rights are rights (allocated by WRID) to use water previously stored in upstream reservoirs (specifically Bridgeport and Topaz Lake Reservoirs).
- Flood water rights are rights (allocated by WRID) to make use of natural river flow when there is excess or surplus water in the river (i.e., no unmet demand for decree rights).

Myers (2001c) differentiated diversion data obtained from NDWP into water right type (Table 3-3). Of the total surface water diversions from 1931 to 1995 along the East Walker River, Smith Valley, and Mason Valley, approximately 60% were decree, 29% storage, and 11% flood. These percents varied by reach with the percent of decree water being as high as 81% (for the mainstem portion of Mason Valley) and as low as 43% (for Smith Valley). As a result, more of the Smith Valley diversions were storage diversions (38%) and floodwater diversions (18%) compared to the other reaches.

Table 3-3. Surface Water Diversions for 1931-1995 Categorized by Water Right Type

	Average Decree Diversion	Average Storage Diversion	Average Flood Water Diversion	Total
Acre-Feet Per Year				
East Walker	40,023	22,043	7,422	69,488
Mason Valley	55,076	9,975	3,195	68,246
Smith Valley	30,765	27,499	13,208	71,472
Tunnel Section	12,663	6,426	2,339	21,428
Total	138,527	65,943	26,164	230,634
Percent of Total for Region				
East Walker	58%	32%	11%	
Mason Valley	81%	15%	5%	
Smith Valley	43%	38%	18%	
Tunnel Section	59%	30%	11%	
Total	60%	29%	11%	

Source: Myers 2001c

BIA diverts water for agricultural purposes out of the Walker River at Canals 1 and 2 and delivers this water to 2,100 acres of Indian trust land in the Walker River Indian Irrigation Project. Canals 1 and 2 are located downstream from Weber Reservoir and immediately upstream of Little Dam. USGS has collected flow data for these canals since 1995. The direct flow water right for the Walker River Indian Irrigation Project is 26.25 cfs diverted on or above the reservation for 180 days during the irrigation season, or about 9,400 af/yr, which the federal water master administers at Wabuska. Additionally, for over 60 years, BIA has stored water in Weber Reservoir and used the stored water to regulate and deliver the direct flow water right. The federal claim for this use of the water stored and released from Weber Reservoir is pending in the Walker Decree proceeding. Capacity of Weber Reservoir is approximately 10,700 af. From water years 1997 through 2006, annual diversions into Canals 1 and 2 averaged about 16,000 af. During 2007, 2008, and 2009, WRPT offered fallowing agreements to the landowners of the 2,100 acres in the Walker River Indian Irrigation Project, which were accepted by the landowners and approved by BIA. As such, BIA did not divert water through Canals 1 and 2 in 2007, 2008, and 2009; BIA established an operating plan for water releases from Weber Dam to Walker Lake in coordination with WRPT and other entities. During all 3 years of the fallowing program, April through October flow downstream of Canals 1 and 2 measured at USGS Gage 10301745 have exceeded the WRPT water right of approximately 9,400 af/yr, indicating a full transfer of water from WRPT to Walker River.

Land Coverage

Amounts of irrigated land and riparian and wetland vegetation in the study area are relevant to the upstream water balance presented later in this section. Total acreage in the valley floors is presented for context.

Acreage of Valley Floors

Acres of the flat portion of each valley indicate the potential surface area of the aquifers and can be used to assess the relative magnitude of groundwater effects. USGS topographic maps and GIS data were used to estimate the relatively flat areas of the East Walker area and Smith and Mason Valleys as follows:

- East Walker area including the valley of Sweetwater Creek – 26,000 acres
- Smith Valley – 81,000 acres
- Mason Valley – 114,000 acres

Water-Righted Acres

Water-righted acres (acres with water rights) are important for assessing land use, magnitude of potential water rights available for acquisition, and impacts from a water-rights perspective. They are used in the Consumptive Use Scenarios described below for the assessment of impacts on irrigated lands and groundwater. In the East Walker area, Smith Valley, and Mason Valley, there are approximately 45,800 acres with natural flow Decree C-125 water rights, 34,500 acres with New Land storage water rights, and 1,070 acres with primary groundwater rights, for a total of approximately 81,370 water-righted acres (Table 3-4).

Table 3-4. Water-Righted Acres

	Decree Acres with Natural Flow Rights[a,b]	New Land Acres with Storage Rights[a,c]	Acres with Primary Groundwater Rights[d]	Total
East Walker	3,722	5,090		8,812
Smith Valley	8,905	11,886	933	21,724
Mason Valley	33,174	17,525	136	50,835
Total	45,801	34,500	1,069	81,370

[a] These values are based on Myers 2001c.

[b] Land with natural flow decree rights may also have rights to supplemental storage water, supplemental groundwater, and floodwater

[c] New Land acres also have rights to supplemental groundwater and floodwater.

[d] These acres are roughly estimated as equal to the acres with center-pivot groundwater pumping as reported by Lopes and Allander (2009a).

Acreage of Irrigated Land and Riparian/Wetland Vegetation

Vegetated land coverage can be used to estimate the consumptive use of irrigated lands and the incidental use of water by non-riverine riparian and wetland vegetation. DRI has used GIS evaluation of remote sensing results to estimate the number of irrigated and riparian/wetland acres in Smith Valley, Mason Valley, the East Walker River between Mason Valley and the California border, and the region of the Walker River Indian Reservation between Wabuska and Walker Lake. (The DRI investigation also covered Antelope Valley, but because Antelope Valley is not expected to be affected by the acquisition alternatives, it is not discussed further here.) The evaluation was based on six Landsat Thematic Mapper images taken during the late summer of each of 6 years between 1986 and 2002 (Desert Research Institute 2006). Fallow land and vegetation in urban areas were not included in the irrigated or riparian/wetland acres (Desert Research Institute 2006).

Irrigated area in Mason Valley varied between about 30,000 and 39,500 acres, with an average of 35,000 acres (Table 3-5). Irrigated area in Smith Valley varied between about 13,500 and 19,500 acres, with an average of 17,500 acres. Irrigated acres along the East Walker River and at the Walker River Indian Reservation were considerably less, with average values of about 4,000 acres and 2,500 acres, respectively. The combined irrigated acres ranged widely, between 62,300 and 46,200 acres, a very large difference of 16,100 acres.

In Mason and Smith Valleys, riparian/wetland acres were considerably less than irrigated acres, with average values of about 7,500 and 3,500 acres, respectively. Along the East Walker River, the average riparian/wetland acres were 3,000 acres and on the Walker River Indian Reservation, the average riparian/wetland acres were about 4,000 acres. The riparian/wetland area in Mason Valley and on the reservation are relatively large because they include portions of the Mason Valley WMA and the marsh areas upstream of Weber Reservoir and Walker Lake.

The University and DRI assessment of irrigated land for 2006 and 2007 (Bonnenfant et al. 2009) was not used in this analysis because the estimated irrigated acres were very similar to the values shown here and because there were no corresponding estimates of riparian/wetland area.

Table 3-5. Estimated Acreage of Irrigated Land and Riparian/Wetland Land

Region	Estimated Irrigated Lands (acres)						Average
	1986	1992	1995	1998	2000	2002	
Mason Valley	35,853	29,963	33,412	37,503	39,459	33,641	34,972
Smith Valley	19,446	13,554	17,562	18,002	18,843	17,306	17,452
East Walker River	5,108	2,731	4,990	3,979	4,033	3,248	4,015
Reservation	2,495	2,245	2,574	2,847	2,815	2,155	2,522
	Estimated Riparian/Wetland Vegetation (acres)						
Mason Valley	10,707	5,828	7,518	7,912	6,507	6,129	7,434
Smith Valley	5,259	2,659	3,165	4,401	2,358	2,012	3,309
East Walker River	3,156	3,001	2,863	3,466	2,924	2,631	3,007
Reservation	6,075	2,890	4,613	4,476	3,918	3,045	4,170

Source: Desert Research Institute 2006, Appendix A

Acreage of Riverine Vegetation

The riparian/wetland acres were divided into riverine and non-riverine acres using GIS analysis of maps from the Gap Analysis Program (GAP) (U.S. Geological Survey National Gap Analysis Program 2004). Because most vegetation along the Walker River grows within 1,000 feet of the river, it was assumed that this vegetation depends on shallow groundwater provided by the river. Riparian/wetland vegetation farther from the river was assumed to be directly dependent on irrigation, or indirectly dependent on irrigation, using shallow groundwater maintained by irrigation. It was estimated that 88%, 33%, and 34% of the riparian/wetland vegetation within the East Walker Valley, Smith Valley, and Mason Valley, respectively, is riverine (i.e., within 1,000 feet of the Walker River).

Groundwater

Key groundwater topics include hydrogeology, groundwater levels, groundwater pumping, and the river-groundwater connection.

Hydrogeology

Surface water is the primary source of groundwater in the Walker River Basin. Groundwater inflow occurs via infiltration into alluvial aquifers from both crop irrigation water and water bodies (primarily Walker River) (Sharpe et al. 2008).

There is little groundwater movement between the groundwater basins associated with each valley (Thomas 1995). In this Revised DEIS, groundwater recharge refers to groundwater recharge from all sources, whereas incidental groundwater recharge refers to groundwater recharge resulting from the conveyance and use of irrigation water.

Smith Valley

The Smith Valley aquifer occurs in alluvial deposits consisting of unconsolidated gravel, sand, silt, and clay; the older deposits are more consolidated than the younger deposits (Sharpe et al. 2008). Similar to the majority of other basins in the Walker River system, the aquifer in Smith Valley is bounded by low-permeability consolidated rocks. The presence of flowing wells with thick clay layers indicates that there are some confined portions of the Smith Valley aquifer (Lopes and Allander 2009b). It is estimated that Smith Valley contains 1.5 million af of water stored in the upper 100 feet of saturated alluvium, based on an effective area of 100,000 acres for the aquifer (Rush and Schroer 1976).

In Smith Valley north of the West Walker River, there is a groundwater and topographic divide that separates the motion of groundwater and surface water drainage (Myers 2001a). North of the divide, groundwater tends to move toward Alkali Lake, which is 200 feet lower in elevation than the West Walker River and south of the divide, groundwater tends to move toward the Walker River (Myers 2001a). Prior to the advent of surface water irrigation, groundwater probably flowed from the river toward Alkali Lake (Myers 2001a).

The main source of aquifer recharge is the West Walker River, either directly or through irrigation. Some recharge also comes from subsurface flow from the mountains, supplying an estimated 17,000 af/yr, primarily from the Pine Nut Mountains, Sweetwater Mountains, and Wellington Hills. Desert Creek, with an estimated average flow of 8,500 af/yr, also provides groundwater recharge directly or through irrigation (Rush and Schroer 1976). At altitudes less than 6,000 feet, valley floor precipitation does not contribute to aquifer recharge (Sharpe et al. 2008). Groundwater recharge from areas north of Alkali Lake and north of the groundwater divide have not been well quantified (Myers 2001a). Groundwater outflow from the basin is assumed to be minimal (Sharpe et al. 2008).

Mason Valley

Similar to Smith Valley, Mason Valley has an alluvial aquifer. Unconsolidated gravel, sand, silt, and clay comprise the Mason Valley alluvium (Huxel and Harris 1969). Relative to the valley fill deposits, the surrounding bedrock has little hydraulic conductivity, resulting in minimal groundwater outflow from the consolidated rock (Sharpe et al. 2008). Approximately 1.1 million af of groundwater are stored in the upper 50 feet of saturated alluvium in Mason Valley (Huxel and Harris 1969).

Like Smith Valley, the aquifer in Mason Valley is primarily recharged by percolation of irrigation water derived mainly from diversions of Walker River (Sharpe et al. 2008). Aquifer recharge from precipitation in the surrounding mountains is estimated to be only 2,000 af/yr (Huxel and Harris 1969). There is no contribution to aquifer recharge from precipitation on the valley floor (Sharpe et al. 2008). Mason Valley groundwater outflow is estimated to be 1,600 af/yr, and inflow, beneath the East and West Walker Rivers, is approximately 500 af/yr (Huxel and Harris 1969). Some of the groundwater exits the valley to the Schurz area (Huxel and Harris 1969) and some moves through the Desert Mountains via the Wabuska lineament into Churchill Valley (Lopes 2008b).

East Walker River Area

There are three distinct aquifer systems in the East Walker River area: Sweetwater Flat, the Rough Creek area, and the area tributary to the East Walker River in the downstream portion of the drainage basin (Sharpe et al. 2008). Young and old alluvium comprise the aquifers in the East Walker River area; the old alluvium is unconsolidated to consolidated deposits of boulders, gravel, sand, silt, and clay, and the young alluvium is primarily unconsolidated zones of gravel, sand, silt, and clay (Sharpe et al. 2008). Similar to the other Walker River Basin aquifers previously discussed, the alluvial aquifers in the East Walker River area are bounded by consolidated rock, which transmits little water (Sharpe et al. 2008). It is estimated that 800,000 af of water is stored in the upper 100 feet of saturated sediment in the area (Glancy 1971).

The alluvial aquifers in the East Walker River are recharged by East Walker River water and from precipitation in the surrounding mountains. Of the 31,000 af/yr recharged from precipitation, it is estimated that 18,000 af/yr goes to the Rough Creek drainage area’s alluvial aquifers (Glancy 1971). Groundwater inflow from Bridgeport Valley is approximately 200 af/yr, and groundwater outflow from East Walker River area to Mason Valley is approximately 150 af/yr (Glancy 1971). More than 97% of the 18,000 af of recharge water in the Rough Creek area is estimated to flow out of the East Walker River drainage area toward Mono Valley (Glancy 1971).

Schurz and Walker River Indian Reservation Area

Consolidated rock surrounds the valley fill deposits in the area, and is considered nearly impermeable (Schaefer 1980). The valley fill deposits are alluvial and are composed primarily of sand, silt, and clay (Schaefer 1980). Approximately 1.5 million af of groundwater is stored in the upper 100 feet of saturated alluvial deposits in the Schurz area (Resource Concepts 2000).

Groundwater recharge in the area comes primarily from the seepage of Walker River water into the aquifer. Precipitation, subsurface inflow, and infiltration of irrigation water also contribute to the recharge of the area's alluvial aquifer (Sharpe et al. 2008). An estimated 500 af/yr from precipitation contributes to aquifer recharge in the Schurz area (Everett and Rush 1967). Inflow to the basin from Mason Valley through Walker and Parker gaps is approximately 1,400 af/yr (Huxel and Harris 1969). The outflow of groundwater from the Schurz area to Walker Lake was estimated at nearly 11,000 af/yr by Shaefer (1980), but more recently has been estimated as 5,000 af/yr by Lopes and Allander (2009a). In addition, some groundwater leaves the Schurz area by heading east out of the Walker River Basin toward Double Springs (Lopes 2008a).

Whiskey Flat-Hawthorne Area

The Whiskey Flat-Hawthorne area extends south from the southern end of Walker Lake. Consolidated rock lies beneath the alluvial deposits and surrounds the valley fill deposits in the area and is assumed to have low permeability (Everett and Rush 1967). The alluvial deposits are poorly consolidated to unconsolidated (Everett and Rush 1967).

Approximately 900,000 af of groundwater is stored in the upper 100 feet of saturated alluvial deposits in the Whiskey Flat-Hawthorne area (Everett and Rush 1967). The aquifer is the drinking water source for the town of Hawthorne and is used for limited irrigation in both Hawthorne and Whiskey Flat (Everett and Rush 1967). The sources of groundwater recharge in the Whiskey Flat-Hawthorne area include precipitation, Walker River seepage, and irrigation water (Everett and Rush 1967). Everett and Rush (1967) estimated that the annual recharge to the Whiskey Flat-Hawthorne area is 5,400 af.

Walker Lake Area

The Walker Lake area includes the east and west sides adjacent to Walker Lake. Walker Lake is bounded by the Wassuk Range on the west side, which is solid rock nearly to the shore. Approximately 100,000 af of groundwater is stored in the upper 100 feet of saturated alluvial deposits in the area's aquifer (Everett and Rush 1967). Groundwater in the area is recharged by seepage from Walker River, percolation of irrigation water, and precipitation, primarily from the surrounding mountains (Everett and Rush 1967). Little recharge enters from the mountains immediately west of the lake because of the consolidated rock and steep slopes (Everett and Rush 1967). Annual recharge to the alluvial aquifer in the Walker Lake area is approximately 600 af (Everett and Rush 1967).

Groundwater Withdrawals

There are two types of groundwater rights, as described below.

- Primary groundwater rights: The holder of these rights can apply water only to specific pieces of land. The land to which these rights are appurtenant does not receive surface water.
- Supplemental groundwater rights: The holder of these rights can use groundwater to supplement surface water diversions or primary groundwater rights; however, the combination of the surface water diversions and supplemental groundwater is not to exceed a specified amount.

Groundwater pumping can be combined with surface water diversions and other information to estimate total water withdrawals and water efficiency.

Groundwater pumping records have been compiled for Smith and Mason Valleys for 1994 through 2004 by NDWR (Gallagher 2006). As river flow increases (and the availability of surface water increases), the amount of groundwater pumping decreases (Lopes 2008a). Annual groundwater pumping in Smith Valley ranged from 10,000 to 33,000 af, with an average of 24,000 af (Table 3-6). Annual groundwater pumping in Mason Valley ranged from 40,000 to 122,000 af, with an average of 79,000 af. Myers (2001) estimates that, on average, about 50% of all groundwater withdrawals involve supplemental pumping, with considerable year-to-year variability (e.g., 45 to 55% in Smith Valley and 36 to 62% in Mason Valley during the 3-year period [1994 through 1996] for which estimates by type were available).

Table 3-6. Groundwater Pumping in Smith and Mason Valleys from 1994 through 2004

	Smith Valley (acre-feet)	Mason Valley (acre-feet)
1994	33,204	122,001
1995	10,340	41,427
1996	17,249	51,302
1997	15,901	43,264
1998	13,391	39,645
1999	16,957	48,856
2000	29,579	83,888
2001	31,313	116,016
2002	32,518	114,809
2003	30,959	101,512
2004	32,805	108,495
Average	24,020	79,201

Source: Gallagher 2006

NDWR has not collected groundwater pumping records for the East Walker River upstream of Mason Valley, nor for the Walker River Indian Reservation (Beutner pers. comm.).

Smith Valley, Mason Valley, and Whiskey Flat-Hawthorne (Walker Lake) groundwater subbasins have been designated by the NSE and are closed to new groundwater appropriations for irrigation purposes.

Groundwater Levels

Measurements of groundwater levels over time indicate whether aquifer storage is changing. Information on existing trends in Smith and Mason Valleys is presented below.

Smith Valley

Groundwater levels in Smith Valley appear to have decreased (Figure 3-16). Between 1972 and 1993, the groundwater gradient toward the river decreased from 0.0083 to 0.0033 (i.e., for every 10,000 feet in a horizontal direction toward the river, there is a 33-foot drop in the top of the aquifer). Despite the decrease in gradient, the Smith Valley reach of the West Walker River continues to be a gaining reach, partly because surface water irrigation and local inflows (e.g., Desert Creek and subsurface flow from the mountains) contribute enough to groundwater that levels still slope toward the river (Myers 2001a).

A linear trend line fit to groundwater level data collected from wells in Smith Valley by NDWR between 1976 and 2007 (Nevada Division of Water Resources 2009) indicates an average increase in depth to water of approximately 16 feet over the 31 years evaluated, an overall drop of about 0.5 foot per year. Much of the variation in the water levels in the wells is caused by differences between well locations and differences in year-to-year surface water hydrology and groundwater pumping.

The estimated decrease in groundwater levels is somewhat dependent on the years selected for evaluation. For Smith Valley, 1976 was chosen as the starting point because there was much less data collected prior to 1976. The individual extent of decrease and yearly variation depends on the well evaluated, with water depth varying more in wells with greater depth to groundwater. When groundwater is nearer to the surface, it suggests the close proximity of a source of substantial recharge such as the Walker River.

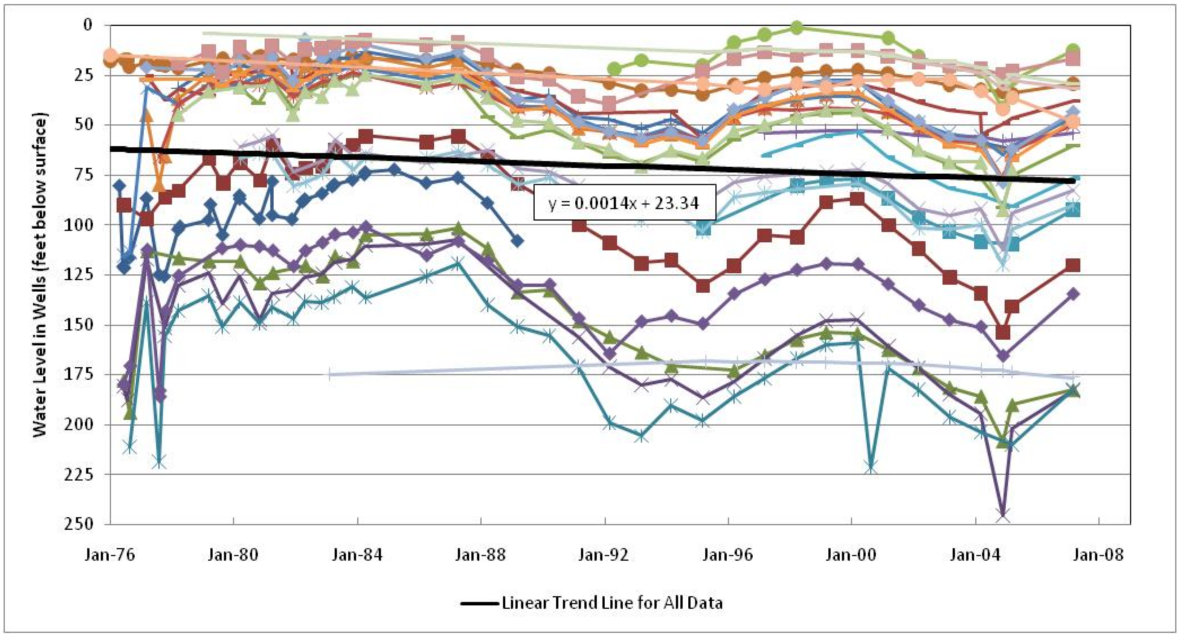


Figure 3-16. Smith Valley Water Level Data Collected from 27 Wells, Winter 1976 through Winter 2007 (Nevada Division of Water Resources 2009)

Mason Valley

Groundwater trends in Mason Valley are similar to those in Smith Valley. Groundwater levels appear to have decreased, and gradients once directed toward the river are now directed away from the river. However, levels in Mason Valley do not appear to have dropped as much as in Smith Valley (Myers 2001b).

The groundwater level data collected by NDWR indicate that average depth to groundwater in Mason Valley may be less than in Smith Valley (Figures 3-16 and 3-17). A linear trend line fit to groundwater level data collected from wells in Mason Valley by NDWR from November 1981 through 2007 (Nevada Division of Water Resources 2009) indicates an average increase in depth to water of approximately 11 feet over the 26 years evaluated, an overall decrease of about 0.4 foot per year (Figure 3-17). Much of the variation in the water levels in the wells is caused by differences between well locations and differences in year-to-year surface water hydrology and groundwater pumping.

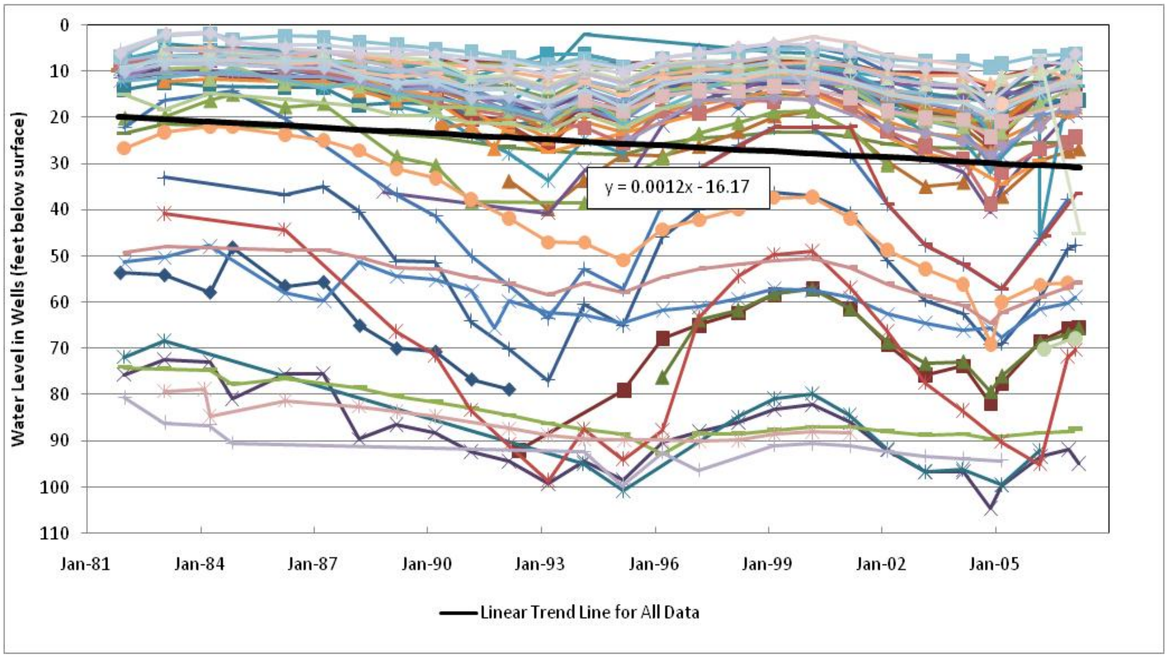


Figure 3-17. Mason Valley Water Level Data Collected from 64 Wells, Fall 1981 through Spring 2007 (Nevada Division of Water Resources 2009)

The estimated decrease in groundwater levels is somewhat dependent on the years selected for evaluation. For Mason Valley, November 1981 was chosen as the starting point for the trend line because multiple wells with greater water level depth were added at that time. The individual extent of decrease and yearly variation depends on the well evaluated, with water depth varying more in wells with greater depth to groundwater. When groundwater is nearer to the surface, it suggests the close proximity of a source of substantial recharge such as the Walker River.

Schurz, Whiskey Flat-Hawthorne, and Walker Lake Areas

Groundwater levels near Walker Lake have declined as a result of the decrease in lake surface elevation and groundwater pumping (Allander and Lopes 2008). On the Walker River Indian Reservation, groundwater levels dropped prior to 1960, but have not changed greatly since then. Preliminary analysis shows that since the 1950s, groundwater levels on the Hawthorne Army Depot have dropped 15 feet and groundwater levels south of Hawthorne (Whiskey Flat) have dropped 70 feet (Lopes 2008a).

River-Groundwater Connection

In the study area, there is a strong relationship between groundwater recharge and extraction and Walker River flows. Information from two studies by Myers (2001a and 2001b) was used for this Revised DEIS to assign a quantitative value to the link between groundwater recharge and river flow. Recent modeling work by the University indicates that a degree of river-aquifer connection may be comparable to conclusions of the Myers work (Boyle et al. 2009), although future use of the University model could indicate that adjustments in the assumptions would be appropriate.

Smith Valley

The Smith Valley aquifer contains clay layers that tend to slow the vertical movement of groundwater (Myers 2001a) as well as the response of the river to changes in groundwater recharge and pumping. Nevertheless, there is still a strong connection between the Walker River and the Smith Valley aquifer; it is strongest close to the river and weakest north of the groundwater divide.

Myers used groundwater-surface water modeling to estimate that if groundwater pumping were reduced within 2 miles of the river, river flows would increase by about 80% of the amount of the pumping reduction (Myers 2001a). As another example, on a valley-wide basis, it was simulated that a reduction in recharge could lead to a reduction in river flow equal to about 52% of the recharge reduction within 25 years (Myers 2001a).

Mason Valley

The Mason Valley aquifer contains some silt/clay layers that could slow the vertical movement of groundwater as well as the response of the river to changes in groundwater recharge and pumping (Myers 2001b). Nevertheless, there is still a strong connection between the Walker River and the Mason Valley aquifer; it is strongest close to the river (Myers 2001b).

Myers used groundwater-surface water modeling to estimate that if groundwater pumping were reduced near the river, river flows would increase by 40 to 90% of the amount of the pumping reduction (Myers 2001b). As another example, on a valley-wide basis, it was simulated that a reduction in recharge could lead to a reduction in river flow equal to about 82% of the recharge reduction within 25 years (Myers 2001b).

Reservation Reach

There is also a strong connection between the river and groundwater aquifer in the Reservation reach. Preliminary results from USGS found that as flow increases, the water level in wells adjacent to the river increases almost immediately. The well sites examined were Willows (north of Weber Reservoir), lateral 2-A (near Schurz), and Powerline (approximately half way between Lateral 2-A and Walker Lake) (Lopes and Allander 2006, Lopes 2008a).

Water Balance for Study Area Upstream of Wabuska

This water balance assessment focuses on the East Walker Valley, Smith Valley, and Mason Valley. Current losses of water from the Walker River downstream of Wabuska are addressed above in the Surface Water subsection. A separate water balance for Walker Lake is described in the Environmental Consequences section.

To understand the flow of water through the Walker River system, flows along the river can be compared to diversions and consumptive use in order to estimate some of the flows that are not measured. There is some uncertainty in the values used in this upstream water balance, particularly associated with ET rates, the acres of land to which different ET rates should apply, and amount of groundwater pumping in the East Walker area above Mason Valley.

The water balance assessment presented here is based on average values. Although river flows, water demands, and reservoir operations change daily, an assessment based on relatively recent averages is appropriate for determining the long-term effects that are pertinent to evaluating the potential for increasing inflow to Walker Lake. Ideally, each average value would be based on the same time span. However, because of data limitations, this was not always possible. Table 3-7 presents some of the values used in the assessment.

Table 3-7. Data Sources for Walker River Basin Upstream of Wabuska Water Balance

Variable	Data Source	Time Period	Average Values
Surface Water Diversions (af)	Pahl 2000 and Shaw pers. comm.	1981–2007	East Walker: 22,000 Smith: 59,000 Mason: 126,000
Groundwater Pumping (af)	Gallagher 2006	1994–2004	Smith: 24,000 Mason:79,000
Groundwater Pumping (af)	Estimate[a]		East Walker: 0
Irrigated Area (ac)	Desert Research Institute 2006	1986, 1992, 1995, 1998, 2000, 2002	East Walker: 4,015 Smith: 17,452 Mason: 34,972
Riparian/Wetland Area (ac)	Desert Research Institute 2006	1986, 1992, 1995, 1998, 2000, 2002	East Walker: 3,307 Smith: 3,309 Mason: 7,434
Percent of riparian/wetland that is considered riverine[b]	GIS analysis of GAP data (U.S. Geological Survey National Gap Analysis Program 2004)		East Walker: 88% Smith: 33% Mason: 34%
Annual Flow East Walker downstream from Bridgeport Reservoir (af)	U.S. Geological Survey 2008	1981–2007	118,000
Annual Flow East Walker upstream of Strosnider Ditch (af)	U.S. Geological Survey 2008	1981–2007	125,000
Annual Flow West Walker at Hoye Bridge (af)	U.S. Geological Survey 2008	1981–2007	191,000
Annual Flow West Walker near Hudson (af)	U.S. Geological Survey 2008	1981–2007	151,000
Annual Flow at Wabuska (af)	U.S. Geological Survey 2008	1981–2007	139,000

[a] East Walker groundwater pumping was estimated based on ratios for Smith and Mason Valleys of overall water use (surface water diversions plus groundwater pumping) to irrigated plus non-riverine riparian acreage.

[b] This evaluation assumed all riparian/wetland vegetation within 1,000 feet of the river channel to be riverine (directly linked to the river). Riparian/wetland vegetation that is farther from the river channel is assumed to be dependent on irrigation or incidental groundwater recharge resulting from irrigation.

Water extracted by diversions (from the river) and pumping (from the aquifer) has three possible fates:

- **Evapotranspiration (ET)** – water that is "lost" through evaporation or transpiration.

  Note: for the purposes of this Revised DEIS, net ET equals total ET minus precipitation and consumptive use equals net ET from irrigated land.
- **Incidental groundwater recharge** – irrigation water seeps through the soil and contributes to recharging the local groundwater aquifer.
- **Return flow** – water that returns to the Walker River either via surface drains or groundwater flow. Water that drains off fields and is used elsewhere (e.g., in other fields or WMAs) is not counted as return flow unless it eventually returns to the Walker River.

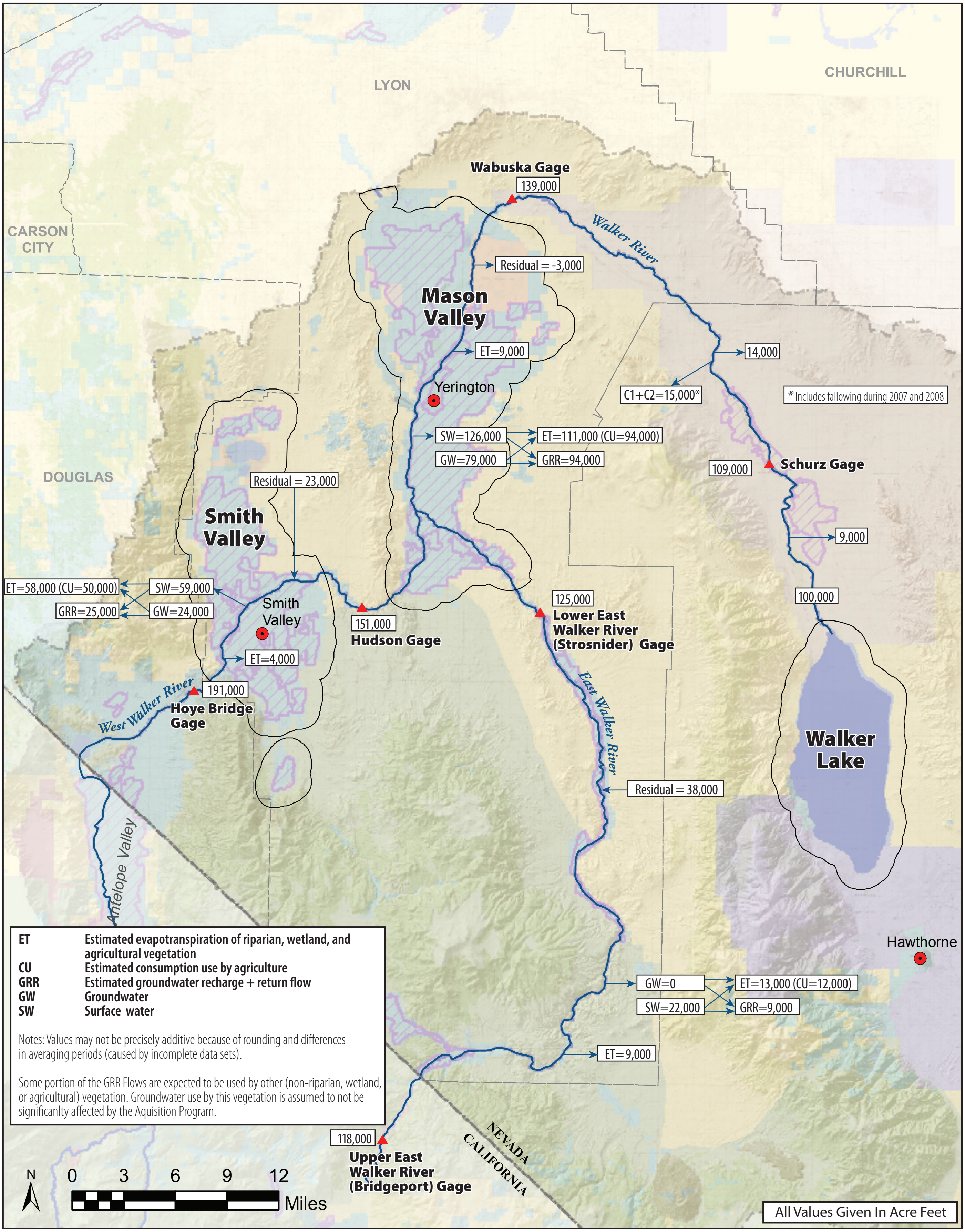
In the following evaluation, evapotranspiration is estimated and the combination of incidental groundwater recharge and return (GRR) flows are calculated as the sum of diverted and pumped water minus evapotranspiration.

Evapotranspiration

The amount of water that disappears through ET can be approximated using measured net ET rates for typical vegetation, where net ET equals total ET minus precipitation. Net ET was estimated for irrigated lands, riverine vegetation, and non-riverine riparian and wetland vegetation. Riverine vegetation was assumed to draw water indirectly from river flows. Non-riverine riparian and wetland vegetation was assumed to obtain water incidentally from surface water diversions and groundwater extractions.

Measured ET rates can be quite variable. For alfalfa, which makes up more than half of the irrigated lands (see DRI acreage summaries in Chapter 7, Land Use and Agriculture), net ET measurements in the Walker and Carson River Basins have ranged between 31 and 37 inches (Allander pers. comm. 2008a, Felling pers. comm., Lopes and Allander 2009a, and Maurer et al. 2006). Net ET rates for irrigated pasture have ranged between 28 and 47 inches (Maurer et al. 2006). Riparian and wetland areas have relatively high ET, but other crops grown in the Walker River basin, such as onions and garlic, probably have lower ET rates (Allander pers. comm. 2008a).

For this analysis, the average values measured for alfalfa in the Walker and Carson River Basins were adjusted downward to estimate the ET for other crops. The downward adjustment was based on comparing alfalfa ET to ET measurements made for a range of other crop types. The various estimated crop ET rates were then weighted by the occurrence of the crops to estimate overall ET rates for Smith and Mason Valleys as 34.5 and 32.4 inches, respectively. The ET



00516.07 Walker River Basin Restoration Project/Average Flow Volumes (01-10)

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Figure 3-18
Average Annual Flow Volumes for the Walker River Basin for all Data Available from 1981 to 2008

rate for the East Walker reach was assumed to be the same as the Smith Valley rate. The ET rate for riparian/wetland areas was assumed to be 41.2 inches based on ET rates measured for Willow in the Walker River Basin by USGS (Lopes pers. comm.). Note: the ET rates used in this assessment do not include a recent 14% reduction in the ET rates estimated by USGS (Lopes and Allander 2009a).

When the agricultural ET rates are applied to the estimated irrigated acres and the riparian ET rate is applied to the fraction of the riparian/wetland acres that are estimated to be non-riverine, the resulting combined ET annual volumes are 13,000 af, 58,000 af, and 111,000 af for the East Walker area, Smith Valley, and Mason Valley, respectively. Because these values include water used incidentally by riparian vegetation, these values are greater than the consumptive use of the water as that term is used in this analysis (i.e., consumptive use equals the net ET associated with agricultural crops grown on irrigated, water-righted lands). The consumptive use values are estimated to be 12,000 af/yr, 50,000 af/yr, and 94,000 af/yr for the East Walker Valley, Smith Valley, and Mason Valley, respectively.

This calculation was also made for estimating the ET associated with the riverine portion of the riparian vegetation (i.e., the portion of the riparian vegetation expected to obtain water from shallow groundwater that is adjacent to the river). Riverine ET was estimated to be 9,000 af/yr, 4,000 af/yr, and 9,000 af/yr for the East Walker reach, Smith Valley, and Mason Valley, respectively. There is much uncertainty in these numbers, but they are useful for indicating the potential magnitude of this term relative to river flow. These calculations indicate that riverine ET may be about 8%, 2%, and 3% of the annual inflow to the East Walker reach, Smith Valley, and Mason Valley, respectively. The riverine ET for the East Walker reach is a relatively high percent of flow as a result of the amount of riparian vegetation within 1,000 feet of the river channel.

There is also a certain amount of ET associated with natural phreatophytic vegetation such as rabbitbrush and greasewood. Phreatophytes have deep roots and are not dependent on the high groundwater table produced by the river or irrigation as is riparian/ wetland vegetation. Preliminary results show that in some locations, annual ET associated with this vegetation is similar to annual precipitation, resulting in little effect on the water balance for the aquifer (Lopes 2006). In other locations, phreatophytic vegetation may draw from the aquifer. This potential effect on the aquifer was not analyzed because it was assumed that ET from phreatophytic vegetation would be largely unaffected by the acquisition alternatives.

Incidental Groundwater Recharge and Return Flows

Of the water that is applied, the water that is not lost to ET would either go to incidental groundwater recharge or the return flows to the river. Incidental GRR flows were calculated as the residual of diverted and pumped water minus evapotranspiration of agricultural crops and non-riverine riparian and wetland vegetation.

Total incidental groundwater recharge and returns was calculated as:

GRR = SW + GW – ETag – ETnrrip

Where:

GRR = incidental groundwater recharge plus returns

SW = surface water diversions

GW = groundwater pumpage

ETag = estimated ET for agricultural fields, and

ETnrrip = estimated ET for non-riverine riparian and wetland vegetation

For the ET volumes calculated above, the combined estimated annual GRR volumes are:

East Walker River: 9,000 af

Smith Valley: 25,000 af

Mason Valley: 94,000 af

There is a groundwater divide in Smith Valley. GRR north of the divide flows toward Alkali Lake instead of the Walker River. The estimate provided here is for the entire Smith Valley, both north and south of the divide.

Water Efficiency

The amount of water diverted from surface water and groundwater and the estimated consumption by crops can be used to produce an estimate of water efficiency. Some of the water that is applied runs off the field or seeps into the ground. In addition, there are conveyance losses, which either provide water for the ET of non-riverine vegetation or add to GRR flows.

In this revised DEIS, water efficiency is estimated as:

$$E = CU / (SW + GW)$$

Where:

E = water efficiency

CU = net consumptive use (agricultural ET)

SW = average annual surface water diversions

GW = average annual groundwater pumpage

For the East Walker reach, Smith Valley, and Mason Valley, the estimated water efficiency is 53%, 60%, and 46%, respectively, with an overall value of 50%. Note that these efficiency rates include the effect of conveyance losses. The water that is not used consumptively is either used by riparian/wetland vegetation or contributes to incidental groundwater recharge and return flows.

Upstream Water Balance Results

Table 3-8 provides a summary of the average flow volumes in the East Walker, Smith Valley, and Mason Valley reaches. These numbers are presented graphically in Figure 3-18. The river inflows and river outflows for each reach in Table 3-8 are based on gaged river flows. The river inflow to each reach minus the surface water diversions and the estimated riverine ET does not equal the river outflow because there can be numerous unmeasured, small local inflows and outflows such as return flows, tributary flow, and interaction with groundwater. The return flow portion of the estimated GRR flows is a potential source of any unexpected increase in river flow from the upstream to the downstream end of a reach. In the East Walker reach, the estimated GRR flows are only 9,000 af/yr, not enough to account for the average increase in flow of 38,000 af/yr. In comparison, in Smith Valley, the estimated GRR flow (25,000 af/yr) is approximately equal to the increase in flow (23,000 af/yr), although some of the increase in flow probably comes from contributions from the mountains and Desert Creek (Myers 2001a). In Mason Valley, the estimated GRR flow is large (94,000 af/yr), but on average there is a small measured loss in river flow (3,000 af/yr), suggesting a slight net loss to groundwater.

Table 3-8. Estimated Average Annual Flow Volumes in Three Subareas of the Walker River Basin

	East Walker[d]	Smith Valley[d]	Mason Valley[d]
Inflow (af)	118,000	191,000	276,000
Surface water diversion (af)	22,000	59,000	126,000
Groundwater pumping (af)	0	24,000	79,000
Irrigated acres	4,015	17,452	34,972
Riparian/wetland acres	3,007	3,309	7,434
Fraction of riparian/wetland acres supported by irrigation	0.12	0.67	0.66
Estimated riparian/wetland acres supported by irrigation	353	2,217	4,906
Estimated acreage supported by irrigation[a]	4,367	19,669	39,877
Acre-feet per acre [b]	5.0	4.2	5.1
Agricultural ET rate (inches)	34.5	34.5	32.4
Non-riverine ET estimate (af) [c]	13,000	58,000	111,000
Agricultural ET estimate (consumptive use) (af)	12,000	50,000	94,000
Percent of diversions and pumping used consumptively	53%	60%	46%
Riverine ET estimate (af)	9,000	4,000	9,000
Riverine ET as % of inflow	8%	2%	3%
Incidental groundwater recharge and return (af)	9,000	25,000	94,000
Inflow minus surface water diversion minus riverine ET (af)	87,000	128,000	141,000
Outflow (af)	125,000	151,000	139,000
Flow change within reach (af)	38,000	23,000	-3,000

Note: This table does not include water budget values not expected to change, such as ET from natural phreatophytic vegetation or evaporation from the Anaconda Mine Pit lake or Alkali Lake.

[a] Irrigated acres plus the riparian/wetland acres supported by irrigation (e.g., from canal seepage, tailwater runoff, or shallow groundwater)

[b] Surface water diversions plus groundwater pumping divided by estimated acreage dependent on irrigation

[c] Combined ET from crops and non-riverine riparian vegetation

[d] Water volumes are rounded to the nearest 1,000 af. As a result, some calculations may appear to be imprecise.

Water Quality

Key water quality topics are the water quality of Walker River and Walker Lake, and of groundwater, particularly as affected by the plume of contaminated groundwater from the Anaconda Mine site.

While several water quality constituents are of concern in the Walker River Basin, this Revised DEIS focuses on TDS because of its effects on the ecosystem of Walker Lake. TDS is a measure of all dissolved solids in water, including salts, metals, and all organic and inorganic components of water that are dissolved or extremely small (small enough to pass through a fine-mesh filter).

Walker River

The water quality of rivers is determined largely by interaction of water with the landscape and human activities. Water moving across and through the landscape is exposed to minerals in the soils and rocks of different geomorphic regions. Human activities that alter the land, consume water, or discharge material to a water body further modify water quality. It is common to find differences in surface water quality across a large region like the Walker River Basin, which encompasses urban, rural, and undeveloped desert areas.

Under Section 303(d) of the federal Clean Water Act, Nevada is required to develop a list of water bodies that require action to achieve water quality standards. Water bodies that do not meet established water quality standards and are listed on a state's 303(d) list are considered impaired. An impaired water body is a water body that has concentrations of pollutants or contaminants that exceed the threshold to support its beneficial uses (e.g., irrigation, or municipal and domestic water supply). The East and West Walker Rivers and the mainstem Walker River are listed as impaired waters on Nevada's 303(d) list, as shown in Table 3-9. Nevada's 2006 303(d) Impaired Waters List (Nevada Division of Environmental Protection 2009a) is the most recent U.S. Environmental Protection Agency (EPA)-approved 303(d) list for the state.

Water quality constituents on the 303(d) list are candidates for creation of a TMDL, which is a regulatory document that requires actions for attaining water quality goals of the Clean Water Act. Generally this means reducing the load of pollutants into water bodies, but it can also mean dilution of pollutants (as is the case for Walker Lake).

Table 3-9. 303(d) Impaired Waters List for Walker Lake and Tributaries[a]

Water Body	Location	Parameter	TMDL Priority
West Walker River	At state line	Zinc	Low
		Iron	Low
Topaz Lake	Topaz Lake (Nevada portion)	Phosphorus (Total)	Low
		Temperature	Low
West Walker River	From state line to Wellington	Temperature	Low
		Iron	Low
		Boron	Low
West Walker River	From Wellington to confluence with East Walker River	Temperature	Low
East Walker River	At state line	Phosphorus (total)	Low
		pH	Low
		Temperature	Low
East Walker River	From state line to Bridge B-1475	Phosphorus (total)	Low
		Temperature	Low
		pH	Low
East Walker River	From Bridge B-1475 to the confluence with the West Walker River	Temperature	Low
		Iron	Low
Walker River	From the confluence of East and West Walker Rivers to the boundary of WRPT Reservation	Iron	Low
Walker Lake	Entire lake	Arsenic	Low
		Cadmium	Low
		Molybdenum	Low
		Phosphorus (Total)	Low
		Selenium	Low

Source: Nevada's 2006 303 (d) Impaired Waters List (Nevada Division of Environmental Protection 2009a)

[a] Note that this list does not include waters quality constituents that have TMDLs (TDS in Walker Lake and total suspended solids (TSS) in the East Walker River downstream of Bridge B-1475 and TSS in Walker River upstream of the Walker River Indian Reservation).

Sediment, nutrients, and metals are the most widespread pollutants contributing to the exceedance of water quality standards in the major rivers of Nevada (Nevada Department of Conservation and Natural Resources 2008). In East and West Walker Rivers, phosphorus is the nutrient found most consistently at elevated concentrations. Possible sources of phosphorus to these rivers include fertilizers from agricultural runoff, animal feedlots (manure), and natural sources such as soil and rock formations. Historic mining activities and natural sources, such as metal-bearing rock formations and geothermal springs, are associated with high metal concentrations in surface water.

Sediment has been a concern for all branches of the Walker River (East, West, and mainstem). Sediment transported in a stream or present in the water column of a standing body of water is commonly measured as total suspended solids (TSS). TMDL criteria for controlling TSS have been established for the East Walker River in Nevada (U.S. Environmental Protection Agency 2008a) and the Walker River upstream of the Walker River Indian Reservation (Nevada Division of Environmental Protection 2009a).

In the Walker River upstream of Wabuska, active sediment transport occurs. Recent University research employing multiple methods of analysis found that sediment transport would be expected to occur at essentially all flow conditions. This analysis is consistent with field observations (Dennett et al. 2009).

Since 1998, when elevated concentrations of mercury were found in common loons from Walker Lake (Seiler et al. 2004), mercury has been a concern in the Walker River Basin. Weathering of naturally occurring minerals, mining activities in the basin (i.e., Aurora, Bodie, and Yerington mines), geothermal springs, and atmospheric deposition of mercury from regional and global sources are all potential sources of mercury in the basin.

A summary of water quality data recently collected by the University are provided in Table 3-10 (Hershey et al. 2009). These data were collected between April 2007 and September 2008 during the months of February, April, August, and September. The data show that electrical connectivity and TDS concentrations tend to be lower in headwaters and increase downstream. As expected, water temperature was also found to generally increase as the river moves downstream (Davis et al. 2009). At the downstream end of the Walker River, water temperature is approximately equal to average air temperature (Stone et al. 2009).

TDS at Walker River near Schurz had a median concentration of 337 milligrams per liter (mg/L), whereas TDS in the East and West Walker Rivers had median TDS concentrations of 156 and 121 mg/L, respectively. These concentrations are below the 500 mg/L annual average maximum limit for water supply, irrigation, and livestock uses set by the Nevada Administrative Code (NAC) (NAC

445A.160, NAC 445A.162, and NAC 445A.163). Seasonal changes in stream flow also affect TDS; TDS concentration generally decreases as flow increases.

Table 3-10. Summary of Select Water Quality Measurements, 2007 to 2008

Reach	pH	EC (µS/cm)	TDS (mg/L)	TSS (mg/L)
East Walker				
Minimum	8.05	192	116	4.2
Median	8.17	238	156	15.1
Maximum	9.33	317	206	73.6
West Walker				
Minimum	7.64	62	34	0.6
Median	8.11	200	121	3.8
Maximum	8.61	571	345	67.0
Mainstem				
Minimum	8.03	235	150	1.1
Median	8.20	435	253	14.2
Maximum	8.82	644	394	59.0
Schurz				
Minimum	8.05	472	283	1.1
Median	8.22	539	337	4.8
Maximum	8.82	644	394	12.2

Notes: EC = electrical conductivity, TDS = total dissolved solids, TSS = total suspended solids

Source: Hershey et al. 2009

Water quality data collected by the University researchers from April 2007 to September 2008 showed that TSS concentrations were relatively low (less than 20 mg/L) in the upper portions of the West and East Walker Rivers and in the lower portion of the mainstem Walker River near Schurz. Concentrations were highest in the lower portion of the East Walker River, about 25 river miles upstream of the main confluence, with an average of 27.7 mg/L and a median value of 35.8 mg/L, based on seven measurements. Intermediate concentrations were generally found in the lower portion of the West Walker River (also about 25 river miles upstream of the main confluence) and in the mainstem Walker River from the confluence of the East and West Walker Rivers to Wabuska.

West Walker River

As indicated in Table 3-9, portions of the West Walker River are on Nevada's 2006 303(d) list for zinc, iron, boron, and temperature (Nevada Division of Environmental Protection 2009a). In addition, according to the West Walker River Basin Watershed Assessment, excess sediment (TSS) has been identified as a primary water quality concern in the West Walker River (Mono County 2007). TDS is not a constituent of concern on the West Walker River because concentrations tend to be low; recent measurements have ranged between 34 and 345 mg/L (Hershey et al. 2009).

East Walker River

East Walker River is listed as an impaired water body on Nevada's 2006 303(d) list for pH, temperature, total phosphorus, and iron (Nevada Division of Environmental Protection 2009a) (Table 3-9). A TMDL for TSS has been established for East Walker River in Nevada and approved by EPA (U.S. Environmental Protection Agency 2009). TDS is not a constituent of concern on the East Walker River because concentrations tend to be low; recent measurements have ranged between 116 and 206 mg/L (Hershey et al. 2009).

A recent USGS study suggests that the primary mercury source areas are associated with the Bodie and Aurora mining districts in the Rough Creek watershed, which is part of the East Walker River Basin (Seiler et al. 2004). Mercury concentrations in the East Walker River system vary widely by location and are highest just upstream of the confluence with the West Walker River. The USGS reported that mercury concentrations in the East Walker River increased from 0.0014 microgram per liter (μg/L) upstream of Sonoma Creek to approximately 0.057 μg/L just upstream of the confluence with West Walker River (Seiler et al. 2004), which is well below thresholds of concern based on Nevada's water quality standards for mercury for municipal and domestic supply beneficial uses (2 μg/L) as well as aquatic life beneficial use (1.4 μg/L 1-hour average, and 0.77 μg/L 96-hour average) (NAC 445A.144). Total mercury concentrations in streambed sediment samples greater than 200 nanograms per gram (ng/g) have been recorded for several tributaries of the East Walker River where mining activities occurred during the 19th century (Seiler et al. 2004).

Mainstem Walker River

The Walker River from the confluence of the East and West Walker Rivers to the boundary of the Walker River Indian Reservation is listed as impaired for iron (Table 3-9). In addition, a TMDL for TSS has been established for this same reach (Nevada Division of Environmental Protection 2009a).

The lower mainstem Walker River channel near and downstream of Schurz is unstable and, as a result, substantial amounts of sediment can be eroded during high flow events. For example, in June 2005 when flows reached as high as 1400 cfs, approximately 477,000 metric tons of sediment were eroded from the banks of the lowermost 1.5 kilometers (0.9 mile) of the Walker River (Adams and Chen 2009). The instability of the lower Walker River can be attributed to the recession of Walker Lake. As the lake recedes, the topographic gradient increases, leading to substantial down-cutting of the river channel. This down-cutting propagates upstream as the gradient becomes more severe. As of early 2009, the head cut had propagated as far upstream as the defunct siphon that crosses the river near Lateral 2A about 1 mile below Schurz and had begun undercutting the siphon. As the lake recedes, the river also extends through terrain that formerly was river delta or lake bottom with deposits of finely grained sediment that are highly erodible (Adams and Chen 2009).

Walker River contributes an annual average TDS load of approximately 21,000 tons per year (Thomas 2004, as cited in Nevada Division of Environmental Protection 2005). NDEP data indicate that TDS concentration tends to be slightly higher at Schurz than at Wabuska. From May 1998 to March 2001, the period of data overlap for the two locations, TDS concentrations from grab samples ranged from 111 to 412 mg/L at Wabuska (average of 241 mg/L) and from 132 to 476 mg/L near Schurz (average of 274 mg/L) (Nevada Division of Environmental Protection 2008). Recent studies by the University and DRI found that TDS in the Walker River near Schurz is typically 300 to 400 mg/L (Hershey et al. 2009).

Walker Lake

Walker Lake is listed as an impaired water body on Nevada’s 2006 303(d) list for cadmium, arsenic, molybdenum, selenium, and total phosphorus (Nevada Division of Environmental Protection 2009a). A TMDL for TDS has been established for Walker Lake and approved by EPA (Nevada Division of Environmental Protection 2005). Mercury concentration in Walker Lake has also been a concern (Seiler et al. 2004).

Limnology

Walker Lake is thermally stratified from May or June to November and undergoes a period of complete mixing in late fall (Beutel 2001, Sharpe et al. 2008). The boundaries of the epilimnion (upper warm layer) and hypolimnion (lower cool layer), and consequently, the metalimnion (middle layer where the thermocline is located), undergo broad shifts during the warmer months of the year (Sharpe et al. 2008). Summer water temperature in the epilimnion ranges from 68° to 78°F and from 50° to 54°F in the hypolimnion (Beutel et al. 2001). Late winter water temperatures ranges from 43° to 46°F throughout the water column (Beutel et al. 2001).

The hypolimnion of Walker Lake becomes anoxic following thermal stratification. Decomposition of organic matter, primarily algae, depletes the oxygen, making it an unsuitable habitat for fish. Hypolimnetic anoxia in Walker Lake results in the accumulation of ammonia and sulfide in the hypolimnion. The ammonia enters the epilimnion during summer wind mixing events and by diffusion across the thermocline. Ammonia within the hypolimnion then promotes eutrophication (Beutel et al. 2001).

Walker Lake is limited in nitrogen and rich in phosphorus, a characteristic common to lakes in semi-arid environments (Beutel et al. 2001). This characteristic has promoted spring and summer blooms of nitrogen-fixing cyanobacteria, particularly of the genus *Nodularia* (Acharya et al. 2009). *Nodularia* dominates the phytoplankton community in summer, and consequently reduces phyto- and zooplankton diversity (Sharpe et al. 2008). Another type of cyanobacteria, *Synechococcus*, which can grow in anaerobic conditions, was found to bloom in the hypolimnion (Acharya et al. 2009).

Predominant zooplankton species include the cladoceran *Monia hutchinsoni*, the calanoid copepod *Leptodiaptomus sicilis*, and the rotifer *Hexarthra fennica*; *M. hutchinsoni* is most abundant from July through October, *L. sicilis* is perennial in the lake, and *H. fennica* abundance exhibits yearly variations (Beutel et al. 2001).

Total Dissolved Solids

As Walker Lake surface elevation has declined, TDS concentration has increased (see Affected Environments, Walker Lake Surface Elevations). TDS concentration has increased from 2,560 mg/L in 1882 (Russell 1885 as cited by Allander pers. comm. 2008b) to approximately 17,500 mg/L in 2009 (Heggeness pers. comm.), a net increase of approximately 15,000 mg/L over 127 years (an average increase of about 120 mg/L per year).

The increase in TDS concentration is a function of reduced freshwater inflow and evaporation. As water evaporates, dissolved solids are left behind; with less dilution (and lake volume) from reduced inflow, TDS concentration increases.

Thomas (1995) estimated TDS flux into the lake to be 66,000 tons/year. More recently, net TDS flux into the lake has been estimated to be 56,000 tons/year, with the river, groundwater, and movement to and from the lake bed sediments all playing a role (Thomas 2004, as cited in Nevada Department of Environmental Protection 2005a). As a result, the TDS in the lake has been estimated to have increased from 31 million tons in 1882 (Nevada Department of Environmental Protection 2005) to 38 million tons in 2007.

TDS concentration can be described with the following equation:

[TDS in mg/L] = tons of TDS in the lake * 735.56 / lake volume in af

Where:

Tons of TDS in the lake = $31*10^6$ + (# of years since 1882)*56,000

This equation matches the measured data fairly well (Figure 3-19).

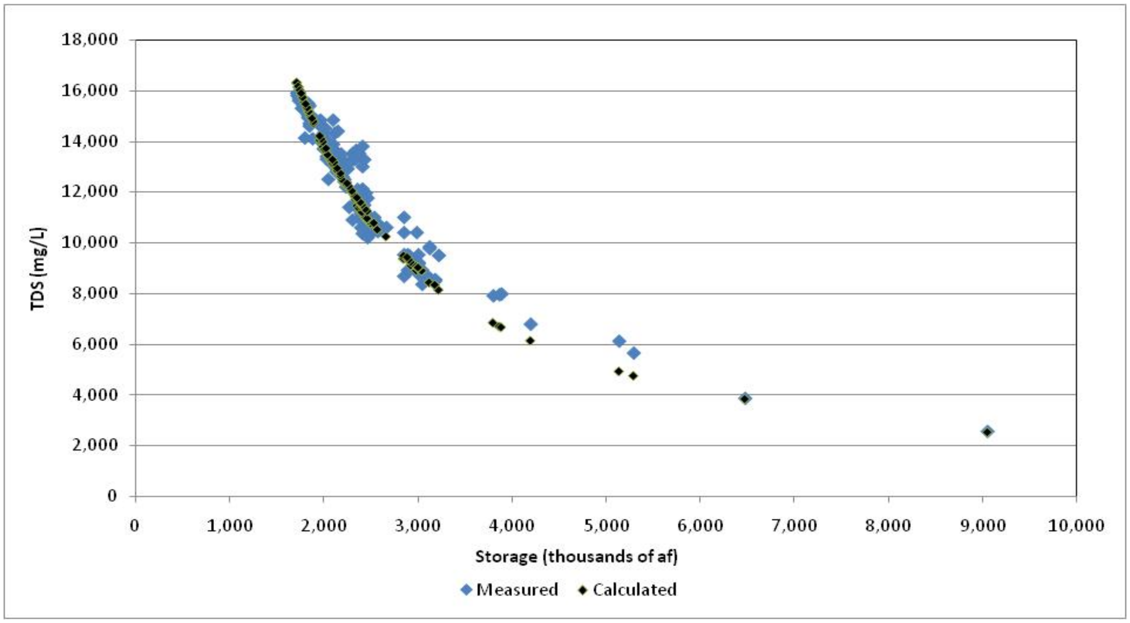

Figure 3-19. Walker Lake Volume Compared to Concentration of Total Dissolved Solids

Groundwater

Groundwater quality is important for evaluating issues associated with the potential purchase of groundwater to augment Walker Lake inflow or with groundwater recharge.

Total Dissolved Solids

The concentration of TDS in groundwater is an indicator of the general quality of the water. In groundwater, much of the TDS originates from natural sources such as mineral springs, and carbonate and salt deposits in rock. Other sources include stormwater and agricultural runoff, and point/nonpoint wastewater discharges. High TDS concentration may indicate aquifer contamination from agricultural drainage, industrial wastes, or geothermal water (Thodal 1996).

The quality of groundwater in the Walker River Basin is variable. In general, the TDS concentration in recharge areas in the mountains is low and increases closer to discharge areas in the lower parts of the valley (Everett and Rush 1967). Recent work by USGS (Lopes and Allander 2009b) has shown that wells closer to the river often had TDS concentrations that were less than 500 mg/L, whereas farther from the river, TDS concentrations were often greater than 1,000 mg/L. The wells with the higher TDS concentration also tended to have high concentrations of sulfate, chloride, and fluoride.

The federal recommended drinking water standard for TDS is 500 mg/L. Nevada Division of Environmental Protection (NDEP) currently uses federal Safe Drinking Water Act standards for groundwater quality.

Anaconda Mine Site

In Mason Valley, a plume of contaminated groundwater from the site of the Anaconda Copper Mine is moving north, in the direction of local groundwater flow. This site, also known as the Yerington Mine, covers more than 3,400 acres just west of Yerington. Portions of the site are owned by Arimetco (now in bankruptcy) and portions are public lands managed by the Bureau of Land Management (BLM) (U.S. Environmental Protection Agency 2008b). When open-pit mining ceased on the property, the groundwater pumping that had been used to keep the pit dry also stopped, and Pit Lake was formed. The lake volume is around 40,000 af. The water has filled approximately 500 feet of the total pit depth of 800 feet. The lake surface elevation increases at the rate of 10 feet per year (U.S. Environmental Protection Agency 2008b). At this rate, the lake would fill in roughly 30 years, but the rate of increase would probably decline as the water elevation approaches the ground surface elevation.

Although the site is not on the National Priorities List, the EPA Region 9 Superfund Program does have the lead for the site as a special project (Seter pers. comm.) (EPA Project ID NVD083917252). EPA has spent approximately $6 million at the Anaconda Mine site since 2000 investigating and addressing environmental issues. Actions include capping 100 acres of mine tailings to prevent erosion and fugitive dust, constructing and lining a new pond to prevent overflow of mine drainage, and completing other upgrades to the system.

ARCO is conducting response actions at the site, including broad investigation of the nature and extent of groundwater contamination. Wells have been placed in the path of the contaminated groundwater plume to create a “pump back” system that is used for monitoring water quality and for restricting the movement of the plume by pumping contaminated groundwater into lined evaporation ponds (U.S. Environmental Protection Agency 2009).

Although groundwater monitoring data are limited, six contaminants were detected in drinking water wells north of the mine site: arsenic, boron, fluoride, uranium, radium, and gross alpha radioactivity. In some wells, arsenic and uranium concentrations and gross alpha activity have exceeded federal water standards of the Safe Drinking Water Act (U.S Department of Health and Human Services 2006, U.S. Environmental Protection Agency 2008c).

Geothermal Water

As indicated in Chapter 2, Alternatives, there is an option to purchase water from the Homestretch Geothermal power plant (operated by Homestretch Geothermal), which is located immediately upstream of the Wabuska gage. If secured, discharge to the river from this source would occur via pipeline at a suitable point of delivery near the Wabuska gage in accordance with the terms of an NPDES water quality discharge permit and all other necessary approvals. NDEP has issued a draft discharge permit for public review (Nevada Division of Environmental Protection 2009b). Spent geothermal water from the power plant is currently discharged to an alkali flat east of the power plant and to a basin west of the power plant.

Water quality data from the power plant from 2003 to 2005 indicate arsenic, boron, copper, fluoride, sulfate, and TDS concentrations in excess of water quality criteria (Nevada Division of Environmental Protection 2006), with fluoride being of greatest concern (Bureau of Reclamation 2009). Average TDS concentration is approximately 1,000 to 1,100 mg/L. Arsenic, boron, copper, and fluoride make up a tiny fraction of the TDS from the site, whereas sulfates constitute about 40% of the TDS (Nevada Division of Environmental Protection 2006). A recent report by the Bureau of Reclamation (2009) indicates that aluminum, arsenic, boron, fluoride, sulfates, TDS, and the sodium absorption ratio all exceeded state water quality standards in a significant percentage of samples, that adequate dilution flows would limit the frequency and duration of the allowable Homestretch Geothermal discharge, and that when dilution flows are adequate to meet the fluoride standard all other constituents of concern would be in compliance with their respective water quality standards.

Environmental Consequences

This section describes the impact analysis relating to water resources for the acquisition alternatives and the No Action Alternative. It lists the criteria used to determine whether an impact would be adverse or beneficial.

Assessment Methods

Some potential water resources impacts were assessed qualitatively based on existing processes and issues in the Walker River Basin and how they may change in response to the acquisition alternatives. These impacts are listed below.

- *Improve River Water Quality as a Result of Increased Dilution of Poor Quality Inflows*
- *Diminish River Water Quality as a Result of Introduction of Water with Poor Quality*
- *Reduce River Water Temperature as a Result of Increased Flow*
- *Alter the Movement of the Anaconda Mine Groundwater Plume as A Result of Change in Groundwater Recharge*
- *Change in Amount of Groundwater Pumping*
- *Reduce Water Supplies for Remaining Canal Users as a Result of Reduced Canal Flow*
- *Reduce Incidental Availability of Water as a Result of Reduced Field Runoff, Seepage, or Return Flow*
- *Improve River Water Quality as a Result of Reduced Return Flow*
- *Increase Erosion as a Result of Increased River Flow and Increased Exposed Soil*
- *Decrease Quality of Stormwater Runoff as a Result of Construction-Related Activities* (short-term impacts potentially associated with construction under Alternative 3)

Other potential water resources impacts were assessed quantitatively. Quantitative evaluations of impacts were based on two distinct analyses: one for the portion of the study area upstream of Walker Lake, and one for Walker Lake. The methods employed in these analyses are described below. Hydrologic effects evaluated quantitatively for the upstream area were:

- reduction in surface water diversions,
- reduction in irrigated lands (a potential indirect effect of reduced surface water diversions), and

- effects of reduced irrigation on groundwater recharge.

Hydrologic effects evaluated quantitatively for Walker Lake were:

- change in Walker Lake surface elevation and storage as a result of increased inflow, and
- change in Walker Lake TDS concentration as a result of increased inflow.

Average annual values were used for the quantitative analyses. Because the effects of Alternatives 1 and 3 would take many years to reach fruition, the use of average annual values is appropriate. The duration of Alternative 2, as analyzed, is shorter, but because it is impossible to predict year-to-year variations in future hydrologic conditions, average annual values are still considered an appropriate way to estimate effects.

The University has recently developed three integrated models and data for assessing hydrologic conditions in the basin (Boyle et al. 2009). The three models simulate:

- runoff in response to precipitation,
- groundwater–surface water interactions, and
- operations and water rights allocation.

The models have not yet been used to estimate hydrologic impacts associated with the Acquisition Program, but future use of these models may refine the assessment of impacts described below by incorporating smaller time periods, more fine-scale evaluation of water right types, and groundwater modeling.

Conflicts with policies and goals in the master plans of Lyon and Mineral Counties that relate to water resources are addressed in Chapter 7, Land Use and Agriculture.

Upstream Analysis

Purpose

The purpose of the upstream analysis is to estimate the effect of the alternatives on the flow of water to Walker Lake, on remaining water supplies for agriculture, and on incidental recharge of groundwater. To these ends, and to provide input to the Walker Lake analysis, the upstream analysis was used to estimate the following variables.

- The amount of water to be acquired from the East Walker area, Smith Valley, and Mason Valley to achieve an additional 50,000 af/yr of inflow to Walker Lake, on average, under Alternatives 1 and 2.

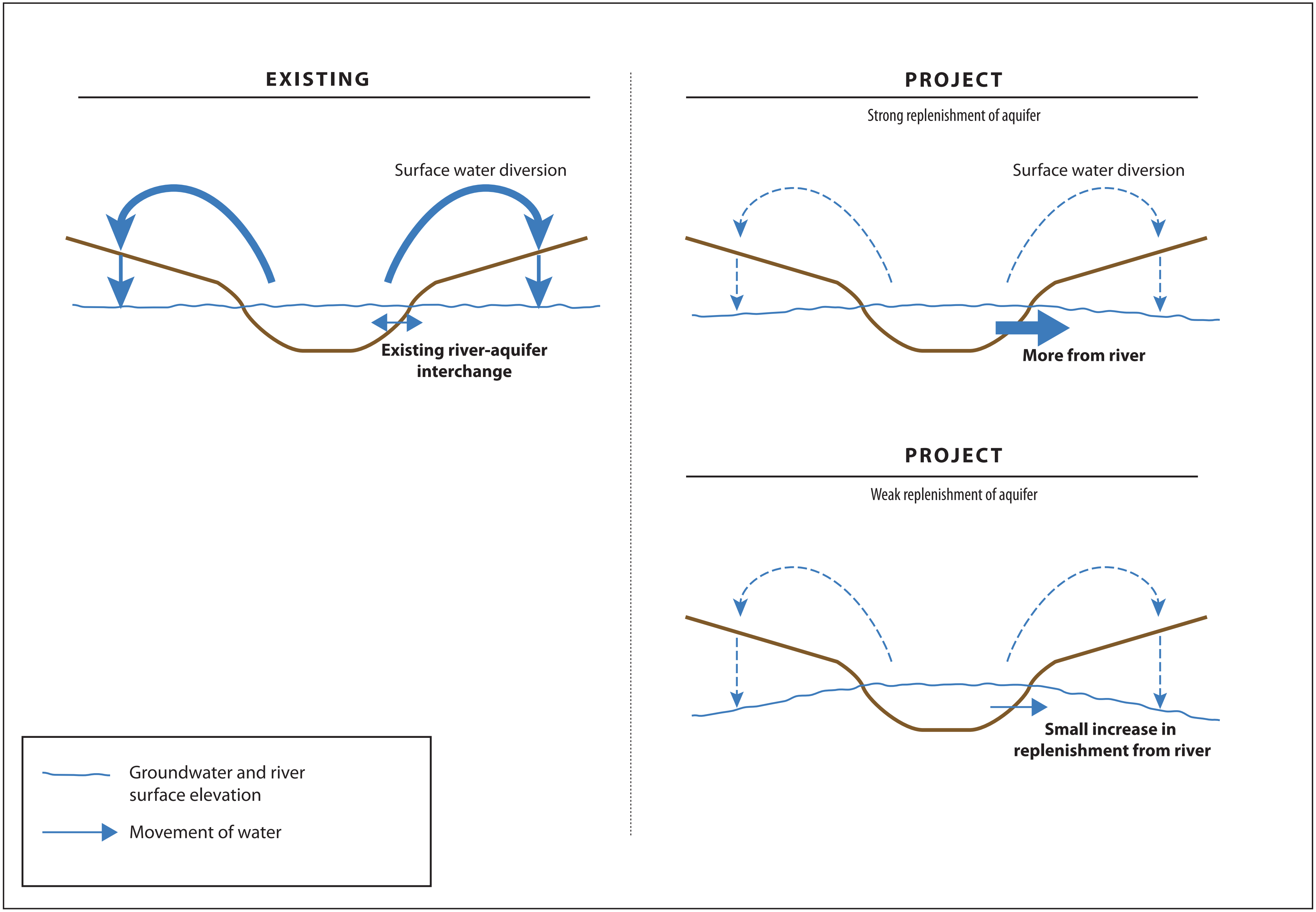

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Figure 3-20
Conceptual Diagram Showing How Project Effects on the Aquifer and River are Dependent on the Rate of Interchange between the River and the Aquifer

- The portion of acquired water that would reach Walker Lake under each alternative.
- The estimated maximum increase in Walker Lake inflow under Alternative 3 assuming no change in crops.
- The reduction in irrigated acres under Alternatives 1 and 2.
- The effect of each alternative on groundwater recharge.

The upstream assessment is useful for providing an understanding of the processes that affect groundwater recharge, irrigation, and river losses and the magnitude of potential Acquisition Program effects on these hydrologic processes. It also provides a framework for integrating many pieces of information and highlights necessary assumptions.

Methods – Introduction for All Alternatives

Scenarios

The same scenarios are used to evaluate Alternatives 1 and 2 because both alternatives include the transfer of water from agricultural land to Walker Lake. Both alternatives result in the same estimated reduction in irrigated lands and incidental groundwater recharge. The distinction between these two alternatives is that, under Alternative 1, some land would be permanently removed from irrigated agricultural production and the resulting flow changes would be permanent, whereas under Alternative 2, as analyzed, fallowing would likely be rotated between different land parcels over time and the resulting flow changes would be temporary (i.e., until funds are exhausted).

Alternatives 1 and 2 are evaluated using a Full Transfer Scenario and two Consumptive Use Scenarios (the Full Consumptive Use Scenario and the Partial Consumptive Use Scenario). These scenarios are designed to evaluate a range of potential effects on irrigated lands and groundwater. Alternative 3 is evaluated using estimated overall potential increases in water use efficiency and the effect of this change on existing river flows and the interaction between the river and groundwater. These scenarios are discussed in more detail below.

Losses

To estimate the amount of acquired water that would reach Walker Lake each year, on average and over the long term, the upstream analysis includes estimates of additional losses that could occur as a result of the acquisition alternatives. When acquired or saved water is left in the river instead of being diverted into a canal, there are several key ways that the additional volume of water could be reduced before it reaches Walker Lake:

- Return flows – Return flows include surface water returns and shallow groundwater returns to the river that are associated with the application of irrigation water from both surface and groundwater sources. If return flows were associated with water obtained through any of the action alternatives, those return flows would no longer be contributing to base river flow.
- Groundwater – If incidental groundwater recharge from irrigation is reduced, the groundwater table could drop. If this happens, river flows would be reduced because either there would be less groundwater inflow to the river or there would be more seepage from the river to groundwater.
- Loss downstream of Wabuska – Increases in flow downstream of Wabuska could produce an increase in river losses associated with groundwater infiltration or riparian ET.

The loss associated with a reduction in incidental GRR flows depends on the connectivity between the river and the aquifer. If a river is the primary source of water for an aquifer, as it is for most of the Walker River system, and the water moves readily through the substrate, a reduction in groundwater recharge can have a fairly large effect on river flow. Figure 3-20 is a conceptual diagram of two different levels of interaction between a river and an adjacent groundwater aquifer. When water moves readily from a river to the aquifer, the river is able to compensate for reductions in incidental groundwater recharge associated with a reduction in surface water diversions or increased water use efficiency. This compensation, however, comes at a cost of reduced river flow. If there is weak replenishment from the river to the aquifer, then river flow would not be much reduced, but the groundwater table would drop more significantly.

Two other possible sources of loss were considered for the river reaches upstream of Wabuska: increased ET, and increased infiltration to groundwater resulting from increases in river flow. Losses from these sources are not likely to be large.

Losses are discussed in more detail below in Incidental Groundwater Recharge and Return Flows and River Losses, and in Assumptions and Methods for Additional Losses.

Methods – Alternatives 1 and 2

General

The effects of water right acquisitions on agricultural lands and groundwater depend on how much of the acquired water would be allowed to be transferred. Out of concern for impacts on other existing water right holders, the NSE could impose restrictions on transfers, such as limiting transfers to the consumptive use portion of a water right (i.e., only the net crop ET). The NSE indicated such restrictions have been imposed in the past, but such issues could be addressed on a case-by-case basis (Gallagher pers. comm.).

Two types of scenarios, the Full Transfer Scenario and the Consumptive Use Scenarios, were established to represent likely extremes for evaluating Alternatives 1 and 2. The Full Transfer Scenario assumes no restrictions on the downstream transfer of water rights and the Consumptive Use Scenarios assume that the downstream transfer of water would be restricted to the consumptive use portion of the water right. These scenarios bound the range of potential impacts, such as the amount of irrigated land needed to implement the Acquisition Program. There are two Consumptive Use Scenarios, the Full Consumptive Use Scenario (which assumes that 3.1 af per decree-acre can be transferred downstream) and the Partial Consumptive Use Scenario (which assumes that 2.37 af per decree-acre can be transferred downstream). The Partial Consumptive Use Scenario corresponds to an estimated 33% reduction in water-righted acres. The primary difference between the Full Transfer and Consumptive Use Scenarios is the transfer assumptions.

However, the Full Transfer and Consumptive Use Scenarios differ in other ways. The Full Transfer Scenario assumes that if X% of water is removed from agriculture, there would be an X% reduction in irrigated lands. For this reason, the Full Transfer Analysis depends on irrigated acres, not water-righted acres. In contrast, the Consumptive Use Scenarios are tied to restrictions that would be applied to water-righted acres and must, therefore, be tied to water-righted acres. Table 3-11 compares the assumptions used for the scenarios.

Table 3-11. Comparison of the Full Transfer and Consumptive Use Scenarios

	Full Transfer Scenario	Consumptive Use Scenarios
Transfer allowed	Full	Less than or equal to ideal net consumptive use
Acreage basis	Irrigated acres	Water-righted acres
Supplemental groundwater pumping	Unchanged – supplemental groundwater rights can be transferred to other fields (least impact on irrigated acres)	Retirement of supplemental groundwater pumping associated with acquired water rights
Groundwater effect	Decrease in groundwater recharge, partially compensated by increase in river infiltration (which affects amount of flow augmentation reaching Walker Lake)	Either no change or potential increase in groundwater levels

Both the Full Transfer Scenario and the Consumptive Use Scenarios are based on actual water use and availability. For the Full Transfer Scenario, the key parameter is the average amount of water that is applied to each irrigated acre. For the Consumptive Use Scenarios the key parameter is the average amount of water that could be transferred per water-righted acre. A discussion of the relationship between paper water rights and real water yield is provided in Chapter 2, Alternatives, and Appendix 2B. Water-right yield is relevant to the Consumptive Use Scenarios but not the Full Transfer Scenario.

Alternatives 1 and 2 were evaluated assuming that the percent reduction in irrigated land in each of the three valleys (East Walker, Mason Valley, and Smith Valley) would be relatively similar, while the percent of total acquisitions for each valley would fall within the ranges described in Chapter 2, Alternatives (i.e., of the 50,000 af/yr average additional inflow to Walker Lake that is expected to accrue as a result of upstream water acquisitions, 60 to 85% would come from Mason Valley, 10 to 30% from Smith Valley, and 5 to 10% from East Walker). In reality, the percent reduction in irrigated land would likely differ among the valleys because of the willing-seller requirement.

Another key difference between the Full Transfer Scenario and the Consumptive Use Scenarios is the fate of supplemental groundwater rights that are associated with acquired surface water rights. If supplemental groundwater rights are acquired along with surface water rights, the supplemental groundwater rights might have to be retired and the associated groundwater pumping would be discontinued. However, it is likely that many supplemental groundwater rights would not be retired. For the Masini and Sunrise options, for example, the sellers were not willing to include their supplemental groundwater rights in their offers except on a contingent basis (i.e., if not in the process of being transferred at the time of the close of escrow). It is not clear how the NSE would handle supplemental groundwater rights in this context.

For the purposes of the Full Transfer Scenario, it is assumed that supplemental groundwater rights could continue to be used for irrigation and that they would be transferred to and used in conjunction with a different surface water right of equal or greater seniority. For the purposes of the Consumptive Use Scenarios, it is assumed that supplemental groundwater rights associated with acquired water would be retired.

The assumptions for the Full Transfer Scenario and the Partial Consumptive Use Scenario were chosen to result in the widest range of irrigated land and aquifer effect that might be expected. A qualitative description of the range of the results expected from these scenarios is shown in Table 3-12.

Table 3-12. Qualitative Description of Results from the Full Transfer Scenario and the Partial Consumptive Use Scenario.

Scenario	Reduction in Irrigated Land	Reduction in Incidental Groundwater Recharge
Full Transfer Scenario	Least	Greatest
Partial Consumptive Use Scenario	Greatest	Least

Full Transfer Scenario

The Full Transfer Scenario assumes that all acquired water could be left in the river to flow downstream, and that no supplemental groundwater rights would be retired. Supplemental groundwater would be available to the seller, potentially to supplement other primary rights; however, it is assumed that supplemental groundwater pumping would not increase, based on expected conditions of NSE approval. The Full Transfer Scenario would minimize future reductions in irrigated land resulting from acquisition of appurtenant water rights (identified as the least reduction in irrigated land in Table 3-12), but would have the greatest impact on groundwater because existing incidental groundwater recharge associated with an acquisition would be eliminated and pumping of supplemental groundwater could continue (greatest reduction in incidental groundwater recharge in Table 3-12). This scenario would cause the greatest reduction in surface or subsurface return flows to the river.

The Full Transfer Scenario does not separately account for the different types of surface and groundwater rights that may be appurtenant to irrigated lands, but is instead based on analysis of average total surface water diversions, average total groundwater withdrawals, and average total irrigated land within each valley. While important for day-to-day operations, these distinctions by type should not matter for determining the long-term average annual relationships between water application, irrigated land, and GRR flows.

Incidental GRR flows are important for evaluating the Full Transfer Scenario. Incidental GRR flows are estimated as the difference between the amount of irrigation water diverted and pumped and the amount of irrigation water consumed by agricultural crops and non-riverine riparian/wetland vegetation. The two components of GRR cannot be readily separated because it is unknown how much of the irrigation water drains to the river either directly in canals or via subsurface flows, nor is it known how much is reapplied by another user. (Return flows can be estimated using upstream to downstream changes in flow, but other uncertain factors such as riverine ET and river infiltration to groundwater also affect river flows.) GRR flows have a large effect on river flows.

To evaluate the Full Transfer Scenario it was necessary to estimate how the movement of water would deviate from existing conditions in response to a reduction in irrigation diversions resulting from acquisitions. The effect of each alternative on groundwater recharge was estimated by evaluating potential reductions in incidental GRR flows (resulting from reduced irrigation) and how much additional water the river would lose in response to the reduction in GRR flows. For each valley, the increase in river infiltration was estimated as a certain percent of the reduction in GRR flows and as a certain (smaller) percent of acquired water. This estimation process is described below.

Incidental Groundwater Recharge and Return Flows and River Losses

This section provides detailed information about estimating the relationship between reduction in incidental GRR flows and increase in river infiltration for the Full Transfer Scenario.

Under the Full Transfer Scenario, GRR flows would be affected by water rights acquisitions. Under existing conditions, the estimated agricultural GRR flows for the East Walker River, Smith Valley, and Mason Valley are 9,000 af/yr, 25,000 af/yr, and 94,000 af/yr, respectively (see Affected Environment).

To estimate the effect of water acquisitions on GRR and river flows under the Full Transfer Scenario, the following assumptions were made:

- agricultural GRR flows decrease in proportion to the fraction of the irrigation water that is acquired, and
- river flow would be reduced in response to a reduction in GRR flows (i.e., some of the reduction in groundwater recharge would be offset by groundwater infiltration from the river).

Work by Myers (2001a and 2001b) indicates that there is a moderate to strong connection between flows in the river and the groundwater aquifer in Mason Valley and Smith Valley, with the exception of the far northern portion of Smith Valley. Generally, if groundwater recharge were reduced in the Walker River basin, either the rate of movement from groundwater to the river would be reduced or more water would seep from the river to groundwater. Any long-term decline in groundwater levels is likely to reduce flows in the river. The exact reduction in river flows cannot be predetermined, especially because the location of all the farmland to be affected is currently unknown. If the land is close to the river, the link between the river and the groundwater is more direct than if the land is far from the river.

Myers investigated the potential long-term effect that a reduction in groundwater recharge would have on river flows using a groundwater model. Myers' work is currently the only source of published information regarding how infiltration from Walker River may respond to long-term decreases in groundwater recharge

(Myers 2001a and 2001b). The Myers analysis was performed for four locations in Smith and Mason Valleys. The estimated valley-wide percent connection between the recharge reduction and the river flows forecasted for 25 years in the future were 52% for Smith Valley (Myers 2001a) and 82% for Mason Valley (Myers 2001b). This means that 52% (Smith Valley) and 82% (Mason Valley) of any reduction in GRR is estimated to be offset by reduced river flows over time. The Smith Valley value is much lower than the Mason Valley value because water that is applied north of the groundwater divide in Smith Valley tends to flow towards Alkali Lake instead of the river. The value for the East Walker reach was assumed to be the same as the value for Mason Valley. In the following text, these values are referred to as the Link values (i.e., to reflect the link between the river and groundwater).

These Link values can be used to estimate the reduction in river flow as a percent of surface water purchases. Assuming that groundwater pumping remains unchanged (the Full Transfer Scenario assumes no reduction in supplemental groundwater pumping) this percent can be calculated as:

$$PercRed = 100 * Link * GRR_e / (SW_e + GW_e)$$

Where:

PercRed = the percent reduction of transferred water resulting from a reduction in incidental groundwater recharge assuming full transfer of water.

Link = the fraction of a reduction in incidental groundwater recharge that is compensated by a reduction in river flow (0.82 for the East Walker reach and the Mason Valley reach and 0.52 for the Smith Valley reach as estimated by Myers, 2001a and 2001b).

GRR_e = Average annual GRR flow volume estimate for existing conditions.

SW_e = Average annual surface water diversion volume estimate for existing conditions.

GW_e = Average annual groundwater pumping volume estimate for existing conditions.

The calculated values for PercRed are:

East Walker reach: 34.1%

Smith Valley reach: 15.9%

Mason Valley reach: 37.3%

Part of the reason there is such a strong connection between groundwater recharge and the river is that some agricultural return flows to the river move through the ground. The assessment of GRR flows assumes that most of the GRR flows are either incidental groundwater recharge or return flow that moves through the groundwater aquifer. If all of the GRR flows were composed of return flows, there would be a 100% connection between a loss in the GRR flows and reduction in river flow (and the PercRed values would be 41.8% for East Walker reach, 30.4% for Smith Valley reach, and 45.7% for Mason Valley reach). River flows would decline in response to a reduction in GRR flows most quickly by a loss in direct return flows and then less directly, or secondarily, by a change in the river interaction with the aquifer. Any reduction in GRR flows that is not compensated by the river would affect net groundwater recharge.

Consumptive Use Scenarios

The Consumptive Use Scenarios assume that only the consumptive use portion of a water right could be transferred. Therefore, more water rights would need to be acquired to achieve the same flow, resulting in a larger effect on water-righted acres and irrigated lands. If a consumptive use limitation is placed on water transfers, then the water that normally would have infiltrated to groundwater or would have been used by non-agricultural vegetation could not be transferred. This water would be left either in canals or the river where it could continue to infiltrate to groundwater or be used by non-agricultural vegetation. As a result, if a consumptive use limitation is placed on water transfers, groundwater levels should not be greatly affected (least reduction in incidental groundwater recharge in Table 3-12).

Furthermore, the Consumptive Use Scenarios assume that acquired supplemental groundwater rights would be retired. The retirement of this water could increase the amount of irrigated lands that would be retired, but may allow increases in groundwater levels. Under the Consumptive Use Scenario, river losses are not expected to increase.

Under the Consumptive Use Scenario, transfers would be restricted to the consumptive use value. However there is uncertainty in this value. In the past, when the NSE issued a consumptive use limitation on transfers, the limit was often based on a consumptive use value for ideal watering conditions (i.e., sufficient water to maximize crop yield of the most common crop). For the Walker River Basin, the current estimate of this value is a net consumptive use of 3.1 feet/year for alfalfa (Felling pers. comm.). The average estimated yield of decree acres that are currently under option is 3.0 af per acre. For New Land acres, the average estimated yield is 1.14 af per acre. When yield is less than the ideal consumptive use limit, it is likely that the NSE would allow full transfer of the yield provided that supplemental groundwater pumping that would have made up the shortfall would be discontinued.

For the Consumptive Use Scenarios, the transfer rate for New Land acres was treated differently than the transfer rate for decree acres. The ratio of New Land acres to decree acres involved in water rights purchases was estimated as 19% based on the information from the existing water right options as of December 2009. The transfer rate for New Land acres was assumed to be 1.14 af per acre (i.e., equal to the yield). Two sets of numbers were used for the transfer rate for decree acres: an upper limit of 3.1 af per acre and a lower value of 2.37 af per acre. The lower value (2.37 af per acre) is the transfer rate that is used for the Partial Consumptive Use Scenario and it results in an estimated 33% reduction in water-righted acres. The upper value (3.1 af per acre) is the transfer rate that corresponds to the Full Consumptive Use Scenario.

The assumptions and results of both Consumptive Use Scenarios are discussed in this chapter. However, an emphasis is placed on the Partial Consumptive Use Scenario because it results in the largest impact to irrigated acres. Only results from the Partial Consumptive Use Scenario are discussed in other resource chapters.

Funding Assumptions

The upstream analysis assumes that sufficient funds would become available to obtain, in perpetuity, an average additional 50,000 af/yr at Walker Lake under Alternative 1 (Purchase Alternative). A comparable amount of total funding is then assumed to be available for Alternative 2 (Leasing Alternative); however, the need for recurrent expenditures to sustain a leasing program means that funding would eventually run out, and the effects of Alternative 2 would only be temporary. If only partial funding were available, the effects would be expected to be proportional to the funding. For example, if only 50% of the total funding needed for Alternative 1 were available, Alternative 1 would only yield an average of half as much water to the lake (25,000 af/yr) and effects on irrigation and groundwater recharge would also be half of that expected for the fully funded project. If the funding for Alternative 2 were diminished by 50%, the increased inflow to Walker Lake and effects on irrigation and groundwater recharge would only last half as long.

The conversion between face value of water rights and expected yield is addressed in Chapter 2, Alternatives. This conversion is important for assessing cost and how much water could be purchased with $56 million.

Methods – Alternative 3

There are many uncertainties about how Alternative 3 would be implemented. Fourteen possible actions are listed in the description of this alternative (Chapter 2). Because the exact actions to be taken are uncertain, the effects of Alternative 3 were evaluated by assuming that water use efficiency could be increased to a high but theoretically attainable value. An overall efficiency value of 75% was used to assess impacts from Alternative 3. This 75% overall efficiency value roughly represents a 90 to 95% conveyance efficiency combined with an 80 to 85% on-farm or application efficiency. Literature indicates that application efficiency rates ranging from 60 to 90% are attainable with a variety of irrigation technologies (Howell 2003, Solomon 1988). Attaining an efficiency of 90% would require a very large investment in conveyance infrastructure improvements such as canal lining and piping.

This assessment is somewhat theoretical because it is unlikely that all farmers would want to participate in this program and unlikely that overall efficiency of 75% could be attained everywhere. Even on a single field, attainment of 75% efficiency could be difficult; open canals would probably have to be converted to pipes and typical sprinkler efficiency for alfalfa of 75% (Miller pers. comm.) would have to be increased to about 80% (perhaps with drip irrigation).

For Alternative 3 it is assumed that regulatory mechanisms would be developed to allow conserved water to pass downstream without being diverted by downstream or junior priority rights holders. For example, diversion rights might be reduced in amounts commensurate with the conservation savings to ensure that conserved water can be administered like a water right and thus protected from simply becoming part of the available water supply.

Alternative 3 would have fairly large impacts on incidental groundwater recharge because a large portion of current losses contributes to groundwater recharge. As a result, Alternative 3 was evaluated in a manner similar to the Full Transfer Scenario by estimating the reduction in GRR flows and the effect of this reduction on river flow.

Evaluation of crop switching (shifting to crops that use less water) was not part of the upstream analysis because it is unclear to what extent farmers would be willing to switch crops as part of the Acquisition Program. If crop switching were to occur, it could result in increased river flow with relatively little reduction in GRR flows and could result in water savings that could significantly increase the yield from Alternative 3.

For existing conditions, the amount of water lost to non-riverine riparian and wetland vegetation (incidental or non-crop ET) combined with the estimated incidental GRR flows provides an estimate of the amount of water lost to inefficiencies in the conveyance or application of water for irrigation (see Affected Environment section). For the three valleys, East Walker, Smith Valley, and Mason Valley, the inefficiencies were estimated as 47%, 40%, and 54%, respectively, of the total irrigation water. The estimated volumes of water lost to inefficiency are approximately 10,000 af/yr for East Walker Valley, 33,000 af/yr for Smith Valley, and 111,000 af/yr for Mason Valley. The corresponding efficiency values are 53%, 60%, and 46%, respectively.

For this alternative the following assumptions are made.

- Flows would be augmented by increasing the percent efficiency for each valley to the same value. The most water savings would come from Mason Valley because it appears to have the lowest percent efficiency as well as the largest use of irrigation water.
- Efficiency measures would reduce incidental ET by the same percent they would reduce incidental GRR flows.
- Groundwater pumping and consumptive use (i.e., net ET from crops) would remain unchanged.

Compared to the GRR flows, the incidental ET is relatively small. Total existing incidental ET is estimated to only be 26,000 af/yr for all three valleys, as compared to 128,000 af/yr for total GRR flows. Thus, removal of incidental ET by itself could not provide an additional 50,000 af/yr to Walker Lake. Reduction in GRR flows would also be necessary. Reduction in GRR flows is not as effective as reduction in incidental ET because the GRR flows help maintain river flows and may also help to support other existing water rights.

Incidental Groundwater Recharge and Return Flows and River Losses

This section provides detailed information about estimating the relationship between reduction in incidental GRR flows and increase in river infiltration for Alternative 3.

Similar to the Full Transfer Scenario, the variable Link was used to estimate the percent by which the water savings left in the river would be reduced as a result of increased river infiltration to groundwater resulting from a reduction in incidental GRR flows. When the above assumptions are made, the percent reduction in water savings is independent of the target efficiency rate.

PercRed = 100 * Link * GRR_e / (GRR_e + IET_e)

Where:

PercRed = the percent reduction in saved water resulting from a reduction in incidental groundwater recharge.

Link = the fraction of a reduction in incidental groundwater recharge that is compensated by a reduction in river flow (0.82 for the East Walker and the Mason Valley reach and 0.52 for the Smith Valley reach based on work by Myers [2001a and 2001b]).

GRR_e = Estimated average annual GRR flow volume for existing conditions.

IET_e = Estimated average annual incidental ET (i.e., ET for non-riverine riparian and wetland vegetation or non-crop ET) under existing conditions.

Note that, if IET_e is zero, then all water savings come from a reduction in GRR and the percent reduction equals the savings times the Link parameter.

The calculated values for PercRed are:

East Walker reach:	72.1% (because incidental ET is low)
Smith Valley reach:	40.2%
Mason Valley reach:	69.2%

Funding Assumptions

For Alternative 3, the analysis assumes that sufficient funding would be available to increase water efficiency to a high level. Potential costs associated with Alternative 3 are discussed in Chapter 2 and Appendix 2B.

Summary of Key Assumptions for the Full Transfer Scenario, Consumptive Use Scenarios, and Alternative 3 Analysis

Because of uncertainties in the upstream analysis, the following assumptions were made.

- Acquisitions would be evenly distributed in each valley (distribution between valleys is expected to differ).
- Non-riverine riparian/wetland vegetation depends on irrigation water.
- ET of native phreatophytic vegetation would not significantly change in response to project actions.

- All water acquisitions would be derived from irrigation supplies. This assumption was made only for the purposes of the upstream hydrologic analysis and to estimate the amount of irrigated land that could be affected. Impacts on existing irrigated lands could be lessened by the purchase of non-agricultural water (e.g., geothermal).
- Acquired water would not be diverted by downstream water users.
- The river would partially compensate for reductions in GRR by increased infiltration to groundwater, which would reduce the magnitude of the incremental increase in river flow caused by the acquisition alternatives.
- Approximately 10% of the incremental flow increase at Wabuska would be lost between Wabuska and the lake. The basis for this assumption is described below.
- The volume of river losses resulting from ET by riparian vegetation near the river would not substantially increase upstream of Wabuska, but may increase downstream of Wabuska, particularly downstream of Schurz where the channel is now often dry.
- For Alternatives 1 and 2, water efficiency (crop ET divided by diverted and pumped water) would remain unchanged.
- For Alternatives 1 and 2, the percent reduction in water-righted acres would cause a similar percent reduction in irrigated land.
- For Alternative 3, the same level of water efficiency would be attained in all valleys.
- For Alternative 3, total ET from irrigated lands would not change.

Assumptions and Methods for Additional Losses – All Alternatives

Whatever portion of acquired water is eventually approved for transfer, additional physical losses would occur between the existing points of diversion and Walker Lake. Losses related to a potential decrease in GRR flows, which are particular to the alternative being evaluated, are discussed above. This section describes how potential additional losses were assessed for all alternatives.

The loss rates discussed here are estimates of average increases in river losses as a percent of increases in flow. These loss rates are applied to the estimated average increase in flow expected for each alternative. In reality the flow augmentation (and the volume of water lost) would vary from year to year as hydrological conditions vary, but the long-term lake effects depend on changes in average flows.

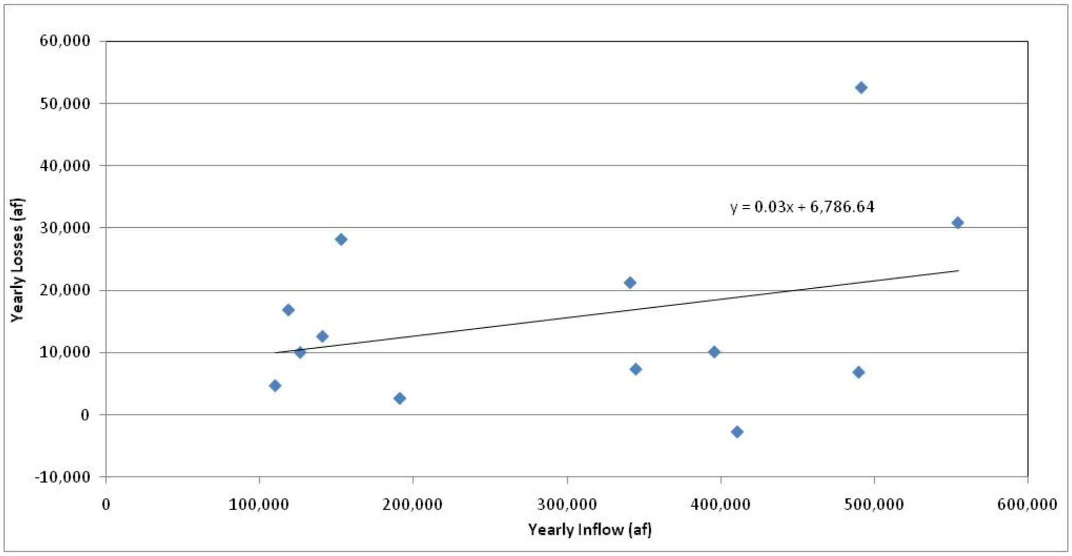
Riverine Evapotranspiration Upstream of Wabuska

As the river flows downstream, some flow is lost directly to ET along the river. As estimated in the Affected Environment section, this includes flow reductions associated with trees using shallow groundwater within 1,000 feet of the river channel. Estimated riverine ET represents a fairly small percent of total flow volume (8% for the East Walker reach, 2% for the Smith Valley reach, and 3% for the Mason Valley reach).

It is uncertain whether riverine ET along the Walker River would increase in response to increases in flow. Increase in river flow would likely have a relatively small effect on the elevation of the shallow groundwater that supports riparian vegetation along the river. Furthermore, this small effect might be negated by potential project-related lowering of the groundwater table. Other factors affecting riverine ET are the amount of space available for riparian vegetation and the type of vegetation present. Riverine vegetation is often limited to the extent of the floodplain, which is not expected to change as a result of the Acquisition Program. It is unclear whether riverine ET would increase beyond existing levels. If there were an increase, it would likely represent a small percent of the total acquired water. Therefore, riverine ET was assumed to remain at existing levels in the upstream valleys. The existing riverine ET is supported by existing flows and would not reduce the volume of a flow increase.

Mason Valley Transit Losses

As water flows through Mason Valley, a certain amount of water is lost to ET (discussed above) and infiltration. As river flow increases, there is an increase in the wetted perimeter, which theoretically could increase the amount of infiltration to groundwater. However, most infiltration, which largely depends on local groundwater conditions, already occurs under base flow conditions and would not reduce the amount of acquired water moving through the valley. There is no clear significant relationship between groundwater infiltration and increases in flow in Mason Valley. For the Full Transfer Scenario, any increases in infiltration associated with increases in flow (transit losses) are likely to be insignificant compared to the losses estimated to be associated with reductions in GRR flows. As a result, for the Full Transfer Scenario, no transit losses were assumed for water passing from East Walker Reach or Smith Valley Reach through Mason Valley. For the Consumptive Use Scenario, a small transit loss of 3% was selected based on a very weak trend of increasing river losses (excluding diversions) with increasing river flow in Mason Valley (Figure 3-21).



Note: A modified water year (November – October) was used to keep irrigation seasons intact

Figure 3-21. Mason Valley Inflow Compared to Instream Losses for 1995 – 2007

Incremental Increase in Losses between Wabuska and Walker Lake

A discussion of existing losses in the Reservation Reach, as well as the relationships between losses in the reach and flow at Wabuska, is included in the Affected Environment section. The analysis below builds on that information.

Wabuska to Schurz

There are sufficient flow measurements from Wabuska and Schurz to estimate how riverine losses in this reach may increase in response to increases in flow. Based on the analysis in the Affected Environment section, the incremental loss associated with a flow increase over and above existing flows is assumed to be 4% of the additional flow at Wabuska.

Schurz to Walker Lake

The flow measurements taken at Schurz and near the lake indicate the magnitude of the existing flow losses in this reach. However, it is difficult to say how much the losses in this reach may increase if river flow is increased as a result of the Acquisition Program. Clearly, if river flow goes from zero to some value, losses would increase. Under existing conditions, there is usually some flow at Schurz (e.g., median flow of 5 to 7 cfs for August through September, the months with the lowest flow) to provide for a base level of ET and infiltration. However, about a quarter of the summer months have no flow at Schurz under existing conditions. If the increases in flow were to bring flows to Schurz during such times, losses associated with flow augmentation could be relatively high. However, because acquired water rights are more likely to yield water when more water is available, increased flows in this reach are likely to occur when flow is already present at Schurz.

In addition, there is some potential for Weber Reservoir to be operated to optimize the flow of water into the lake. Weber Reservoir may provide an opportunity to manage lower river flows and discharge to Walker Lake during the irrigation season. To the extent that there is available capacity, it may be possible to store acquired water in the reservoir in order to focus releases during a particular period to benefit aquatic and riparian resources or minimize flow losses downstream from the reservoir, provided that reservoir operating criteria are met. Such reservoir operations would be secondary to those for irrigation and flood control and require agreement among the project manager, BIA, and WRPT. Changes in the use of Weber Reservoir would require development and implementation of an operations plan for Weber Reservoir to assure that use of decreed water rights in the Walker River Indian Irrigation Project would not be impaired and to protect the safety of the downstream community. (See Chapter 2, Alternatives, for additional discussion about potential operations of Weber Reservoir.)

Factors that could cause an increase in river losses in association with increased flow between Schurz and Walker Lake are listed below.

- Increase in evaporation from the river – this would be limited by the increase in water surface area.
- Increase in ET from existing vegetation – it may be reasonable to assume that existing vegetation is already obtaining sufficient water to survive.
- Increase in ET resulting from increase in riparian vegetation – this would depend in part upon the success of restoration efforts (see Chapter 14, Cumulative Impacts).
- Increase in groundwater infiltration – this would be largest when flow increases result in a change from zero base flow to a positive flow value. However, groundwater that is not used for irrigation or by riparian vegetation in this area may eventually flow to the lake.

Wabuska to Walker Lake

As described in Chapter 2, Alternatives, it is assumed that WRPT, BIA, and the University (or other implementing entities) would develop an agreement for the management of acquired water through the reservation for delivery to Walker Lake.

For the purposes of estimating the incremental losses associated with increased flows between Wabuska and Walker Lake, a composite value of 10% of flow at Wabuska was used. This 10% represents a combination of the estimated 4% increase in losses between Wabuska and Schurz, along with an additional 6% loss for the reach downstream of Schurz. Based on this 10% loss factor, in order to deliver an additional 50,000 af/yr to Walker Lake on average, the estimated increase in flow needed at Wabuska would be an average of 55,555 af/yr.

The additional 6% roughly accounts for incremental increased losses between Schurz and the lake. These incremental losses would result from occasionally providing flow at times when there would normally be no baseline flows as well as from increases in ET from additional growth of riparian and wetland vegetation made possible by the increase in flow from the acquisition alternatives. The additional 6% might be more than enough to cover incremental losses between Schurz and the lake. In water year 2005, the only water year with a full set of flow measurements at the upstream and downstream ends of this reach, total losses between Schurz and Walker Lake were 6% of the flow at Wabuska. Incremental increases in the percent of losses associated with an increase in flow are expected to be less than the baseline percent loss.

Upstream Analysis Results

Results of the upstream analysis are presented first generally and then more specifically for each alternative. Additional information appears in the impact section.

Percent of Flow Augmentation Reaching Walker Lake

Table 3-13 illustrates estimate the combined effects of incremental flow losses on the percent of the acquired or saved flow reaching Walker Lake. Numbers are presented for the Full Transfer Scenario and the Consumptive Use Scenario (Alternatives 1 and 2) and the Efficiency Alternative (Alternative 3). The amount of flow augmentation is listed as 10,000 af/yr merely for the purposes of illustrating analytically the percent of water remaining in the river. These percents can be used to estimate what portion of a volume of acquired water would reach Walker Lake.

Under the Full Transfer Scenario, an estimated 59%, 76%, and 56% of the acquired or leased water would reach Walker Lake from the East Walker reach, Smith Valley reach, and Mason Valley reach, respectively. Under the Consumptive Use Scenario, it is estimated that 87% of the acquired or leased water would reach Walker Lake from each reach. In contrast, under Alternative 3, it is estimated that only 25%, 54%, and 28% of the water savings would reach Walker Lake from the East Walker reach, Smith Valley reach, and Mason Valley reach, respectively (Table 3-13). The percent of flow augmentation estimated to reach the lake is much lower for Alternative 3 because a large proportion of the water savings for this alternative come at the expense of a reduction in GRR flows that help to sustain river flows. The percent of flow augmentation estimated to reach the lake is highest for the Consumptive Use Scenario because this scenario would not cause a drop in the aquifer or the resulting increased infiltration from the river.

For the Full Transfer Scenario, it may seem counterintuitive that more water acquired from Mason Valley would be lost on the way to Walker Lake than would be lost from water acquired from Smith Valley. Most of the estimated loss is caused by the river response to a reduction in GRR flows. This loss would result directly from acquisitions within the valley. If no water were acquired within a valley, then there would be almost no incremental increase in losses within the valley. For that reason, water acquired in Mason Valley would be reduced in response to the connection between the river and the aquifer in Mason Valley and water acquired in Smith Valley would be reduced in response to the connection between the river and the aquifer in Smith Valley. The primary reason for the seemingly odd result of losing more Mason Valley water than Smith Valley water is the presence of the groundwater divide in the Smith Valley. The groundwater divide has the effect of reducing the valley-wide average connection between the river and the aquifer in Smith Valley. As a result, more of the water acquired from Smith Valley would stay in the river and there would be a larger reduction in groundwater.

Table 3-13. Estimated Percent of Acquired, Leased, or Saved Water that Would Reach Walker Lake

	East Walker	Smith Valley	Mason Valley
Full Transfer Scenario (Acquisition and Lease Alternatives)			
Water Acquisitions or Leases (af/yr)	10,000	10,000	10,000
Percent Loss from Reduction in GW Recharge Plus Returns	34.1%	15.9%	37.3%
Acquired Water at Downstream End of Valley (af/yr)	6,590	8,410	6,270
Percent Loss between Wabuska and Lake	10%	10%	10%
Percent Acquired Water Arriving at Lake	59%	76%	56%
Consumptive Use Scenario (Acquisition and Lease Alternatives)			
Water Acquisitions or Leases (af/yr)	10,000	10,000	10,000
Incremental Percent Loss from Increased Flow	3%	3%	3%
Acquired Water at Downstream End of Valley (af/yr)	9,700	9,700	9,700
Percent Loss between Wabuska and Lake	10%	10%	10%
Percent Acquired Water Arriving at Lake	87%	87%	87%

	East Walker	Smith Valley	Mason Valley
Efficiency Alternative			
Water Savings (af/yr)	10,000	10,000	10,000
Percent Loss from Reduction in GW Recharge Plus Returns	72.1%	40.2%	69.2%
Saved Water at Downstream End of Valley (af/yr)	2,790	5,980	3,080
Percent Loss between Wabuska and Lake	10%	10%	10%
Percent Acquired Water Arriving at Lake	25%	54%	28%

Estimated Impacts on Irrigated Land and Groundwater Recharge

The main purpose of the upstream analysis is to estimate potential impacts on irrigated lands and groundwater recharge that may be associated with the Acquisition Program. Table 3-14 provides a summary of estimated impacts and further detail is provided below. For the Full Transfer Scenario, the estimated reduction in irrigated land would be approximately 26% and reduction in net groundwater recharge would be approximately 5 to 11% of the estimated incidental GRR flows. For the Consumptive Use Scenario, the reduction in irrigated land would be 33% for the Partial Consumptive Use Scenario and 26% for the Full Consumptive Use Scenario. The reduction in net groundwater recharge would be minimal and groundwater levels could increase compared to the No Action Alternative as a result of the retirement of acquired supplemental groundwater rights. For Alternative 3, without a reduction in ET from irrigated lands, it would be unlikely that inflow to Walker Lake could be increased an average of 50,000 af/yr. (Crop substitution offers one potential method to reduce ET.) When water efficiency was increased to 75% from the approximately 50% for existing conditions, the estimated reduction in net groundwater recharge was estimated to be 12 to 23% of the estimated incidental GRR flows.

Table 3-14. Estimate of Hydrological Effects Upstream of Walker Lake

	Alternative 1[a]			Alternative 2[a]	Alternative 3[b]
		Consumptive Use Scenario			
	Full Transfer Scenario	Partial Consumptive Use	Full Consumptive Use	Full Transfer Scenario	75% Water-Use Efficiency
Acquisition of Real Water (average af/yr)					
East Walker	6,000	6,000	6,000	Same as Alternative 1 but temporary	7,000
Smith Valley	20,000	15,000	15,000		16,000
Mason Valley	56,000	36,000	36,000		79,000
Total	82,000	57,000	57,000		102,000
Increase in Walker Lake Inflow (average af/yr)					
East Walker	3,500	5,400	5,400		1,600
Smith Valley	15,000	13,400	13,400		8,700
Mason Valley	31,500	31,200	31,200		21,900
Total	50,000	50,000	50,000		32,200
Maximum Reduction in Irrigated Land (acres)[c,d]					
East Walker	1,100	NA	NA		0
Smith Valley	4,200	NA	NA		0
Mason Valley	9,500	NA	NA		0
Total	14,800	NA	NA		0
Maximum Reduction in Water-Righted Acres (acres)[c,d]					
East Walker	NA	2,900	2,300		0
Smith Valley	NA	7,200	5,600		0
Mason Valley	NA	16,700	13,100		0
Weighted Average	NA	26,800	21,000		0
Maximum Percent Reduction in Irrigated Land[d]					
East Walker	27	33	26		0
Smith Valley	24	33	26		0
Mason Valley	27	33	26		0
Weighted	26	33	26		0

	Alternative 1[a]			Alternative 2[a]	Alternative 3[b]
		Consumptive Use Scenario			
	Full Transfer Scenario	Partial Consumptive Use	Full Consumptive Use	Full Transfer Scenario	75% Water-Use Efficiency
Average					
Percent Reduction in Net Groundwater Recharge (% of Existing GRR)					
East Walker	5	0[f]	0[f]		12
Smith Valley	11	0[f]	0[f]		23
Mason Valley	5	0[f]	0[f]		13
Weighted Average	6	0[f]	0[f]		15
Reduction in Groundwater Level (inches/year)					
East Walker	0.8	0[f]	0[f]		1.9
Smith Valley	1.7	0[f]	0[f]		3.5
Mason Valley	2.0	0[f]	0[f]		5.2
Weighted Average	1.7	0[f]	0[f]		4.2

Notes:

Many assumptions were used in generating these estimates. See description of assessment methods above

[a] Estimates for Alternatives 1 and 2 assume that funding would be sufficient to attain an average increase in Walker Lake inflow of 50,000 af/yr under Alternative 1.

[b] Water savings were assumed to result from reductions in ET from non-riverine riparian/wetland vegetation and reductions in incidental groundwater recharge, not reductions in ET from irrigated lands (as may result from crop switching).

[c] The Full Transfer Scenario is based on water use (so irrigated acres are evaluated), whereas the Consumptive Use Scenario is based on water rights and transfer restrictions (so water-righted acres are evaluated).

[d] The estimated reduction in irrigated land for Alternatives 1 and 2 assumes no increase in water-use efficiency.

[f] Groundwater levels could increase relative to the No Action alternative as a result of retirement of acquired supplemental groundwater rights.

Alternatives 1 and 2

The Full Transfer Scenario assumes no restrictions would be placed on the transfer of acquired water (where acquired water is the real-water yield of acquired water rights) and that all supplemental groundwater rights associated with acquired water would continue to be exercised at historic rates of use instead of retired. However, it also assumes that any decreases in river flow associated with the Acquisition Program would reduce the quantity of acquired water available for conveyance to Walker Lake. The Full Transfer Scenario is expected to result in the least reduction in irrigated land, but the greatest reduction in groundwater recharge. If restrictions are placed on the transfer of water as in the Consumptive Use Scenario, the reductions in irrigated land could reach 33% (under the Partial Consumptive Use Scenario), but groundwater levels would be unaffected or could increase relative to the No Action Alternative. Results indicate little difference between the Full Transfer Scenario and the Full Consumptive Use Scenario in terms of reduction to irrigated land. This unexpected similarity is caused by the relatively high transfer rate assumed for the Full Consumptive Use Scenario as well as differences in the analysis approach for the two types of scenarios.

Impacts on Irrigated Land

For the Full Transfer and Consumptive Use Scenarios, the estimated percent of acquired water arriving at Walker Lake (see above) was used to estimate the amount of water needed from each valley in order to have an additional 50,000 af/yr reach the lake. The amounts were adjusted until the agricultural impacts (lands removed from production or no longer irrigated) were similar in percentage terms for each valley (Tables 3 -15 and 3-16).

For the Full Transfer Scenario, average baseline (existing) irrigated land coverage is estimated to be 4,000 acres for East Walker Valley, 17,500 acres for Smith Valley, and 35,000 acres for Mason Valley (see Table 3-15 and the Land Coverage subsection above). When the acquisition/lease amounts were set to 6,000 af/yr, 20,000 af/yr, and 56,000 af/yr for the East Walker, Smith Valley, and Mason Valley, respectively, the estimated average increase in inflow at the lake was 50,000 af/yr and the estimated percent reduction in water use (and percent reduction in irrigated land) was 27%, 24%, and 27%, respectively, for each of the valleys (average of 26%). This corresponds to a reduction in irrigated lands of 1,100 acres for East Walker, 4,200 acres for Smith Valley, and 9,500 acres for Mason Valley.

Under the Consumptive Use Scenarios, the reduction in water use and irrigated land would be 33% for each valley for Partial Consumptive Use and 26% for each valley for Full Consumptive Use. Partial Consumptive Use corresponds to a reduction in irrigated lands of 1,300 acres for East Walker, 5,800 acres for Smith Valley, and 11,500 acres for Mason Valley.

Incidental Groundwater Recharge and Return Flows

Project-related change in groundwater levels would depend on whether conveyance and irrigation inefficiencies are maintained by restrictions (conditions of approval) on water right transfers. It also would depend on the fate of supplemental groundwater rights that are associated with acquired surface water rights. Groundwater effects would depend on whether water transfers were more similar to the Full Transfer Scenario or the Consumptive Use Scenario.

Under the Full Transfer Scenario, a reduction in incidental GRR flows under Alternatives 1 or 2 could cause a reduction in groundwater levels. Details of potential groundwater impact associated with the Full Transfer Scenario are discussed in more detail below for Impact WI-8. Under the Consumptive Use Scenario, GRR flows would be minimally affected. In addition, retirement of supplemental groundwater rights could allow groundwater levels to rise in comparison to groundwater levels under the No Action Alternative.

Table 3-15. Estimated Water Acquisitions or Leases, Reduction in Agricultural Acres, and Groundwater Effects for the Full Transfer Scenario

	East Walker	Smith Valley	Mason Valley	Total
Water Augmentation at Lake (%)	7%	30%	63%	100%
Water Augmentation at Lake (af/yr)[a]	3,500	15,000	31,500	50,000
Percent Acquisition/Lease at Lake[b]	59%	76%	56%	
Amount of Surface Water Acquisition/Lease (af/yr)	5,900	19,800	55,800	81,500
Percent of Total Surface Water Acquisition/Lease	7%	24%	68%	100%
Average Existing SW Diversion (af/yr)[c]	21,900	59,100	125,700	206,700
Average Existing GW Pumping (af/yr)[c]	0	24,000	79,200	103,200
Total % Reduction in Water Use	27%	24%	27%	26%
Existing Irrigated Land (acres)[c]	4,015	17,452	34,972	56,439
Reduction in Irrigated Land (acres)	1,081	4,162	9,525	14,768
Incidental GRR Flows before Flow Augmentation (af/yr)[c]	9,200	25,300	93,600	128,100
Reduction in Incidental GRR (af/yr)[d]	2,500	6,000	25,500	34,000
Fractional Effect of GRR on River Flow (Link)[e]	0.82	0.52	0.82	
Increased River Percolation to GW (af/yr)[f]	2,000	3,200	20,800	26,000
Net Reduction in GW Recharge (af/yr)[g]	500	2,900	4,700	8,000
Net Reduction in GW Recharge (inches/year)[h]	0.8	1.7	2.0	1.7
Net Percent Reduction in Incidental GW Recharge	5.0%	11.4%	5.0%	6.3%

[a] Values selected to create similar percent agricultural impacts in each valley.
[b] Calculation shown in Table 3-13
[c] Described in Affected Environment.
[d] Reduction in incidental groundwater recharge and return flows (GRR) calculated as (estimated existing GRR) * (the fraction of the irrigation water that is acquired or leased).

Note: this assumes that farmers would not change their water application rate in response to water sales.
[e] This fraction (Link) is applied to the reduction in GRR to estimate reduction in river flow.
[f] Calculated as the ((reduction in GRR) - the reduction in supplemental GW pumping) * Link.

Note: the reduction in supplemental groundwater pumping is assumed to be zero.
[g] Calculated as the ((reduction in GRR) - the reduction in supplemental GW pumping) * (1-Link)
[h] Calculated as (net reduction in GRR flows) ÷ (estimated surface area of each of the valleys) ÷ typical soil porosity of 0.25.

Table 3-16. Estimated Water Acquisitions or Leases, Reduction in Water-Righted Acres, and Groundwater Effects for the Consumptive Use Scenario

	Scenario[a]	East Walker	Smith Valley	Mason Valley	Total
Water Augmentation at Lake (%)	both	11%	27%	62%	
Water Augmentation at Lake (af/yr)[b]	both	5,400	13,400	31,200	50,000
Percent Acquisition/Lease Reaching Lake[c]	both	87%	87%	87%	
Amount of Surface Water Acquisition/Lease (af/yr)	both	6,200	15,300	35,700	57,300
Existing Decree Acres[d]	both	3,722	8,905	33,174	45,801
Existing New Land Acres[d]	both	5,090	11,886	17,525	34,500
Percent of Acquisitions from New Land Acres	both	19%	19%	19%	
Transfer from New Land Acres (feet)	both	1.14	1.14	1.14	
Transfer Rate from Decree Acres (feet)	Partial CU	2.37	2.37	2.37	
	Full CU	3.1	3.1	3.1	
Reduction in Total Water-Righted Acres	Partial CU	2,895	7,185	16,729	26,810
	Full CU	2,268	5,627	13,103	20,998
Percent Reduction in Total Water-Righted Acres	Partial CU	33%	33%	33%	
	Full CU	26%	26%	26%	
Reduction in Irrigated Land (acres)[e]	Partial CU	1,319	5,772	11,509	18,601
	Full CU	1,033	4,521	9,014	14,568
Net Reduction in GW Recharge (inches/year)[f]	both	0	0	0	

Notes:

[a] Full CU = Full Consumptive Use, and Partial CU = Partial Consumptive Use

[b] Values selected to create similar percent agricultural impacts in each valley.

[c] Calculation shown in Table 3-13.

[d] Described in Affected Environment.

[e] Calculation assumes that the percent reduction in irrigated land is the same as the percent reduction in water-righted acres.

[f] Retirement of acquired supplemental groundwater rights could increase groundwater levels.

Alternative 3

For Alternative 3 (Efficiency Alternative), an overall maximum efficiency value of 75% was used to assess impacts and to estimate average annual increase in flow to the lake resulting from widespread adoption of efficiency measures in the study area. Efficiency of 75% would represent a substantial increase from the estimated existing efficiency of 50% (overall value for all three valleys calculated as estimated consumptive use divided by volume of water diverted and pumped). The analysis of Alternative 3 is somewhat hypothetical because it is unlikely that this level of efficiency could be attained everywhere, especially considering that many farmers would be unlikely to participate. With an efficiency value of 75%, the estimated average increase in flow to Walker Lake is 32,300 af/yr, assuming existing ET rates remain unchanged.

Because of feasibility concerns (particularly regarding market demand), crop switching was not included in the upstream analysis for Alternative 3. Crop switching could further increase lake inflow under Alternative 3. Total crop ET for the Mason Valley, Smith Valley, and East Walker River study areas is estimated to be 156,000 af/yr. A relatively small reduction in this number could bring the average increase in lake inflow from 32,300 af/yr to 50,000 af/yr. Because reductions in crop ET resulting from crop switching would minimally affect GRR flows, reductions in crop ET could reach Walker Lake with very little loss. Applying a 10% loss rate for the Reservation reach, only an approximate 19,700 af/yr reduction in average crop ET (about 13% of the total estimated crop ET) would be needed to augment lake inflow by an average additional 17,700 af/yr to bring the average increase in lake inflow to 50,000 af/yr. Because it is unlikely that 75% efficiency could be attained everywhere, even more crop switching would probably be needed to augment flow by the full Acquisition Program goal of an average 50,000 af/yr.

Impacts on Irrigated Lands

Under Alternative 3, there would be no direct reduction in irrigated acres. Water saved would flow to the lake instead of being used to irrigate new land. Theoretically there could be some indirect effects on the area of irrigated lands associated with potential reductions in groundwater levels (see below).

Impacts on Non-Riverine Riparian and Wetland Habitat

If water use efficiency were 75%, much of the riparian and wetland habitat that depends on leaking canals or shallow groundwater recharge associated with irrigation would no longer be able to survive. Under existing conditions the estimated acreages of non-riverine riparian and wetland habitat are 350 acres for East River Walker Valley, 2,200 acres for Smith Valley, and 4,900 for Mason Valley (based on Desert Research Institute 2006 and GIS calculations of riparian vegetation more than 1,000 feet from the river according to the GAP data; see Affected Environment).

Incidental Groundwater Recharge and Return Flows

If water use efficiency were 75%, incidental GRR flows would be greatly reduced (Table 3-17). However, the strong link between the river and groundwater would help to minimize the net reduction in groundwater recharge. Potential groundwater impacts associated with Alternative 3 are discussed in more detail below for impact WI-8.

Table 3-17. Estimated River Flow Augmentation and Groundwater Effects Associated with the Efficiency Alternative

	East Walker	Smith Valley	Mason Valley	Total
New Percent Efficiency	75%	75%	75%	
Water Saved (af/yr)	6,500	16,200	79,000	101,700
Percent of Total Savings	6%	16%	78%	100%
Percent of Savings Reaching Lake[b]	25%	54%	28%	
Water Augmentation at Lake (af/yr)	1,600	8,700	21,900	32,300
Percent Augmentation at Lake	5%	27%	68%	100%
Consumptive Use, Crop ET (af/yr)	11,600	50,200	94,400	156,200
Incidental ET before Efficiency Measures (af/yr)	1,200	7,600	16,800	25,700
Incidental ET after Efficiency Measures (af/yr)	400	3,900	4,800	9,100
Incidental GRR Flows before Efficiency Measures (af/yr)[c]	9,200	25,300	93,600	128,100
Reduction in Incidental GRR (af/yr)[d]	5,800	12,400	67,000	85,100
Fractional Effect of GRR on River Flow (LINK)[e]	0.82	0.52	0.82	
Increased River Percolation to GW (af/yr)[f]	4,700	6,500	54,600	65,800
Net Reduction in GW Recharge (af/yr)[g]	1,100	5,900	12,300	19,300
Net Reduction in GW Recharge (inches/year)[h]	1.9	3.5	5.2	4.2
Net Percent Reduction in Incidental GW Recharge	12%	23%	13%	15%

Notes:

[a] Potential achievable overall water- efficiency including effect of conveyance losses and incidental GRR flows.

[b] Calculation shown in Table 3-13.

[c] Described in Affected Environment.

[d] Reduction in incidental groundwater recharge and return flows (GRR) calculated as (estimated existing GRR) * (factor needed to generate a specified new level of efficiency).

[e] This fraction (Link) is applied to the reduction in GRR to estimate reduction in river flow.

[f] Calculated as the (reduction in GRR) * Link

[g] Calculated as the (reduction in GRR) * (1-Link)

[h] Calculated as (net reduction in GRR flows) ÷ (estimated surface area of each of the valleys) ÷ typical soil porosity of 0.25.

Discussion of Key Uncertainties

Multiple assumptions were made to estimate upstream hydrologic effects associated with the Acquisition Program. Most of these assumptions are discussed above. Some key assumptions that have an associated moderate degree of uncertainty and that are more likely to affect results are discussed below.

Uncertainties Relevant to All Alternatives

Transfer Restrictions

One substantial uncertainty is the extent of restrictions that may be imposed on water transfers by the NSE or other agencies. Restrictions are likely to depend on the individual circumstances of water acquisitions. Restrictions are more likely if there is some potential for other existing water rights to be negatively affected by the transfer of a water right that has been acquired from a willing seller. For example, conveyance losses along a canal are borne by all the water rights holders along the canal. If flow through the canal is reduced, the percent conveyance loss for individual farmers could increase. In addition, farmers benefit from having more water in their canals because it increases head for taking water out of the canal more quickly or efficiently. As a result of the distributed benefits of irrigation water, there is potential for some water rights transfers to be restricted to some portion of the full amount of water available.

The NSE is charged with initial jurisdiction concerning proposed changes to decreed water rights (apart from allocated storage rights, see below); and under Nevada Law, the NSE may not approve a transfer that conflicts with existing rights, with protectable interests in existing domestic wells, or that threatens to be detrimental to the public interest; nor may the proposed change adversely affect the cost of water for other holders of rights in an irrigation district, nor lessen the efficiency of the district in the delivery or use of water (NRS Section 533.370 *et. seq*.). However, water transfers would not likely be restricted for the purpose of maintaining a water supply for water users who may have depended on the inefficiency of others (e.g., those dependent on incidental groundwater recharge).

NSE ruling No. 5760 provides an example of how groundwater recharge issues might be handled by the NSE. This ruling was made in August 2007 regarding a 2004 change application submitted by the Cities of Reno and Sparks and Washoe County, which sought to transfer an existing Newlands Project surface water irrigation right (one acquired from a willing seller) to an instream wildlife purpose in the Truckee River downstream of Derby Dam, the existing point of diversion. In this ruling, it was stated that:

> While the water that leaked or seeped into the ground from ditches, drains, or irrigation became a source of recharge, the State Engineer concludes that he cannot compel the continuation of that situation in order to create that recharge and removal of the recharge is not the type of injury to existing rights contemplated under the water law. (Nevada State Engineer 2007)

Because of the large uncertainty in the transfer restrictions that may be applied to water right acquisitions, two extremes were described and evaluated above: the Full Transfer Scenario and Consumptive Use Scenario.

Connection between River and Aquifers

The calculations for the interrelationship between river flow and changes in groundwater recharge and return flows that were used for the Full Transfer Scenario and Alternative 3 are very dependent on the work performed by Myers, which showed that groundwater recharge has a strong effect on river flow (Myers 2001a and 2001b). If river flow were, in reality, not so responsive to incidental groundwater recharge, less water would need to be acquired, leased, or saved to meet a given increased inflow objective for the Full Transfer Scenario or Alternative 3. However, groundwater impacts would be larger.

Work by DRI and University researchers through the Walker Basin Project provides some support to the conclusion that river diversions left in the river would be lost to infiltration as a result of decreased irrigation. For Mason Valley researchers found that "The fraction of diversion left in the river, but then lost to the aquifer, ranges from four to 97% depending on the HRU [Hydrologic Response Unit]. Average losses are 16 percent, but if several river pumps are excluded from the analysis, then average losses reach 42 percent" (Boyle et al. 2009). Myers numbers for the relationship between reduced groundwater recharge and river flow were used to estimate that 37% of the diversions left in the river under the Full Transfer Scenario would be lost (see discussion of PercRed above in the description of methods for the Full Transfer Scenario under the header titled "Incidental groundwater recharge and return flows and river losses"). This value is comparable to the initial results from the University study. However, future use of the university models could result in adjustments to the conclusions.

Even if the valley-wide long-term estimates for the connection between incidental groundwater recharge and river flows are accurate, the actual effect of the project would depend on the locations of agricultural land that is fallowed or retired, or the locations of any efficiency-increasing actions. Furthermore, short-term effects of reduced groundwater recharge on river flow would probably be less than the long-term effects. This is particularly pertinent to Alternative 2, which would only last as long as there is funding. River infiltration could also be affected by the existing trend of decreasing groundwater levels (see Affected Environment). In the absence of the Acquisition Program, decreasing groundwater levels have the potential to increase river infiltration, thereby reducing base flows.

Water Accounting

New river losses associated with a reduction in incidental GRR flows (under the Full Transfer Scenario and the assessment of Alternative 3, the Efficiency Alternative) are assumed to reduce the volume of the flow augmentation and not affect or conflict with existing water rights. Similarly, new river losses associated with increased flow downstream of Wabuska (estimated to be 10% of the increase in flow) are assumed to reduce the volume of the flow augmentation and not affect or conflict with water rights held by WRPT. In reality, separate accounting for different types of river losses may be difficult and it is possible that existing and new river losses would be comingled. It is also assumed throughout this Revised DEIS that the portion of acquired water supplies that ends up in Walker Lake would actually build on (rather than supplant) existing Walker Lake inflows based on an assumed repeat of period-of-record averages.

Natural Vegetation

As part of the water balance approach used for the analysis of the Full Transfer Scenario and Alternative 3, it was assumed that most natural vegetation (e.g., phreatophytes such as rabbitbrush and greasewood) away from the river would continue to survive and use groundwater at about current rates with or without the project. However, because riparian and wetland vegetation needs water that is closer to the surface, riparian/wetland vegetation that is more than 1,000 feet from the river was assumed to be dependent on irrigation. The Full Transfer Scenario assumes that if irrigation is reduced, not only would there be a reduction in crops, but there would also be a reduction in non-riverine riparian/wetland acres. Similarly, the analysis for Alternative 3 assumes an increase in efficiency would reduce non-riverine riparian/wetland acres. In reality, some riparian vegetation may survive a loss of irrigation and be able to use groundwater, but there may also be a decrease in groundwater use by natural vegetation.

Protection of Acquired Water

Water that is acquired but not protected through the water rights change application process and/or by agreements with appropriate parties may be diverted by other water rights holders. For all acquisition alternatives, it is assumed that there would be methods to ensure that all acquired water would be protected from such diversions consistent with the assumptions for each scenario and alternative (e.g., full transfer, partial or full consumptive use restrictions, and transfer of conserved water).

Uncertainties Relevant to Alternatives 1 and 2

Under Alternatives 1 and 2, if non-agricultural water can be purchased, the extent of agricultural water acquisitions and reduction in irrigated acres would be reduced. For example, the Homestretch Geothermal option for 7,000 af/yr could have a large effect on reducing the need for water acquisitions from agriculture. Other potential acquisitions that could help reduce agricultural impacts in the upstream valleys would include acquisitions from WRPT (or land fallowing undertaken on the reservation) for the benefit of Walker Lake, or acquisitions from willing sellers who have already taken their land out of agricultural production or converted their land to non-agricultural purposes. In addition, if farmers remaining in production can use water more efficiently, agricultural impacts would be reduced.

Uncertainties Relevant to Alternative 3

For Alternative 3, one key uncertainty is the level of overall water use efficiency that can be attained. The overall maximum efficiency of 75% was chosen for analysis based on conveyance and farm/field efficiencies that have been attained elsewhere (Howell 2003, Solomon 1988), but actual overall efficiency attained would likely be less because efficiency of 75% would be difficult to attain for alfalfa and not all farmers would want to participate. Although crop switching was not part of the quantitative analysis, it could help to increase river flow (see results discussion for Alternative 3).

In addition, Alternative 3 may have somewhat more uncertainty associated with the assumption that Acquisition Program water could be transferred to the lake without reduction in volume by downstream water rights holders. Downstream transfer may be more difficult for Alternative 3 because there is little precedent in Nevada for assigning water rights to water saved through efficiency measures.

Summary of Uncertainties

There are many factors that could cause the estimated upstream volume of water needed to attain an average additional 50,000 af/yr at Walker Lake (and the estimated agricultural effects) to be high or low. Some of the key uncertainties (some of which are described above) are listed below.

Uncertainties that would reduce impacts on agricultural lands:

- non-agricultural acquisitions (e.g., Homestretch Geothermal or purchases from farmers who have already retired their land);
- improved efficiency (e.g., crops that use less water, lining of ditches, or improved irrigation management or technology) occurring along with Alternatives 1 and 2;

- less connection between GRR flows and river flows; and
- an increase in baseline inflows to Walker Lake (e.g., greater or more frequent flood flows).

Uncertainties that would increase impacts on agricultural lands:

- increase in riverine ET in the upstream valleys in response to flow augmentation;
- water transfer restrictions imposed by the NSE or other jurisdictional entities (as in the Consumptive Use Scenario);
- retirement of supplemental groundwater rights (as in the Consumptive Use Scenario); and
- potential reduction in base flow resulting from declining groundwater levels or persistent drought.

Walker Lake Analysis

The analysis of Walker Lake includes hydrologic and water quality (TDS) components. The TDS component depends on the hydrologic evaluation. A water balance of the lake was developed using two different baseline inflow scenarios (low and high). The lake water balance was then used to estimate future lake elevations and TDS concentrations for all alternatives.

Walker Lake Hydrologic Analysis Methods

To develop the Walker Lake water balance, lake storage values at the end of each water year were used to calculate the change in storage. The amounts of water entering the lake as direct precipitation and leaving as gross evaporation were calculated to determine net evaporation (i.e. outflow). The change in storage that was not attributable to evaporation or precipitation was assigned to the net inflow from Walker River, groundwater, and local surface water.

Use was made of prior Walker Lake hydrologic analyses (Table 3-18). Water balance calculations initiated by Pahl in 1999 (Pahl pers. comm.) were updated to include more recent data including a recent average precipitation value from Allander and Lopes (2008) and storage data from USGS (Allander pers. comm. 2008b). (Collectively, the information from Pahl, Allander, and Lopes, and USGS are referred to below as the updated NDWP analysis.) A range of lake evaporation rates was used to evaluate changes in Walker Lake conditions.

Table 3-18. Estimated Average Annual Values for Walker Lake Water Balance Parameters by Various Authors

Parameter	Everett and Rush 1967	Thomas 1995	Allander and Lopes 2008	Lopes 2009	Kleinfelder 2007
Evaluation Period	(1908-1965)	(1939-1993)	(1995-2007)	(1988-1994)	(1939-1993; 1926-2004)
Evaporation (feet)	4.1	4.1	4.9[d]	4.3[e]	4.3[c]
Precipitation (inches)	4	4.9	3.8		
Walker River inflow (af)	140,000	76,000	117,000[b]	0 during 1988-1994	77,200, 1939-93; 89,000, 1926-2004
Local Surface Water (af)	3,000	3,000			
Groundwater (af)		11,000[a]			3,000 local, 8,000 from Walker River

[a] Cited as coming from Schaefer 1980, p. 31

[b] Average flow at Schurz gage (13.5 miles upstream of Walker Lake) for water years 1995–2007.

[c] Based on Topaz Lake Reservoir pan evaporation * 0.75; estimate may be low because value did not compensate for missing December–March data (Allander and Lopes pers. comm.).

[d] Based on measurements of evaporation

[e] Preliminary result based on water balance assessment for the 1988-1994 drought after determining that evaporation measurements were too high

Projection of No Action Alternative

The inflow and evaporation values can be used to project future lake elevations. High and low average inflow and evaporation scenarios were used to produce a range of future lake storages.

Estimated inflow and evaporation must correspond in order to explain observed changes in storage. For example, if a relatively high value for evaporation is assumed, there must be a relatively high inflow to meet the observed sequence of historic storage values. Consequently, projections of future lake elevation similarly must use inflow and evaporation rates that correspond with each other.

The selected net inflow and evaporation values used in the two scenarios are:

- Low inflow/low evaporation scenario: average annual net inflow = 90,000 af and net evaporation = 3.7 feet (Thomas 1995).

- High inflow/high evaporation scenario: average annual net inflow = 106,100 af and net evaporation = 4.0 feet. The inflow value is the estimated average for the period 1960 to 2007 using the updated NDWP analysis and evaporation is a preliminary USGS estimate (Lopes 2009). The period of record is relatively long and reflects recent historic conditions that involve substantial groundwater pumping in addition to surface water diversions.

Projection of Action Alternatives

If average annual inflow to Walker Lake is increased by 50,000 af, lake surface elevation would increase relative to current conditions. The extent of this expected increase was assessed by adding 50,000 af/yr to the low and high lake inflow scenarios described above. The selected net inflow values were as follows:

- Low lake inflow: average annual net inflow = 90,000 af (base) + 50,000 af (flow augmentation) = 140,000 af (net evaporation = 3.7 feet).
- High lake inflow: average annual net inflow = 106,100 af (base) + 50,000 af (flow augmentation) = 156,100 af (net evaporation = 4.0 feet).

To assess lake elevation for Alternative 1 under funding of $56 million, it was assumed that an additional 7,300 af/yr reached Walker Lake (as described in Chapter 2, Alternatives) instead of 50,000 af/yr.

For Alternative 2, it was assumed that enough water could be leased to increase average annual lake inflow by 50,000 af. Such increase, however, is only expected to last 3 years (as analyzed) with a funding level of $56 million, or about 20 years with full funding. With the $56 million level of funding, Alternative 2 could have been evaluated by assuming a lower level of flow augmentation (average of 7,300 af/yr), spread out over a longer period (20 years). However, the method selected for assessing Alternative 2 with a funding level of $56 million makes little difference. Both methods result in only small differences from the No Action Alternative. The method selected has a greater improvement in lake level compared to the No Action Alternative, although for a shorter period of time.

Alternative 3 was evaluated by assuming that an average of 32,300 af/yr would reach Walker Lake (as described above) in addition to baseline inflows, in a manner similar to that used for Alternative 1.

Groundwater inflow to the lake was assumed to remain constant for each acquisition alternative, although it could increase (by aquifer augmentation) or decrease (by reduced gradient) in response to increased lake inflow.

Table 3-19. Estimated Future Water Surface Elevation and TDS Concentrations for Walker Lake for All Alternatives

	Estimated Future Lake Elevation (feet)						Estimated Future TDS (mg/L)				
	At High Point[a]	Approximate Year of High Point[b]	At Year 2200	At High Point-Change from September 2007[c]	At Year 2200-Change from September 2007	At Year 2200-Change from No Action Alternative	at Low Point	Approximate Year of Low Point[b]	at Year 2200	At Low Point-Change from September 2007[c]	At Year 2200-Change from No Action Alternative
No Action Alternative											
High Average Inflow	NA	NA	3,906	NA	-29		NA[d]	NA[d]	39,500		
Low Average Inflow	NA	NA	3,898	NA	-37		NA[d]	NA[d]	51,000		
Alternative 1 - Proposed Project											
Current Funding (average additional 7,300 af/yr)											
High Average Inflow	NA	NA	3,915	NA	-20	9	NA[d]	NA[d]	31,600		-7,900
Low Average Inflow	NA	NA	3,905	NA	-30	7	NA[d]	NA[d]	40,700		-10,300
Full Funding (average additional 50,000 af/yr)											
High Average Inflow	NA	NA	3,970	NA	35	64	11,300	2090	12,400	-4,319	-27,100
Low Average Inflow	NA	NA	3,965	NA	30	67	12,300	2090	13,500	-3,319	-37,500
Alternative 2 – Leasing Alternative											
Current Funding (additional 50,000 af/yr for 3 years)[a]											
High Average Inflow	3,937	2011	3,906[d]	2	-29[d]	0[d]	15,400	2011	39,500[d]	-219	0[d]
Low Average Inflow	3,936	2011	3,898[d]	1	-37[d]	0[d]	15,600	2011	51,000[d]	-19	0[d]
Full Funding (additional 50,000 af/yr for 20 years)[a]											
High Average Inflow	3,948	2028	3,906[d]	13	-29[d]	0[d]	13,200	2028	39,500[d]	-2,419	0[d]
Low Average Inflow	3,945	2028	3,898[d]	10	-37[d]	0[d]	13,900	2028	51,000[d]	-1,719	0[d]
Alternative 3 - Efficiency Alternative											
75% Efficiency (average additional 32,300 af/yr)[f]											
High Average Inflow	NA	NA	3,948	NA	13	42	14,800	2060	16,800	-819	-22,700
Low Average Inflow	NA	NA	3,939	NA	4	41	16,000	2030	19,600	381	-31,400

[a] Lake elevations for Alternatives 1 and 3 are expected to generally tend towards their equilibrium values, which are estimated to be attained after year 2100. However, because the increased inflow for Alternative 2 would be temporary, lake level would be expected to rise to a high point and then tend towards the same equilibrium as the No Action Alternative.

[b] Assumes that the Walker Lake Acquisition Program was initiated at the beginning of water year 2008 (fall 2007).

[c] Fall 2007 was used as a basis of comparison (elevation of 3,935 feet and TDS concentration of 15,600 mg/L in September 2007) because calculations assumed the Acquisition Program was initiated at the start of water year 2008 (October 1, 2008 - September 30, 2008). Because the actions of Alternatives 1 and 3 could continue indefinitely, the lake elevation would change until it eventually would fluctuate about a particular equilibrium value that is independent of the starting elevation. Because Alternative 2 would be temporary, the starting elevation is more important. Because the exact start date of the Acquisition Program is unknown, the short-term results for Alternative 2 are best evaluated not in terms of elevations and TDS concentrations, but in terms of change from the starting point used in the assessment.

[d] No low point for TDS because lake level continues to drop from current elevation

[e] Alternative 2 was evaluated using the year 3 and year 20 values from the analysis for the fully-funded Alternative 1 (all these scenarios assume an additional average inflow of 50,000 af/yr). Whether the increased inflow was ended at year 3 or 20, the eventual lake levels would be the same as for the No Project Alternative, it would just take 3-20 years longer to reach the equilibrium, and the TDS concentration at year 2200 would be similar to that for the No Project Alternative.

[f] The 75% efficiency assessment is a hypothetical evaluation of a theoretical optimal efficiency that would be difficult to attain throughout the Walker Basin. It does not include any increase in flow resulting from farmers shifting to crops that use less water.

The increased inflow to the lake was assumed to start instantaneously in water year 2008. In reality, it would take some unknown amount of time to fully implement each of the acquisition alternatives. The start date would have little effect on the end results of Alternatives 1 and 3 because the effects would be long term and the eventual equilibrium lake elevation would be independent of the starting elevation.

However, because the effect of Alternative 2 is more transient, the estimated lake elevation when the leasing program ends would depend on the start date as well as the hydrologic conditions. None of the acquisition alternatives was implemented in water year 2008 as was assumed in the evaluation, and deviations from the average increased inflow of 50,000 af/yr would have a pronounced effect for actions lasting a limited number of years. As a result, the lake water surface elevations estimated for years 3 and 20 for Alternative 2 are not expected to be accurate. However, the change in lake elevation and TDS relative to the No Action Alternative should be close to correct if average hydrologic conditions prevail.

For future conditions, the low and high average annual inflows were assumed to occur each year. This assumption yields smooth curves for future conditions. In reality, flows would vary greatly from year to year and the long-term equilibrium values would not be constant but fluctuate about a mean.

Walker Lake TDS Analysis Methods

To assess future concentration of TDS in Walker Lake under the No Action Alternative, the equation for TDS as a function of time and lake storage, described above under Affected Environment, was applied for each year and lake elevation. The equation was adjusted to account for increased TDS flux from the river associated with the increase in flow, and then used to calculate TDS concentration that would correspond to the lake elevations estimated with the future inflow values described above.

Lake Analysis Results

Results of the lake assessment for water surface elevation and TDS concentration are summarized for all alternatives in Table 3-19. In addition, they are discussed below under impacts.

Impact Criteria

An impact on water resources would be considered adverse if implementation of an acquisition alternative or the No Action Alternative would:

- conflict with existing water rights;

- substantially alter the existing drainage pattern of the study area, including changes that result in substantial erosion, siltation, or flooding;
- substantially degrade water quality;
- substantially reduce groundwater supplies or interfere with recharge to the extent that it substantially lowers groundwater elevations; or
- violate local regulations or guidelines pertaining to water resources.

A substantial change is one that would be noticeable and measurable and that would have either a short-term or long-term beneficial or detrimental effect.

An impact on water resources would be considered adverse if it would exacerbate or create an impairment of surface water or groundwater. It would be considered beneficial if it would diminish impairment.

Impacts

Environmental impacts were determined by evaluating projected future conditions under each alternative versus the baseline of existing conditions and trends. Impacts are discussed in comparison to existing conditions as well as in comparison to future conditions estimated for the No Action Alternative. In determining the nature of an impact (beneficial, minor, or adverse), the No Action Alternative is compared to existing conditions and the acquisition alternatives are compared to the No Action Alternative.

Some of the potential hydrologic changes associated with the acquisition alternatives are not considered to be either adverse or beneficial by themselves. However, these changes could be adverse or beneficial to other resources. For example, a change in lake elevation by itself is neither adverse nor beneficial, but it may affect fish in the lake. This type of project-related change is labeled as a *hydrologic change* instead of an *impact*. The environmental consequences of hydrologic changes are discussed in other resource chapters. Hydrologic changes (HC) are distinguished from water impacts (WI). Changes to river flows, lake elevations, irrigation, and amount of groundwater pumping are considered to be hydrologic changes (which could affect other resources) and are not considered to be water resource impacts.

Future conditions under each of the alternatives are estimates and are dependent on the validity of the assumptions that were made to conduct the analyses.

No Action Alternative

Under the No Action Alternative, water resources in the Walker River Basin would likely change. For example, farmers may become more efficient with their use of water and groundwater levels may decline. If groundwater levels decline, river flows could also decline.

Future hydrologic conditions may be affected by global warming (Chapter 15, Climate and Climate Change). The effect of climate change on total runoff is uncertain, but it is likely to reduce the portion of precipitation falling as snow, cause the runoff pattern to shift to earlier in the year, and result in higher peak flows. A shift toward earlier runoff and/or higher seasonal peak flows could reduce surface water available for diversion during the irrigation season, but could be beneficial to Walker Lake because it may cause a greater percent of the runoff to reach the lake as a result of decreased river losses and decreased ability of water rights holders to divert flow. Climate change (warming) could also increase lake surface evaporation rates as well as both crop and non-crop ET rates, leading to increased demand for surface water and groundwater. Because the magnitude of each of these changes remains uncertain at this time, future water availability for irrigation and river flow was assumed to be similar to past water availability in this impact analysis.

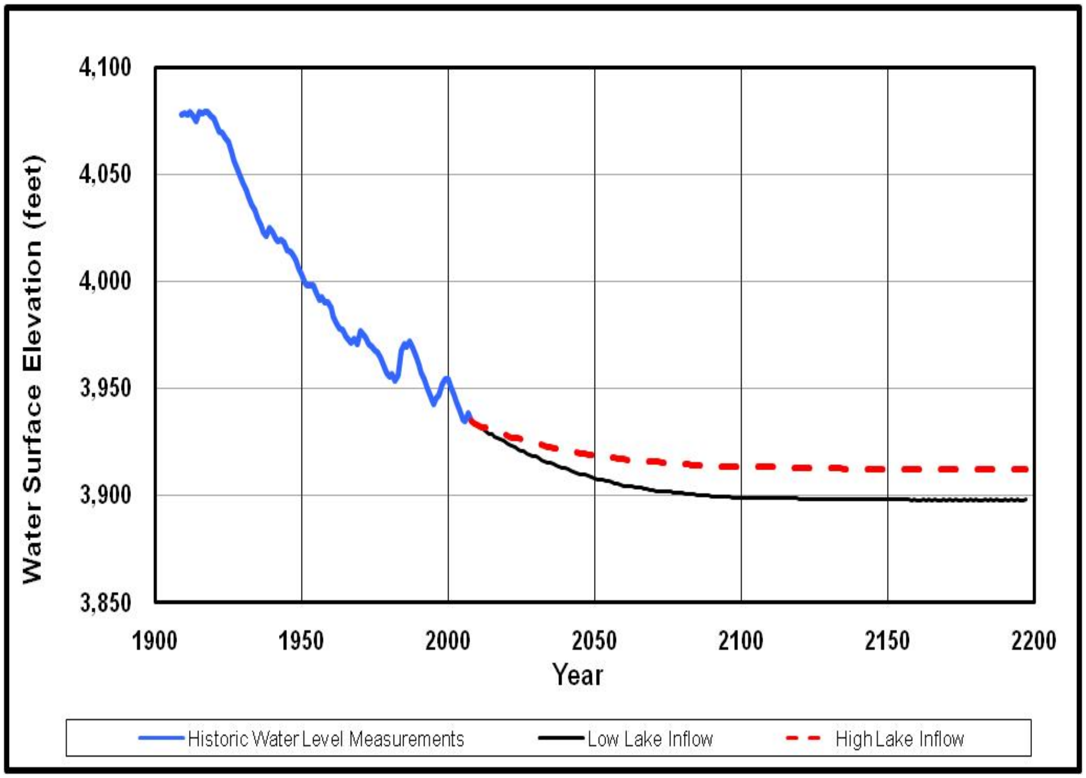
For this Revised DEIS, the key changes associated with the No Action Alternative would be decreased storage, surface elevation, surface area, and water quality in Walker Lake. These hydrologic changes and impacts are discussed below.

Hydrologic Changes

Hydrologic Change HC-1: Alter Walker Lake Storage and Surface Area (Decrease)

Figure 3-22 shows past and projected lake elevations for the No Action Alternative for the high and low inflow scenarios described in the methods section above. The equilibrium lake elevation range is 3,898 to 3,906 feet (Table 3-19). These elevations correspond to storages of 701,900 to 906,000 af and represent elevation decreases of approximately 37 to 29 feet from the September 2007 elevation of 3,935 feet. Based on lake bathymetry data (Lopes and Smith 2007), this would represent a decrease in lake surface area of approximately 7,300 to 5,100 acres.

Projected lake elevations and surface areas are compared to September 2007 values because that is the date when the analysis and graphs transition from measured to projected values. For the No Action Alternative and Alternatives 1 and 2, the comparison could be made to more recent information (e.g., the November 2009 lake elevation of 3,927 feet). For these alternatives, the starting value for the analysis does not affect the eventual equilibrium lake level that would be reached. However, because Alternative 2 would not last long enough for the lake to reach equilibrium, its effect must be compared to the September 2007 analytical starting point. For consistency, September 2007 is used for all alternatives (Table 3-19).



Note: Lines representing the future are smooth because they are based on average annual inflow values. Actual lake elevation would fluctuate around these values.

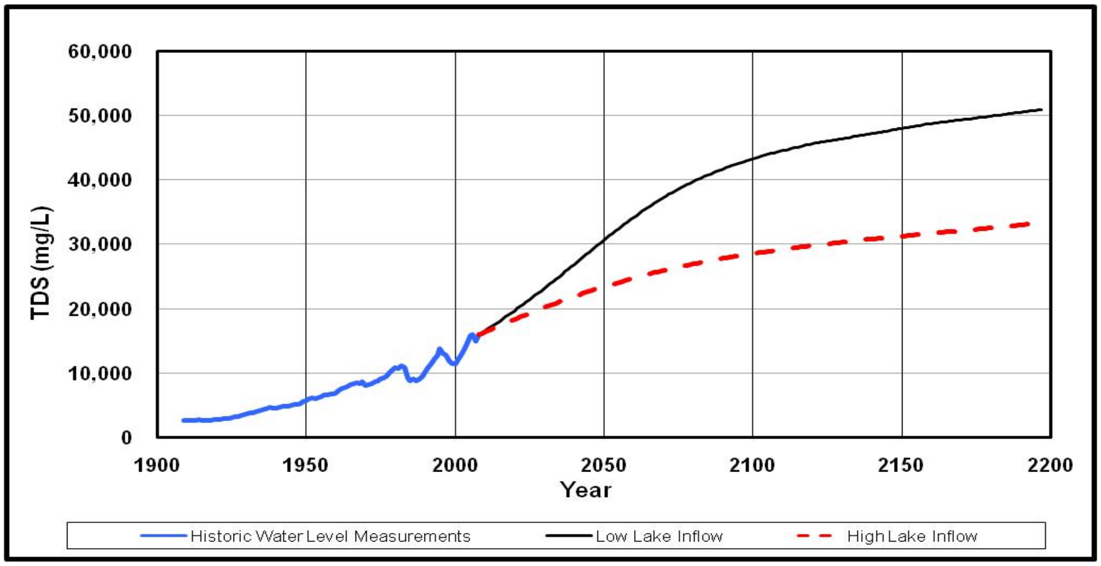
Figure 3-22. Historic and Projected Water Surface Elevation of Walker Lake under the No Action Alternative based on High and Low Inflow Scenarios

Direct Impacts

Impact WI-1: Alter Walker Lake Water Quality as a Result of Change in Lake Storage (Adverse)

According to Nevada's 303(d) list of impaired waters (Nevada Division of Environmental Protection 2009a), Walker Lake is considered impaired by high concentrations of arsenic, cadmium, molybdenum, phosphorus, and selenium. In addition, Walker Lake has a TMDL for TDS. Under the No Action Alternative, this impairment would increase.

Projected TDS concentrations for the high and low inflow scenarios for the No Action Alternative are shown in Figure 3-23.



Note: Lines representing future conditions are smooth because they are based on average annual inflow. Actual TDS concentrations would fluctuate around these values.

Figure 3-23. Historic and Projected TDS Concentration in Walker Lake under the No Action Alternative based on High and Low Inflow Scenarios

The projected TDS values under the No Action Alternative range from 39,500 to 51,000 mg/L by 2200 (Table 3-19), compared to 15,600 mg/L in September 2007 and 16,100 mg/L in March 2008. TDS concentration would continue to increase over time because of the continual influx of salts and other dissolved solids, although this might be offset to some extent by other factors (e.g., mineral precipitation, wind/wave dispersal, and decrease in evaporation rate resulting from high concentration of TDS). In addition, as lake volume changes, TDS flux to and from bed sediments could change.

Under the No Action Alternative, lake water quality may be degraded in additional ways. For example, concentrations of other water quality constituents would increase as lake elevation decreases. In addition, changes in lake storage and TDS would likely cause changes in the thermal stratification of the lake. The volume of cool water at the bottom of the lake would likely decrease. Eventually thermal stratification may cease to occur and there may be times when cool fresh water rests on top of warmer denser water with high TDS concentration. Addressing the TDS problem would prevent these additional deleterious water quality effects.

The decrease in lake volume under the No Action Alternative would result in increased concentration of many water quality constituents. There would be a deterioration of water quality. This would be an adverse impact.

Impact WI-2: Decrease Down-Cutting in Lower Walker River as a Result of Increased Lake Level (Adverse)
Currently, the Walker River below Schurz is unstable, with dramatic erosion and down-cutting occurring downstream of the siphon near Lateral 2A partially as a result of dropping lake surface elevation. This down-cutting creates steep channel edges which contribute substantial volumes of sediment to Walker River and Walker Lake as lateral migration of the channel occurs, especially through terrain composed of deposits of former river delta and lakebed. Currently, sediment loads on the order of hundreds of thousands of tons per year are delivered to Walker Lake from a combination of vertical and lateral erosion (Adams and Chen 2009).

With no reduction in upstream water diversions, erosion problems in the lower Walker River would intensify. The existing incision is expected to migrate further upstream if existing trends continue. As indicated in recent University research, this would likely lead to the siphon being dislodged during a flood event and the erosive incision progressing rapidly upstream. This would affect roads, bridges, and other infrastructure in the Schurz area, in addition to the riparian ecology. It would also lead to the geomorphic destabilization of the river between the siphon and Weber reservoir (Adams and Chen 2009).

Alternative 1 (Purchase Alternative)

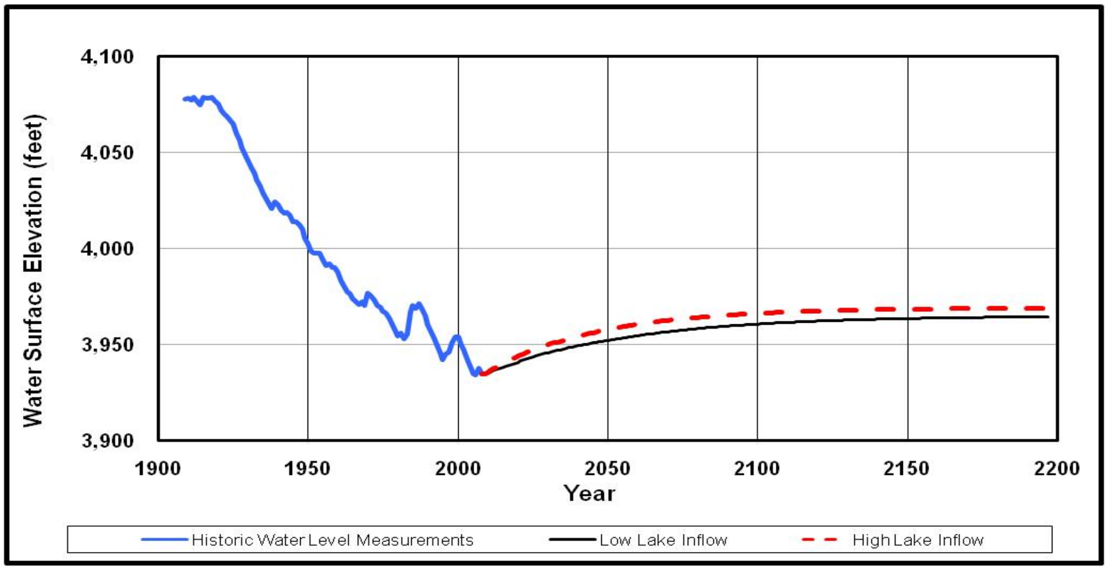
This analysis of impacts under Alternative 1 assumes that the Purchase Alternative would be fully funded and that water rights acquired would increase the average annual inflow to the lake by the full 50,000 af/yr. For all hydrologic changes and impacts other than HC-1 and WI-1, if the full amount of water rights were not acquired, the impacts would be similar in nature (i.e., adverse, minor, beneficial, or no impact), but of less magnitude. HC-1 and WI-1, however, depend on the change in Walker Lake storage. Under full funding, Walker Lake storage would increase and water quality would improve. If acquisitions were limited to funding of $56 million, however, the Acquisition Program would have limited benefit to the lake. Walker Lake storage would continue to decrease and water quality would diminish (albeit at a slower rate than for the No Action Alternative).

Hydrologic Changes

Hydrologic Change HC-1: Alter Walker Lake Storage and Surface Area (Increase with Full Funding; Continue to Decrease with Funding of $56 Million)

Figure 3-24 shows past and projected lake elevations for the high and low inflow scenarios with an average additional 50,000 af/yr. Under Alternative 1, the equilibrium lake elevation ranges from 3,965 feet to 3,970 feet (Table 3-19). These elevations correspond to lake storages of 2,801,700 af and 3 million af.

Compared to the September 2007 elevation of 3,935 feet, these lake elevations would represent long-term elevation increases of 30 to 35 feet (i.e., 64 to 67 feet higher than for the No Action Alternative). Based on lake bathymetry data (Lopes and Smith 2007), this represents an increase in lake surface area of 6,200 to 7,100 acres.



Note: Lines representing future conditions are smooth because they are based on average annual inflow values. Actual lake elevation would fluctuate around these values.

Figure 3-24. Historic and Projected Future Water Surface Elevation of Walker Lake under Alternative 1 based on a High and Low Average Annual Lake Inflow

With funding of $56 million and average inflow increase of 7,300 af/yr, lake water surface elevation would be expected to continue to decline to 3,905 to 3,915 feet (7 to 9 feet higher than under the No Action Alternative).

Recent work by USGS (Lopes and Allander 2009a) indicates that the higher base inflows to Walker Lake are more likely than the lower base inflows and that base inflow may be even higher than the higher levels that were evaluated, potentially resulting in an even higher lake level than is estimated here. The USGS report estimates that if Walker River inflow were increased by an average additional 53,000 af/year, lake level would increase to 3,986 feet. The primary reason for this higher value is a higher estimate of base inflows (difference of approximately 5,500 af/yr), which is partly a result of differences in the periods used for analysis (1971 to 2000 for USGS vs. 1960 to 2007 for this analysis). In addition, USGS calculations used slightly less net evaporation (difference of approximately 0.1 foot).

Hydrologic Change HC-2: Reduce Irrigated Land as a Result of Acquisitions (Decrease)

The effect of the Purchase Alternative on the amount of irrigated land is expected to be between that estimated for the Full Transfer Scenario and the Consumptive Use Scenario (see description above), although the effect could be lessened by acquisitions of non-agricultural water or by increased water efficiency.

Under the Full Transfer Scenario, when the portion of irrigated lands acquired in each valley is similar and the share of acquired water reaching Walker Lake falls within the ranges indicated in Chapter 2, Alternatives (i.e., approximately 60 to 85% from Mason Valley, 10 to 30% from Smith Valley, and 5 to 10% from East Walker), then the percent reduction in irrigated land for each valley is 27%, 24%, and 27%, respectively (average of 26%). This corresponds to a reduction in irrigated lands of 9,500 acres for Mason Valley, 4,200 acres for Smith Valley, and 1,100 acres for East Walker, with a combined reduction of 14,800 acres (Table 3-14).

Under the Consumptive Use Scenario, two levels of water available for transfer were assessed; Partial Consumptive Use and Full Consumptive Use. Partial Consumptive Use (2.37 af per decree acre) resulted in a 33% reduction in water-righted acres (and irrigated land) for each valley, corresponding to a reduction in irrigated lands of 11,500 acres for Mason Valley, 5,800 acres for Smith Valley, and 1,300 acres for East Walker, a combined reduction of 18,600 acres. Full Consumptive Use (3.1 af per decree acre) resulted in a 26% reduction in water-righted acres (and irrigated land) for each valley.

The similarity between the Full Transfer Scenario and the Full Consumptive Use Scenario in terms of effects on irrigated lands (both 26%) is somewhat unexpected because the Full Transfer Scenario assumes that more water per acre would be transferred downstream and that all supplemental groundwater pumping could continue to be used for irrigation (i.e., minimum impact on irrigated lands). However, unlike the Consumptive Use Scenario, the Full Transfer Scenario is expected to cause a reduction in GRR flows, which would in turn increase river infiltration to groundwater and necessitate that more water be acquired. The river infiltration effect is expected to cause the Full Transfer Scenario effect on irrigated lands to approach that of the Full Consumptive Use Scenario, but it should not cause the results to be the same.

Another reason for the unexpected similarity is that the assumed amount of water available for transfer under the Full Consumptive Use Scenario (3.1 af per decree acre with an overall average of 2.7 af per water-righted acre including new land acres) is relatively high compared to the Full Transfer Scenario values (3.4 and 3.6 af of surface water diversions per irrigated acre for Smith Valley and Mason Valley, respectively based on the water balance analysis above).

Because the approach used for the Full Transfer Scenario is not exactly the same as that for the Consumptive Use Scenarios, the two sets of results should not be expected to precisely align with each other. The Full Transfer Scenario is based on irrigated lands, whereas the Consumptive Use Scenario is based on water-righted acres, which are much higher than the irrigated acres (approximately 81,400 acres vs. 56,400 acres, see Affected Environment). The difference in methods was required because of the assumptions involved in each scenario. The difference is also beneficial in that it helps to ensure that results are reasonable (i.e., they are not vastly different from each other).

Hydrologic Change HC-3: Increase River Flow (Increase)

Flow augmentation that is based on water right acquisitions would most likely occur during the irrigation season (March through October). If 50,000 af were spread evenly across this period, it would represent an increase of 103 cfs at the downstream end of the river. (Similarly, if the 7,300 af under funding of $56 million were spread evenly across this period, it would represent an increase of 15 cfs at the downstream end of the river). However, it is unlikely that increases in flow would remain constant through the irrigation season. Based on historic irrigation season flow patterns, the greatest flows and increases in flow would be expected to occur during May, June, and July. The increase in flow would likely be greatest at the point of diversion for the most downstream acquisition, with flows at other locations being dependent on instream flow losses and the location of the acquisitions. The percent flow increase would be greatest between Schurz and the lake, where existing summer flows can be zero.

Not only would there be month-to-month and upstream-to-downstream variations if flow augmentation, there would also be year-to-year variations in flow augmentation dependent on variability in hydrologic conditions. Yearly surface water diversions from the East Walker area, Mason Valley, and Smith Valley have ranged between 57,200 af/yr and 345,000 af/yr with an average of 206,700 af/yr (values for 1981 to 2007 from Table 3-2). Applying this same range of variation to 50,000 af/year roughly indicates a potential range of 13,800 af/yr to 83,400 af/year.

Weber Reservoir may provide an opportunity to manage river flows and discharge to Walker Lake. To the extent that there is available capacity, it may be possible to store acquired water in the reservoir in order to focus releases during a particular period and benefit aquatic and riparian resources or minimize flow losses downstream of the reservoir, provided that reservoir operating criteria are met. Such reservoir operations would be secondary to those for irrigation and flood control and require agreement with BIA and WRPT. Changes in Weber Reservoir operation would require development and implementation of an operating agreement to assure that use of decreed water rights on Walker River

Indian Irrigation Project would not be impaired and to protect the safety of the downstream community.

If some acquisitions come from sources other than irrigation water, increased flow could occur outside of the irrigation season. For example, potential discharge from the Homestretch Geothermal option might occur year-round.

In addition, it may be possible to store a portion of the acquired water in Weber Reservoir for release during the non-irrigation season (November through February), depending on the management considerations described above, and any potential to carry acquired water over from the fall to the spring would be limited by flood control criteria and by the relatively small storage capacity of the reservoir, 10,700 af (U.S. Geological Survey 2009b).

Hydrologic Change HC-4: Change in Amount of Groundwater Pumping (Increase or Decrease)

Potential project effects on the two types of groundwater rights are described below.

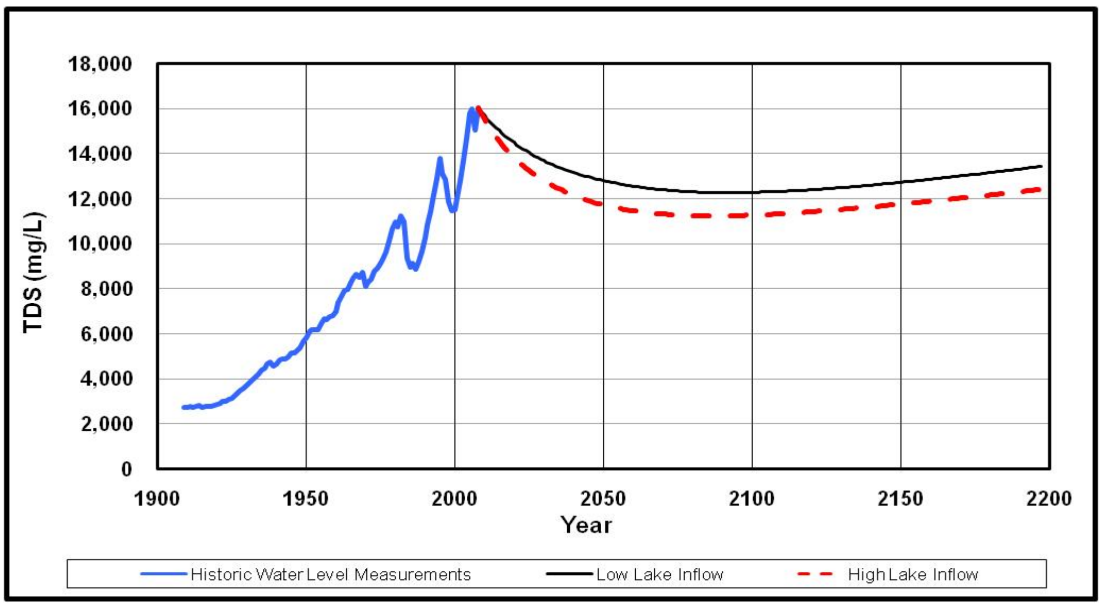
- Primary groundwater rights: The use of primary groundwater rights is not expected to change in response to the Purchase Alternative, except in the case of a willing sale of such a right.
- Supplemental groundwater rights: If a surface water right with an associated supplemental groundwater right is purchased, the supplemental groundwater right would either need to be retired (resulting in less groundwater pumping) or transferred. To avoid the potential for increased groundwater pumping, the NSE only allows supplemental groundwater rights to be transferred to or used with a surface water right that is equal or more senior in priority to the prior surface water right.

Theoretically, farmers who sold water rights could begin to farm remaining land more intensively, potentially increasing groundwater use, although this action could be taken with or without the Purchase Alternative. On the whole, because of the NSE restrictions on the use and transfer of supplemental groundwater rights (see above), the potential for decreased groundwater pumping, resulting mostly from the retirement of supplemental groundwater rights (which is assumed for the Consumptive Use Scenario), appears to be greater than the potential for increased groundwater pumping.

Direct Impacts

Impact WI-1: Alter Walker Lake Water Quality as a Result of Change in Lake Storage (Beneficial Impact with Full Funding; No Impact with Funding of $56 Million)

According to Nevada's 303(d) list of impaired waters (Nevada Division of Environmental Protection 2009a), Walker Lake is considered impaired by high concentrations of arsenic, cadmium, molybdenum, phosphorus, and selenium. In addition, Walker Lake has a TMDL for TDS. Increases in lake level associated with full funding of Alternative 1 would help improve water quality in Walker Lake by reducing the concentrations of these water quality constituents and would help to attain the goals of the TMDL for TDS (Nevada Division of Environmental Protection 2005). TDS concentration is of greatest concern and is discussed in more detail below. Estimated TDS concentrations corresponding to the high and low inflow scenarios are shown in Figure 3-25.



Note: Lines representing future conditions are smooth because they are based on average annual inflow. Actual TDS concentrations would fluctuate around these values.

Figure 3-25. Historic and Projected TDS Concentration in Walker Lake under Alternative 1 based on a High and Low Lake Inflow Scenarios

If an additional 50,000 af/yr reached Walker Lake on an average annual basis, the estimated TDS concentration would decline until about the year 2090. At that point, TDS would range between approximately 11,300 mg/L (high inflow scenario) and 12,300 mg/L (low inflow scenario) (Table 3-19). With time, however, these values would creep upward so that by 2200, TDS would be approximately 12,400 mg/L to 13,500 mg/L (27,100 to 37,500 mg/L less than under the No Action Alternative).

This upward creep would depend on the TDS flux into the lake. For example, as lake volume increases, TDS flux to and from bed sediments could change. Other factors could also influence TDS concentration (e.g., mineral precipitation and wind/ wave dispersal). In addition, for this acquisition alternative, the TDS flux (load) from the river was estimated to increase in proportion to the flow increase, which could be a slight overestimate because TDS concentration tends to decrease as flow increases. However, this tendency could be counteracted by any acquired water that had a higher TDS concentration (e.g., Homestretch Geothermal) than the river.

If increased inflow were limited to what could be purchased with funding of $56 million, it is estimated that the additional inflow would not reduce lake TDS concentration compared to existing conditions. TDS concentration would increase, although not as much as under the No Action Alternative. With funding of $56 million for Alternative 1, TDS in Walker Lake is estimated to reach 31,600 to 40,700 mg/L by the year 2200 (7,900 to 10,300 mg/L less than under the No Action Alternative).

If funding were limited to $56 million, water quality would be better than under the No Action Alternative, but would not be sufficient to sustain or improve the current lake ecology. However, the improved water quality under the fully funded Purchase Alternative would be a beneficial impact.

Impact WI-2: Decrease Down-Cutting in Lower Walker River as a Result of Increased Lake Surface Elevation (Beneficial Impact)

Increased inflow to Walker Lake would decrease vertical erosion in lower Walker River. With sufficient inflows to raise the surface elevation of Walker Lake (i.e., full funding of Alternative 1), the topographic gradient of the Walker River below Schurz would be improved, and portions of the river which now pass through highly erodible deposits of former lake bed and river delta would be shortened. This would decrease vertical erosion that now occurs. Compared to both existing conditions and the No Action Alternative, this would be a beneficial impact.

If acquisitions do not raise the lake surface elevation but reduce the lake’s decline (i.e., with funding of $56 million for Alternative 1), there would be less vertical erosion downstream of Weber Reservoir than under the No Action Alternative.

Impact WI-3: Increase Erosion as a Result of Increased River Flow and Increased Exposed Soil (Adverse Impact)

As river flow increases, the potential for erosion and greater sediment transport also increases. The potential for erosion increases because the velocity of the flow would increase, as would the amount of river channel in contact with flowing water (the wetted perimeter). A recent University study of sediment transport in the Walker River system upstream of Wabuska concluded that increased sediment transport would be expected to occur with essentially any increase in flow (Dennett et al. 2009).

One way that increased sediment load can become a problem is if sedimentation (the settling of sediment) occurs in undesirable locations. Sedimentation generally occurs where water slows down (such as in reservoirs). As a result, the Acquisition Program could increase sedimentation within Weber Reservoir. The magnitude of the effect, however, would depend on Weber Reservoir operations.

Soil erosion caused by rain on fields could also increase under Alternative 1 and contribute additional sediment load to Walker River. The greatest reduction in irrigated land (under the Partial Consumptive Use Scenario) would be 33% for each valley. This would be approximately 1,300 acres for East Walker Valley, 5,800 acres for Smith Valley, and 11,500 acres for Mason Valley (see Hydrologic Change HC-2). Land that is currently covered with crops or crop stubble could be left bare under Alternative 1 and could contribute additional sediment to the Walker River during intense storm events. This dynamic could be stronger in Smith Valley, where fields have greater slope, but the amount of exposed land and the drainage patterns would also have a strong influence. However, in general, erosion from fields is likely to be minimal because the fields are mostly flat and there is relatively little total precipitation in the valleys (on the order of a few inches per year). In addition, weeds or natural vegetation may grow on land involved in acquisitions, and this would help retain soil.

In sum, Alternative 1 could increase erosion and sediment load in the river by increasing river flow and increasing the amount of exposed earth. In reaches of the river where TSS concentration is relatively low, some increase in TSS concentration could probably be tolerated and the impact might be minor. However, TMDLs for TSS have been established for the East Walker River downstream of Bridge B-1475 and for the Walker River upstream of the Walker River Indian Reservation. Consequently, an increase in the sediment load that affects these portions of the river would be an adverse impact.

Impact WI-4: Increase Localized Flooding as a Result of Increased River Flow (Minor Impact)

Increasing flow in the Walker River system during the irrigation season could result in increased localized flooding. Upstream of where acquisitions are made, the Purchase Alternative is not expected to affect the frequency or magnitude of flooding. However, downstream of where acquisitions are made, at locations where the river channel’s flow capacity is limited, the increase in river flow would likely result in more frequent localized flooding and greater depth of overbank flow compared to existing conditions.

A recent University study team developed a hydraulic model of the Walker River system upstream of Wabuska using the U.S. Army Corps of Engineers’ HEC-

RAS software program and determined locations and depths of over-bank flow for a range of river flows that are well within the historical record. For example, at a flow of 500 cfs, about 25 locations were identified in the agricultural valleys of Lyon County where overbank flow would occur. Depths of overbank flow at all locations in the system that the model helped identify ranged from 0.3 to 2.8 feet (Dennett et al. 2009).

A flow of 500 cfs is comparable to the peak annual flows typically seen on the Walker River system during the late spring and early summer in the agricultural valleys of Lyon County. The highest average monthly flows at the USGS gages on the lower West Walker River near Hudson, the lower East Walker River upstream of Strosnider Ditch, and the mainstem Walker River near Wabuska range from about 350 cfs to about 575 cfs. During the high flow parts of the year, median daily flows at these same locations range from about 200 cfs to 400 cfs (Dennett et al. 2009).

Consequently, the HEC-RAS results for a flow of 500 cfs provide a fair indication of the extent of overbank flooding that might be expected to occur in association with the Purchase Alternative if the flows were maintained throughout the irrigation season, including times of higher flow. Overbank flow attributable to the Purchase Alternative would only be the incremental effect caused by the portion of flow that was acquired water. If the acquired flows were managed so as to avoid periods of peak flow, the impacts would be somewhat less than if they were spread out evenly over the annual hydrograph during the irrigation season. With full funding, Alternative 1 would add about 103 cfs to the river flow at Wabuska if spread out uniformly during the irrigation season. With funding of $56 million, Alternative 1 would add about 15 cfs if managed the same way. Because flows are unlikely to be evenly spread through the year and because some years will have greater flow augmentation than others, the incremental flow increase resulting from the Acquisition Program would be higher in some years than others. However, project-related flow increases are likely to remain relatively small compared to peak flow events.

The locations where some additional overbank flow could be expected to occur are already subjected to flooding in many years at times of peak flow. In addition, the type of flooding that would occur is not the catastrophic type with a relatively low probability of occurring. For example, a peak flow event of 500 cfs at the USGS gage near Wabuska has a greater than 1 in 2 chance of occurring in any single year (Adams and Chen 2009). By comparison, the January 1997 flood had peak flows of about 2,500 cfs at Wabuska (U.S. Geological Survey 2008, as cited in Dennett et al 2009) and its probability of occurrence is about 1 in 10 years (Adams and Chen 2009). Consequently, the incremental flooding that might occur as a result of Alternative 1 would probably not be considered substantial or greatly damaging.

In summary, at areas downstream of the historic diversion points of the acquired water, flow increases in Walker River could cause some overbank flow to occur that would not have otherwise occurred. However, the increased localized flooding that could occur as a result of the implementation of Alternative 1 would be considered a minor impact.

Impact WI-5: Improve River Water Quality as a Result of Increased Dilution of Poor Quality Inflows (Beneficial Impact)

Acquisitions would increase flow in Walker River and help to dilute concentrations of problematic water quality constituents such as phosphorous (see Table 3-9, 303(d) listings) that are contributed by river inputs that are of relatively poor water quality, such as irrigation drainage or runoff from grazing and feeding areas. Increased river flow would help to reduce the fraction of the flow coming from sources with poor water quality. This would be a beneficial impact.

Impact WI-6: Diminish River Water Quality as a Result of Introduction of Water with Poor Quality (Minor Impact)

It is possible that some of the acquired water would be of lower quality than river water. For example, water quality data from Homestretch Geothermal indicate that aluminum, arsenic, boron, fluoride, sulfates, TDS, and the sodium absorption ratio all exceeded state water quality standards in a significant percentage of samples (Bureau of Reclamation 2009). However, any discharge to the river would be subject to a National Pollutant Discharge Elimination System (NPDES) permit that would minimize water quality impacts.

The temperature of water discharged from Homestretch Geothermal to cooling ponds is approximately 170º F. Were this water to be used to increase flows in the Walker River, it would be cooled to ambient temperature before release into the river in order to meet state requirements for the temperature of water entering the Walker River (NAC 445A.167).

Homestretch Geothermal effluent water TDS concentration is approximately 1,000 to 1,100 mg/L (Nevada Division of Environmental Protection 2006). This is greater than the typical TDS concentration in the Walker River of about 240 mg/L at Wabuska. This is not a concern for water quality in the river because TDS from Homestretch Geothermal would be subject to an NPDES permit that would ensure that TDS discharged to the river would be adequately diluted by river flow.

Although the Homestretch Geothermal water contains higher concentrations of TDS than river water, it would still help to dilute TDS concentration in Walker Lake, where the concentration was measured at approximately 17,500 mg/L in 2009 (Heggeness pers. comm.). Because the Homestretch Geothermal effluent TDS concentration is greater than that of the lower Walker River, flow augmentation with Homestretch Geothermal water could slightly increase the rate at which TDS concentration in the lake would creep upward over the long run.

This impact is considered minor because the acquisition alternative would not degrade water quality substantially. Most acquisitions would involve surface water that would remain in the Walker River, not water that would be introduced from other sources. Additionally, before any point source water could be discharged into the river, it would be necessary to obtain an NPDES permit and comply with effluent limits based on applicable technology- and water quality-based standards. Furthermore, the introduction to the river of water from other sources likely would undergo separate environmental review. For example, the permanent acquisition of Homestretch Geothermal water could occur only after the pilot project is implemented, which is being reviewed separately under a NEPA Environmental Assessment process (see Chapter 14, Cumulative Impacts, for additional discussion.)

Impact WI-7: Reduce River Water Temperature as a Result of Increased Flow (Beneficial Impact)

Increased flow could reduce water temperature in the Walker River. As flow increased, velocity would increase and travel time would decrease and cooler water from the upstream reaches could flow farther downstream before reaching equilibrium temperature. The magnitude of this impact would depend on the volume, timing, and location of increased flow. However, because most flow increases would occur in the lower watershed, where water temperatures are likely already fairly warm, this benefit may be small.

Increased flow would also help improve water temperature by increasing the depth of flow. When depth increases, the diurnal temperature variation decreases, thus reducing the daily maximum temperature.

Most portions of the East Walker and West Walker Rivers are impaired with respect to water temperature (Nevada Department of Environmental Protection 2009a). As a result, a decrease in river water temperature, even if small, would be an improvement. This would be a beneficial impact.

Indirect Impacts

Impact WI-8: Reduce Groundwater Recharge and Elevation as a Result of Reduced Infiltration from Fields and Canals or from Transfer of Geothermal Water to Walker River (Adverse, Beneficial, or No Impact)

A reduction in diversions of water for irrigation under Alternative 1 could cause a reduction in groundwater recharge and elevation. Because of increased river flows, groundwater levels could rise slightly near the river. However, if there is a widespread reduction in incidental groundwater recharge, the area of decreased groundwater levels would likely be greater than the area of increased groundwater levels.

The extent of the effect on groundwater recharge depends on whether or not conveyance and irrigation inefficiencies would be maintained by restrictions on water right transfers, as distinguished by the Consumptive Use Scenario versus the Full Transfer Scenario in the upstream analysis. Under the Consumptive Use Scenario, GRR flows would not be affected if transfer restrictions required the maintenance of conveyance losses and incidental groundwater recharge. Furthermore, under the Consumptive Use Scenarios, groundwater levels could actually increase relative to the No Project Alternative as a result of retirement of supplemental groundwater rights associated with acquired water rights. Under the Consumptive Use Scenarios, there would be no adverse impacts on groundwater levels and there could even be a benefit.

Groundwater would be most affected under the Full Transfer Scenario, in which all of the available acquired water is left in the river rather than contributing incidentally to groundwater recharge.

For the Full Transfer Scenario, the gross reduction in incidental GRR flows could be fairly large. For example, based on the upstream analysis, the reduction in incidental GRR flows in Mason Valley could be as much as 25,500 af/yr if the Mason Valley flow acquisition were 56,000 af/yr (Table 3-15). However, the strong link between the river and groundwater would help minimize the reduction in net groundwater recharge. Initially, reduced groundwater recharge would have little effect on river flows, but eventually average river infiltration would increase (or groundwater inflow would decrease) in response to dropping groundwater levels as a result of reductions in incidental recharge. Increased river flows might lead to groundwater levels rising slightly near the river. However, the area of decreased groundwater levels would likely be greater than the area of increased groundwater levels.

For the Full Transfer Scenario, 20,800 af/yr of the reduction in GRR flows would be offset by increased infiltration from the river, resulting in only a 4,700 af/yr decrease in net groundwater recharge in Mason Valley. This offset was estimated with the upstream analysis (described above). Under the Full Transfer Scenario, the long-term average annual reduction in net groundwater recharge could be 500 af for East Walker Valley, 2,900 af for Smith Valley, and 4,700 af for Mason Valley based on the flow acquisition volumes described for HC-2 (and in Table 3-15), above. This would represent between 5% and 11% of the existing incidental GRR flows.

Groundwater levels would be more greatly impacted if the river did not replenish the aquifer as much as expected. In addition, the groundwater aquifer could eventually drop to a low enough level that river infiltration would reach a maximum rate that could not increase in response to further declines in groundwater level.

Spread over the estimated surface areas of each of the three valleys and assuming a typical soil porosity of 25%, these annual volumes of decreased recharge would represent 0.8 inch/year for the East Walker area, 1.7 inches/year for Smith Valley, and 2.0 inches/year for Mason Valley (Table 3-14). However, any changes in groundwater levels would vary across each valley, with the largest drops most likely to occur farthest from the influence of the river, although impacts may vary depending on local groundwater dynamics and geologic profiles. For example, any relatively shallow local aquifers that are supplied by water use inefficiencies could be more profoundly affected by Alternative 1 than the aquifer for the valley as a whole if the supply water is reduced by acquisitions.

These rough estimates of average rates of groundwater decline are much less than those estimated for existing conditions: 6 inches/year for Smith Valley and 5 inches/year for Mason Valley (see Affected Environment). In other words, Alternative 1 would exacerbate existing rates of groundwater decline by 28 to 40%. Because acquisitions would be permanent, the total decline caused by Alternative 1 over time could be substantial under the Full Transfer Scenario. This would be an adverse impact.

The percent reduction in groundwater recharge would be higher in Smith Valley (11% of existing incidental GRR flows) compared with Mason Valley because the groundwater divide in the Smith Valley reduces the extent to which the river would compensate for a reduction in incidental recharge. There is also some potential for the groundwater divide to move in response to changes in groundwater recharge. A reduction in recharge associated with irrigation could move the divide closer to the river, which would be more similar to conditions prior to irrigation. However, any response of the groundwater divide would depend upon the specific location of all acquisitions, which is unknown.

For the East Walker reach, groundwater impacts may be highly localized because of the river gradient and the isolation of the relatively flat portions of the valley. For example, groundwater in the upper portion of the reach is unlikely to be affected by acquisitions made lower in the reach.

Long-term transfer of spent geothermal water to Walker River (e.g., from the Homestretch Geothermal project) could potentially decrease groundwater levels. It is likely that there is some connection between the geothermal and alluvial aquifers (Lopes and Allander 2009b). A decrease in groundwater levels resulting from the Homestretch Geothermal project could result from increased geothermal production and a reduction of groundwater recharge from the existing discharge ponds. These concerns are being investigated further. Potential use of Homestretch Geothermal water is being analyzed in an Environmental Assessment of the Homestretch Geothermal pilot project, and would only be considered for permanent acquisition if approved through NDEP and after evaluation of the success of the pilot project.

Impact WI-9: Alter the Movement of the Anaconda Mine Groundwater Plume as A Result of Change in Groundwater Recharge (Minor Impact)
Under Alternative 1, change in groundwater recharge near the Anaconda Mine cleanup site could modify the movement of the contaminated groundwater plume by affecting the local hydraulic gradient. Unless extensive acquisitions are made in the vicinity of the mine site, however, it is expected that this impact would be small. This is considered a minor impact.

Impact WI-10: Reduce Water Supplies for Remaining Canal Users as a Result of Reduced Canal Flows (Minor Impact)
Acquisitions under Alternative 1 could cause a reduction in canal flow. As canal flow is reduced, the percent that is lost would increase and conveyance losses that are borne by remaining canal users could increase under the Full Transfer Scenario. In addition, acquisitions could reduce the ability of farmers to maintain adequate canal head (height of water in the canal) for easily diverting water from the canal.

In some circumstances there may be little or no influence on other canal users. This might be the case if the conveyance distance from the point of diversion was very short, if only a small portion of flow was associated with the exercise of acquired water rights along the ditch or canal at issue, or, at the other extreme, the entire flow in a canal was acquired.

The NSE is expected to restrict or refrain from approving transfers that would conflict with other existing water rights. The NSE would condition or not approve transfers that would otherwise injure other rights holders. Consequently, this impact would be minor.

Impact WI-11: Reduce Incidental Availability of Water as a Result of Reduced Field Runoff, Seepage, or Return Flow (Minor Impact)
As a result of reduced irrigation, Alternative 1 could cause a reduction in field runoff, seepage, and groundwater recharge. This could result in reduced soil moisture from neighboring lands involved in acquisitions and reduced return flows.

Reduced return flow to the river is not expected to affect water users because a reduction in river return flows would reduce the amount of the flow augmentation and not the amount of water available to other users.

However, farmers who rely in part on seepage or return flows from neighboring land or nearby field runoff could be affected. This effect is not expected to be substantial, however, because neighboring irrigators not involved in an acquisition can be expected to depend primarily upon other more reliable sources of supply. Furthermore, there is no established right to this incidental water because its availability is dependent on the exercise of water rights by, and/or inefficiencies of, other water right holders. This would be a minor impact.

Impact WI-12: Improve River Water Quality as a Result of Reduced Return Flow (Beneficial Impact)
The Purchase Alternative is expected to reduce the volume of return flows from Mason Valley, Smith Valley, and the East Walker area. Because return flows tend to be of lower water quality than river flows, this impact should help to improve water quality in the river. This would be a beneficial impact.

This impact is similar to WI-5, except that the mechanism is different. WI-5 is a direct impact resulting from increased river flow, whereas WI-12 is an indirect impact resulting from decreased return flows to the river.

Alternative 2 (Leasing Alternative)

Because Alternative 2 involves recurring water leases, the actions of Alternative 2 would last only until the funding is exhausted.

Environmental Effects Similar to Those Under Alternative 1 but Temporary

The following effects of Alternative 2 would be similar in nature (i.e., adverse, minor, beneficial, or no impact) to those of Alternative 1, but temporary:

Hydrologic Change HC-3: Increase River Flow (Increase)

Hydrologic Change HC-4: Change in Amount of Groundwater Pumping (Increase or Decrease)

Impact WI-4: Increase Localized Flooding as a Result of Increased River Flow (Minor Impact)

Impact WI-5: Improve River Water Quality as a Result of Increased Dilution of Poor Quality Inflows (Beneficial Impact)

Impact WI-6: Reduce River Water Quality as a Result of Introduction of Water with Poor Quality (Minor Impact)

Impact WI-7: Reduce River Water Temperature as a Result of Increased Flow (Beneficial Impact)

Impact WI-10: Reduce Water Supplies for Remaining Canal Users as a Result of Reduced Canal Flow (Minor Impact)

Impact WI-11: Reduce Incidental Availability of Water as a Result of Reduced Field Runoff, Seepage, or Return Flow (Minor Impact)

Impact WI-12: Improve River Water Quality as a Result of Reduced Return Flow (Beneficial Impact)

Environmental Effects Different Than Those Under Alternative 1-Hydrologic Changes

Environmental effects of Alternative 2 that differ in important ways from those of Alternative 1 are discussed below.

Hydrologic Change HC-1: Alter Walker Lake Storage and Surface Area (Temporarily Increase)

Under Alternative 2, storage in Walker Lake would initially increase. However, storage would stop increasing in approximately 3 to 20 years under funding of $56 million and full funding, respectively. Because the estimated rise for Alternative 2 is not based upon an ultimate equilibrium value but on a comparison of temporary elevations in specific years, the projected water surface elevations and lake surface areas are not exact. Elevations attained at the end of the leasing period would depend greatly on when acquisitions under Alternative 2 are initiated as well as actual hydrologic conditions. However, change in elevation is more likely to be correct. Assuming average hydrologic conditions prevailed during the leasing program, Alternative 2 would result in approximately a 1- to 2-foot rise in lake water surface elevation over 3 years and a 10- to 13-foot rise over 20 years (Table 3-19). The particular elevations reached would depend on when acquisitions would be fully initiated as well as actual hydrological conditions. Once Alternative 2 runs out of funding, however, the lake would tend toward the same water surface elevation expected under the No Action Alternative.

Hydrologic Change HC-2: Reduce Irrigated Land as a Result of Acquisitions (Decrease)

The percent reduction in irrigated land for Alternative 2 would be approximately the same as for Alternative 1. However, under Alternative 1, much land would likely be permanently retired from agriculture, whereas for Alternative 2, it could be temporarily fallowed.

Environmental Effects Different Than Those Under Alternative 1-Direct Impacts

Impact WI-1: Alter Walker Lake Water Quality as a Result of Change in Lake Storage (Beneficial Impact with Full Funding; No Impact with Funding of $56 Million)

Under Alternative 2, it is expected that initially TDS concentration in Walker Lake would drop. However, this beneficial effect would cease in approximately 3 to 20 years for funding of $56 million and full funding, respectively. Assuming average hydrologic conditions, Alternative 2 would result in an estimated drop in TDS of 200 mg/L in 3 years and 1,700 to 2,400 mg/L in 20 years (Table 3-19). The exact concentration would depend on when acquisitions would be initiated as well as actual hydrologic conditions. Once Alternative 2 runs out of funding, TDS in the lake would be expected to eventually reach the same concentration as under the No Action Alternative.

Improved water quality in Walker Lake resulting from the actions of Alternative 2 would be a temporary beneficial impact. However, if funding were limited to $56 million, the benefit would be negligible.

Impact WI-2: Decrease Down-Cutting in Lower Walker River as a Result of Increased Lake Surface Elevation (Beneficial Impact)
With Alternative 2, increased inflow to Walker Lake would decrease vertical erosion in the lower Walker River temporarily.

With full funding, the lake surface elevation could rise substantially during the period of implementation (but it would not reach the same elevation as for Alternative 1). The topographic gradient of the Walker River below Weber Reservoir would be improved, and portions of the river which now pass through highly erodible deposits of former lake bed and river delta would be shortened. This would decrease vertical erosion for the duration that the leasing program is funded. Compared to both existing conditions and the No Action Alternative, this would be a beneficial impact, but temporary.

With funding of $56 million, the decline of Walker Lake's surface elevation would be arrested temporarily, assuming average hydrologic conditions. Compared to existing conditions there would be little difference during the few years that the leasing program operated, but it would be an improvement compared to the No Action Alternative.

Impact WI-3: Increase Erosion as a Result of Increased River Flow and Increased Exposed Soil (Adverse Impact)
Potential erosion effects under Alternative 2 could be less than those under Alternative 1 because, although river flows would still increase, the reduction in irrigation is expected to result in fallowing instead of retirement of currently irrigated lands involved in acquisitions. Farmers in the Walker River Basin generally conserve topsoil on fallowed fields by leaving some protective vegetative cover such as crop stubble. As a result, it is expected that there would be less exposed earth on existing irrigated agricultural lands under Alternative 2 than under Alternative 1. The magnitude of the impact therefore would be somewhat less, but increased sediment transport caused by greater river flows would still aggravate an impaired reach of the Walker River to some degree. Consequently, this would be an adverse but temporary impact.

Environmental Effects Different Than Those Under Alternative 1-Indirect Impacts

Impact WI-8: Reduce Groundwater Recharge and Elevations as a Result of Reduced Infiltration from Fields and Canals or from Transfer of Geothermal Water to Walker River (Beneficial, No Impact, or Minor Impact)
As for Alternative 1, the effect of the alternative on groundwater would be dependent on the details of how the alternative is administered. If the transfer of water is restricted as under the Consumptive Use Scenarios and supplemental groundwater associated with the acquired water is no longer pumped, then groundwater levels could stay the same or increase relative to the No Action Alternative (no impact or minor beneficial impact). However, if the full amount of water is transferred and supplemental groundwater pumping continues, as under the Full Transfer Scenario, groundwater levels could decline.

Under Alternative 2 with the Full Transfer Scenario, groundwater elevation would be expected to drop because of decreased recharge in a manner similar to Alternative 1. However, the impact would be temporary and of less magnitude than under Alternative 1. Because Alternative 2 would last only until funding is exhausted, the aquifer would not drop as much as with a fully-funded Alternative 1. Consequently, the hydraulic gradient would not be affected as much as for Alternative 1, and the amount of infiltration from the river to groundwater would be less than for a fully funded Alternative 1.

As with Alternative 1, any changes in groundwater levels for Alternative 2 would vary across each valley, with the largest drops most likely to occur farthest from the influence of the river, although impacts may vary depending on local groundwater dynamics and geologic profiles. For example, any relatively shallow local aquifers that are supplied by water use inefficiencies could be more profoundly affected by Alternative 2 than the aquifer for the valley as a whole if the supply water is reduced by acquisitions.

For Alternative 2 with the Full Transfer Scenario, it is estimated that groundwater elevation would decline on average by 0.8 inch/year for the East Walker area, 1.7 inches/year for Smith Valley, and 2.0 inches/year for Mason Valley. This would exacerbate existing rates of decline by 28 to 40%. Over the estimated 20 year period of full funding, this would represent a decline of 1.3 feet (East Walker area) to 3.3 feet (Mason Valley). With funding of $56 million the estimated decline in groundwater elevation would be less than or equal to 6 inches over 3 years.

Once Alternative 2 ends, groundwater elevations would be expected to vary from year to year in a manner similar to the No Action Alternative. Because groundwater elevations in many locations appear to be dropping, the impact of Alternative 2 on groundwater may be to slightly hasten the drop in the groundwater table if the assumptions of the Full Transfer Scenario hold true or if geothermal water is leased. This would be a minor impact.

Impact WI-9: Alter the Movement of the Anaconda Mine Groundwater Plume as A Result of Change in Groundwater Recharge (Minor Impact)
For Alternative 2 this impact would be similar in nature (i.e., minor) to that under Alternative 1, but temporary and of less magnitude. Because the duration of the influence of the project would be temporary, the total change in plume movement occurring over time caused by the project, if any, would likely be less under Alternative 2 than under Alternative 1.

Alternative 3 (Efficiency Alternative)

The impacts for Alternative 3 are not expected to be as large as for Alternative 1 because it is estimated that Alternative 3 would produce less than an additional 50,000 af/yr of inflow, on average, to Walker Lake. Based on the analysis of Alternative 3 (see Assessment Methods), the estimated average increase in flow to Walker Lake would be 32,300 af/yr (Table 3-17), assuming that average water use efficiency would increase to 75%, but there would be no crop switching.

Crop switching could increase the yield of Alternative 3 (see discussion of Alternative 3 results above). A reduction in crop ET of less than 15% probably could be attained by crop switching and would likely be sufficient to bring an average additional 17,700 af/yr to Walker Lake (bringing the average total increase to 50,000 af/yr). However, because of feasibility concerns (particularly regarding profitability and market demand), crop switching was not included in the Alternative 3 assessment.

Unless otherwise noted, the hydrologic changes and impacts of Alternative 3 would be similar in nature (i.e., adverse, minor, beneficial, or no impact) to those of Alternative 1 with full funding, but of less magnitude. Hydrologic changes or impacts of Alternative 3 that would be comparable to those of Alternative 1 are listed below first. Those that would differ in important ways from the effects of Alternative 1 are subsequently discussed in more detail.

Environmental Effects Similar to Those Under Alternative 1 But of Less Magnitude

Hydrologic Change HC-3: Increase River Flow (Increase)

Impact WI-4: Increase Localized Flooding as a Result of Increased River Flow (Minor Impact)

Impact WI-5: Improve River Water Quality as a Result of Increased Dilution of Poor Quality Inflows (Beneficial Impact)

Impact WI-7: Reduce River Water Temperature as a Result of Increased Flow (Beneficial Impact)

Impact WI-12: Improve River Water Quality as a Result of Reduced Return Flows (Beneficial Impact)

Environmental Effects Different Than Those Under Alternative 1 – Hydrologic Changes

Hydrologic Change HC-1: Alter Walker Lake Storage and Surface Area (Increase)

Based on the methods described for the upstream analysis above, average annual inflow to Walker Lake would increase by 32,300 af/yr if Alternative 3 is fully implemented at 75% combined conveyance and on-farm water efficiency. This additional inflow is projected to increase lake surface elevation to a range of 3,939 to 3,948 feet (Table 3-19). This would be 4 to 13 feet higher than the September 2007 level of 3,935 feet and 41 to 42 feet higher than under the No Action Alternative.

Hydrologic Change HC-2: Reduce Irrigated Land as a Result of Acquisitions (No Change)

Alternative 3 would have no direct effect on the amount of land that is irrigated.

Hydrologic Change HC-4: Change in Amount of Groundwater Pumping (No Change)

Alternative 3 would be unlikely to affect the volume of groundwater pumping.

Environmental Effects Different Than Those Under Alternative 1 – Direct Impacts

Impact WI-1: Alter Walker Lake Water Quality as a Result of Change in Lake Storage (Beneficial Impact)
With the increased inflow of 32,300 af/yr estimated for Alternative 3, Walker Lake water surface elevation is projected to rise, as indicated in HC-1. However, TDS would not be greatly reduced compared to existing conditions. Initially, for a period of approximately 20 to 50 years, TDS would change little from existing levels, reaching concentrations of 14,800 to 16,000 mg/L (Table 3-19), and then it would gradually increase because of continual TDS load from the Walker River. Concentrations for the year 2200 would be approximately 16,800 mg/L to 19,600 mg/L. There would be essentially no benefit compared to existing conditions. However, this result would be beneficial to the lake in comparison to future conditions under the No Action Alternative, which would result in projected a TDS concentration in the range of 39,500 to 51,000 mg/L. Alternative 3 would

result in a TDS concentration 22,700 to 31,400 mg/L less than under the No Action Alternative. Because Alternative 3 could help maintain TDS concentration at a level similar to current conditions, this would be a beneficial impact when compared to the No Action Alternative.

Impact WI-2: Decrease Down-Cutting in Lower Walker River as a Result of Increased Lake Surface Elevation (Beneficial Impact)
With Alternative 3, the lake surface elevation would rise substantially, but less than under Alternative 1. The topographic gradient of the Walker River below Weber Reservoir would be improved, and portions of the river which now pass through highly erodible deposits of former lake bed and river delta would be shortened. This would decrease vertical erosion. Although the magnitude of the effect would be less than under full funding of Alternative 1, this would be a beneficial impact.

Impact WI-3: Increase Erosion as a Result of Increased River Flow and Increased Exposed Soil (Adverse Impact)
The maximum potential amount of exposed earth generated by Alternative 3 would equal the acres of non-agricultural vegetation that currently depend on the inefficiencies of irrigation, which is estimated as the acres of non-riverine riparian/wetland vegetation (approximately 350 acres for East Walker, 2,200 acres for Smith Valley, and 4,900 acres for Mason Valley). These areas are less than the potential amount of previously irrigated land generated by Alternative 1. Walker River flows would also be somewhat less under Alternative 3 than Alternative 1. The magnitude of the erosion impact therefore would be somewhat less, but increased sediment transport caused by greater river flows would still aggravate an impaired reach of the Walker River to some degree. Consequently, this would be an adverse impact.

Impact WI-6: Reduce River Water Quality as a Result of Introducing Water with Poor Quality (No Impact)
Alternative 3 would not introduce water from other sources to Walker River.

Environmental Effects Different Than Those Under Alternative 1 – Indirect Impacts

Impact WI-8: Reduce Groundwater Recharge and Elevations as a Result of Reduced Infiltration from Fields and Canals or from Transfer of Geothermal Water to Walker River (Adverse)
The transfer of spent geothermal water is not part of Alternative 3; as a result, groundwater levels could only be affected by agricultural efficiency measures. Under Alternative 3, only an estimated 25%, 54%, and 28% of the water savings would reach Walker Lake from the East Walker, Smith Valley, and Mason Valley reaches, respectively. Most of the rest of the acquired water savings would be lost from the river through increased infiltration from the river to groundwater and

reduced return flows to the river. The percent of acquired water estimated to reach the lake is much lower for Alternative 3 because a larger portion of the water savings would come at the expense of a reduction in GRR flows that help to sustain the river.

Under Alternative 3, assuming 75% efficiency is attained, estimated average annual total GRR flows for the three valleys could drop from 128,100 af/yr for existing conditions to 42,900 af/yr. However, the strong link between the river and groundwater would help to minimize the reduction in net groundwater recharge. It is estimated that 65,800 af/yr of the reduction in incidental GRR flows would be compensated by a reduction in river flow, resulting in a net reduction of groundwater recharge of 19,300 af/yr for all three valleys (1,100 af/yr for East Walker, 5,900 af/yr for Smith Valley, and 12,300 af/yr for Mason Valley). This represents 12%, 23%, and 13% of the existing incidental GRR flows for East Walker, Smith Valley, and Mason Valley, respectively. The percent reduction in incidental groundwater recharge would be higher in Smith Valley because the groundwater divide reduces the extent to which the river would compensate for a reduction in incidental recharge.

If these volumes are spread over the surface areas of the three valleys and a typical soil porosity of 25% is assumed, these net reductions in groundwater recharge would represent 1.9 inches/year for East Walker Valley, 3.5 inches/year for Smith Valley, and 5.2 inches/yr for Mason Valley (Table 3-17). Changes in groundwater levels would vary across each valley with the largest drops likely to occur farthest from the influence of the river. Effects may vary locally depending on groundwater dynamics and geologic profiles. These estimated rates of groundwater decline associated with Alternative 3 approach the magnitude of the average rates of decline estimated for existing conditions, 6 inches/year for Smith Valley and 5 inches/year for Mason Valley (see Affected Environment). Because improvements would be permanent, the decline caused by Alternative 3 over time would likely be substantial. This would be an adverse impact.

For Alternative 3 to avoid effects on incidental groundwater recharge, it would be necessary to remove non-riverine riparian and wetland vegetation and limit improvements only to those actions that would eliminate incidental ET and not groundwater recharge (to keep the net incidental groundwater recharge unchanged). Because estimated incidental ET for all valleys combined is 26,000 af/yr, such actions could represent a fairly large portion of the additional 32,300 af/yr estimated to arrive at Walker Lake. However, because efficiency cannot be 100%, some of the incidental ET would likely remain. Reductions in incidental GRR flows are not as effective as reductions in incidental ET because reductions in incidental GRR flows would cause reduction in river flow over the long term. In reality, it would be difficult to limit incidental ET without affecting net incidental GRR flows. Removal of vegetation adjacent to canals (particularly tamarisk) may be the easiest way to help reduce conveyance losses without affecting groundwater recharge.

Impact WI-9: Alter the Movement of the Anaconda Mine Groundwater Plume as A Result of Change in Groundwater Recharge (Minor Impact)
Under Alternative 3, impacts on groundwater are expected to be greater than for Alternative 1. Nevertheless, unless Alternative 3 involved large scale efficiency measures in the immediate vicinity of the mine site, any effects on the movement of the Anaconda Mine plume would be small. This is considered a minor impact.

Impact WI-10: Reduce Water Supplies for Remaining Canal Users as a Result of Reduced Canal Flow (Minor Impact)
Under Alternatives 1 and 2, there is potential for water rights holders along canals to be affected by increases in the percent of water lost during conveyance and reduced canal head. Canal conveyance losses would be greatly reduced under Alternative 3; however the savings would be transferred downstream. Consequently, there could be a reduction in head that affects some farmers located closer to the point of diversion. This would be a minor impact.

Impact WI-11: Reduce Incidental Availability of Water as a Result of Reduced Field Runoff, Seepage, or Return Flow (Minor Impact)
Similar to Alternatives 1 and 2, Alternative 3 could cause a reduction in field runoff and seepage. This could result in reduced soil moisture from neighboring lands directly involved in acquisitions as well as in reduced return flows. The mechanism, however, would be different. Under Alternatives 1 and 2 there would be a reduction in irrigated land and under Alternative 3, efficiency measures would reduce runoff and seepage.

As described for WI-11 under Alternative 1, reduced return flow to the river associated with the acquisition alternatives is not expected to affect water users because a reduction in river return flows would reduce the amount of the flow augmentation and not the amount of water available to other users. However, farmlands that use soil moisture from neighboring land or nearby field runoff could be affected by this type of impact. This type of impact may be greater for Alternative 3 than for Alternatives 1 and 2 because reduction in the amount of incidentally available water not used by irrigated vegetation is the main target of an efficiency-based program.

Nevertheless, this effect is not expected to be substantial because irrigators can be expected to depend primarily upon other more reliable sources of water. Furthermore, there is no established right to this incidental water because its availability is dependent on the exercise of water rights by, and/or inefficiencies of, other water right holders. This would be a minor impact.

Impact WI-13: Decrease Quality of Stormwater Runoff as a Result of Construction-Related Activities (Minor Impact)

Under Alternative 3, construction activities may be necessary to improve conveyance and irrigation efficiency. These activities could include lining canals with concrete; replacing surface conveyances with underground pipelines; consolidating canals, laterals and ditches; and improving diversion works. These activities have the potential to degrade the quality of local stormwater runoff through spill of contaminants such as petroleum products (e.g., diesel fuel or oil used by construction equipment) or as a result of temporary ground disturbances that could increase erosion and sediment transport during construction.

This impact, however, would be minor because a large-scale project would require a general construction permit that would require implementation of a stormwater pollution prevention plan (SWPPP) and the use of best management practices to control runoff and the potential discharge of pollutants during construction; the impact also would be short-term.

Chapter 4 Biological Resources—Vegetation and Wetlands

Chapter 4 Biological Resources—Vegetation and Wetlands

Introduction

This chapter describes the affected environment for vegetation and wetland resources in the study area and the potential impacts on vegetation and wetland resources that would result from the acquisition alternatives and the No Action Alternative.

Descriptions of vegetation cover and community types are provided in Appendix 4A. Additional information on noxious weeds is provided in Appendix 4B.

Sources of Information

The key sources of data and information used in the preparation of this chapter are listed below.

- Nevada Natural Heritage Program's Nevada SynthMap (Peterson 2008a)
- Provisional digital land cover map for the southwestern United States (U.S. Geological Survey National Gap Analysis Program 2004)
- Southwest Regional Gap Analysis Project—Land Cover Descriptions (U.S. Geological Survey National Gap Analysis Program 2005)
- Classification of terrestrial systems (Comer et al. 2003)
- Southwest Regional Gap Analysis Project mapping methods (Lowry et al. 2005)
- Nevada Native Plant Society (NNPS) status lists (2008)
- Recorded endangered, threatened, candidate, and at-risk plant lists (Nevada Natural Heritage Program 2008)
- Rare plant fact sheets (Nevada Natural Heritage Program 2001)
- Nevada noxious weed list (Nevada Department of Agriculture 2008a)
- The California Natural Diversity Database (CNDDB) (2008)
- California Native Plant Society (CNPS) Inventory of Rare and Endangered Plants in California (2008)

No field survey or vegetation mapping was performed for this analysis. Vegetation mapping for the study area is based on the Southwest Regional Gap

Analysis Project[1] (U.S. Geological Survey National Gap Analysis Program 2004, Lowry et al. 2005).

Affected Environment

This section describes the environmental setting related to vegetation communities and drainages, special-status plant species, and invasive and noxious plant species in the study area. Although the project area is the entire Nevada portion of the Walker River Basin (Chapter 1), the study area for vegetation and wildlife was defined as the following areas in Lyon and Mineral Counties: the mainstem Walker River, the East Walker River, and the West Walker River in Nevada; Walker Lake; irrigation canals that connect to the Walker River system; irrigated land adjacent to the canals; and a 1-mile zone around each of these areas. Study area boundaries were defined based on the areas that could be affected by the acquisition alternatives.

California and Douglas County, Nevada, were not included in the study area. Although the Walker River watershed originates in Mono County, California, the Purchase Alternative would not change any operations or acquire land, water appurtenant to the land, and related interests in California or Douglas County, Nevada. Operating criteria for upstream reservoirs are assumed to remain within ongoing patterns and historic use for all alternatives. The California and Douglas County, Nevada, portions of the basin would not be affected directly or indirectly by the acquisition alternatives.

Vegetation Communities

Most of the Walker River watershed is located in the Great Basin Province, which extends from the region south of Lake Tahoe across Nevada, east of the Sierra Nevada. The region supports sagebrush steppe, pinyon/juniper woodland, and riparian cottonwood communities (Hickman 1993). Riparian and wetland communities are considered sensitive because of their high species diversity, high productivity, and limited and declining distribution. Nevertheless, not all riparian and wetland communities are of equal species composition and habitat density. As described in Chapter 2, Alternatives, there are three proposed acquisition areas: Mason Valley, Smith Valley, and East Walker. The distribution of irrigated lands and riparian and wetland communities where acquisitions are expected to occur is shown in Table 4-1.

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[1] The Nevada Natural Heritage Program has a recent, more detailed vegetation map, called the Nevada SynthMap, that uses southwest regional GAP data as a base map with additional more specific and local data (Grossman et al. 1998; Peterson 2008a, 2008b). The SynthMap cover types are based on the International Vegetation Classification (IVC) system. This map may be useful for future analysis of the acquisition alternatives, but many new vegetation types proposed on the SynthMap that currently do not have a corresponding IVC classification and description. Because of the preliminary nature of the SynthMap, it was not used for the analysis in this document. A more detailed vegetation map, which incorporates field mapping, aerial imagery and light detecting and ranging (LiDAR) imagery is being completed by USFWS. This information is expected to be finalized in fall of 2009 and will be publicly available.

Table 4-1. Distribution of Irrigated Lands and Riparian/Wetland Habitat in Study Area

	Mason Valley	Smith Valley	East Walker	Total
Irrigated Acres	34,972	17,452	4,015	56,439
Riparian/Wetland Acres	7,434	3,309	3,007	13,750
Total Acres	42,406	20,761	7,022	70,189

Note: Acreages represent averages for 6 years between 1986 and 2002.
(Yardas 2007)

Vegetation mapping for the study area, as shown on Figure 4-1, is based on the Southwest Regional Gap Analysis Project (U.S. Geological Survey National Gap Analysis Program 2004, Lowry et al. 2005). The land cover types on the GAP maps are based on the ecological systems classification system (Comer et al. 2003), and the basic unit for each type is the ecological system. Ecological systems are groups of plant community types (associations) that tend to co-occur within landscapes with similar ecological processes, substrates, and/or environmental gradients (Comer et al. 2003). For this analysis, ecological systems are equated with vegetation communities, although these types can be divided into more specific types based on dominant plant species that occur together.

The approximate minimum mapping unit for the Southwest Regional Gap Analysis Project map is slightly less than 0.25 acre. Because of the minimum unit size, the vegetation mapping might not include all existing areas of vegetation because some areas of habitat, including riparian and wetland habitats, are smaller than 0.25 acre.

Detailed descriptions of the vegetation communities and cover types shown on Figure 4-1 are provided in Appendix 4A.

Distribution of Vegetation Communities in the Study Area

This section describes the general distribution of vegetation communities in each part of the study area. To facilitate the analysis in this document, the study area is divided into the East Walker River, West Walker River, mainstem Walker River, and Walker Lake, with their associated irrigation canals and drains and adjacent lands.

East Walker River

At the Nevada/California border, the East Walker River flows through a mountainous area of mostly pinyon-juniper woodland and big sagebrush shrubland. Intermixed with these two communities are areas of xeric mixed sagebrush shrubland and semi-desert grassland. Small areas of montane sagebrush steppe and mixed salt desert scrub are present. Riparian vegetation grows adjacent to the river.

In low-gradient river reaches, the dominant surrounding vegetation transitions to mostly mixed salt desert scrub and numerous areas of agriculture (Chapter 7, Land Use and Agriculture) near the river channel, although the adjacent area supports riparian habitat. Within the transition zone from mountain to basin are patches of Sierra cliff and canyon vegetation or basin cliff and canyon at lower elevations. There are also minor areas of mesic mixed conifer forest, dry-mesic mixed conifer forest, semi-desert shrub steppe, and montane sagebrush steppe. Small herbaceous areas of semi-desert grassland and perennial grassland are present.

At lower elevations mixed salt desert scrub is still dominant, but there are inclusions of big sagebrush shrubland, semi-desert shrub-steppe, semi-desert grassland, forbland, and greasewood flat. Areas of agriculture are more extensive along the downstream part of the East Walker River (Chapter 7, Land Use and Agriculture). Immediately adjacent to the river are small areas of emergent marsh and a continuous riparian corridor. Close to its confluence with the West Walker River, the surrounding area is primarily agriculture with only small inclusions of the other vegetation community types. Mixed salt desert scrub borders the edges of agricultural land.

West Walker River

In contrast with the East Walker River, the West Walker River flows through a more level area at the Nevada/California border that is predominantly big sagebrush shrubland, xeric mixed sagebrush shrubland, and agriculture (Chapter 7, Land Use and Agriculture). Along the river is riparian vegetation and emergent marsh, with patches of greasewood flat, semi-desert grassland, and forbland outside the riparian border. Small inclusions of mixed salt desert scrub and pinyon-juniper woodland are also present. Areas of montane sagebrush steppe are scattered in this region. At the south end of Smith Valley, foothills support pinyon-juniper woodland, xeric mixed sagebrush shrubland, semi-desert shrub steppe, and Sierra and basin cliff and canyon.

Between Smith Valley and Mason Valley, the West Walker River supports riparian vegetation, with mostly mixed salt desert scrub outside of the riparian corridor. Near the confluence with the East Walker River, the West Walker River supports a mix of riparian, big sagebrush shrubland, and greasewood flat.

Smith Valley

Smith Valley supports large areas of agriculture (Chapter 7, Land Use and Agriculture) and big sagebrush shrubland. Riparian communities extend along

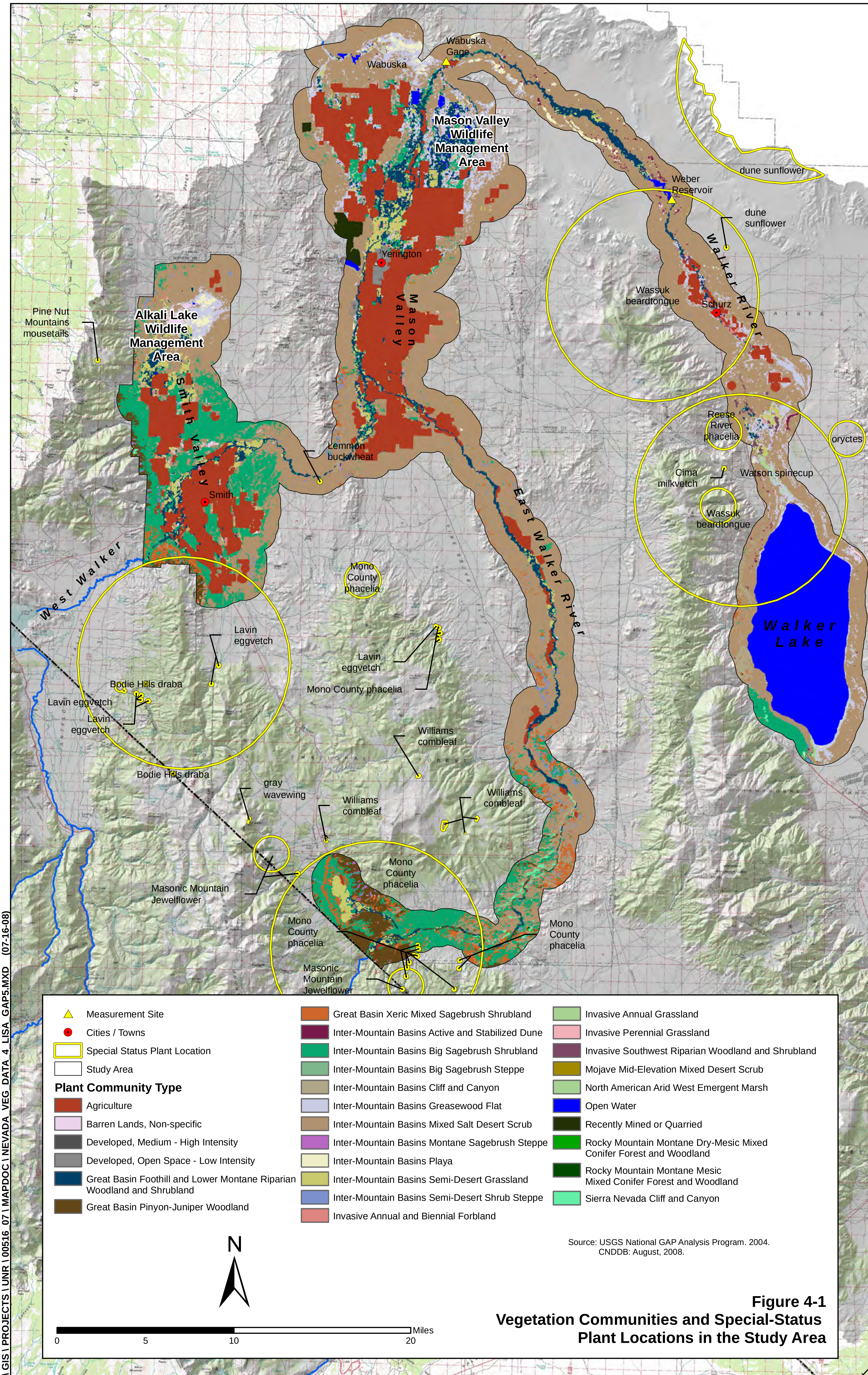

Figure 4-1
Vegetation Communities and Special-Status Plant Locations in the Study Area

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most of the West Walker River through the valley and in scattered areas around irrigation canals and drains. Riparian and wetland habitats associated with irrigation canals and drains are more likely to support nonnative species and invasive species such as tamarisk (*Tamarix* sp.). Some irrigation supply canals in Smith Valley support species such as coyote willow (*Salix exigua*), cattail (*Typha* sp.), and bulrush (*Schoenoplectus acutus*), most of which are native species (Bull pers. comm.). Irrigated pasture that has not been laser leveled can also support patches of wetland habitat in low-lying areas (Bull pers. comm.). Valley edges in the south support mixed salt desert scrub. The western foothills include a mix of pinyon-juniper woodland, montane sagebrush steppe, and big sagebrush shrubland. Throughout the valley, there are minor inclusions of other communities, such as forbland, barren areas, semi-desert grassland, and greasewood flat. The primary vegetation community of one specific part of Smith Valley, the Alkali Lake WMA, is discussed below.

Alkali Lake Wildlife Management Area

The Alkali Lake WMA lies in the northernmost part of Smith Valley and is bordered by large areas of mixed salt desert scrub. The predominant feature of the WMA is a large playa area toward the north side. The playa is surrounded by emergent marsh on the south side and mixed salt desert scrub on the west, north, and east sides (Bull pers. comm.). Although there are several springs on the west side of the lake, the primary water sources for the WMA historically included agricultural tailwater from the surrounding fields and meadows and mountain runoff. However, these water sources have dwindled over the past 20 years as a result of limited precipitation, reduced snowmelt from the Pine Nut Mountains, and reduced agricultural tailwater caused by water conservation measures for agriculture. The WMA has only small dedicated water rights, and the lake level has gone down significantly. The lake typically is dry by the end of the summer (Bull pers. comm.).

Mainstem Walker River

At the confluence of the East and West Walker Rivers, the mainstem Walker River area is heavily agricultural (Chapter 7, Land Use and Agriculture) with vegetation along the river similar to that described for the West Walker River upstream of the confluence.

Between the Wabuska gage and Weber Reservoir, the Walker River supports a broad riparian and wetland corridor with mostly mixed salt desert scrub outside the corridor. Areas of greasewood flat, big sagebrush shrubland, semi-desert grassland, playa, and scattered dunes are intermixed with the desert scrub in this area.

Downstream from Weber Reservoir, the Walker River is buffered by a riparian corridor for several miles; agricultural land is also present for nearly 10 miles.

This land is bounded by greasewood flats, forbland, and mixed salt desert scrub. Developed areas occur in and around the town of Schurz on the Walker River Indian Reservation.

The vegetation in the study area surrounding Schurz and this part of the Walker River is primarily mixed salt desert scrub and greasewood flat, with emergent marsh along the river channel and some areas of invasive riparian and semi-desert grassland. Small areas of forbland, playa, and barren land are present. The section of Walker River immediately downstream of Schurz is deeply incised as a result of the historic lowering of the water level in Walker Lake (University of Nevada, Reno and Desert Research Institute. 2008). The area in the lowermost section of the river currently erodes in response to the ongoing drop in lake level. This part of the river is wide, shallow, braided, and has sandy substrate. The banks are lined with tamarisk, and a tamarisk eradication program, as described below in the Invasive Plants section, is currently underway (Wright pers. comm. 2008). For details about the tamarisk eradication program, see Chapter 14, Cumulative Impacts.

The primary vegetation communities of several specific parts of the mainstem Walker River basin are described below.

Mason Valley

Mason Valley includes the downstream parts of the East and West Walker Rivers and the mainstem Walker River to the area near the Wabuska gage. Agriculture is the dominant vegetation cover type on the east side of the Walker River (Chapter 7, Land Use and Agriculture), with mixed salt desert scrub outside the agricultural zone. Agricultural areas include irrigation canals and drains, some of which support riparian vegetation and native plant species (Bull pers. comm.). As mentioned for Smith Valley, irrigated pasture land can support patchy wetland vegetation in low-lying areas. West of the Walker River, the mixed salt desert scrub is adjacent to the riparian corridor. Areas of semi-desert grassland, big sagebrush shrubland, and greasewood flat are interspersed along the river corridor. Yerington and a smaller area south of Yerington and west of the river are mapped as developed open space. The Yerington Mine (Anaconda Copper Mine) pit is at the western edge of the study area. A mix of riparian and semi-desert grassland, with small areas of emergent marsh, forbland, and big sagebrush shrubland, occurs north of Yerington.

The northernmost part of Mason Valley is agriculture with adjacent areas of playa and greasewood flat, and is grazed by cattle. The Homestretch Geothermal property in this part of the valley includes a cooling pond system that was constructed for use in the energy conversion process. The 170ºF water from the geothermal units is cooled through a series of ditches and spray ponds then surface-discharged at two sites for wildlife habitat purposes. The ditches and ponds are open water areas with narrow bands of emergent wetland vegetation around the edges, and some ponds are used to grow algae (Homestretch Energy undated, Sapp 2007). One discharge site is on a playa located east of the power plant; this playa is located entirely on lands owned by Homestretch Geothermal. There are 360 acres available; the acres covered by discharge vary from approximately 40 acres in summer to approximately 80 acres in winter. The second discharge site is in a created wetland across U.S. Highway 95, also on privately owned lands. Hodges Transportation has approximately 100 acres available for Homestretch Geothermal discharge. How many acres are used depends on whether Hodges has constructed dikes in the area to leave the water in ponds or has allowed the water to run through sloughs into numerous ponds. Consequently, covered acreage may vary from 60 acres to 300 acres or more. Both of these sites are created wetlands, and neither Homestretch Geothermal nor the owner of the private land is under any obligation to continue to provide water to this area. It is expected that there is submergent vegetation in these wetlands.

Mason Valley Wildlife Management Area

Mason Valley WMA is located in the northeast section of Mason Valley. The WMA is a complex mosaic of open water, riparian, and emergent marsh with upland areas of greasewood flat, big sagebrush shrubland, semi-desert grassland, and mixed salt desert scrub. The WMA also has approximately 1,200 acres of agriculture farmed for wildlife habitat (Bull pers. comm.).

Weber Reservoir

Weber Reservoir is a broad open water area created by Weber Dam along the mainstem Walker River. At the upstream end of the reservoir the riparian community is interspersed with emergent marsh and semi-desert grassland. The surrounding area is mixed salt desert scrub, dunes, and greasewood flat.

Walker Lake

Walker Lake is a large, primarily open water area surrounded by mixed salt desert scrub with greasewood flat, basins, cliff and canyon, and playa along much of the lake edge. Areas of xeric mixed sagebrush shrubland, dune, Sierra cliff and canyon, and big sagebrush shrubland are scattered on the west side of the lake, with barren land, dune, and semi-desert shrub steppe on the east side.

Shallow parts of the lake support areas of widgeon grass (*Ruppia maritima*), an important food plant for waterfowl. On the south side of the lake an area of emergent marsh, vegetated primarily by cottonwood (*Populus fremontii*) and cattails, extends out from the lake edge for approximately 650 feet (Espinoza and Tracy 1999). This marsh is fed by freshwater springs, and a riparian area occurs beyond this marsh within the Hawthorne Army Depot boundary.

Special-Status Plants

Based on the search of the Nevada Natural Heritage Program (NNHP) database (2008), NNPS status lists (Nevada Native Plant Society 2008), the CNDDB (California Natural Diversity Data Base 2008), the CNPS Inventory (California Native Plant Society 2008), and the USFWS list (U.S. Fish and Wildlife Service 2007), 47 special-status plant species were identified as occurring in the project region, which generally includes the Walker River watershed (Table 4-2 and Figure 4-1). Five special-status species are recorded as occurring in or adjacent to the study area: Lavin eggvetch, Watson spinecup, Wassuk beardtongue, Reese River phacelia, and Mono County phacelia.

Lavin Eggvetch

Lavin eggvetch (*Astragalus oophorus* var. *lavinii*) is a perennial herb in the *Fabaceae* (pea family) and on the BLM Nevada special-status species list and the NNHP at-risk list. This species has not been thoroughly surveyed in Nevada but is known from Douglas and Lyon Counties, and possibly Mineral County in Nevada, as well as in California. It grows on dry, fairly barren areas on gravelly clay soils, usually on northeast- to southeast-facing slopes in pinyon-juniper or sagebrush communities. Lavin eggvetch blooms in late spring from May to June (Nevada Natural Heritage Program 2001).

Table 4-2. Special-Status Plants with Potential to Occur in the Walker River Acquisitions Program Study Area

Common and Scientific Name	Nevada Status[a]	Geographic Distribution/Floristic Province	Habitat Requirements	Blooming Period[b]	Potential for Occurrence in the Study Area
Bodie Hills rockcress *Arabis bodiensis*	A	Mineral County in NV, Wassuk Range, Brawley Peaks, and Bodie Hills; east of Sierra Nevada: Fresno, Inyo, Mono, and Tulare Counties in CA	Alpine boulder and rock field, Great Basin scrub, pinyon and juniper woodland, subalpine coniferous forest; 2,085–3,530 m	Jun–Jul	Recorded in the Walker River watershed, both California and Nevada
Tiehm's rock cress *Arabis tiehmii*	A	Northern high Sierra Nevada: Mount Rose area in the northern Carson Range, NV; near Tioga Crest in Mono County, CA	Granitic soils in alpine boulder and rock field; 2,970–3,590 m	Jul–Aug	Recorded in the California part of Walker River watershed
Cima milkvetch *Astragalus cimae* var. *cimae*	A	Mineral and Nye Counties in NV; eastern desert mountains in San Bernardino County, CA	Clay soils in pinyon-juniper woodland, Great Basin scrub, Joshua tree "woodland"; 890–1,850 m	Apr–May	Recorded in the Nevada part of Walker River watershed
Long Valley milkvetch *Astragalus johannis-howellii*	A	Mineral County, NV; east of Sierra Nevada in Mono County, CA	Sandy loam soils in Great Basin scrub, usually in swales near hot springs; 2,040–2,530 m	Jun–Aug	Recorded in the Walker River watershed, both California and Nevada
Lavin eggvetch *Astragalus oophorus* var. *lavinii*	A	Douglas, Lyon, and possibly Mineral Counties, NV; Bodie Hills in CA	Great Basin scrub, pinyon and juniper woodland; 2,450–3,050 m	Jun	Recorded in the Walker River watershed, both California and Nevada
Bodie Hills draba *Cusickiella quadricostata*	A	Douglas, Lyon, and Mineral Counties, NV; Mono County, CA	Great Basin scrub, pinyon and juniper woodland on clay soils or rocky areas; 2,000–2,800 m	May–Jul	Recorded in the Walker River watershed, both California and Nevada
Gray wavewing *Cymopterus cinerarius*	A	Esmeralda, Lyon, and Mineral Counties, NV, in Wassuk and Sweetwater Ranges; high Sierra Nevada in CA	Rocky slopes; 2,500–3,500 m	Jul–Aug	Recorded in the Walker River watershed, both California and Nevada
Lemmon buckwheat *Eriogonum lemmonii*	W	Churchill, Lyon, Pershing, Storey, and Washoe Counties, NV (endemic)	Shadscale scrub on bluffs and badlands; 1,280–1,650 m	May–Jun	Recorded in the Nevada part of Walker River watershed
Desert sunflower *Helianthus deserticola*	A	Churchill, Clark, Mineral, and possibly Lyon Counties, NV; not recorded in CA	Sand dunes, generally alkaline; 410–1,490 m	May–Jul	Recorded in the Nevada part of Walker River watershed

Common and Scientific Name	Nevada Status[a]	Geographic Distribution/Floristic Province	Habitat Requirements	Blooming Period[b]	Potential for Occurrence in the Study Area
Pine Nut Mountains ivesia *Ivesia pityocharis*	A	Douglas County, NV (endemic to Pine Nut Mountains)	Decomposed granite soils or sod in moist grasslands; 2,130–2,600 m	Jul–Sep	Recorded in the Nevada part of Walker River watershed
Oryctes *Oryctes nevadensis*	A	Churchill, Humboldt, Mineral, Pershing, Washoe, and possibly Esmeralda and Storey Counties, NV; Inyo County, CA	Sandy soils in chenopod scrub and Mojavean desert scrub; 1,100–2,535 m	Apr–Jun	Recorded in the Nevada part of Walker River watershed
Shevock's bristle moss *Orthotrichum shevockii*	W	Known from Kern, Mono, and Tulare Counties, CA	On granitic rock in Joshua tree woodland, pinyon and juniper woodland; 750–2,100 m	—	Recorded in the California part of Walker River watershed
Watson spinecup *Oxytheca watsonii*	W	Eureka, Lander, Mineral, and Nye Counties, NV; Inyo and Nevada Counties, CA	Sandy soils in Joshua tree "woodland" and Mojavean desert scrub; 1,200–2,000 m	May–Jul	Recorded in the Nevada part of Walker River watershed
Wassuk beardtongue *Penstemon rubicundus*	A	Douglas, Mineral, and possibly Esmeralda Counties, NV (endemic)	Rocky to gravelly soils in pinyon and juniper woodland, sagebrush, and shadescale scrub, usually recovering disturbed areas; 1,290–2,090 m	May–Sep	Recorded in the Nevada part of Walker River watershed
Reese River phacelia *Phacelia glaberrima*	W	Churchill, Lander, Lincoln, Mineral, and Pershing Counties, NV (endemic)	Alkaline clay soils in shadscale-greasewood scrub, sagebrush, and pinyon and juniper woodland; 1,220–1,830 m	May–Jun	Recorded in the Nevada part of Walker River watershed
Mono County phacelia *Phacelia monoensis*	A	Esmeralda, Lyon, and Mineral Counties, NV; Inyo and Mono Counties, CA	Clay soils in Great Basin scrub and pinyon and juniper woodland, often roadsides; 1,900–2,900 m	May–Jul	Recorded in the Walker River watershed, both California and Nevada
Mason's sky pilot *Polemonium chartaceum*	A	Esmeralda County, known only from near the summit of Boundary Peak in the White Mountains, NV; Inyo, Mono, Siskiyou, and Trinity Counties in CA	On serpentinite, granitic, or volcanic substrates in alpine boulder and rock field, subalpine coniferous forest, rocky areas; 1,800–4,200 m	Jun–Aug	Recorded in the California part of Walker River watershed

Common and Scientific Name	Nevada Status[a]	Geographic Distribution/Floristic Province	Habitat Requirements	Blooming Period[b]	Potential for Occurrence in the Study Area
Williams combleaf *Polyctenium williamsiae*	CE	Douglas, Lyon, Mineral, Nye, and Washoe Counties, NV; Lassen and Mono Counties, CA	Sandy, volcanic soils in Great Basin scrub, marshes and swamps, pinyon and juniper woodland, playas, vernal pools, lake margins; 1,347–2,700 m	Mar–Jul	Recorded in the Walker River watershed, both California and Nevada
Masonic Mountain jewelflower *Streptanthus oliganthus*	A	Esmeralda, Lyon, and Mineral Counties, NV; Inyo, Mono, and Tuolumne Counties, CA	Pinyon and juniper woodland, volcanic or granitic, rocky; 1,980–3,050 m	Jun–Jul	Recorded in the Walker River watershed, both California and Nevada

[a] Status explanations:

Note: No species listed, proposed for listing, or candidate species under the Federal ESA was found.

Nevada Status

CE = Critically endangered in Nevada

A = At risk list

W = Watch list

[b] Blooming period is based on the "most frequent survey months" listed in the Nevada Natural Heritage Program Rare Plant Fact Sheets (Nevada Natural Heritage Program 2001) for most species; for Tiehm's rock cress and Mason's sky pilot, blooming period is based on months given in the CNPS Inventory (2008).

Watson Spinecup

Watson spinecup (*Oxytheca watsonii*) is an annual herb in the *Polygonaceae* (buckwheat family) and is on the NNHP watch list. This species has not been thoroughly surveyed in Nevada but is known from Eureka, Lander, Mineral, and Nye Counties, as well as in California. Watson spinecup grows on dry sandy soils in desert scrub communities in association with saltbush species, greasewood, and spiny hopsage. It tolerates light disturbance and can occur on roadsides. Watson spinecup blooms from March to September (Nevada Natural Heritage Program 2001).

Wassuk Beardtongue

Wassuk beardtongue (*Penstemon rubicundus*) is a perennial herb in the *Scrophulariaceae* (figwort family) and on the NNHP at-risk list. It is endemic to Nevada and is known from Douglas, Mineral, and possibly Esmeralda Counties. This species grows on open, rocky to gravelly soils in recovering disturbed areas with adequate runoff, such as rocky slopes, drainage bottoms, roadsides, and recently burned areas. Wassuk beardtongue occurs in pinyon-juniper woodland, sagebrush, and cliff and canyon vegetation communities. This species blooms from late spring to summer in May to September (Nevada Natural Heritage Program 2001).

Reese River Phacelia

Reese River phacelia (*Phacelia glaberrima*) is a small annual herb in the *Hydrophyllaceae* (waterleaf family) and is on the NNHP watch list. It is endemic to Nevada and is known to occur in Churchill, Lander, Lincoln, Mineral, and Pershing Counties. This species grows on alkaline clay soils on sparsely vegetated or scree-covered slopes. It occurs in greasewood, sagebrush, pinyon-juniper woodland, and cliff and canyon vegetation communities. Reese River phacelia blooms in late spring from May to June (Nevada Natural Heritage Program 2001).

Mono County Phacelia

Mono County phacelia (*Phacelia monoensis*) is a small annual herb in the *Hydrophyllaceae* (waterleaf family) and is on the BLM Nevada and California special-status species lists and NNHP at-risk list. This species is known to occur in Esmeralda, Lyon, and Mineral Counties, as well as in California. Mono County phacelia grows on alkaline soils in areas that are sparsely vegetated to barren. It favors disturbed areas, including road berms in pinyon-juniper or sagebrush communities. Threats to this species include road construction and maintenance and mineral exploration and development. Mono County phacelia blooms in late spring from May to June (Nevada Natural Heritage Program 2001).

Noxious and Invasive Weeds

Noxious weeds are regulated by the Nevada Department of Agriculture, which maintains a list of noxious weeds in the state (Nevada Department of Agriculture 2008a) (Appendix 4B). Nevada has 30 weed management areas (see map in Appendix 4B) and nine weed districts (not all active) (Nevada Cooperative Weed Management Areas 2006). The Walker River watershed is identified as having noxious weed infestations (Nevada Department of Agriculture 2008b) and requires control of specific noxious weeds.

A noxious weed of high concern in riparian habitats in the Walker River Basin is tamarisk, also known as salt cedar. Reduction of tamarisk along the Walker River was the number one riparian weed goal cited by a special focus group, along with reducing other noxious weeds such as knapweed (University of Nevada, Reno 2001). Tamarisk consumes groundwater and can cause a lowering of the water table and drying of groundwater-fed surface water (Wiesenborn 1996). Tamarisk is also better adapted than native riparian vegetation to saline conditions and lowered water tables (Zouhar 2003). Current legislation has provided funds for tamarisk treatment, which are being used to treat tamarisk infestations along the mainstem Walker River upstream of Walker Lake and reduce its spread.

Perennial pepperweed (*Lepidium latifolium*), also called tall whitetop, is another noxious weed that invades many habitat types in the Walker River Basin, including pastures, agricultural fields, irrigation canals, and riparian areas (Morisawa 1999). Perennial pepperweed competes with native species, reduces biodiversity, and increases erosion potential in infested stream banks. Perennial pepperweed propagates quickly and is able to exploit nutrients under favorable soil moisture conditions.

Hoary cress (*Lepidium draba* ssp. *draba* [*Cardaria draba*]) is another noxious weed that colonizes disturbed areas and occurs in the Walker River Basin.

Invasive weeds have the ability to alter habitats and multiply rapidly, and are difficult to control. However, these weeds are not specifically regulated by the state of Nevada. Kochia (*Kochia scoparia*) and tumbleweed (*Salsola tragus*) are commonly found invasive weeds. Similar to noxious weeds, these species can increase potential for fire and soil erosion, and reduce crop value and yield. However, when flooded kochia can provide feed for migrating birds. Without suitable land management, native grass and shrub communities are extremely slow to re-establish on agricultural lands that have been taken out of cultivation, increasing the potential for these lands to become infested with kochia and tumbleweed (Langsdorf pers. comm.). Halogeton (*Halogeton glomeratus*) is another invasive weed that commonly colonizes disturbed areas (Bull pers. comm.).

Environmental Consequences

This section describes the impact analysis relating to vegetation and wetlands for the acquisition alternatives and No Action Alternative. It lists the criteria used to determine whether an impact would be adverse or beneficial.

Assessment Methods

The assessment of project impacts on vegetation and wetlands focuses on riparian and wetland habitat types located along water conveyances or on agricultural land in the study area. The only areas expected to experience a loss of wetland or riparian vegetation as a result of the acquisition alternatives or No Action Alternative are along water conveyances that currently support wetland or riparian vegetation or within agricultural wetlands. Upland areas not affected by agricultural operations are not expected to be affected by the acquisition alternatives or No Action Alternative and are not analyzed further.

For the purposes of this analysis, impacts relating to the spread of noxious weeds under the Purchase Alternative are based on a worst-case scenario (i.e., maximum acreages that could be retired or converted from active cultivation without weed control). It should be noted, however, that farmers could also continue agricultural practices through fallowing, growing low-water crops, or improving water efficiency, which could be done using less water. In addition, retired land could be brought back into agricultural use if access to water is re-established on the land through another source. Under Alternative 2, this issue would not occur because the water leases and potential cessation of active cultivation would be temporary.

Assumptions

The following assumptions informed the impact analysis for vegetation and wetlands.

- Impacts were based on the Partial Consumptive Use Scenario (i.e., acquisitions of 33% of the existing irrigated land in each of the three acquisition areas—Mason Valley, Smith Valley, and East Walker River area). This analysis is described in Chapter 2, Alternatives, and in Chapter 3, Water Resources.
- Both Alternative 1, which would permanently acquire water, and Alternative 2, which would lease water, would deliver an average additional inflow of 50,000 af/yr to Walker Lake with full project funding. Alternative 1 would provide the water permanently, and Alternative 2 would provide water until funding for a leasing program runs out. Alternative 3, which would implement water conservation and efficiency measures, is unlikely to provide the average inflow of 50,000 af/yr to

Walker Lake (see Chapter 3, Water Resources, for additional discussion of expected water deliveries).

- Individual water rights leases under Alternative 2 would be in effect for 1 to 3 years, after which properties would rotate out of the lease program. Alternative 2 could affect more properties over a larger area than Alternative 1 and impacts would occur over a shorter period of time.
- With full funding as much irrigated land would be involved in the implementation of Alternative 2 as in Alternative 1 in any given year.
- Changes in Walker River water flow upstream of the Wabuska gage as a result of the action alternatives would be within the range of existing variation. If acquired water is being moved downstream during peak flow events, the incremental increase in flow would be relatively small compared to existing peak flows and typically the augmented flow would be much less than historic peak flows (see Chapter 3, Impact WI-4 regarding flooding).
- Results from a University of Nevada/Desert Research Institute study on the effects of increased flows on river basin ecology could be used to develop recommendations for the management of water in the Walker River in order to minimize erosion and sediment transport and minimize degradation of the lower river (University of Nevada Reno and Desert Research Institute 2008).
- Under Alternatives 1 and 2, the magnitude of impacts on riparian vegetation in each part of the study area would be proportional to the proposed acquisitions or leases in each area (Chapter 7, Land Use and Agriculture; Table 7-10).
- Under any of the action alternatives, the potential increase in recreation as a result of increased Walker Lake elevations is not anticipated to affect plant species of special use to YPT, because there is little vegetation on most of the lake shore. See Chapter 11, Recreation, for the list of these plant species and a discussion of project impacts on recreation.
- Any impacts on vegetation or wetlands related to construction of the Homestretch Geothermal Pilot Project will be addressed in the EA for that project. The analysis for Alternative 1 assumes that the pilot project will be constructed and that no additional impacts from infrastructure construction or water delivery to Walker River would occur under Alternative 1. Water delivery begun under the pilot project, which would last for 5 years, would continue with exercise of the permanent option for purchase of the Homestretch Geothermal water.

Impact Criteria

Impacts on vegetation and wetlands would be considered adverse if implementation of the acquisition alternatives or No Action Alternative would:

- cause temporary or permanent removal, filling, grading, or disturbance of waters of the United States regulated under the Clean Water Act ;
- cause any loss of habitat that is sensitive or rare, such as native riparian woodland and shrubland, and wetlands;
- cause substantial loss of natural vegetation that is slow to recover;
- cause substantial loss of populations or habitat of a species that is
  - a Nevada state listed species,
  - regionally rare, or
  - otherwise so sensitive as to jeopardize the continued existence of the species in the region;
- cause substantial loss of diversity of species or natural communities;
- be incompatible with local, state, or federal land management plans; or
- spread or introduce noxious weed species into new areas within the project area.

Impacts on vegetation and wetlands would be considered beneficial if implementation of the acquisition alternatives or No Action Alternative would:

- increase habitat that is sensitive or rare in the region in question, such as native riparian woodland and shrubland, and wetlands;
- substantially increase populations or habitat of a species that is
  - a Nevada state listed species,
  - regionally rare, or
  - otherwise so sensitive as to jeopardize the continued existence of the species in the region; or
- substantially increase the diversity of species or natural communities;

Impacts

No Action Alternative

Under the No Action Alternative, no additional water would accrue to the Walker River to provide inflow to Walker Lake, and lake area and elevation would continue to decline and recede from wetlands at the south end of the lake. Because these wetlands are primarily spring fed, they would likely persist at lower lake elevations.

Farming practices in agricultural fields would continue to result in control of invasive and other weeds. Control of weeds in agricultural fields is also expected to reduce the spread of weeds in proximity to the agricultural fields and along conveyance ditches and drains.

Submergent vegetation in Walker Lake, consisting primarily of widgeon grass, has generally increased as water elevation has dropped and TDS concentration has increased. Initially, the continued decline of lake elevations under the No Action Alternative could cause an increase in widgeon grass wetlands, but also a corresponding loss of open water habitat. By 2200, the projected TDS concentration in Walker Lake would be approximately 39,500 mg/L (Chapter 3, Water Resources), which is above the tolerance of widgeon grass (Dineen 2001) and could ultimately result in the loss of widgeon grass in the lake.

Erosion of the area along Walker River below Schurz would continue, causing wetland and riparian communities along the river to decline further. Noxious weed invasion of riparian habitat in the lower Walker River, particularly the establishment of tamarisk, would likely increase as a result of the increased salinity and erosion and lowered groundwater table expected to occur under the No Action Alternative. These would be adverse impacts in these areas.

Alternative 1 (Purchase Alternative)

Water rights acquired under Alternative 1 are expected to add an average of 50,000 af/yr to Walker Lake. It is possible, however, that less than the average 50,000 af/yr would be provided to the lake either because of funding issues or because there would not be enough willing sellers. With funding of $56 million, it is estimated that the annual average inflow to the lake would increase by 7,300 af.

This analysis of impacts under Alternative 1 assumes that the Purchase Alternative would be fully funded and that water rights acquired would increase the average inflow to the lake by 50,000 af/yr. Unless otherwise noted, if the full amount of water rights were not acquired, the impacts would be similar in nature (i.e., adverse, minor, beneficial, or no impact) but of less magnitude.

Direct Impacts

Alternative 1 would not result in any construction activities or ground disturbance as part of the proposed water rights acquisitions. Because no direct disturbance is proposed under this alternative, no direct impact on vegetation and wetlands attributable to acquisitions of land or water rights is anticipated.

Indirect Impacts

Riparian and Wetland Impacts

Impact VEG-1. Loss of Wetland Communities at Alkali Lake WMA Caused by Potential Acquisitions in Smith Valley (Adverse Impact)
Acquisitions of irrigated agricultural land adjacent to Alkali Lake WMA would result in the reduction of water delivery to the area and subsequent reduction of

tailwater that reaches Alkali Lake. The reduction and potential eradication of playa wetland habitat supported by this water source would be an adverse impact.

Impact VEG-2. Loss of Riparian and Wetland Habitat Associated with Irrigation Canals and Drains Caused by Decreased Water Flow (Minor Impact)
Acquisition of irrigated agricultural land could result in the reduction or cessation of water transport in associated irrigation canals and drains. The loss of water transport could cause the loss of riparian and wetland habitat in and adjacent to the existing irrigation canals and drains.

Although some irrigation supply canals in Mason Valley and Smith Valley support native species (Bull pers. comm.), riparian habitat supported by irrigation features generally has lower habitat value in comparison to riparian communities along natural streams because it is narrow and patchy and is more likely to support nonnative and invasive plant species, such as tamarisk. Existing riparian areas that are dominated by tamarisk would be more likely to persist under low flow conditions than native riparian vegetation. Tamarisk is a facultative phreatophyte (not solely reliant on groundwater) and is more tolerant of reductions in surface water and groundwater levels than are native riparian or marsh community types. Nevertheless, based on available vegetation mapping (Figure 4-11), minimal amounts of riparian woodland occur outside of the river corridor in the study area in comparison to the extent of riparian habitat along the West Walker, East Walker, and mainstem Walker Rivers. Therefore, the projected potential loss of native riparian habitat along irrigation canals would be relatively small. Moreover, because of regular maintenance of canals and drains by burning or cutting vegetation, many canals and drains support little riparian or wetland habitat (Langsdorf pers. comm.).

This impact would be offset to some extent by an increase in riparian habitat along the mainstem Walker River that is expected with increased flows, as described in Impact VEG-6. The amount of the increase would be affected by land management techniques along the mainstem. Loss of riparian vegetation along canals and drains would result in a local decline of this habitat, but no net loss is anticipated for the project as a whole, if the average 50,000 af/yr is supplied to Walker Lake. Therefore, this would be a minor impact.

Impact VEG-3. Loss of Wetlands at South End of Walker Lake Caused by Increased Lake Surface Elevation (Minor Impact)
Although most of the shoreline is unvegetated, a marsh wetland area occurs at the southeast end of the lake. This wetland area is fed by several springs and formed as a result of the decline in lake elevation. Because the area is subject to the seasonal and annual variation of inflow to the lake, it is not a stable feature. The proposed acquisitions in the Walker Basin would increase water delivery to Walker Lake and, if the Purchase Alternative is fully funded, the additional average inflow of 50,000 af/yr would raise the lake surface elevation (see additional detailed discussion in Chapter 3, Water Resources). The higher lake elevation would then inundate wetland habitat and possibly the springs that feed

into the wetland at the southeast lake edge. Wetland communities are rare, and loss would add to the decline of this community type and the diversity of natural communities in the area. This impact would be indirectly offset to some extent by an increase in wetland habitat along the mainstem Walker River that is expected with increased flows (Impact VEG-6). In addition, the higher lake surface elevation would return this area to its natural condition. This would be a minor impact.

If the Purchase Alternative is not fully funded, the lake surface elevation would continue to drop, and the wetland would receive less water from the lake. However, this wetland is primarily springfed from groundwater (Espinoza and Tracy 1999) and is not fully dependent on water from Walker Lake. It is anticipated that while there could be a short-term impact, the wetland would ultimately re-establish and there would be no net loss of wetlands in this area. This would be a minor impact.

Impact VEG-4. Loss of Submergent Wetlands in Walker Lake Caused by Increased Lake Surface Elevation (Minor Impact)

Submergent wetland vegetation, primarily widgeon grass, is present in shallow water areas of Walker Lake. As the lake surface elevation increases, water depths would be expected to increase beyond the depths in which widgeon grass can grow. The eastern shore of Walker Lake is a gradual slope in the area that could become inundated. As the lake elevation rises, new shallow water areas would be created. This process would occur slowly as the water inflow increases and would allow adequate time for the widgeon grass to establish in the new shallow waters, offsetting the loss of the existing vegetation. It is anticipated that while there could be a short-term impact, the vegetation would ultimately re-establish and there would be no net loss of submergent wetland vegetation in this area. This would be a minor impact.

Impact VEG-5. Loss of Wetland Communities in Irrigated Lands Caused by Curtailed Irrigation (Minor Impact)

Wetlands can occur on irrigated pasture land that has not been laser-leveled. Wetlands in these pasture areas are artificially created by the presence of irrigation water, generally disturbed by agricultural practices, and likely to support nonnative species. As a result of these factors, these areas are of lower habitat quality than naturally occurring wetlands. Although too small for the minimum map unit size on the vegetation community figure (Figure 4-1), wetland vegetation that relies on irrigation water can occur in low-lying parts of agricultural fields and along the field edges. Reducing or eliminating irrigation would cause wetlands to dry up and the vegetation community to return to a more natural upland type or possibly noxious weed communities. This impact might be avoided on properties where irrigation and agricultural cultivation would continue from an alternative source (e.g., as anticipated on Option 1 Masini Investments and L&M Ltd Partnership properties).

Although wetland communities are generally rare, the loss of artificially created wetlands dominated by nonnative species would be of less concern than loss of natural wetlands. In addition, this impact would be indirectly moderated to some extent by enhanced wetland habitat along the mainstem Walker River with increased flows, as described in Impact VEG-6. This would be a minor impact.

Impact VEG-6. Increase in Riparian and Wetland Habitat along the Mainstem Walker River Downstream from Schurz as a Result of Increased Flow (Beneficial)
Acquisitions to increase flows to Walker Lake would pass through the mainstem Walker River. Although flows would begin to increase at the highest upstream acquisitions, the greatest percent increase in flow would be in the downstream part of Walker River between Schurz and the lake, where summer flows can drop to zero. That reach of the river is bordered primarily by shrublands (greasewood flat and mixed salt desert scrub) and agricultural land, with emergent marsh along the river channel and some areas of invasive riparian and semi-desert grassland.

In the Walker River downstream of Schurz, increased flows to Walker Lake would help establish and sustain riparian and wetland vegetation, which, depending on the actual flows that result, may help to stabilize the lower portion of the Walker River and reduce erosion in that area. The increased flow would also contribute to an increase in natural community diversity. Depending on the timing of flow, the depth to groundwater or river stage, and the soil conditions, the increased flow could favor the establishment of native riparian trees such as cottonwood and willow. In addition, increased flows may improve habitat quality along the Walker River and provide suitable locations for special-status plants to establish. This would be a beneficial impact.

This beneficial impact would be commensurate with the level of funding. If Alternative 1 does not receive full funding and the average 50,000 af/yr of water, the river channel would not be expected to stabilize completely and the potential area for establishment of riparian and wetland communities would be smaller.

Special-Status Plant Impact

Impact VEG-7. Loss of Special-Status Plants Caused by Changes in Hydrology (No Impact)
No special-status plant species is expected to be affected by Alternative 1. Acquisitions in the Walker Basin would increase flows to Walker Lake, and those flows would pass through the mainstem Walker River. No special-status plant species is known to occur near the Walker Lake shoreline; therefore, no impacts on special-status plants are anticipated in this area. Alteration of existing hydrology in the mainstem Walker River may change the vegetation types and habitat for some special-status plants.

Three special-status plant species (Wassuk beardtongue, Reese River phacelia, and Watson spinecup) are documented in the area of the Walker River between

Weber Reservoir and Walker Lake. These species grow in upland habitats, which would be unaffected.

Lavin eggvetch is a special-status plant documented in the West Walker River area and in southern Smith Valley. Although water rights acquisitions are planned for the Smith Valley area, Lavin eggvetch grows in scrub and woodland communities that would not be affected by changes in hydrology as a result of Alternative 1.

Mono County phacelia is a special-status plant documented in the East Walker River area near the Nevada/California border. This species is located outside of the area that would be affected by acquisition of water rights. In addition, Mono County phacelia grows in upland areas away from the river or irrigation canals and would not be affected by Alternative 1.

The five special-status species documented in the study area occur in upland habitats. It is unlikely that Alternative 1 would affect these habitats or the known locations of special-status plants. There would be no impact on any special-status species under this alternative.

Noxious Weed Impacts

Impact VEG-8. Spread of Noxious and Invasive Weeds Caused by Reduction of Irrigated Agricultural Land (Adverse Impact)

Acquisitions involving irrigated agricultural land could result in the conversion or retirement of agricultural land. Although the NRS require landowners or occupants to control noxious weeds (Chapter 555 sections .005–.217), loss of active cultivation without weed control could result in establishment of noxious weeds in these areas and/or higher soil erosion if vegetation is sparse. Common invasive weeds that establish in areas where natural vegetation has been removed for development or agriculture include kochia, tumbleweed, and halogeton (Langsdorf pers. comm., Bull pers. comm.).

Some noxious weed species regulated under NRS 555.005-.217 spread via water conveyance in irrigation canals and drains, and reduced irrigation may reduce the transmission of some noxious weed species. However, the reduction or elimination of water from canals and drains could also result in establishment of noxious weed species that thrive in disturbed upland habitats. In general, the spread or introduction of noxious and invasive weed species to lands in the study area would be an adverse impact.

This adverse impact would be commensurate with the level of funding. If Alternative 1 does not receive full funding and deliver an average of 50,000 af/yr of water, less agricultural land would likely be converted or retired, providing a lower potential for the spread or introduction of invasive and noxious weed species in the project area.

Impact VEG-9. Spread of Tamarisk Caused by Increased Flow in Walker River (Minor Impact)

Increased flows to Walker Lake would pass through the mainstem Walker River, providing a water source for establishment of riparian vegetation, which could include tamarisk, a noxious weed regulated under NRS 555.005-.217. Tamarisk is present in some riparian areas, particularly areas mapped as invasive southwest riparian woodland and shrubland. The area between Schurz and Walker Lake is colonized by weeds and tamarisk. The type of vegetation that would become established in these areas depends on two factors: timing of flow and the depth to groundwater or river stage relative to exposed sediments.

If the timing of flows in lower Walker River is controlled to reach a low point and expose sediment during seed dispersal season in early summer for cottonwood or willow, those species are likely to become established (Zouhar 2003). However, if flows are low and sediment is exposed during the fall, tamarisk is likely to persist as the dominant vegetation. Increased flows resulting from the fully funded Alternative 1 are not expected to be at low levels during the irrigation season, which occurs from March through October, and may not obviously favor either the native riparian species or tamarisk. The flow regime likely would follow this pattern, because storage in Weber Reservoir limited and substantial releases are required in average and wet years. To the extent that there is available storage capacity in the reservoir, it may be possible to store acquired water in early summer and benefit riparian resources, subject to applicable operating criteria. See Hydrologic Change HC-3 in Chapter 3, Water Resources, for additional details of expected flows between Schurz and Walker Lake.

If groundwater and river levels drop too far below the root zone of cottonwoods and willows, plant mortality would begin to occur, opening gaps for tamarisk and other species to establish. However, depth to groundwater is expected to decrease and river stage is expected to increase as a result of Alternative 1, favoring the survival of cottonwoods and willows if these species become established. In addition, flood flows late in the growing season and prolonged inundation may increase tamarisk mortality (Zouhar 2003).

Alternative 2 (Leasing Alternative)

Because Alternative 2 involves water leases, the proposed action would be temporary and continue only until the funding is exhausted. Assuming that sufficient water is leased to increase inflow to Walker Lake by an average of 50,000 af/yr, the funding of $56 million is estimated to last 3 years and full funding would last an estimated 20 years.

Some of the impacts of Alternative 2 (both adverse and beneficial) would be similar to those of Alternative 1, but temporary, of less magnitude, or both.

Direct Impacts

Alternative 2 would not result in any construction activities or ground disturbance as part of the proposed water leases or land acquisitions. Because no direct disturbance is proposed under this alternative, no direct impacts on vegetation and wetlands attributable to water leases or land acquisitions are anticipated.

Indirect Impacts

The following impacts under Alternative 2 would be similar to the impacts under Alternative 1, but temporary:

Impact VEG-1 Loss of Wetland Communities at Alkali Lake WMA Caused by Potential Acquisitions in Smith Valley (Adverse Impact)

Impact VEG-3 Loss of Wetlands at South End of Walker Lake Caused by Increased Lake Surface Elevation (Minor Impact)

Impact VEG-4 Loss of Submergent Wetlands in Walker Lake Caused by Increased Lake Surface Elevation (Minor Impact)

Impact VEG-6 Increase in Riparian and Wetland Habitat along the Mainstem Walker River Downstream from Schurz as a Result of Increased Flow (Beneficial Impact)

This impact would be of less magnitude with funding of $56 million only because the habitat that does establish in 3 years would be less mature and of a lesser extent than the habitat supported for 20 years.

Impact VEG-9 Spread of Tamarisk Caused by Increased Flow in Walker River (Minor Impact)

The following impacts under Alternative 2 would be similar to the impacts under Alternative 1, but temporary and of less magnitude:

Impact VEG-2 Loss of Riparian and Wetland Habitat Associated with Irrigation Canals and Drains Caused by Decreased Water Levels (Minor Impact)

Impact VEG-5 Loss of Wetland Communities within Irrigated Lands Caused by Curtailed Irrigation (Minor Impact)

The following impact of Alternative 2 differs from that of Alternative 1 in other important ways:

Impact VEG-8 Spread of Noxious and Invasive Weeds Caused by Reduction of Irrigated Agricultural Land (No Impact)
Impact VEG-8 is unlikely to occur under Alternative 2 because the agricultural land would be out of cultivation only temporarily. It would not be in a landowner's interest to allow invasive and noxious weeds to establish. In addition, landowners could lease a portion of their water rights and rotate fields or otherwise reduce the level of cultivation to accommodate less water use. NRS require landowners or occupants to control noxious weeds (Chapter 555, sections .005–.217).

Alternative 3 (Efficiency Alternative)

As discussed in Chapter 3, Water Resources, full implementation of Alternative 3 could yield an average additional inflow of 32,300 af/yr.

The following impacts of Alternative 3 would be similar to those of Alternative 1:

Impact VEG-1 Loss of Wetland Communities at Alkali Lake WMA Caused by Potential Acquisitions in Smith Valley (Adverse Impact)

Impact VEG-4 Loss of Submergent Wetlands in Walker Lake Caused by Increased Lake Surface Elevation (Minor Impact)
The following impacts of Alternative 3 would be similar in nature to those of Alternative 1, but of less magnitude:

Impact VEG-3 Loss of Wetlands at South End of Walker Lake Caused by Increased Lake Surface Elevation (Minor Impact)

Impact VEG-6 Increase in Riparian and Wetland Habitat along the Mainstem Walker River Downstream from Schurz as a Result of Increased Flow (Beneficial Impact)

Impact VEG-7 Loss of Special-Status Plants Caused by Changes in Hydrology (No Impact)

Impact VEG-9 Spread of Tamarisk Caused by Increased Flow in Walker River (Minor Impact)
The following impacts of Alternative 3 differ from those of Alternative 1 in other important ways:

Impact VEG-2 Loss of Riparian and Wetland Habitat Associated with Irrigation Canals and Drains Caused by Decreased Water Levels (No Impact)
Impact VEG-2 would not apply to Alternative 3 because there would be no acquisition or lease that would reduce water transportation in canals and drains. Loss of habitat could occur through other mechanisms discussed in Impacts VEG-10 and VEG-11.

Impact VEG-5 Loss of Wetland Communities within Irrigated Lands Caused by Curtailed Irrigation (No Impact)
Impact VEG-5 would not occur under Alternative 3 because water delivery to irrigated fields is not expected to cease. Loss of wetland habitat could occur through other mechanisms discussed in Impact VEG-12.

Impact VEG-8 Spread of Noxious and Invasive Weeds Caused by Reduction of Irrigated Agricultural Land (Adverse Impact)
Impact VEG-8 would not apply to Alternative 3 because there would be no reduction of irrigated lands.

Direct Impacts

Impact VEG-10. Loss of Riparian and Wetland Habitat along Irrigation Canals and Drains Caused by Construction Activities Associated with System Efficiency Measures (Adverse Impact)
System efficiency measures could include lining canals with concrete; replacing canals with underground pipelines; consolidating surface conveyances in the Mason and Smith Valleys, which would involve construction of new facilities; consolidating diversion works; and removing vegetation in or along ditches and canals. Any of these measures would result in direct, site-specific impacts, including filling, grading, or disturbance of existing wetlands and removal of wetland and riparian vegetation for construction or control of phreatophytes (plants that obtain water from groundwater).

Irrigation canals in the study area could include features that were once natural streams as well as features that were wholly constructed in uplands. Natural streams could potentially qualify as waters of the United States, which are under Corps jurisdiction. Because of the varied circumstances for canals in the study area, the determination of Corps jurisdiction for individual canals would be made on a case-by-case basis under the current guidance for Clean Water Act jurisdiction (U.S. Environmental Protection Agency and U.S. Army Corps of Engineers 2008). Similarly, drains in the study area that return water to the Walker River could be under jurisdiction of the Corps, but final determinations would be made on a case-by-case basis. Placement of fill in irrigation canals or drains that are classified as waters of the United States would require a CWA Section 404 permit. Placement of fill in irrigation canals or drains that are not waters of the United States could still result in loss of ecological functions such as groundwater recharge and wildlife habitat.

Loss of riparian and wetland habitat would be offset to some degree by the increase in riparian and wetland habitat along the mainstem Walker River that would be anticipated with increased flows, as described in Impact VEG-6. However, because more land could potentially be affected under Alternative 3 than under Alternatives 1 or 2, and less water would be expected to reach the mainstem of Walker River, a net loss of riparian and wetland habitat could result under this alternative, although the magnitude is uncertain. Because this impact would directly result in the permanent removal, filling, grading, or disturbance of waters of the United States and/or non-jurisdictional wetlands and woody riparian vegetation, it would be an adverse impact.

Indirect Impacts

Impact VEG-11. Loss of Riparian Habitat along Irrigation Canals and Drains Caused by Decreased Flows Due to System Efficiency Measures (Minor Impact)
System efficiency measures would result in decreased subsurface flow and probable loss of riparian vegetation adjacent to the canals (Walker River Basin Advisory Committee 2000). Riparian habitat supported by irrigation features has generally lower habitat value than riparian communities along natural streams and is also more likely to support nonnative species and potentially invasive species, such as tamarisk. In Mason Valley and Smith Valley, however, some irrigation supply canals support native species such as coyote willow, cattail, and bulrush (Bull pers. comm.).

This indirect impact would be offset by an increase in riparian habitat along the mainstem Walker River with increased flows, as described in VEG-6. Loss of riparian vegetation along ditches would result in a local decline of this habitat, but no net loss is anticipated. Because the loss would be primarily of low quality riparian habitat and no net loss is anticipated, this would be a minor impact.

Impact VEG-12. Loss of Wetland Communities within Irrigated Lands Caused by On-Farm Efficiency Measures (Minor Impact)
Implementation of on-farm conservation and efficiency measures that could make water available for purchase and subsequent movement to Walker Lake would result in loss of wetlands on those agricultural parcels. Irrigation provides the water source for wetlands that can occur within irrigated agricultural areas. Although too small for the minimum map unit size on the vegetation community figure (Figure 4-1), wetland vegetation that relies on irrigation water can occur in low-lying parts of agricultural fields and along the field edges. Decreased irrigation could cause these wetlands to dry up, and the vegetation community could transition to an upland type, establish undesirable vegetation, or become infested with noxious weeds. Alternatively, vegetation could die back as a result of the lack of irrigation, and topsoil could erode from the site, making revegetation difficult. While high quality wetlands can occur on agricultural land, wetlands in habitat adjacent to canals and drains are likely to support more nonnative species than naturally occurring or designed and managed wetlands and, therefore, are of lower habitat quality. Although wetland communities are generally rare, and loss would add to the decline of this community type and the diversity of natural communities in the area, the loss of wetlands dominated by nonnative species would be a less important impact. In addition, this impact would be indirectly moderated by increased wetland habitat along the mainstem Walker River with increased flows, as described in VEG-6. Therefore, the loss of some on-farm wetland habitat would be a minor impact.

Chapter 5 Biological Resources—Fish

Chapter 5 Biological Resources—Fish

Introduction

This chapter describes the affected environment for fish species (including special-status species) and fish habitat in the study area and the potential impacts on fish species and habitat that would result from the acquisition alternatives and the No Action Alternative.

Impacts on fish species in the study area would be beneficial as a result of the increased water flow in the mainstem Walker River and increased inflow to Walker Lake. Water quality indicators such as TDS concentration would be improved, increasing survival of LCT and tui chub, the only fish species present in Walker Lake. Temporary construction impacts of Alternative 3 would be minimized by a stormwater pollution prevention plan (SWPPP) and other BMPs that would reduce release of sediment and contaminants into Walker River.

Sources of Information

The key sources of data and information used in the preparation of this chapter are listed below. Full references can be found in Chapter 17, References.

- The Walker Basin, Nevada and California: Physical Environment, Hydrology, and Biology (Sharpe et al. 2008)
- Lahontan Cutthroat Trout, *Oncorhynchus clarki henshawi*, Recovery Plan. (U.S. Fish and Wildlife Service 1995)
- Short-Term Action Plan for Lahontan Cutthroat Trout (*Oncorhynchus clarki henshawi*) in the Walker River Basin. (Walker River Basin Recovery Implementation Team 2003)

Affected Environment

This section describes the environmental setting related to fish resources, including special-status fish species, and fish habitat in the study area. Although the project area is the entire Nevada portion of the Walker River Basin (Chapter 1), the study area for fish species and their habitat includes the Nevada portions of the East and West Walker Rivers and the mainstem Walker River, up to and including Weber Reservoir and Walker Lake. The discussion focuses on Walker Lake and the mainstem Walker River upstream of Weber Dam.

Habitat Conditions, Fish Species Composition, and Distribution in the Walker River Basin

Table 5-1 lists fish species observed in the Walker River Basin, along with their associated habitats. Nonnative species are stocked (historically and/or currently) in the reservoirs of the Walker River Basin and also the rivers.

Irrigation diversions, dams, berms, and levees have been constructed throughout the Walker River Basin. Many of these structures fragment the basin and act as complete or partial barriers to fish migration, limiting the ability of adults, juveniles, and fry to migrate to required habitats (Deacon and Minckley 1974, Behnke 1992). Fry and juveniles may be injured or killed during downstream migration and passage over obstructions. When access to spawning areas is limited, fish may spawn in and use suboptimal habitats.

Natural channel formation results in more complex habitat features such as pools, riffles, meandering channels, different sizes of gravel substrate, and riparian vegetation. Healthy, intact riparian zones provide hydraulic diversity, add structural complexity, buffer the energy of runoff events and erosive forces, moderate temperatures, and provide a source of nutrients (Harris 1989). Riparian zones provide cover for fish species in the form of woody debris (Triska 1984).

Regulated flow in the Walker River Basin has disrupted the natural channel-forming processes that create and maintain river and stream habitats. Flows diverted for agriculture and releases of water during months when natural precipitation and runoff would not occur disrupt channel processes, resulting in channelization (straight channel). The river downstream of Weber Reservoir is braided and shallow. The reduction or elimination of upstream riparian vegetation results in excessive erosion (Walker River Basin Recovery Implementation Team 2003). The introduction of nonnative plant species has disrupted hydrologic processes. The combined effects of these actions result in a loss of habitat required to sustain a diverse community of native fish and invertebrate species (Gerstung 1988, Hicks et al. 1991, Behnke 1992, Church 1995).

West Walker River

The headwaters of the West Walker River lie east of the Sierra Nevada crest just south of Sonora Pass, California, and originate from Kirkwood and Tower Lakes. Four of the six remaining LCT populations in the Walker River Basin are found in the West Walker River tributaries of Slinkard Creek, Silver Creek, Mill Creek, and Wolf Creek (Sharpe et al. 2008).

Other native fish species occurring in the West Walker River include mountain whitefish, Lahontan redside, Lahontan speckled dace, Tahoe sucker, Lahontan mountain sucker, Paiute sculpin, and Lahontan tui chub (Stockwell 1994).

Table 5-1. Fish Species of the Walker River Basin

Species	Scientific Name	Native or Introduced	Abundance	Current Distribution	Habitat
Lahontan cutthroat trout	*Oncorhynchus clarki*	Native	Uncommon /Stocked	Walker River, Walker Lake	River type fish: pools with cover (instream woody material, undercut banks) and velocity breaks, and riffle-run habitats with clear water and rocky substrate (U.S. Fish and Wildlife Service 1995, 19). Lake fish: water temperatures less than 22°C, pH values of 6.5 to 8.5, TDS concentrations less than 11,000 mg/l, and dissolved oxygen concentrations greater than 8 mg/l (Moyle 2002, 290).
Lahontan tui chub	*Siphateles bicolor*	Native	Common	Walker River, Walker Lake	Quiet alkaline water with well-developed aquatic vegetation and fine substrate. Summer temperatures in excess of 20°C (Moyle 2002, 124).
Lahontan redside	*Richardsonius egregius*	Native	Uncommon	Walker River	Pools and slow riffles and alkaline lakes. Swim close to the surface during summer months and in the winter descend to lake bottoms in deep water (Moyle 2002, 135).
Lahontan speckled dace	*Rhinichthys osculus robustus*	Native	Unknown	Walker River	Clear, well-oxygenated water, with abundant cover such as woody debris, submerged aquatic plants, and moving water from stream currents, springs, or wave action (Moyle 2002, 162).
Tahoe sucker	*Catostomus tahoensis*	Native	Common	Walker River	Abundant in natural lakes. Also inhabit small streams with pools and runs and heavy cover. Can be found in waters exceeding 25ºC in the summer (Moyle 2002, 192).
Lahontan mountain sucker	*Catostomus platyrhynchus*	Native	Uncommon	Walker River	Clear streams with moderate gradients and substrate of rubble, sand, or boulders. Also live in large rivers and turbid streams. Found in waters ranging from 1-28ºC (Moyle 2002, 180).
Mountain whitefish	*Prosopium williamsoni*	Native	Unknown	Walker River	Clear, cold streams with large pools and mountain lakes. Can be found in summer water temperatures of 11-21 ºC (Moyle 2002, 244).

Species	Scientific Name	Native or Introduced	Abundance	Current Distribution	Habitat
Paiute sculpin	*Cottus beldingi*	Native	Uncommon	Walker River	Clear, cold mountain streams (< 20ºC) with shallow, rocky riffles, in association with trout (Moyle 2002, 358).
Rainbow trout	*Oncorhynchus mykiss*	Introduced	Common/ Stocked	Walker River	Well-oxygenated, cool, riverine habitat with water temperatures from 7.8 to 18°C (Moyle 2002). Habitat types are riffles, runs, and pools.
Smallmouth bass	*Micropterus dolomieu*	Introduced	Common/ Stocked	Walker River, Weber Reservoir	Large, clear lakes and clear rivers with abundant cover and summer water temperatures 20-27ºC (Moyle 2002, 402).
Largemouth bass	*Micropterus salmoides*	Introduced	Common/ Stocked	Walker River, Weber Reservoir	Warm, shallow, low-velocity waters of moderate clarity and dense aquatic plants. Optimal temperatures of 25-30 ºC (Moyle 2002, 398).
Sacramento perch	*Archoplites interruptus*	Introduced	Unknown	Weber Reservoir	Lakes and reservoirs. Associated with aquatic vegetation and submerged objects. Prefer summer water temperatures range from 18-28ºC (Moyle 2002, 378).
Brown trout	*Salmo trutta*	Introduced	Common/ Stocked	Walker River	Medium to large slightly alkaline streams with riffles and large, deep pools. Prefer water temperatures of 12 to 20°C (Moyle 2002, 294).
Mosquitofish	*Gambusia affinis*	Introduced	Uncommon	Walker River	Many habitats. Can tolerate high water temperatures (up to 35ºC), various salinities, and low dissolved oxygen (Moyle 2002, 318).
Yellow perch	*Perca flavescens*	Introduced	Common/ Stocked	Weber Reservoir	Lakes associated with heavy growth of aquatic plants. Prefer warm water (22-27ºC) and can tolerate low dissolved oxygen concentrations (Moyle 2002, 412).
Black crappie	*Pomoxis nigromaculatus*	Introduced	Common/ Stocked	Weber Reservoir	Large warmwater lakes and reservoirs with water temperatures up to 29ºC. Associate with large submerged objects (Moyle 2002, 396).

Species	Scientific Name	Native or Introduced	Abundance	Current Distribution	Habitat
White crappie	*Pomoxis annularis*	Introduced	Common/ Stocked	Weber Reservoir	Warm, turbid lakes and reservoirs. Can tolerate high turbidity, alkaline water, high temperatures (up to 31ºC), and lack of aquatic vegetation and cover (Moyle 2002, 394).
Black bullhead	*Ameiurus melas*	Introduced	Common/ Stocked	Walker River, Weber Reservoir	Ponds, small lakes, river backwaters, sloughs, and pools of low-gradient streams with slow currents, warm turbid water (35ºC), and muddy bottoms (Moyle 2002, 209).
Brown bullhead	*Ameiurus nebulosus*	Introduced	Unknown	Walker River	Low velocity, low-gradient reaches with deep pools, high turbidity and aquatic vegetation. Optimum water temperatures of 20-33 ºC (Moyle 2002, 211).
Channel catfish	*Ictalurus punctatus*	Introduced	Common/ Stocked	Weber Reservoir	Main channels of large streams and in reservoirs. Optimal water temperatures are 24-30ºC (Moyle 2002, 216).
White catfish	*Ameiurus catus*	Introduced	Common/ Stocked	Weber Reservoir	Reservoirs in water temperatures exceeding 20ºC (Moyle 2002, 215).
Bluegill	*Lepomis macrochirus*	Introduced	Common/ Stocked	Weber Reservoir	Warm, shallow lakes, reservoirs, ponds, streams, and sloughs at low elevations. Associated with aquatic plants and substrate of silt, sand, or gravel. Optimal water temperature is 27-32ºC. (Moyle 2002, 382).
Green sunfish	*Lepomis cyanellus*	Introduced	Common/ Stocked	Weber Reservoir	Lakes and reservoir edges in shallow, weedy areas. Optimal water temperature is 26-30ºC (Moyle 2002, 390).
Asiatic/common carp	*Cyprinus carpio*	Introduced	Common/ Stocked	Walker River, Weber Reservoir	Eutrophic lakes, reservoirs, and sloughs with silty bottoms and submergent and emergent aquatic vegetation. Active in water temperatures of 4-24ºC. (Moyle 2002, 173).

Nonnative species such as common carp, largemouth bass, brown trout, rainbow trout, and others occur in the West Walker River (Sada 2000).

South of the town of Walker, the river channel becomes a network of boulders in the constraints of the Walker River canyon. This reach of the river was reconstructed by the U.S. Army Corps of Engineers (Corps) after the 1997 flood. Water is diverted from the main river channel downstream into Topaz Lake Reservoir. From Topaz Lake Reservoir, the West Walker River is predominantly bordered by sagebrush shrub-scrub and irrigated agricultural fields and flows through Smith Valley, Wilson Canyon, and Mason Valley. The West Walker River and East Walker River join in Mason Valley to form the mainstem Walker River (Sharpe et al. 2008).

East Walker River

The East Walker River originates in the Sierra Nevada above Twin Lakes outside of Bridgeport, California. LCT occurs in By-Day Creek Reservoir and in Murphy Creek, approximately 4 miles downstream of Bridgeport Reservoir. Nonnative rainbow trout and brown trout from the Mason Valley Fish Hatchery are stocked in the East Walker River (Sharpe et al. 2008).

Downstream of Bridgeport Reservoir, the river is lined with high desert riparian woodland habitat and supports mountain whitefish, Lahontan redside, speckled dace, Tahoe sucker, Lahontan mountain sucker, tui chub, and nonnative species such as common carp, brown trout, and rainbow trout (Sada 2000).

Mainstem Walker River

The mainstem Walker River begins downstream of the convergence of the West and East Walker Rivers in Mason Valley and terminates at Walker Lake. Fish species found in the mainstem Walker River during recent surveys by the University are Lahontan mountain sucker, Lahontan redside, smallmouth bass, brown bullhead, and common carp (Umek and Chandra pers. comm.). Paiute sculpin also occupy the Walker River. NDOW has found native fish species in the East and West Walker Rivers (Wright pers. comm.); however, during recent sampling, only introduced warmwater fish species were found in the Walker River downstream from Weber Dam (Walker Lake Fisheries Improvement Team 2008).

The riparian zone along mainstem Walker River to Weber Reservoir is dominated by cottonwood and willows. The Walker River below Weber Reservoir has substantial tamarisk, an invasive species commonly known as saltcedar (Sharpe et al. 2008). WRPT and USFWS are in Year 2 of a tamarisk removal and revegetation project on the Walker River Paiute Reservation. In addition, a 5-year plan for removal and management of tamarisk on the lower portion of the Walker River is being developed. Historically, the mainstem Walker River was part of the migratory corridor for LCT to reach their spawning grounds (U.S. Fish and Wildlife Service 1995). The entire river reach from Weber Reservoir to Walker Lake does not provide quality migratory, spawning, or rearing habitat for LCT. Currently, the channel below Schurz is shallow and braided, and native vegetation is minimal. From below Weber to Schurz, there appears to be suitable trout habitat (Walker Lake Fisheries Improvement Team 2008).

A fish survey on the mainstem Walker River was conducted on May 28, 2008, between Weber Reservoir and Schurz. No LCT were found at any of four sampling sites. All captured fish were warmwater nonnative species such as bluegill, largemouth bass, and common carp (Walker Lake Fisheries Improvement Team 2008). Cooper and Koch (1984) reported that LCT and Tahoe suckers no longer spawn in the mainstem Walker River.

Weber Dam and Reservoir

Weber Dam and Reservoir are located approximately 25 river miles upstream of Walker Lake on the Walker River Indian Reservation (Figure 1-2). Weber Dam currently is the upstream migration limit for LCT when they are able to access the river from Walker Lake. Weber Dam has recently been repaired and modified; the reservoir capacity is 10,700 af. This facility is operated primarily to store and release water for irrigation on the reservation and also for flood control.

Weber Reservoir is not stocked; fish move into the reservoir from the river upstream where they are stocked (Table 5-1). Resident warmwater species include brown bullhead, channel catfish, carp, largemouth bass, and white crappie (Miller Ecological Consultants 2005).

Future plans for the reservoir include building a fishway to provide passage for LCT upstream of Weber Dam into Walker River (Figure 1-2) (Walker River Paiute Tribe 2008). The fishway would also permit downstream migration of juvenile and adult fish (Miller Ecological Consultants 2005). BIA has scheduled to install a fishway at Weber Dam during 2009 and 2010 (Walker River Paiute Tribe 2008).

Walker Lake

Walker Lake is the terminus of the Walker River Basin (Figure 1-2). Five fish species are native to Walker Lake: LCT, Lahontan tui chub, Tahoe sucker, Lahontan redside, and Lahontan speckled dace (Sigler and Sigler 1987, LaRivers 1962, Page and Burr 1991). Only LCT and Lahontan tui chub are currently found in Walker Lake (Walker Lake Fishery Improvement Plan 2007).

LCT was once abundant in the Walker River system and supported an extensive fishery (LaRivers 1962). However, the decline of lake surface elevation and loss of access to spawning habitat led to the near loss of this fishery by the 1950s (Koch et al. 1979, Cooper and Koch 1984). LCT has been produced by Lahontan

National Fish Hatchery and Mason Valley Hatchery since the 1960s. The 1995 LCT Recovery Plan (U.S. Fish and Wildlife Service 1995) identifies the importance of maintaining these populations while recovery strategies are developed and Lahontan National Fish Hatchery Complex provides production to support recovery and recreational fishing. In November 2005, Congress appropriated $5 million funding in PL 109-103 for Western Inland Trout Initiative and Fishery Improvements through Reclamation's Desert Terminal Lakes Program. This funding was transferred to USFWS and funds a collaborative partnership between NDOW, WRPT, and USFWS to design and implement fishery improvements in the State of Nevada with an emphasis on the Walker River Basin. The Walker Lake Fishery Improvement Program emphasizes improving understanding of the fishery in Walker Lake and lower Walker River, helping to improve the stocking and survivability of LCT, and refining strategies for establishing a self-sustaining, lacustrine LCT population. This allows adaptive management for long-term recovery and maintenance of a healthy recreational fishery (Walker Lake Fisheries Improvement Team 2008).

Many nonnative fish species, such as salmon species, various trout species, catfish, threadfin shad, perch species, and others have been stocked in Walker Lake in the past, but none was able to establish a self-supporting population (LaRivers 1962, Moyle et al. 1995).

The decrease in lake surface elevation and depth has changed the entire lake ecosystem— physically, chemically, and biologically. Increasing TDS concentration and water temperature and decreasing dissolved oxygen concentration have played a role in altering nutrient cycling, changing biotic communities, and affecting the extent and quality of fish habitat, particularly in summer months. As a result, Walker Lake is experiencing eutrophication, a degradation of lake water quality (Sharpe et al. 2008). Insufficient freshwater inflow to Walker Lake has resulted in aquatic conditions that are inhospitable to LCT, its prey base, and probably other lake-dependent faunal species. See Chapter 3, Water Resources, Walker Lake Limnology, for a detailed description of Walker Lake processes and resulting water quality.

Special-Status Fish Species

LCT is the only special-status fish species in the study area. Lahontan tui chub also is discussed because of its importance as a prey base for LCT.

Lahontan Cutthroat Trout

LCT is currently listed as threatened by USFWS (40 FR 29864, 1975) and is a Nevada protected species (U.S. Fish and Wildlife Service 2008). It is also listed as at-risk (Nevada Natural Heritage Program 2007). No critical habitat has been designated (U.S. Fish and Wildlife Service 1995, 2009).

There are two forms of LCT: fluvial (stream-dwelling) and lacustrine (lake-dwelling). Fluvial type fish prefer pools with cover (instream woody material, undercut banks) and velocity breaks, and riffle-run habitats with clear water and rocky substrate (U.S. Fish and Wildlife Service 1995). Optimal riverine habitat consists of clear cold water, well-vegetated streambanks, abundant instream cover, stable water flow, and approximately 1:1 pool-to-riffle ratio (Hickman and Raleigh 1982). Fluvial LCT can tolerate water temperatures up to 25°C, but growth ceases at 24°C. High mortality occurs at water temperatures of 26°C and above (Dickerson and Vinyard 1999a).

Lacustrine type LCT can tolerate high alkalinity and TDS concentration (U.S. Fish and Wildlife Service 1995) within limits. Numerous studies have examined optimal water quality conditions for lacustrine type LCT. Studies have shown that 20% of acclimated LCT survived when TDS concentration exceeded 15,000mg/L and that only 4 to 5% of acclimated LCT survived when TDS concentration reached 16,000 mg/L (Nevada Department of Wildlife 2006). Best survival and growth occur with water temperatures less than 22°C, pH values of 6.5 to 8.5, and dissolved oxygen greater than 8 mg/L (Moyle 2002) (Table 5-2).

Table 5-2. LCT and Tui Chub Water Quality Parameter Tolerance Limits

		Water Temperature (ºC)		Dissolved Oxygen (mg/L) (preferred)	Total Dissolved Solids (ppm) (preferred)
Species	Life Stage	Acceptable Range	Optimal		
Lahontan cutthroat trout	Spawning (river)	8 to 16	Unknown	≥5	Unknown
	Eggs (river)	6 to 12	10	≥8	Unknown
	Juveniles (river)	9 to 20	15	≥8	Unknown
	Adults (lake)	9 to 20	Unknown	≥8	<15,467
Tui chub	Spawning	13 to 16.5	Unknown	Unknown	Unknown
	Eggs	18 to 24	Unknown	Unknown	<15,532
	Larvae	18 to 24	Unknown	>2	<16,000
	Juveniles	15 to 30	Unknown	>2	Unknown
	Adults	15 to 30	Unknown	>2	Unknown

Sources: Hickman and Raleigh 1982, Moyle 2002, U.S. Fish and Wildlife Service 1995, Cooper 1978.

Optimal TDS concentration for survival of lacustrine LCT is unknown and not defined by Moyle (2002). In a laboratory study, LCT ranging in size from 2 to 3 inches tested at 10,300 mg/L TDS had a survival rate of approximately 78%. LCT tested at 15,467 mg/L TDS and above all died (Dickerson and Vinyard 1999b). The next lowest concentration of TDS tested was 130 mg/L, which was the control group. The fish in the control group had 100% survival. No fish were tested for TDS concentration between 130 and 10,300 mg/L, so the threshold TDS concentration for inducing LCT mortality is not known. Susceptibility to TDS concentration in Walker Lake seems to be affected by fish size or age as smaller fish experienced higher mortality in Walker Lake water.

The results from the previously mentioned studies are consistent with observations from the Lockheed Ocean Science Laboratories (1982) that 10-month-old LCT were able to tolerate a higher TDS concentration in Pyramid Lake water than were 2-month-old fish. In this study, LCT of different sizes were placed in aquaria of varying concentrations of Pyramid Lake water. The objective of the testing was to determine concentration values that resulted in LC_{50} mortality (this represents the point where 50% of the test fish expire) in 96-hour exposure tests. The concentrations reported from that study may not be indicative of mortality caused by long-term exposure to TDS concentrations lower than the 96-h LC_{50} threshold concentrations. Comparison of the 2-month-old (50 millimeter [mm]), and the 10-month-old (175 mm) LCT shows major differences in their sensitivity and response to TDS concentrations. The 96-h LC_{50} value for the smaller trout was 14,305 mg/L. At a concentration of 19,152 mg/L, there was no mortality of the larger trout. A mortality of 100% occurred at a TDS concentration of 21,487 mg/L with the smaller trout, and at 29,837 mg/L with the larger trout. These studies suggest that options such as spring freshets and timing and durations of flow may be used to lessen the impacts of high TDS concentration.

Both types of LCT spawn in stream habitats from April to July. The timing and success of spawning depend on streamflow, surface elevation, and water temperature. Lacustrine type fish migrate into tributaries to spawn. Spawning occurs in riffle habitat over gravel substrate. Migration to spawning areas is observed in water temperatures ranging from 5°C to 16°C (Table 5-2). Eggs hatch in 4 to 6 weeks, depending on water temperature, and fry emerge 13 to 23 days later. Fry typically will move out of tributary spawning locations in the fall and winter when flows increase, but some stay in their natal streams for 1 to 2 years (U.S. Fish and Wildlife Service 1995).

Fluvial fish are opportunistic feeders, typically feeding on drift such as aquatic and terrestrial invertebrates. Lacustrine fish feed on insects and zooplankton when small, and other fish when the larger fish exceed the smaller-sized fish by 25% (U.S. Fish and Wildlife Service 1995, Bigelow pers. comm.). In Walker Lake, LCT feed primarily on *Odonata* nymphs (damselflies and dragonflies) and tui chub (Nevada Department of Wildlife 2007).

Historically, LCT was distributed throughout northern Nevada. The fluvial form inhabits the Humboldt River system, isolated streams in northwestern and central Nevada, and tributaries of the Truckee, Carson, and Walker Rivers (Nevada Natural Resources 2008).

In the Walker River Basin, six populations exist in the tributaries of the East and West Walker River (Murphy, Mill, Slinkard, Silver, Wolf, and By-Day Creeks). By-Day Creek has the only endemic population, and its fish have been introduced into the other creeks (U.S. Fish and Wildlife Service 1995). The population of LCT in Walker Lake is maintained by annual NDOW and USFWS stocking programs (U.S. Fish and Wildlife Service 1995). All stocked LCT are produced at either Mason Valley Hatchery or Lahontan National Fish Hatchery.

Lahontan Tui Chub

Lahontan tui chub is listed as a subspecies of special concern by the Endangered Species Committee of the American Fisheries Society (Williams et al. 1989), but it is not protected by law. Tui chub is self-sustaining in Walker Lake and is a prey item for LCT. Some mortality of embryos and eggs occurs in the range of 8,759 to 9,342 mg/L TDS. Tui chub eggs experienced 80% and 100% mortality at TDS concentrations of 12,379 and 15,532 mg/L, respectively (Stockwell unpublished) (Table 5-2). Although TDS concentration reached approximately 15,982 mg/L in 2005, netting and hydroacoustic data indicate that tui chub spawned and produced a year class that year (Jellison and Herbst 2008). TDS concentration for more recent years has been near 16,000 mg/L and in 2009 TDS concentration was 17,500 mg/L. The capture of young tui chub in gill and trap nets set in Walker Lake from 2002 through 2007 indicates that recruitment into the population can occur when lake TDS concentration is elevated.

Environmental Consequences

This section describes the impact analysis relating to fish and fish habitat for the acquisition alternatives and the No Action Alternative. It lists the criteria used to determine whether an impact would be adverse or beneficial.

Assessment Methods

Impacts were determined by evaluating expected future conditions with each alternative versus the baseline of existing conditions and trends. An alternative's impact is the future change from baseline conditions that is attributable to the alternative.

LCT and other fish species occurring in Walker River and Walker Lake are considered to be affected by an alternative if the quality of their habitat would be affected. Potential impacts on LCT and tui chub are assessed qualitatively, based on predicted water quality conditions, such as water temperature and TDS concentration, quality of existing habitat, and known environmental thresholds (Table 5-2). Graphs showing predicted TDS concentration (Chapter 3, Water Resources) were compared to tolerance thresholds of LCT and tui chub to determine impacts on those species.

Impact Criteria

Impacts on fish or fish habitat would be considered adverse if the alternative would:

- cause a substantial loss of fish habitat, including a substantial decrease in the quantity or quality of fish habitat;
- substantially disturb special-status fish species as a result of human activities;
- cause fish to avoid important habitat for substantial periods, which can increase mortality or reduce reproductive success;
- disrupt natural movement corridors; or
- substantially reduce local population size of species that are federally or state-listed or proposed for listing as threatened or endangered as a result of direct mortality or habitat loss, lowered reproductive success, or habitat fragmentation.

Also considered in determining whether an impact on fish would be adverse or beneficial were:

- federal or state legal protection of the resource;
- federal, state, and local agency regulations and policies regarding the resource;
- documented local or regional scarcity and sensitivity of the resource; and
- local and regional distribution and extent of the resource.

An alternative was considered to have a beneficial impact if it would result in an increase in the quantity or quality of aquatic habitat for fish species.

Impacts

No Action Alternative

The No Action Alternative would result in no increased inflow to Walker Lake. Lake volume and surface elevation would continue to decline. TDS concentration would continue to increase and would be expected to reach 30,000 mg/L by 2050 and ultimately reach 50,000 mg/L by the year 2200 (Chapter 3, Water Resources, Figure 3-23). LCT appears to have low survival rates at a TDS concentration above 16,000 mg/L, even those fish that are acclimated prior to stocking in Walker Lake. Eventually, TDS would reach a concentration that would preclude stocking. As TDS concentration continued to increase, tui chub would also be unable to survive in the lake. Other water quality issues are discussed in Chapter

3, Water Resources, under No Action Alternative, Impact WI-1: Alter Walker Lake Water Quality as a Result of Change in Lake Storage.

Alternative 1 (Purchase Alternative)

Water rights acquired under Alternative 1 are expected to add an average of 50,000 af/yr of water to Walker Lake. It is possible, however, that less than an average of 50,000 af/yr would be provided to the lake either because of funding limitations or because there would not be enough willing sellers. With funding of $56 million, it is estimated that the average inflow to the lake would increase by 7,300 af/yr.

This analysis of impacts under Alternative 1 assumes that the Purchase Alternative would be fully funded and that water rights acquired would increase the average inflow to the lake by 50,000 af/yr. Unless otherwise noted, if acquisitions were limited to those achievable only with the funding of $56 million, the impacts would be similar in nature (i.e., adverse, minor, beneficial, or no impact) but of less magnitude.

Direct Impacts

Impact FISH-1: Improved Native Fish Habitat as a Result of Increased Flow in Walker River (Beneficial Impact)
Under the Purchase Alternative, an increase in flows in the Walker River would improve water quality and increase fish habitat for native fish species that reside in the Walker River Basin. An increase in average inflow to transfer 50,000 af/yr (full funding) or 7,300 af/yr to Walker Lake (funding of $56 million) would enhance the potential for decreased water temperatures and increased spawning and rearing habitat area for native fish species.

Impact FISH-2: Decrease of Native Fish Fitness as a Result of Increased Sedimentation in the Walker River (Minor Impact)
As discussed in Chapter 3, Impact WI-3: Increase Erosion as a Result of Increased River Flow and Increased Exposed Soil, a recent University study of sediment transport in the Walker River system upstream of Wabuska concluded that increased sediment transport would be expected to occur with essentially any increase in flow (Dennett et al. 2009). In reaches of the river where TSS concentration is relatively low, some increase in TSS concentration could probably be tolerated and the impact might be minor. However, TMDLs for TSS have been established for the East Walker River downstream of Bridge B-1475 and for the Walker River upstream of the Walker River Indian Reservation. Consequently, an increase in the sediment load that affects these portions of the river could have an adverse impact on native fish species in these parts of the river.

Once in the stream channel, mobilized sediments can result in direct impacts on resident fishes through gill damage and reduced capacity to take in oxygen.

Indirect impacts can include reduced fitness as a result of decreased dissolved oxygen intake ability, increased metabolic costs associated with reduced dissolved oxygen intake ability, and reduced foraging ability as the result of decreased visibility. The threshold for impacts is considered to be an exceedance of 100 mg/L of TSS above background over a 24-hour period (Lloyd 1987; Bash et al. 2001). Table 3-10 (Chapter 3, Water Quality) shows current TSS concentrations in the study area. Most concentrations are low and would not be expected to rise to 100 mg/L due to increased flows.

Impact FISH-3: Increase in Survival of LCT as a Result of Improved Water Quality in Walker Lake (Beneficial Impact with Full Funding; No Impact with Funding of $56 Million)

Under the Purchase Alternative, an average inflow of 50,000 af/yr to Walker Lake would increase lake volume. An increase in volume would decrease TDS concentration, resulting in an overall beneficial impact on water quality for LCT. If river inflow at the lake is increased by an average of 50,000 af/yr, lake surface elevation would increase and TDS concentration would be expected to be between 12,400 mg/L and 13,500 mg/L by the year 2200 (Chapter 3, Water Resources, Table 3-19). This would increase the survival rate of LCT stocked in the lake. This would be a beneficial impact.

If less than an average of 50,000 af/yr of additional inflow is acquired, some benefit might still accrue in the short term, depending upon the timing of releases of acquired water. Data recently collected indicate that spring freshets provide opportunities for stocked LCT to acclimate in the lake when a short-term decrease in TDS concentration occurs. With funding of $56 million, however, Walker Lake surface elevations would continue to decline, despite the contribution by Alternative 1 of an average 7,300 af/yr of additional inflow. TDS concentration would rise over the long term to a projected concentration of over 30,000 mg/L in 2200 (Table 3-19). This is slightly better than the No Action Alternative, but not sufficient to improve the long-term prospects for LCT survival.

The additional inflow that would be provided by Alternative 1 with the funding of $56 million might benefit LCT in the short term, but in the long term it would not enhance prospects for survival of LCT.

Impact FISH-4: Decrease in Water Temperature as a Result of Increased Flow in Walker River (Beneficial Impact)

Under the Purchase Alternative, an increase in average inflow of 50,000 af/yr in to Walker Lake could slightly decrease water temperature throughout the mainstem of the Walker River, depending on the source location of water being transferred. More flow would result from the addition of an average of 50,000 af/yr of water at the lake and therefore water temperatures may be lower than if only 7,300 af/yr of additional inflow at the lake was obtained. Water temperature in the river downstream of Schurz and in Walker Lake during low-flow water years is a limiting factor for LCT (Walker Lake Fisheries Improvement Team 2008).

If the proposed acquisition of geothermal water from Homestretch Geothermal is successful, the water may be used to increase flows from the river into the lake. Because of the hot temperatures of the geothermal effluent (220°F) (Minor pers. comm.), the water would be cooled to ambient temperature before being released into the river. A separate Environmental Assessment under NEPA is being conducted to determine the effects of acquiring water from the geothermal facility.

Impact FISH-5: Increase in Survival of Tui Chub as a Result of Improved Water Quality in Walker Lake (Beneficial Impact with Full Funding; No Impact with Funding of $56 Million)

Under the Purchase Alternative, increases in inflows to Walker Lake of an average of 50,000 af/yr would improve water quality. As discussed above under Impact FISH-3, TDS concentration in Walker Lake is expected to decrease with substantially increased inflow to the lake. Hydroacoustic and netting data confirm that tui chub have spawned and produced year classes in Walker Lake with TDS concentration ranging from 12,000 to 16,000 mg/L (Jellison and Herbst 2008). With full funding, TDS concentration would be expected to decrease to 12,300 mg/L or less by the year 2090 (Table 3-19). Benefits to tui chub reproduction would be seen compared to existing conditions.

If less than an average of 50,000 af/yr of additional inflow is acquired, benefits might still accrue in the short term, depending upon the timing of releases of acquired water from Weber Reservoir. Data recently collected indicate that spring freshets provide opportunities for tui chub reproduction and recruitment, when a short-term decrease in TDS concentration occurs. However, with an increase in average inflows of approximately 7,300 af/yr with funding of $56 million, Walker Lake surface elevations would continue to decline. TDS concentration would rise over the long term to over 30,000 mg/L in the year 2200 (Table 3-19). This concentration is less than would occur with the No Action Alternative, but it still exceeds the threshold for tui chub survival.

The additional 7,300 af additional inflow that would be provided by Alternative 1 with funding of $56 million might benefit tui chub in the short term, but in the long term it would not enhance prospects for its survival.

Impact FISH-6: Increase in LCT Spawning Habitat as a Result of Reconnection of Walker Lake to Walker River (Beneficial Impact)

Currently, Walker Lake LCT is unable to spawn in the Walker River because low river flows prevent its access to suitable spawning habitat. Under the Purchase Alternative, if an average of 50,000 af/yr of additional Walker Lake inflow were released from Weber Reservoir consistently over the months of the irrigation season (March to October), an increase of 103 cfs over the baseline flow would occur at the downstream end of the river. This would benefit several aspects of life history for LCT such as reproduction, survival, and upstream migration. The relative flow increase would be greatest between Schurz and the lake, because existing summer flows can be as low as zero. Assuming flows would be sufficient in the mainstem Walker River to permit upstream passage of LCT to possible spawning habitat between Weber Reservoir and Walker Lake, fish passage would depend on the timing and magnitude of the released flows, and water temperatures would have to be low enough to facilitate spawning. The potential benefit to LCT spawning, recruitment, and rearing also would depend on the quality of the habitat between Walker Lake and Weber Reservoir. The Walker Lake Fisheries Improvement Team will be assessing habitat conditions throughout the basin as restoration work begins.

With funding of $56 million and an average of 7,300 af/yr of additional Walker Lake inflow, approximately 15 cfs would flow through the river to Walker Lake if released evenly from Weber Reservoir during the irrigation season. Depending on the passage condition of the channel at the confluence of the river and lake (no beaver dams, no sand accretion), LCT might be able to move upstream.

Impact FISH-7: Decrease of LCT Spawning Success as a Result of Increased Sedimentation in the Walker River (Minor or Beneficial Impact)
At the current time, the availability and suitability of LCT spawning habitat in the mainstem reach are unknown. If LCT are able to use this reach, they may be affected by increased sediment load. As discussed in Impact FISH-2, an increase in flow is expected to result in an increase in sediment load in the mainstem Walker River. Increased sediment load could be a problem for LCT spawning if sedimentation (the settling of sediment) occurs on spawning gravel. Spawning gravels could become covered with sediment and the circulation of water around the eggs would be impaired. This would result in a decrease in oxygen and a reduced number of eggs hatching. However, sedimentation tends to occur in areas of low velocity (generally not on riffles where spawning gravel tends to be located). If the flow velocity is high enough, this would cause any loose sediment to continue downstream and could clean spawning gravel sites.

Indirect Impacts

Impact FISH-8: Increase in Growth and Survival of LCT as a Result of Increased Abundance of Prey Species (Beneficial Impact with Full Funding; No Impact with Funding of $56 Million)
Under the Purchase Alternative, if an average of 50,000 af/yr is acquired and delivered to Walker Lake and TDS concentration decreases to approximately 12,000 mg/L, the survival of tui chub eggs and embryos would increase. The increased population of tui chub would provide more prey for LCT, which would have better growth and survival as a result of increased food sources. This would be a beneficial impact.

If an average of 7,300 af/yr of additional inflow is acquired and released from Weber Reservoir to provide a spring freshet, TDS concentration could temporarily decrease and potentially provide some short-term benefit. As discussed above under Impact FISH-5, however, over the long run TDS concentration in Walker Lake would rise to over 30,000 mg/L in the year 2200 (Table 3-19), and tui chub would no longer reproduce there, affecting the LCT food supply. TDS concentration would be slightly better than under the No Action Alternative, but there would be no long-term benefit to LCT.

Alternative 2 (Leasing Alternative)

Direct Impacts

Because Alternative 2 requires recurring water leases, the actions of Alternative 2 would last only until the funding is exhausted. Assuming that sufficient water is leased to increase average inflow to Walker Lake by an average 50,000 af/yr, the funding of $56 million would last an estimated 3 years, while full funding would last an estimated 20 years.

The analysis of impacts under Alternative 2 assumes that the Leasing Alternative would have the same level of funding as the fully funded Alternative 1, which would increase the average inflow to the lake by 50,000 af/yr for approximately 20 years. Unless otherwise noted, if acquisitions were limited to those achievable only with the funding of $56 million, the impacts would be similar in nature (i.e., adverse, minor, beneficial, or no impact) but of shorter duration.

Similarly, unless otherwise noted, the impacts below of the fully funded Alternative 2 would be similar in nature (i.e., adverse, minor, beneficial, or no impact) to those of the fully funded Alternative 1, only temporary.

Impact FISH-1: Improved Native Fish Habitat as a Result of Increased Flow in Walker River (Beneficial Impact)
Under Alternative 2, increased flow would generally improve native fish habitat. The improvement to fish habitat would be limited to the duration of the release of flows (3 to 20 years). This would be a beneficial impact, but temporary.

Impact FISH-2: Decrease of Native Fish Fitness as a Result of Increased Sedimentation in the Walker River (Minor Impact)
Under Alternative 2, increased flow would cause an increase in sedimentation into Walker River. The decrease to native fish fitness would be limited to the duration of the release of flows (3 to 20 years).

Impact FISH-3: Increase in Survival of LCT as a Result of Improved Water Quality in Walker Lake (Beneficial Impact)
Under a fully funded Alternative 2, the increase in inflows to Walker Lake would temporarily decrease TDS concentration to less than 14,000 mg/L (Table 3-19)

and increase survival rate for LCT. This would be a beneficial impact, but temporary. After approximately 20 years, Walker Lake surface elevation would begin to decline again and TDS concentration would ultimately rise to over 35,000 mg/L in the year 2200, with no long-term benefit to LCT.

With funding of $56 million, TDS concentration would drop slightly for a few years, temporarily benefiting LCT, then rise again. Ultimately, TDS concentration and direct impacts on LCT survival would be similar to those described for full funding of Alternative 2.

Impact FISH-4: Decrease in Water Temperature as a Result of Increased Flow in Walker River (Beneficial Impact)
Under Alternative 2, water temperatures would be reduced with an increased inflow of an average of 50,000 af/yr. The reduction in temperatures would be related to the amount of water provided and would be limited to the duration of the release of flows (3 to 20 years). This would be a beneficial impact, but temporary.

Impact FISH-5: Increase in Survival of Tui Chub as a Result of Improved Water Quality in Walker Lake (Beneficial Impact)
Under Alternative 2, the increased inflow of water to Walker Lake would temporarily decrease TDS concentration to less than 14,000 mg/L (Table 3-19) and increase survival of tui chub larvae. This would be a beneficial impact, but temporary. After approximately 20 years, Walker Lake surface elevation would begin to decline again and TDS concentration would ultimately rise to over 35,000 mg/L in the year 2200, with no long-term benefit to tui chub.

With funding of $56 million, TDS concentration would drop slightly for a few years, temporarily benefiting tui chub, then rise again. Ultimately, TDS concentration and direct impacts on tui chub survival would be similar to those described for full funding of Alternative 2.

Impact FISH-6: Increase in LCT Spawning Habitat as a Result of Reconnection of Walker Lake to Walker River (Beneficial Impact)
Under Alternative 2, the reconnection of Walker Lake to Walker River would allow passage of LCT to possible spawning habitat. This would be a beneficial impact, but temporary.

Impact FISH-7: Decrease of LCT Fitness as a Result of Increased Sedimentation in the Walker River (Minor Impact)
Under Alternative 2, increased flow would cause an increase in sedimentation into Walker River. The decrease to LCT fitness would be limited to the duration of the release of flows (3 to 20 years).

Indirect Impacts

Impact FISH-8: Increase in Growth and Survival of LCT as a Result of Increased Abundance of Prey Species (Beneficial Impact)
Under Alternative 2 with full funding, the increased flow to Walker Lake would result in an increase in the abundance of prey species, thus providing a benefit to the growth and survival of LCT. This would be a beneficial impact, but temporary. After approximately 20 years, Walker Lake surface elevation would begin to decline again and TDS concentration would ultimately rise to over 35,000 mg/L in the year 2200 (Table 3-19), with no long-term benefit to tui chub or LCT.

With funding of $56 million, TDS concentration would drop slightly for a few years, providing some temporary benefit, and then rise again. Ultimately, TDS concentration and indirect impacts on LCT predation would be similar to those described for full funding of Alternative 2.

Alternative 3 (Efficiency Alternative)

As discussed in the Chapter 3, Water Resources, full implementation of Alternative 1 would provide an average of 50,000 af/year of additional inflow to Walker Lake, while implementation of Alternative 3 would yield an average of 32,300 af/yr of additional inflow. Unless otherwise noted, the impacts of Alternative 3 would be similar in nature (i.e., adverse, minor, beneficial, or no impact) to those of the fully funded Alternative 1, but of less magnitude.

Direct Impacts

Direct Impacts Similar In Nature to Alternative 1

Impact FISH-1: Improved Native Fish Habitat as a Result of Increased Flow in Walker River (Beneficial Impact)
Increased inflow of an average of 32,300 af/yr to Walker Lake would generally improve native fish habitat. Decreased water temperature and the increase in spawning and rearing habitat would occur. This would be a beneficial impact.

Impact FISH-2: Decrease of Native Fish Fitness as a Result of Increased Sedimentation in the Walker River (Minor Impact)
Under Alternative 3, increased flow would cause an increase in sedimentation in Walker River. The decrease to native fish fitness would be limited by the amount of flows released. Less flow moving through the channels would result in less sediment moving through the channel. This would be an adverse impact, but less than under Alternative 1.

Impact FISH-3: Increase in Survival of LCT as a Result of Improved Water Quality in Walker Lake (Beneficial Impact)

Increased inflow of an average of 32,300 af/yr to Walker Lake would increase lake surface elevation by an estimated 4 to 13 feet, resulting in a TDS concentration somewhat less than or close to existing conditions for 20 to 50 years (Table 3-19). This could result in a slight increase in LCT survival, which would be a beneficial impact. Eventually, because it is a terminal lake, TDS concentration in Walker Lake would gradually increase, with concentration of 16,800 mg/L to 19,600 estimated for 2200 (Table 3-19). This may not provide a long-term benefit to LCT survival, although conditions would be better than the No Action Alternative.

Impact FISH-4: Decrease in Water Temperature as a Result of Increased Flow in Walker River (Beneficial Impact)

Water temperature would generally be reduced with an additional average inflow of 32,300 af/yr. This would be a beneficial impact.

Impact FISH-5: Increase in Survival of Tui Chub as a Result of Improved Water Quality in Walker Lake (Beneficial Impact)

As discussed above in Impact FISH-3, an average of 32,300 af/yr of additional inflow to Walker Lake could decrease TDS concentration somewhat. This could result in a slight increase in tui chub survival, which would be a beneficial impact. Eventually, however, TDS concentration would gradually increase, with potentially no long-term benefit to tui chub, although conditions would be better than with the No Action Alternative.

Impact FISH-6: Increase in LCT Spawning Habitat as a Result of Reconnection of Walker Lake to Walker River (Beneficial Impact)

Reconnection of Walker Lake to Walker River with an increased lake inflow of an average of 32,300 af/yr would allow passage of LCT to potential spawning habitat. If the additional inflow is released from Weber Reservoir evenly over the irrigation season, an estimated flow of 67 cfs would occur at the downstream end of Walker River. This could improve upstream passage of LCT to possible spawning habitat, especially if releases were timed to provide a spring freshet. However, fish passage would depend on the timing and magnitude of the released flows, water temperatures would have to be low enough to facilitate spawning, and adequate habitat quality would be needed. This could be a beneficial impact.

Impact FISH-7: Decrease of LCT Fitness as a Result of Increased Sedimentation in the Walker River (Minor Impact)

Under Alternative 3, less flow would move through the river and may decrease the amount of sediment movement in the channel. The decrease in LCT fitness would be limited to the amount of flow released. This would be less of an adverse impact than in Alternatives 1 and 2.

Direct Impacts Different from Alternative 1

Impact FISH-9: Potential Construction-Related Temporary Impairment of Fish Survival, Growth, or Reproduction by Accidental Spills or Polluted Runoff (Minor Impact)
Under Alternative 3, construction activities such as lining canals with concrete, replacing surface conveyances with underground pipelines, and consolidating canals, laterals, and ditches in Mason and Smith Valleys could introduce contaminants or sediment into Walker River and adversely affect fish species and their habitat. Although such an event is unlikely, refueling, operation, and storage of construction equipment and materials could result in accidental spills of pollutants such as concrete, sealants, and oil or fuel. Pollutants entering water bodies in the project area could cause reduced growth during egg, larvae, and juvenile life stages of fish, or cause mortality.

Implementation of requirements of an NPDES construction permit and its associated SWPPP, if applicable to the construction activity, would reduce the likelihood of construction-related discharges.

Indirect Impacts

Impact FISH-8: Increase in Growth and Survival of LCT as a Result of Increased Abundance of Prey Species (Beneficial Impact)
Under Alternative 3, the increased inflow to Walker Lake could result in a slight increase in tui chub survival and provide a greater food supply for LCT, thus providing a benefit to LCT. TDS concentration would gradually increase over time. Although conditions would be better than with the No Action Alternative, they may not be sufficient to result in long-term benefit to tui chub or LCT.

Chapter 6 Biological Resources—Wildlife

Chapter 6 Biological Resources—Wildlife

Introduction

This chapter describes the affected environment for wildlife resources in the study area and the potential impacts on wildlife resources that would result from the acquisition alternatives and No Action Alternative.

A list of terrestrial and avian wildlife potentially occurring in the study area is provided in Table 6-1.

Sources of Information

The key sources of data and information used in the preparation of this chapter are listed below. Full references can be found in Chapter 17, References.

- Wildlife Action Plan (Nevada Wildlife Action Plan Team 2006)
- amphibiaweb.org (2008)
- *Sibley Guide to Birds* (2000)
- *The Mammals of North America* (Hall 1981)
- Phone conversation and emails with Elmer Bull of NDOW (pers. comm.)

Affected Environment

This section describes the environmental setting related to wildlife species and special-status wildlife species in the study area. Although the project area is the entire Nevada portion of the Walker River Basin (Chapter 1), the study area for wildlife is defined as the river corridors and associated riparian communities for the East Walker River and West Walker River in Lyon County, Nevada; the mainstem Walker River; Walker Lake; irrigation canals and drains in the Walker River Basin in Lyon and Mineral Counties, Nevada; and irrigated land adjacent to the canals. In addition, the study area includes a 1-mile zone around each of these areas.

California and Douglas County, Nevada were not included in the study area. The Purchase Alternative would not change any operations or acquire from willing sellers land, water appurtenant to land, or related interests in California, or in Douglas County, Nevada, and there would be no direct or indirect impacts on wildlife and their habitats in California or Douglas County, Nevada from any of the acquisition alternatives. Operating criteria for upstream reservoirs are assumed to remain within ongoing patterns and historic use for all alternatives.

Table 6-1. Wildlife Species with Potential to Occur in the Study Area

Common Name	Scientific Name	Habitat
Amphibians		
Great basin spadefoot toad	*Spea hammondii*	Uplands
Pacific treefrog	*Hyla regilla*	Uplands, Agriculture, River
Western toad	*Bufo boreas*	Uplands
Reptiles		
Zebra-tailed lizard	*Callisaurus draconoides*	Uplands
Great basin collared lizard	*Crotaphytus bicinctores*	Uplands
Long-nosed leopard lizard	*Gambelia wislizenii*	Uplands
Desert spiny lizard	*Sceloporus magister*	Uplands
Western fence lizard	*Sceloporus occidentalis*	Uplands, Agriculture
Sagebrush lizard	*Sceloporus graciosus*	Uplands
Side-botched lizard	*Uta stansburiana*	Uplands
Desert horned lizard	*Phrynosoma platyrhinos*	Uplands
Western skink	*Eumeces skiltonianus*	Uplands
Western whiptail	*Cnemidophorus tigris*	Uplands, Agriculture
Rubber boa	*Charina bottae*	Uplands, Agriculture
Coachwhip	*Masticophis flagellum*	Uplands, Agriculture
Striped whipsnake	*Masticophis taeniatis*	Uplands, Wetland, Agriculture
Western yellow-bellied racer	*Coluber constrictor*	Uplands
Long-nosed snake	*Rhinocheilus lecontei*	Uplands
Common king snake	*Lampropeltis getula*	Uplands, Agriculture
Western patch-nosed snake	*Salvadora hexalepis*	Uplands, Agriculture
Great basin gopher snake	*Pituophis catenifer*	Uplands, Agriculture
Common garter snake	*Thamnophis sirtalis*	Uplands, Agriculture
Western terrestrial garter snake	*Thamnophis elegans*	Uplands, Agriculture
Western ground snake	*Sonora semiannulata*	Uplands
Night snake	*Hypsiglena torquata*	Uplands, Wetland
Western diamondback rattlesnake	*Crotalus atrox*	Uplands, Agriculture

Common Name	Scientific Name	Habitat
Birds		
Common loon	*Gavia immer*	Lake
Horned grebe	*Podiceps auritus*	Lake
Eared grebe	*Podiceps nigricollis*	Lake
Western grebe	*Aechmophorus occidentalis*	Lake, Wetland
Clark’s grebe	*Aechmophorus clarkii*	Lake, Wetland
Pied billed grebe	*Podilymbus podiceps*	Lake, Wetland
American white pelican	*Pelecanus erythrorhynchos*	Lake
Double-crested cormorant	*Phalacrocorax auritus*	Lake
Great blue heron	*Ardea herodias*	Lake, Wetland, Agriculture
Green heron	*Butorides virescens*	Lake, Wetland, Agriculture
Great egret	*Ardea alba*	Lake, Wetland, Agriculture
Cattle egret	*Bubulcus ibis*	Lake, Wetland, Agriculture
Snowy egret	*Egretta thula*	Lake, Wetland, Agriculture
Black-crowned night heron	*Nycticorax nycticorax*	Lake, Wetland, Agriculture
Least bittern	*Ixobrychus exilis*	Wetland
American bittern	*Botaurus lentiginosus*	Wetland
White-faced ibis	*Plegadis chihi*	Wetland, Agriculture
Tundra swan	*Cygnus columbianus*	Lake, Agriculture
Canada goose	*Branta canadensis*	Lake, Agriculture
Greater white-fronted goose	*Anser albifrons*	Lake, Agriculture
Snow goose	*Chen caerulescens*	Lake, Agriculture
Ross’s goose	*Chen rossii*	Lake, Agriculture
Mallard	*Anas platyrhynchos*	Lake, Wetland
Gadwall	*Anas strepera*	Lake, Wetland
Northern pintail	*Anas acuta*	Lake, Wetland
Green-wing teal	*Anas crecca*	Lake, Wetland
Blue-wing teal	*Anas discors*	Lake, Wetland
Cinnamon teal	*Anas cyanoptera*	Lake, Wetland
American wigeon	*Anas Americana*	Lake, Wetland
Northern shoveler	*Anas slypeata*	Lake, Wetland
Wood duck	*Aix sponsa*	Lake, Wetland
Redhead	*Arthya americana*	Lake, Wetland
Ring-necked duck	*Aythya collaris*	Lake, Wetland
Greater scaup	*Aythya marila*	Lake, Wetland

Common Name	Scientific Name	Habitat
Lesser scaup	*Aytha affinis*	Lake, Wetland
Canvasback	*Aythya valisineria*	Lake, Wetland
Common goldeneye	*Bucephala clangula*	Lake, Wetland
Barrow's goldeneye	*Bucephala islandica*	Lake, Wetland
Bufflehead	*Bucephala albeola*	Lake, Wetland
Ruddy duck	*Oxyura jamaicensis*	Lake, Wetland
Hooded merganser	*Lophodytes cucullatus*	Lake, Wetland
Common merganser	*Mergus merganser*	Lake, Wetland
Red-breasted merganser	*Mergus serrator*	Lake, Wetland
Turkey vulture	*Cathartes aura*	Uplands, Agriculture
Northern harrier	*Circus cyaneus*	Wetlands, Farm, Uplands
Cooper's hawk	*Accipiter cooperii*	Riparian, Agriculture, Uplands
Sharp-shinned hawk	*Accipiter striatus*	Riparian, Agriculture, Uplands
Northern goshawk	*Accipiter gentilis*	Uplands
Red-tailed hawk	*Buteo jamaicensis*	Riparian, Agriculture, Uplands
Swainson's hawk	*Buteo swainsoni*	Riparian, Agriculture, Uplands
Rough-legged hawk	*Buteo lagopus*	Uplands, Agriculture
Ferruginous hawk	*Buteo regalis*	Uplands, Agriculture
Golden eagle	*Aquila chrysaetos*	Uplands, Agriculture
Bald eagle	*Haliaeetus leucocephalus*	Lake, Riparian, Agriculture
Osprey	*Pandion haliaetus*	Lake, Riparian
Prairie falcon	*Falco mexicanus*	Uplands, Agriculture
Peregrine falcon	*Falco peregrines*	Uplands, Agriculture
Merlin	*Falco columbarius*	Uplands, Agriculture
American kestrel	*Falco sparverius*	Uplands, Agriculture
Greater sage-grouse	*Centrocercus urophasianus*	Uplands
Ring-necked pheasant	*Phasianus colchicus*	Uplands, Riparian, Agriculture
Chukar	*Alectoris chucker*	Uplands, Agriculture
California quail	*Callipepla californica*	Uplands, Riparian, Agriculture
Mountain quail	*Oreortyx rictus*	Uplands
Wild turkey	*Meleagris gallopavo*	Uplands, Agriculture
Belted kingfisher	*Ceryle alcyon*	Riparian
Red-naped sapsucker	*Sphyrapicus nuchalis*	Uplands
Williamson's sapsucker	*Sphyrapicus thyroideus*	Uplands
Northern flicker	*Colaptes aurstus*	Uplands

Common Name	Scientific Name	Habitat
Hairy woodpecker	*Picoides villosus*	Uplands
Downy woodpecker	*Picoides pubescens*	Uplands
White-headed woodpecker	*Picoides albolarvatus*	Uplands
Black-backed woodpecker	*Picoides arcticus*	Uplands
Lewis’s woodpecker	*Melanerpes lewis*	Uplands
Western kingbird	*Tyrannus verticalis*	Uplands, Agriculture
Cassin’s kingbird	*Tyrannus vociferans*	Uplands, Agriculture
Ash-throated flycatcher	*Myiarchus cinerascens*	Uplands
Say’s phoebe	*Sayornis saya*	Uplands, Riparian
Black phoebe	*Sayornis nigricans*	Uplands, Riparian, Agriculture
Pacific-slope flycatcher	*Empidonax difficillis*	Riparian, Uplands
Dusky flycatcher	*Empidonax oberholseri*	Riparian, Uplands
Gray flycatcher	*Empidonax wrightii*	Riparian, Uplands
Willow flycatcher	*Empidonax traillii*	Riparian, Uplands
Western wood-peewee	*Contopus sordidulus*	Riparian, Uplands
Olive-sided flycatcher	*Contopus cooperi*	Riparian, Uplands
Loggerhead shrike	*Lanius ludovicianus*	Uplands, Agriculture
Cassin’s vireo	*Vireo cassinii*	Uplands
Plumbeous vireo	*Vireo plumbeus*	Uplands
Warbling vireo	*Vireo gilvus*	Uplands
Barn owl	*Tyto alba*	Farm
Western screech owl	*Otus kennicottii*	Uplands, Farm
California spotted owl	*Strix occidentalis*	Uplands
Great horned owl	*Bubo viginianus*	Uplands, Riparian, Agriculture
Flammulated owl	*Otus flammeolus*	Uplands
Long-eared owl	*Asio otus*	Uplands
Short-eared owl	*Asio flammeus*	Uplands, Agriculture
Northern pygmy owl	*Glaucidium gnoma*	Uplands, Agriculture
Burrowing owl	*Athene cunicularia*	Uplands, Agriculture
Common poorwill	*Phalaenoptilus nuttallii*	Uplands, Agriculture
Common nighthawk	*Chordeiles minor*	Uplands, Agriculture
Vaux’s swift	*Chaetura vauxi*	Uplands
White-throated swift	*Aeronautes saxatalis*	Uplands, Riparian
Black-chinned hummingbird	*Archilochus alexandri*	Uplands, Riparian
Broad-tailed hummingbird	*Selasphorus platycerus*	Uplands, Riparian

Common Name	Scientific Name	Habitat
Rufous hummingbird	*Selasphorus rufus*	Uplands, Riparian
Calliope hummingbird	*Stellula calliope*	Uplands, Riparian
Orange-crowned warbler	*Vermivora celata*	Uplands, Riparian
Yellow warbler	*Dendroica petechia*	Uplands, Riparian
Nashville warbler	*Vermivora ruficapilla*	Uplands, Riparian
Yellow-rumped warbler	*Dendroica coronate*	Uplands, Riparian
Townsend’s warbler	*Dendroica townsendi*	Uplands, Riparian
Black-throated gray warbler	*Dendroica nigrescens*	Uplands, Riparian
Macgillivray’s warbler	*Oporornis tolmiei*	Uplands, Riparian
Wilson’s warbler	*Wilsonia pusilla*	Uplands, Riparian
Common yellowthroat	*Geothlypis thrichas*	Uplands, Riparian
Western tanager	*Piranga ludoviciana*	Uplands, Riparian
Spotted towhee	*Pipilo maculates*	Uplands, Riparian
Savannah sparrow	*Passerculus sandwichensis*	Uplands
Lark sparrow	*Chondestes grammacus*	Uplands
Black-headed grosbeak	*Pheucticus melanocephalus*	Uplands, Riparian
Lazuli bunting	*Passerina amoena*	Uplands, Riparian
White crowned sparrow	*Zonotrichia leucophrys*	Uplands, Riparian, Agriculture
Golden-crowned sparrow	*Zonotrichia atricapilla*	Uplands, Riparian, Agriculture
Song sparrow	*Melospiza melodia*	Uplands, Riparian, Agriculture
Chipping sparrow	*Spizella passerine*	Uplands, Riparian, Agriculture
Tree sparrow	*Spizella arborea*	Uplands, Riparian, Agriculture
Brewer’s sparrow	*Spizella breweri*	Uplands
Harris’s sparrow	*Zonotrichia querula*	Uplands, Riparian, Agriculture
Dark-eyed junco	*Junco hyemalis*	Uplands, Riparian, Agriculture
American coot	*Fulica americana*	Lake, Wetland
Common moorhen	*Gallinula chloropus*	Wetlands
Virginia rail	*Rallus limicola*	Wetlands
Sora	*Porzana carolina*	Wetlands
Greater sandhill crane	*Grus canadensis tibida*	Wetlands, Agriculture
Semi-palmated plover	*Charadrius semipalmatus*	Uplands, Lake, Agriculture
Western snowy plover	*Charadrius alexandrines*	Uplands, Lake, Agriculture
Killdeer	*Charadrius vociferous*	Uplands, Lake, Agriculture
Mountain plover	*Charadrius montanus*	Uplands, Lake, Agriculture
Black-bellied plover	*Pluvialis squatarola*	Uplands, Lake, Agriculture

Common Name	Scientific Name	Habitat
American avocet	*Recurvirostra americana*	Lake, Wetland
Black-necked stilt	*Himantopus mexicanus*	Lake, Wetland
Common snipe	*Gallinago gallinago*	Lake, Wetland
Long-billed curlew	*Numenius americanus*	Lake, Wetland, Agriculture
Marbled godwit	*Limosa fedoda*	Lake, Wetland
Spotted sandpiper	*Actitis macularia*	Lake, Wetland
Solitary sandpiper	*Tringa solitaria*	Lake, Wetland
Greater yellowlegs	*Tringa melanoleuca*	Lake, Wetland
Lesser yellowlegs	*Tringa flavipes*	Lake, Wetland
Willet	*Catoptrophorus semipalmatus*	Lake, Wetland
Baird’s sandpiper	*Calidris bairdii*	Lake, Wetland
Western sandpiper	*Calidris mauri*	Lake, Wetland
Least sandpiper	*Calidris minutilla*	Lake, Wetland
Dunlin	*Calidris alpine*	Lake, Wetland
Sanderling	*Calidris alba*	Lake, Wetland
Long-billed dowitcher	*Limnodromus scolopaceus*	Lake, Wetland
Short-billed dowitcher	*Limnodromus griseus*	Lake, Wetland
Wilson’s phalarope	*Phalaropus tricolor*	Lake, Wetland
Red-necked phalarope	*Phalaropus lobatus*	Lake, Wetland
Herring gull	*Larus californicus*	Lake, Agriculture
California gull	*Larus argentatus*	Lake, Agriculture
Ring-billed gull	*Larus delawarensis*	Lake, Agriculture
Franklin’s gull	*Larus pipixcan*	Lake
Bonaparte’s gull	*Larus philadelphia*	Lake
Common tern	*Sterna hirundo*	Lake
Forster’s tern	*Sterna fosteri*	Lake
Caspian tern	*Sterna caspia*	Lake
Black tern	*Chilidonias niger*	Lake
Mourning dove	*Zenaida macroura*	Uplands, Agriculture
Band-tailed dove	*Columba fasciata*	Uplands, Agriculture
Rock dove	*Columba livia*	Uplands, Agriculture
Steller’s jay	*Cyanocitta stelleri*	Uplands
Scrub jay	*Aphelocoma californica*	Uplands, Agriculture
Common raven	*Corvus corax*	Uplands, Agriculture

Common Name	Scientific Name	Habitat
American crow	*Corvus brachyrhynchos*	Uplands, Agriculture
Black-billed magpie	*Pica hudsonia*	Uplands, Agriculture
Horned lark	*Eremophila alpestris*	Uplands, Agriculture
Tree swallow	*Tachycineta bicolor*	Riparian, Uplands, Agriculture
Violet-green swallow	*Tachycineta thalassina*	Riparian, Uplands, Agriculture
Bank swallow	*Riaparia riparia*	Riparian
Northern rough-winged swallow	*Stelgidopteryx serripennis*	Riparian, Uplands, Agriculture
Barn swallow	*Hirundo rustica*	Riparian, Uplands, Agriculture
Cliff swallow	*Petrochelidon pyrrhonota*	Riparian, Uplands, Agriculture
Purple martin	*Progne subis*	Riparian, Uplands, Agriculture
Juniper titmouse	*Baeolophus ridgwayi*	Uplands
Bushtit	*Psaltriparus minimus*	Uplands, Agriculture
White-breasted nuthatch	*Sitta carlinensis*	Uplands
Red-breasted nuthatch	*Sitta canadensis*	Uplands
Pygmy nuthatch	*Sitta pygmaea*	Uplands
Brown creeper	*Certhia americana*	Uplands
Canyon wren	*Catherpes mexicanus*	Uplands
Rock wren	*Salpinctes obsoletus*	Uplands
House wren	*Troglodytes aedon*	Uplands, Agriculture
Marsh wren	*Cistothorus palustris*	Marsh, Riparian
Bewick’s wren	*Thryomanes bewickii*	Uplands
Golden-crowned kinglet	*Regulus satrapa*	Uplands
Ruby-crowned kinglet	*Regulus calendula*	Uplands
Blue-gray gnatcatcher	*Polioptila caerulea*	Uplands
American robin	*Turdus migratorius*	Uplands, Riparian, Agriculture
Hermit thrush	*Catharus guttatus*	Uplands
Swainson’s thrush	*Catharus ustulatus*	Uplands
Townsends solitaire	*Myadestes townsendi*	Uplands
Western blue bird	*Sialia mexicana*	Uplands, Agriculture
Mountain bluebird	*Sialia currucoides*	Uplands
Northern mockingbird	*Mimus polyglottos*	Uplands, Agriculture
Sage thrasher	*Oreoscoptes montanus*	Uplands
European starling	*Sturnus vulgaris*	Agriculture, Riparian
American pipit	*Anthus rubescens*	Uplands, Agriculture

Common Name	Scientific Name	Habitat
Cedar waxwing	*Bombycilla cedrorum*	Uplands, Agriculture
Bohemian waxwing	*Bombycilla garrulous*	Uplands, Agriculture
Phainopepla	*Phainopepla nitens*	Uplands, Agriculture
Brown-headed cowbird	*Molothrus ater*	Uplands, Agriculture
Brewer's blackbird	*Euphagus cyanocephalus*	Uplands, Agriculture
Yellow-headed blackbird	*Xanthocehalus xanthocephalus*	Wetlands, Riparian
Red-winged blackbird	*Agelaius phoeniceus*	Wetlands, Riparian
Tricolor blackbird	*Agelaius tricolor*	Wetlands, Riparian
Great-tailed grackle	*Quiscalus mexicanus*	Uplands, Agriculture
Bullock's oriole	*Icterus bullockii*	Uplands, Riparian, Agriculture
Western meadowlark	*Sturnella neglecta*	Uplands, Agriculture
House finch	*Carpodacus mexicanus*	Uplands, Riparian, Agriculture
Cassin's finch	*Carpodacus cassinii*	Uplands, Riparian, Agriculture
Pine siskin	*Carduelis pinus*	Uplands, Riparian, Agriculture
Lesser goldfinch	*Carduelis psaltria*	Uplands, Riparian, Agriculture
American goldfinch	*Carduelis tristis*	Uplands, Riparian, Agriculture
Mammals		
Broad-footed mole	*Scapanus latimanus*	Uplands
Merriam's shrew	*Sorex merriami*	Wetland, Agriculture
Vagrant shrew	*Sorex vagrans*	Wetland, Agriculture
Northern water shrew	*Sorex palustris*	Wetland, Agriculture
Little brown myotis	*Myotis lucifugus*	Uplands, Riparian, Wetland
Small-footed myotis	*Myotis ciliolabrum*	Uplands, Riparian, Wetland
Long-legged myotis	*Myotis volans*	Uplands, Riparian, Wetland
Long-eared myotis	*Myotis evotis*	Uplands, Riparian, Wetland
Fringed myotis	*Myotis thysanodes*	Uplands, Riparian, Wetland
California myotis	*Myotis californicus*	Uplands, Riparian, Wetland
Yuma myotis	*Myotis yumanensis*	Uplands, Riparian, Wetland
Silver-haired bat	*Lasionycteris noctivagans*	Uplands, Riparian, Wetland
Western pipistrel	*Pipistrellus hesperus*	Uplands, Riparian, Wetland
Big brown bat	*Eptesicus fuscus*	Uplands, Riparian, Wetland
Red bat	*Lasiurus blossevillii*	Uplands, Riparian, Wetland
Hoary bat	*Lasiurus cinereus*	Uplands, Riparian, Wetland
Spotted bat	*Euderma maculatum*	Uplands, Riparian, Wetland

Common Name	Scientific Name	Habitat
Townsend's big-eared bat	*Plecotus townsendii*	Uplands, Riparian, Wetland
Pallid bat	*Antrozous pallidus*	Uplands, Riparian, Wetland
Brazilian freetail bat	*Tadarida brasiliensis*	Uplands, Riparian, Wetland
Black bear	*Ursus americanus*	Uplands
Raccoon	*Procyon lotor*	Uplands, Riparian, Wetland
Short-tailed weasel	*Mustela ermine*	Riparian, Agriculture
Long-tailed weasel	*Mustela frenata*	Riparian, Agriculture
Mink	*Mustela vison*	Riparian
River otter	*Lutra canadensis*	Riparian
Western spotted skunk	*Spilogale gracilis*	Riparian, Agriculture
Striped skunk	*Mephitis mephitis*	Riparian, Agriculture
American badger	*Taxidea taxus*	Uplands, Agriculture
Ringtail	*Bassariscus astutus*	Riparian, Uplands
Kit fox	*Vulpes macrotis*	Uplands
Coyote	*Canis latrans*	Uplands, Agriculture
Cougar	*Felis concolor*	Uplands, Agriculture
Bobcat	*Lynx rufus*	Uplands, Agriculture
American pika	*Ochotona priceps*	Uplands
Pygmy rabbit	*Brachlagus idahoensis*	Uplands
Mountain cottontail	*Sylvilagus nuttallii*	Uplands
White-tailed jackrabbit	*Lepus townsendii*	Uplands
Black-tailed jackrabbit	*Lepus californicus*	Uplands, Agriculture
Least chipmunk	*Tamias minimus*	Uplands
Yellow-bellied marmot	*Marmota flaviventris*	Uplands
California ground squirrel	*Spermophilus beecheyi*	Uplands, Agriculture
White-tailed antelope ground squirrel	*Ammospermophilus leucurus*	Uplands
Golden mantled ground squirrel	*Spermophilus lateralis*	Uplands
Townsend's ground squirrel	*Spermophilus townsendii*	Uplands
Douglas's squirrel	*Tamiasciurus douglasii*	Uplands
Pocket mice species	*Perognathus* sp.	Uplands, Agriculture
Kangaroo rat species	*Dipodomys* sp.	Uplands
Dark kangaroo mouse	*Microdipodops megacephalus*	Uplands
Pinyon mouse	*Peromyscus truei*	Uplands

Common Name	Scientific Name	Habitat
Deer mouse	*Peromyscus maniculatus*	Agriculture, Uplands, Riparian
Western harvest mouse	*Reithrodontomys megalotis*	Wetland, Uplands, Agriculture
Northern grasshopper mouse	*Onychomys leucogaster*	Uplands
Desert woodrat	*Neotoma lepida*	Uplands
Montane vole	*Microtus montanus*	Wetland, Uplands
Long-tailed vole	*Microtus longicaudus*	Uplands
Muskrat	*Ondatra zibethicus*	Uplands
Norway rat	*Rattus norvegicus*	Agriculture, Riparian
House mouse	*Mus musculus*	Agriculture
Northern pocket gopher	*Thomomys talpoides*	Uplands, Agriculture
Botta's pocket gopher	*Thomomys bottae*	Uplands
Bighorn sheep	*Ovis canadensis*	Uplands
Mule deer	*Odocoileus hemionus*	Uplands
Pronghorn	*Antilocapra americana*	Uplands

The Walker River Basin supports many habitat types. For this Revised DEIS, six general habitat types are described: lacustrine, riverine, riparian woodland, wetlands, uplands, and agricultural lands.

These six habitat types are used by wildlife species to varying degrees. The number of wildlife species occurring in the Walker River Basin is extensive because of the large area and the variety of habitats encompassed by the basin. Some wildlife species are associated with one specific habitat type, while others may use a variety of different habitats. Some wildlife species use specific habitats seasonally, such as migratory birds and migrating deer, and other wildlife species are year-round residents of specific habitats.

Federal and state agencies own and manage much of the wildlife habitat throughout the Walker River Basin. While federal agencies are responsible for managing the wildlife habitat on public land, NDOW manages the wildlife. NDOW is charged with restoring and managing fish and wildlife resources on all public lands throughout the state with the exception of tribal lands and lands withdrawn for military operations. The Nevada Department of Conservation and Natural Resources maintains the Nevada Natural Heritage Program NNHP, which contains information on locations, biology, and conservation status of all endangered, threatened, sensitive, and at-risk species in Nevada (2008).

Table 6-1 lists the wildlife species that either have been observed or are expected to occur in the study area, along with associated habitats. Identification of these species was based on information provided by NNHP (2008), USFWS (2007, 2008), NDOW (2004, 2008 and 2009 and personal communications), Wildlife Action Plan (2006), Nevada Audubon (2008), amphibiaweb.org (2008), natureserve.org (2008), *Western Reptiles and Amphibians* (Stebbins 2003), *Sibley Guide to Birds* (Sibley 2000), *Birds of the Great Basin* (Ryser 1985), *The Mammals of North America* (Hall 1981), *Mammals of California* (Jameson and Peeters 2004), and Elmer Bull (pers.comm.).

Habitats

Lacustrine

Lacustrine habitats are associated with open waters. In the study area, these are defined as lakes and reservoirs. Lacustrine habitats in the study area are important to wildlife species, especially water birds, because there is relatively little freshwater habitat in the Great Basin (Ryser 1985). The water environments in lacustrine habitats include the shallow areas close to shore and the deeper mid-lake areas. The physical characteristics of these environments are not static and change daily, seasonally, and annually.

Walker Lake

Walker Lake is at the terminus of the Walker River. Walker Lake is an important water source for a number of wildlife species, especially water birds. The Lahontan tui chub is presently the most abundant fish species in the lake. Lahontan tui chub is a food source for the lake's LCT and migratory fish-eating species such as the common loon and white pelican (Wildlife Action Plan Team 2006).

Walker Lake is an important stopover for many birds on their migration routes. During periods of migration, Walker Lake has the highest number of waterfowl in the state of Nevada and its importance to waterfowl has been increasing as the lake recedes. Submerged bed of widgeon grass, which provide foraging habitat for waterfowl has increased as lake levels have dropped (Saake pers. comm.). The use of Walker Lake by migratory birds changes seasonally. In the spring, shorebirds, waterfowl, and other water birds stop at Walker Lake for food and rest during their northward migration. In the summer, Walker Lake is used by resident birds. During the fall, migratory birds use Walker Lake for food and rest during their southward migration. Significant numbers of waterfowl, such as ducks and coots, may remain at Walker Lake in the winter. Very little waterfowl nesting occurs on Walker Lake because of the lack of suitable nesting habitat around the lake's edge (Bull pers. comm.).

A freshwater marsh at the southern end of Walker Lake provides important habitat for many bird species. This freshwater marsh is fed by springs that flow into the lake. The dominant vegetation of the marsh is cottonwoods and cattails (Espinoza and Tracy 1999). This freshwater marsh provides important habitat for wildlife species, especially as feeding grounds for wading birds and shorebirds.

The shoreline of Walker Lake provides important foraging ground for bird species that feed on aquatic macroinvertebrates such as white-faced ibis, western snowy plover, and American avocet. Western snowy plover are also known to nest on the dry lakebed east of Walker Lake (Stockwell 1999).

Weber Reservoir

Reservoirs are similar to lakes in that they are predominantly aquatic habitats with varying extent and composition of shoreline vegetation. However, unlike natural lake elevations that fluctuate because of external environmental and climatic conditions, reservoir elevations fluctuate because of human controls in addition to environmental and climatic conditions. Discharge from reservoirs is regulated and controlled to accommodate downstream water requirements and reservoir holding capacities.

Weber Reservoir is the farthest downstream reservoir on Walker River before Walker Lake. Shorebirds and migrating waterfowl are common at the reservoir.

Riverine

The riverine system in the Walker River Basin provides important habitat value for wildlife species. The rivers, creeks, and associated wetlands provide habitat for aquatic invertebrates, fish, and amphibian species that are food sources for many wildlife species. Riparian and marsh habitats provide important nesting and foraging habitat for many species of birds and the understory of riparian habitat is used by mammals and reptiles. Refer to Chapter 4, Biological Resources—Vegetation and Wetlands, for a complete description of riparian woodland and marsh habitats.

West Walker River

The headwater of the West Walker River originates in the Sierra Nevada in California, just south of Sonora Pass. In Nevada, the West Walker River flows through Smith Valley, Wilson Canyon, and Mason Valley. In the vicinity of the California/Nevada border, the uplands adjacent to the West Walker River are predominantly big sagebrush shrubland, xeric mixed sagebrush shrubland, and agriculture. Along the river is riparian vegetation and emergent marsh, with patches of greasewood flat, semi-desert grassland, and forbland outside the riparian border. Small inclusions of mixed salt desert scrub and pinyon-juniper woodland are also present. Areas of montane sagebrush steppe are scattered in this region. At the south end of Smith Valley, foothills support pinyon-juniper woodland, xeric mixed sagebrush shrubland, semi-desert shrub steppe, and Sierra and basin cliff and canyon. Between Smith Valley and Mason Valley, the West Walker River supports riparian vegetation, with mostly mixed salt desert scrub outside of the riparian corridor. Near the confluence with the East Walker River, the West Walker River supports a mix of riparian, big sagebrush shrubland, and greasewood flat.

East Walker River

The headwaters of the East Walker River originate in the Sierra Nevada in California, west of the town of Bridgeport. Where the East Walker River crosses into Nevada, it enters the Pine Grove Hills and flows though canyons and more open valleys before entering Mason Valley, where it merges with the West Walker River. In Nevada, the East Walker River flows through open sagebrush and irrigated agricultural lands. High desert riparian woodlands occur along the banks of the river for much of its stretch in Nevada.

Mainstem Walker River

The mainstem Walker River flows from the convergence of the West Walker River and the East Walker River through the Mason Valley to Walker Lake. At the confluence of the East and West Walker Rivers, the mainstem Walker River area is heavily agricultural with vegetation along the river similar to that described for the West Walker River upstream of the confluence. Between the Wabuska gage and Weber Reservoir, the Walker River supports a broad riparian corridor that provides important habitat for migrating birds and mammals. Downstream of Weber Reservoir, a riparian corridor persists for several miles along the Walker River. The delta region of the Walker River where it flows into Walker Lake is primarily mixed salt desert scrub and greasewood flat, with emergent marsh within the river channel. There are areas of invasive tamarisk and semi-desert grassland.

Uplands

Most of the area in the Walker River Basin is upland habitat. Upland habitats in the basin include sagebrush, pinyon-juniper forest, upland conifer forest, and subalpine habitats at the highest elevations. Refer to Chapter 4, Biological Resources—Vegetation and Wetlands, for a complete description of these upland habitats.

Upland habitats near Walker Lake support amphibian and reptile species. Western toad and Great Basin spadefoot occur along the southwest shore of the lake (Espinoza and Tracy 1999). Reptiles that occur close to Walker Lake include side-blotched lizard, zebra-tailed lizard, Great Basin collared lizard, western whiptail, desert horned lizard, long-nosed leopard, and common kingsnake (Stebbins 2003, Espinoza and Tracy 1999).

The predominant habitat in Smith Valley is sagebrush scrub and agricultural fields. In Mason Valley, habitats include mixed desert scrub, greasewood flat, semi-desert grassland, playa, scattered dunes, and agricultural fields.

Sagebrush occurs over large areas in the Smith Valley and provides habitat for many reptiles, birds, and mammals. Sagebrush lizard, Great Basin collared lizard, Great Basin gopher snake, common kingsnake, and western rattlesnake are common reptile species found in sagebrush habitats. Many species of passerine birds and small mammals occur in sagebrush habitat. Large mammals that inhabit sagebrush include mule deer, mountain lion, kit fox, and coyote. The pygmy rabbit occurs in sagebrush habitats throughout most of the Great Basin. Pygmy rabbit is usually found in areas with large dense stands of big sagebrush and deep friable soils. Rabbitbrush also can be an important component in areas where pygmy rabbit occurs (Ulmschneider 2004). The greater sage grouse is currently under status review by USFWS to determine if the species should be listed as threatened or endangered. Sagebrush habitats provide nesting, brooding, fall/winter cover, and forage for greater sage grouse throughout the year (Nevada Department of Wildlife 2004).

Pinyon-juniper woodlands are common in the mid-elevation areas (6,000 to 9,000 feet) and adjoin many other habitat types, such as sagebrush at lower elevations and eastside pine and Jeffery pine at higher elevations. Common wildlife species that occur in pinyon-juniper woodlands include juniper titmouse, pinyon jay, ferruginous hawk, pinyon mouse, and mule deer (Wildlife Action Plan Team 2006).

Coniferous forests and subalpine habitats dominate the higher elevation of the study area. Coniferous forests provide habitat for many bird and mammal species, including white-headed woodpecker, pygmy nuthatch, American marten, golden-mantled ground squirrel, and black bear (Wildlife Action Plan Team 2006).

Cliffs and canyons include barren and sparsely vegetated areas (less than 10% plant cover) of steep cliff faces, narrow canyons, and smaller rock outcrops. Bighorn sheep and American pika are mammals that are adapted to the rocky habitats. Golden eagle and prairie falcon use cliff areas for nesting (Wildlife Action Plan Team 2006).

In the northernmost portion of the upland habitat, across the highway from the Homestretch Geothermal plant, are created wetlands. These wetlands support a variety of waterfowl, shorebirds and passerine birds, including mallard, northern pintail, northern shoveler, cinnamon teal, greenwing teal, gadwall, ring-necked duck, Canada geese, American avocet, black-necked stilt, white-faced ibis cattle egret, great egret, yellow-headed blackbird, red-winged blackbird, marsh wren, American coot and American white pelican (Bull pers. comm. October 2009). There is also a private wetland and waterfowl hunting club located west of US 95.

Agricultural Lands

Much of the native habitats in the Mason and Smith Valleys began to be converted to agriculture starting in the mid 1800s. Before the land in these valleys was irrigated, only a small fraction of these valleys supported riparian and wetland habitat. Irrigation in the Walker River Basin has allowed the expansion of riparian and wetland habitat in Mason and Smith Valleys, although these habitats still make up only a small fraction of these valleys.

Irrigated agricultural lands, such as alfalfa and grain fields, provide foraging habitat for a number of wading birds, such as egret, heron, and white-faced ibis, and waterfowl, such as resident and migratory geese and ducks. Additionally, many upland species such as quail, mourning dove, pheasant, turkey, mule deer, and many species of small mammals have adapted to and commonly use agricultural lands. Agricultural lands also provide important foraging habitat for snakes, raptors, and owls that feed on small mammals and small birds.

Canals and drains transport water to and from agricultural fields. The water elevation in these canals and drains varies greatly during irrigation season. Riparian vegetation can become established on their banks and wetland vegetation can become established in the beds of the canals and drains, although this vegetation may be cleared periodically for maintenance.

Wildlife Management Areas

The State of Nevada, through NDOW, owns or has long-term leases on more than 117,000 acres of land incorporated into WMAs across the state, including two in the study area. In accordance with Nevada Revised Statutes (NRS) 501.105, the Board of Wildlife Commission is responsible for establishing policies and adopting regulations necessary to the preservation, protection, management, and restoration of wildlife and its habitat. The Board of Wildlife Commission has established that the primary objective of the management and use of Alkali Lake and Mason Valley WMAs is directed toward wetland development and waterfowl activities, including the use of these WMAs as public shooting grounds, with all other uses being secondary. Because hunters and anglers benefit fish and wildlife by funding most of the WMA programs in the State of Nevada, the hunting and fishing public will continue to have priority standing in establishing the direction for future management and use of all WMA system properties (Nevada Department of Wildlife 2009).

Alkali Lake Wildlife Management Area

The Alkali Lake WMA is located at the north end of Smith Valley and is managed by NDOW. The WMA encompasses 3,447 acres, of which at least 3,000 acres form a playa lake. The remaining area is upland habitat. The Alkali Lake WMA was once a significant resource when agricultural tailwater from the surrounding fields and meadows and mountain runoff were major sources of water. Alkali Lake WMA once provided foraging and nesting habitat for shore birds and foraging habitat for wading birds and waterfowl. Now these water sources have dwindled as a result of 20 years of mostly dry water years, reduced snowmelt from the Pine Nut Mountains, and reduced agricultural tailwater caused by changing agricultural practices (such as laser-leveling; sprinkler, rather than flood, irrigation; and other water conservation measures). The Alkali Lake WMA has only minor water rights from springs in the Pine Nut Mountains and relies almost solely on drain and return flows. In dry years, the lake is typically dry by the end of the summer (Bull pers. comm.).

When water is present in Alkali Lake, the playa lake provides wetland habitat and foraging habitat for shorebirds, wading birds, and waterfowl. When wet, the lake provides good hunting opportunities for ducks and geese (Bull pers. comm.).

Mason Valley Wildlife Management Area

Mason Valley WMA is located in Mason Valley and is managed by NDOW. It is 13,375 acres in size and encompasses wetland, alkali desert scrub, riparian woodland, agricultural lands, and open-water habitats. The Mason Valley WMA was originally purchased to preserve habitat for waterfowl, although the WMA also provides habitat for wading birds, shorebirds, passerine birds, and raptors. Twelve species of ducks have been recorded breeding in the WMA as well as eared grebe, pied-billed grebe, Forster’s tern, short-eared owl, Cooper’s hawk, American kestrel, Swainson’s hawk, northern harrier, and osprey (Bull pers. comm.). Other bird species that are common include gull, blue heron, white-faced ibis, Wilson’s phalarope, red-necked phalarope, western/least sandpiper, long-billed curlew, spotted sandpiper, willet, American avocet, black-necked stilt, and killdeer.

Approximately 1,200 acres of the WMA are cooperatively farmed to enhance and increase wildlife habitat by growing grain and hay crops. The agricultural practices on the Mason Valley WMA are different from commercial farms in that the crops are selected for the benefit of wildlife, and they are harvested to maximize the benefit for wildlife species. Large numbers of migratory geese, and to a lesser extent, migratory ducks, feed extensively in the agricultural fields during the winter months (Bull pers. comm.). Upland, agricultural, and riparian habitats are used by species such as California quail, ring-necked pheasant, wild turkey, mule deer, black-tailed jackrabbit, bobcat, coyote, long-tailed weasel, badger, and occasionally mountain lion.

The Mason Valley WMA receives most of its water from the Walker River. Other water sources are numerous wells that draw on groundwater supplies, drainwater from the Mason Valley Fish Hatchery, secondary-treated effluent from the City of Yerington Wastewater Treatment Plant, and cooling pond water that is piped from the adjacent Sierra Pacific Power Company (now NV Energy) power plant. The Mason Valley WMA has good populations of large-mouth bass, bullhead and channel catfish, trout, and bluegill, which provide opportunities for sport fishing (Bull pers. comm.).

Wildlife Corridor

Nevada lies within the Pacific Flyway, the primary seasonal movement corridor for birds migrating west of the Rocky Mountains. This flyway adds significantly to the diversity of bird species in Nevada. Wetlands, lakes, rivers, riparian forests, and agricultural fields provide resting and foraging opportunities for migrating birds.

Special-Status Wildlife Species

Special-Status Species Known to Occur in the Study Area

Based on the search of the NNHP database (2008), CNDDB (2008), and USFWS list for the project region (2007), 30 special-status wildlife species were identified as having potential to occur in the study area (fish species are addressed in Chapter 5, Biological Resources—Fish). Mountain yellow-legged frog, Yosemite toad, yellow-billed cuckoo, fisher, Sierra Nevada red fox, and Sierra Nevada bighorn sheep were considered for analysis based on information from USFWS, but were eliminated from further review for the following reasons.

- Mountain yellow-legged frogs are thought to be extirpated in Nevada and if they do occur, occur only in high mountain streams that will not be affected by the acquisition alternatives (Wildlife Action Team Plan 2006).
- Yosemite toads do not occur in Nevada (Stebbins 2003).
- Yellow-billed cuckoo have never been recorded along the Walker River (Neel pers. comm.).
- Fisher do not occur in the study area in Nevada (Hall 1981).
- Sierra Nevada red fox do not occur in the study area in Nevada (Wildlife Action Team Plan 2006).
- Sierra Nevada bighorn sheep do not occur in the study area in Nevada (U.S Fish and Wildlife Service 2008).

Five special-status wildlife species have been recorded as occurring in or adjacent to the study area and could be affected by the acquisition alternatives if present. These species are the common loon, American white pelican, bald eagle, white-faced ibis, and western snowy plover (Nevada Natural Heritage Program 2008). No program-specific surveys for special-status wildlife species were conducted for the DEIS analysis. However, NDOW has conducted spring and fall surveys for waterfowl (including at least three special-status species) at Walker Lake since

1988, and USFWS has conducted aerial surveys of Walker Lake to count waterfowl and pelicans for the past few years.

Bald Eagle

Bald eagles, except for those that occur in the Sonora Desert in central Arizona, have been removed from protection under the Endangered Species Act. However, they are still protected under the Bald Eagle and Golden Eagle Protection Act and are listed as a protected species under the Migratory Bird Treaty Act (MBTA). Bald eagles nest in large trees and on cliffs, often near large water bodies. Winter roosts commonly are large trees and other sheltered sites. They feed primarily on fish but will prey on injured waterfowl, various small mammals, and carrion. Few nests sites have been recorded in northern Nevada and winter numbers are low across the state (Wildlife Action Team Plan 2006). Bald eagles are not known to nest around Walker Lake, although the fishery of Walker Lake and agricultural lands in Mason Valley may provide important hunting grounds for bald eagles.

Common Loon

The common loon is listed as a protected species under the MBTA. Common loons are large birds that breed in freshwater lakes located in the boreal and mixed conifer forests across North America. Their winter ranges include the coastal waters along California and Baja California in the Pacific and the coastal waters of Virginia, the Carolinas, and the North Gulf Coast of Florida. In the west, most common loons migrate along the Pacific coast, although a significant number migrate through western Nevada (Mcintyre and Barr 1997). Walker Lake is an important stopover for the interior western continental migrants (Wildlife Action Team Plan 2006). Over 1,400 common loons have been observed at Walker Lake during their spring migration (Evers 2004). However, recent surveys have documented a significant decrease in loon numbers on Walker Lake. Fall survey counts between 2002 and 2005 averaged 262 loons and spring survey counts between 2003 and 2007 averaged 285 loons. A total of 179 loons were counted during the fall survey in 2008 (Jeffers pers. comm. January 2009). The 2009 spring survey counted 150 loons; 127 loons were counted in the 2009 fall survey (Jeffers pers. comm. December 2009).

American White Pelican

The American white pelican is listed as a protected species under the MBTA. American white pelicans occur mainly along the western and southern portions of North America. White pelicans breed on isolated islands in inland lakes and winter along the southern coasts. American white pelicans feed on a variety of fish that generally are captured in shallow areas of marshes or along the shorelines of deeper lakes (Knopf and Evans 2004). American white pelicans are not known to breed on Walker Lake, although Walker Lake is used for feeding, especially when the tui chub spawn (Bull pers. comm.).

White-Faced Ibis

The white-faced ibis is listed as a protected species under the MBTA. White-faced ibis inhabits freshwater wetlands, especially cattail and bulrush marshes, although it feeds primarily in flooded hay meadows, agricultural fields, and estuarine wetlands (Ryder and Manry 1994). White-faced ibis is known to breed in the Mason Valley WMA (Bull pers. comm.).

Western Snowy Plover

Western snowy plover is listed as a protected species under the MBTA. Western snowy plover occurs on dry mud or salt flats and on the sandy shores of rivers and lakes. It nests on the ground of dry mud or salt flats where vegetation is sparse or absent. Snowy plover feeds on insects and other invertebrates that are picked or probed from the substrate (Wildlife Action Team Plan 2006). Western snowy plover has been known to nest at the Alkali Lake WMA (Nevada Natural Heritage Program 2008) and on dry lake beds just to the east of Walker Lake (Stockwell 1999).

Special-Status Wildlife with Potential to Occur in the Study Area

The ranges of two special-status wildlife species, greater sage grouse and pygmy rabbit, occur within the study area. These species could be affected by the acquisition alternatives if suitable habitat exists. No program-specific surveys have been conducted for these wildlife species.

Greater Sage Grouse

The Mono Basin population of greater sage grouse, including those that occur in Lyon, Mineral, and Douglas Counties, Nevada and Mono County, California, is currently under status review by USFWS to determine if the species should be listed as threatened or endangered. Sage grouse is a sagebrush-obligate species, although wet meadow habitats located adjacent to or near sagebrush are also an important habitat component during certain seasons (Nevada Department of Wildlife 2004, Neel 1999). Sage grouse chicks rely heavily on insects for their diet (Nevada Department of Wildlife 2004) as well as asters, dandelion, and western yarrow seeds (Neel 1999). As sage grouse matures its ability to digest sagebrush leaves increases. Sagebrush leaves account for about 98% of an adult's diet. Hens typically nest under big sagebrush within 3.2 kilometers of active leks (a gathering of males for the purposes of competitive mating display) (Neel 1999). Sage grouse occurs throughout the northern two-thirds of Nevada in sagebrush-dominated vegetation communities. Sage grouse has potential to occur in the project area and the study area.

Pygmy Rabbit

USFWS is currently reviewing information to determine if populations of pygmy rabbits occurring outside of the State of Washington should be listed as threatened or endangered. The Columbia Basin distinct population in the state of Washington was listed as endangered by USFWS. Pygmy rabbit is generally found throughout the Great Basin in areas dominated by tall and dense big sagebrush. Other shrub species that may co-occur include bitterbrush, rabbitbrush, greasewood, and juniper. Another important aspect of suitable habitat is the presence of deep and friable soils (Ulmschneider 2004). The pygmy rabbit is the only rabbit species in the United States that digs its own burrows (Weiss and Verts 1984). Pygmy rabbit will use burrows abandoned by other species such as marmots and badgers (Hall 1981). In Nevada, pygmy rabbit is found in broad valley floors, drainage bottoms, alluvial fans, and other areas with friable soils (Ulmschneider 2004). Based on range maps (Wildlife Action Team Plan 2006, Hall 1981), the study area occurs within the pygmy rabbit range.

Environmental Consequences

This section describes the impact analysis relating to wildlife and their habitat for the acquisition alternatives and the No Action Alternative. It lists the criteria used to determine whether an impact would be adverse or beneficial.

Assessment Methods

The following assumptions were made for this analysis.

- Increases in water flow in Walker River would occur from the location of the furthest upstream water acquisition. However, the greatest percent increase in flows would occur downstream of Schurz and thus the greatest potential increase of riparian vegetation would occur downstream of Schurz.
- Shoreline wetlands at the south end of Walker Lake would be inundated by increased lake elevations. Dramatic inundation of wetlands can occur when heavy rains and snowmelt quickly raise the elevation of the lake. However, increases in lake elevations as a result of water acquisition would be gradual, although still subject to natural year-to-year variations in hydrologic conditions (Chapter 3, Water Resources).
- Full funding under Alternative 1 would add an average of 50,000 af/yr of water to Walker Lake. It is possible, however, that less than the average 50,000 af/yr would be provided. Funding of $56 million under Alternative 1 would add an average of 7,300 af/yr of water to Walker Lake.

- The actions of Alternative 2 would last only until the funding is exhausted. Assuming that sufficient water is leased to increase inflow to Walker Lake by an average 50,000 af/yr, funding of $56 million would last only 3 years, while full funding would provide the average 50,000 af/yr for an estimated 20 years.
- Under Alternative 2, lands would be fallowed or rotated, but would not be taken out of production.

Impact Criteria

Impacts on wildlife species or habitat would be considered adverse or beneficial, respectively, if implementation of the alternatives would:

- cause the loss or gain of individuals or populations of federally listed threatened or endangered species or their habitat, or species that are federally proposed for listing;
- cause the loss or gain of habitat that is sensitive or rare in the region, such as wetlands, riparian woodland, and surface water sources;
- cause substantial loss or gain of populations or habitat of a species that is
    - a federal candidate,
    - protected under NRS 501, or
    - regionally rare;
- cause loss, long-term disruption, or gain of wildlife nursery sites; or
- cause substantial loss or gain of diversity of species or natural communities and wildlife habitat.

Impacts

No Action Alternative

Current TDS concentrations in Walker Lake limit the survival of LCT and other fish species, such as tui chub. Under the No Action Alternative, the current volume of water would continue to be diverted from the river upstream of Walker Lake, and potential geothermal water would not be acquired. TDS concentration in Walker Lake would subsequently continue to rise (Chapter 3, Water Resources). This increase of TDS concentration would result in a decrease in the Walker Lake fishery (Chapter 5, Biological Resources—Fish). Currently, Walker Lake provides important feeding grounds for migratory birds that feed on fish, such as special-status common loon and American white pelican. The collapse of the Walker Lake fishery would have an adverse impact on these bird species.

Beds of widgeon grass have increased as the TDS concentration in Walker Lake has increased. These beds of widgeon grass provide important foraging for waterfowl and coots (Saake pers. comm.). Widgeon grass generally grows in waters with TDS concentrations ranging from fresh water to 32,000 mg/L (Dineen 2001). By 2200, the projected TDS concentration in Walker Lake would be approximately 39,500 mg/L (Chapter 3, Water Resources), which is above the tolerance of widgeon grass. If TDS concentrations do increase to 39,500 mg/L, as projected, the widgeon grass would likely disappear from Walker Lake.

Another concern is the large blooms that occurred in Walker Lake in 2007 and 2008. Algal blooms could have detrimental effects on the lake's use by waterfowl. Projections of lower lake elevations combined with continued internal nutrient loading could result in increasing amounts of phosphorus to a decreasing volume of upper mixed-layer water. The algal blooms of 2007 and 2008 may, therefore, indicate the beginning stages in a hypereutrophic, positive feedback process that can detrimentally affect lakes (University of Nevada, Reno and Desert Research Institute 2009).

Alternative 1 (Purchase Alternative)

Acquisitions under Alternative 1 would add an average inflow of 50,000 af/yr to Walker Lake. It is possible, however, that less than the average 50,000 af/year would be provided to the lake either because of funding issues or because there would not be enough willing sellers. With funding of $56 million, it is estimated that the annual average inflow to the lake would increase by only 7,300 af/yr.

This analysis of impacts under Alternative 1 assumes that the Purchase Alternative would be fully funded and that acquisitions would increase the average annual inflow to the lake by 50,000 af/yr. Unless otherwise noted, if an average 50,000 af/yr were not acquired, the impacts would be similar in nature (i.e., adverse, minor, beneficial, or no impact) but of less magnitude.

Direct Impacts

No direct impact on wildlife species is anticipated as a result of the Purchase Alternative.

Indirect Impacts

Impact WILD-1: Loss of Foraging Habitat for Wildlife Species as a Result of Fallowing, Field Rotation, or Retirement of Agricultural Lands (Adverse Impact)
Under Alternative 1, acquisitions would reduce the amount of water available for agriculture. If the water supply is removed from the land, agricultural production could cease, or the land could be converted to uses other than agriculture (Chapter 7, Land Use and Agriculture, Table 7-10). Agricultural lands, especially alfalfa and grain crops, provide diverse foraging habitat for wading birds, waterfowl, and upland bird species, as well as small and large mammal species that occur in the study area.

Up to a third of agricultural land in Mason and Smith Valleys and the east Walker River could be retired or converted to other uses, as indicated in Chapter 7, Land Use and Agriculture (Table 7-10). This would make them less productive for foraging for wildlife. Retiring or converting agricultural lands to other uses would reduce the amount of foraging habitat available to wildlife species that rely on agricultural lands, and thus could substantially reduce their numbers in the study area.

Impact WILD-2: Loss of Bird Nests along the Shore of Walker Lake Caused by Increased Lake Surface Elevation (No Impact)

Many species of shorebirds forage along the shoreline of Walker Lake, and some species, including killdeer and spotted sandpiper, may nest along the shoreline of the lake. Additionally, many species forage and a few may nest in wetland habitat at the lake edge. Under Alternative 1, acquisitions would increase flows to Walker Lake. An additional 50,000 af/yr of water could reach Walker Lake and raise the lake elevation. The increase in the lake elevation could inundate the shoreline and wetland habitat at the lake's southern end. If this were to occur suddenly, nests along the lake's edge would be flooded and lost. However, it is anticipated that the lake elevations would rise slowly as a result of redirection of water to Walker Lake. This would allow birds to adjust the location of their nests yearly along the lake's edge as the lake elevation increases. The rising elevation of Walker Lake is not expected to affect nesting birds.

Impact WILD-3: Loss of Bird Nests in Wetlands at the Southern End of Walker Lake Caused by Increased Lake Surface Elevation (Minor Impact)

Many bird species forage and a few may nest in wetland habitat at the southern end of Walker Lake. Under Alternative 1, acquisitions would increase flows to Walker Lake. An additional 50,000 af/yr of water could reach Walker Lake and raise the lake elevation. The increase in the lake elevation would partially inundate the wetland habitat at the lake's southern end. Partially inundating these wetlands would result in some loss of nesting habitat for birds. However, this loss would be offset by increases in wetlands where Walker River enters the north end of the lake. Therefore this impact would be minor.

With funding of $56 million, an average increase in flow of 7,300 af/yr is expected. This increase in flow is not expected to substantially raise the surface elevation of the lake in the long term. The wetlands at the southern end of the lake would be inundated to some degree, but not to the extent as under an average inflow of 50,000 af/year. This impact would be minor.

Impact WILD-4: Impacts on Bird Species That Feed on Fish in Walker Lake (Beneficial Impact under Full Funding; No Impact under Funding of $56 Million)

Walker Lake is an important stopover for migrating, fish-eating bird species, including double-crested cormorant, eared grebe, and Clark's grebe, as well as special-status species bald eagle, common loon, and American white pelican that feed on the fish in Walker Lake. Under Alternative 1, an average of 50,000 af/yr of additional water could be delivered to Walker Lake. If 50,000 af/yr reach Walker Lake, TDS concentration is expected to decrease to a level that would be beneficial for LCT and tui chub. Decreased TDS concentration would enhance Walker Lake fish populations, which in turn would benefit bird species that feed on fish at Walker Lake.

With funding of $56 million, an average increase in flows of 7,300 af/yr is expected. It is estimated that 7,300 af/yr would not be sufficient to stop the decrease in lake elevation. Projected TDS concentration would be approximately 39,500 mg/L in 2200 (Chapter 3, Water Resources). The impacts on bird species that feed on these fish would be the same as for the No Action Alternative.

Impact WILD-5: Increased Habitat for Wildlife Species Using Riparian and Wetland Habitat along the Mainstem Walker River Downstream of Schurz as a Result of Increased Flow (Beneficial Impact)

Under Alternative 1, increased flows to Walker Lake would be delivered via the mainstem Walker River. Although flows would increase beginning at the highest upstream acquisitions, with flows at various locations being dependent on the location of the acquisitions, the percent flow increase would be greatest below Schurz, where existing summer flows can be zero. Much of the mainstem Walker River is bordered by shrublands and agricultural land, with emergent marsh along the river channel.

In the river reach downstream of Schurz, increased inflow to Walker Lake would help establish and sustain riparian and wetland vegetation. The increased inflow would contribute to an increase in riparian and wetland communities and an increase in natural community diversity. Increased riparian and wetland habitat in the study area would be beneficial to wildlife species that rely on or use these habitats.

However, in areas where cattle grazing occurs near the Walker River, grazing could negatively affect the amount of new vegetation and reduce the benefits to wildlife species.

Impact WILD-6: Impacts on Wildlife Species as a Result of the Loss of Riparian and Wetland Habitat Associated with Irrigation Canals and Drains Caused by Decreased Flow (Minor Impact)

Acquisition of water rights from irrigated agricultural land could result in the reduction of flows in associated irrigation canals and drains. This could cause the loss of riparian and wetland habitat that relies on this water supply. Riparian and wetland habitats provide important foraging and nesting for many wildlife species in the Walker River Basin. The riparian habitat supported by irrigation features generally has lower habitat value in comparison to riparian communities along natural streams because it is narrow and patchy. Additionally, regular maintenance (i.e., burning or cutting vegetation) has further degraded the riparian or wetland habitat along the canals and drains (Langsdorf pers. comm.).

Therefore, the Purchase Alternative would have only a minor impact on riparian or wetland habitat associated with irrigation features and would therefore have a minor impact on wildlife species that are associated with these habitats along irrigation canals and drains.

Impact WILD-7: Loss of Foraging Habitat for Shorebirds and Wading Birds at Alkali Lake WMA as a Result of Acquisitions in Smith Valley (Adverse Impact)
Foraging and nesting habitat for wading birds, shore birds, and waterfowl Alkali Lake WMA has been severely affected by decreased water flows into Alkali Lake. These decreased flows are a result of water conservation activities on farms upstream from the WMA, a decrease in tailwater reaching the lake, and a decline in recent years of annual precipitation in the mountains surrounding the WMA. If water were acquired from irrigated agricultural land adjacent to Alkali Lake WMA in Smith Valley it would result in the further reduction of agricultural tailwater that reaches Alkali Lake. This would be an adverse impact.

Impact WILD-8: Loss of Foraging Habitat for Waterfowl and Coots as Lake Elevation Increases at Walker Lake (Minor Impact)
Beds of submerged widgeon grass around the edges of Walker Lake have expanded as the surface elevation of Walker Lake has receded and TDS concentration in the lake has increased. Widgeon grass provides forage habitat for many species of waterfowl. It has been suggested that as the lake surface elevation increases under Alternative 1, the beds of submerged widgeon grass around the edge of Walker Lake would decrease, precipitating a decline in the foraging habitat for waterfowl and coots (Saake pers. comm.). However, it is anticipated that widgeon grass would continue to persist to along the lake edge, especially along the shallower eastern end of the lake, and foraging habitat for waterfowl and coots would remain because water conditions (i.e., salinity range and water depth) would remain suitable for widgeon grass (Dineen 2001). Foraging habitat for waterfowl and coots would also still be provided at the Mason Valley WMA. Therefore, this impact would be minor.

With funding of $56 million, an average increase in flow of 7,300 af/yr is expected. This level of inflow would not reverse the increase in TDS concentration in the lake and projected TDS concentration would be approximately 39,500 mg/L in 2200 (Chapter 3, Water Resources). Widgeon grass generally grows in waters with TDS concentration ranging from freshwater to 32,000 mg/L (Dineen 2001). By 2200, the projected TDS concentration in Walker Lake would be approximately 39,500 mg/L (Chapter 3, Water Resources), which is above the tolerance of widgeon grass. If TDS concentration does increase to 39,500 mg/L as projected, the widgeon grass would likely disappear from Walker Lake. This impact would be the same as under the No Action Alternative.

Impact WILD-9. Potential Creation of Habitat for Special-Status Pygmy Rabbit and Sage Grouse as a Result of Retiring of Agricultural Lands (Beneficial Impact)
Much of the native sagebrush habitat (which provides suitable habitat for special-status pygmy rabbit and sage grouse) in the Mason and Smith Valleys has been converted to agricultural lands. Under Alternative 1, agricultural acreage would be reduced as a result of land retirement (i.e., land taken out of agriculture) caused by acquisition of water. If land retirement occurs on parcels that adjoin native sagebrush habitat and the land converts back to sagebrush habitat, with restoration practices, this would increase the available habitat for pygmy rabbit and sage grouse. Although restoration would occur over a long period of time and it is uncertain whether the conditions would meet the habitat requirements of these species, the creation of this habitat would be a beneficial impact.

Alternative 2 (Leasing Alternative)

Because Alternative 2 requires recurring water leases, the actions of Alternative 2 would last only until the funding is exhausted. Assuming that sufficient water is leased to increase inflow to Walker Lake by an average 50,000 af/yr, the funding of $56 million would last 3 years, while full funding would last an estimated 20 years.

Direct Impacts

No direct impacts on wildlife species are anticipated as a result of Alternative 2.

Indirect Impacts

The following impacts would be the same as Alternative 1.

Impact WILD-2: Loss of Bird Nests along the Shore of Walker Lake Caused by Increased Lake Surface Elevation (No Impact)

Impact WILD-7: Loss of Foraging Habitat for Shorebirds and Wading Birds at Alkali Lake WMA as a Result of Water Acquisitions in Smith Valley (Adverse Impact)

The following impacts would be the same as Alternative 1 but temporary.

Impact WILD-1: Loss of Foraging Habitat for Wildlife Species as a Result of Fallowing, Field Rotation, or Retirement of Agricultural Lands (Adverse Impact)

Impact WILD-3: Loss of Bird Nests in Wetlands at the Southern End of Walker Lake Caused by Increased Lake Elevations (Minor Impact)

Impact WILD-5: Increased Habitat for Wildlife Species Using Riparian and Wetland Habitat along the Mainstem Walker River Downstream of Schurz as a Result of Increased Flow (Beneficial Impact)

Impact WILD-6: Impacts on Wildlife Species as a Result of the Loss of Riparian and Wetland Habitat Associated with Irrigation Canals and Drains Caused by Decreased Flow (Minor Impact)

The following impacts would be different than under Alternative 1.

Impact WILD-4: Impacts on Bird Species That Feed on Fish In Walker Lake (No Impact)
While an additional 50,000 af/yr of water flowing into Walker Lake would be beneficial, the benefits would be short-lived under Alternative 2. Once funding was exhausted, flows into Walker Lake would likely return to preprogram levels and TDS concentration would increase. Eventually, this would result in the same impacts as discussed for the No Action Alternative.

Impact WILD-8: Loss of Foraging Habitat for Waterfowl and Coots as Lake Elevation Increases at Walker Lake (No Impact)
While an additional 50,000 af/yr of water flowing into Walker Lake would be a minor impact, these impacts would be short-lived under Alternative 2. Once funding was exhausted, flow into Walker Lake would likely return to preprogram levels and TDS concentration would increase. Eventually, this would result in the same impacts as discussed for the No Action Alternative.

Impact WILD-9: Potential Creation of Habitat for Pygmy Rabbit and Greater Sage Grouse as a Result of Retiring Agricultural Land (No Impact)
Under Alternative 2, lands from which leases are acquired would not necessarily cease agricultural production. On parcels that are fallowed, the amount of time that leases could be in effect (1 to 3 years) would not be sufficient to allow for the establishment of native sagebrush habitats on lands that have been retired or converted from agriculture. There would be no impact.

Alternative 3 (Efficiency Alternative)

As discussed in Chapter 3, Water Resources, full implementation of Alternative 1 would provide an average of 50,000 af/yr to Walker Lake, but it is estimated that full implementation of Alternative 3 would yield only an additional average inflow of 32,300 af/yr. Unless otherwise noted below, the impacts of Alternative 3 would be similar in nature (both adverse and beneficial) to those of Alternative 1, but of less magnitude.

Direct Impacts

No direct impact on wildlife species is anticipated as a result of Alternative 3.

Indirect Impacts

The following impacts would not apply to Alternative 3.

Impact WILD-1: Loss of Foraging Habitat for Wildlife Species as a Result of Fallowing, Field Rotation, or Retirement of Agricultural Lands (No Impact)
Under Alternative 3, land under agricultural production would not be retired from agricultural use. Therefore, the foraging habitat for wildlife species would not be diminished, and there would be no impact on wildlife species.

The following impacts would be the same as Alternative 1.

Impact WILD-2: Loss of Bird Nests along the Shore of Walker Lake Caused by Increased Lake Surface Elevations (No Impact)

Impact WILD-3: Loss of Bird Nests in Wetlands at the Southern End of Walker Lake Caused by Increased Lake Surface Elevations (Minor Impact)

Impact WILD-6: Impacts on Wildlife Species as a Result of the Loss of Riparian and Wetland Habitat Associated with Irrigation Canals and Drains Caused by Decreased Flow (Minor Impact)

The following impacts would be the same as Alternative 1, but of less magnitude.

Impact WILD-4: Impacts on Bird Species That Feed on Fish In Walker Lake (Beneficial Impact)

Impact WILD-5: Increased Habitat for Wildlife Species Using Riparian and Wetland Habitat along the Mainstem Walker River Downstream of Schurz as a Result of Increased Flow (Beneficial Impact)

Impact WILD-7: Loss of Foraging Habitat for Shorebirds and Wading Birds at Alkali Lake WMA as a Result of Water Acquisitions in Smith Valley (Adverse Impact)

Impact WILD-8: Loss of Foraging Habitat for Waterfowl and Coots as Lake Level Increases at Walker Lake (Minor Impact)
Lake levels would not continue to decrease under this alternative. Lake levels are projected to rise 13 feet from 2007 levels by 2200. However, widgeon grass is expected to persist at higher lake levels because water conditions (i.e. salinity range and depth) will still be suitable (Dineen 2001).

The following impact would be different from Alternative 1.

Impact WILD-9: Potential Creation of Habitat for Pygmy Rabbit and Greater Sage Grouse as a Result of Retiring Agricultural Land (No Impact)
Under Alternative 3, lands would not necessarily cease agricultural production as efficiency measures are implemented. There would be no impact.